HITACHI
Inspire the Next

Hitachi Universal Storage Platform V
Hitachi Universal Storage Platform VM
User and Reference Guide

FastFind Links

Hitachi Data Systems

MK-96RD635-04

Contents

Preface

This document describes the physical, functional, and operational characteristics of the *Hitachi Universal Storage Platform V* (USP V) and *Hitachi Universal Storage Platform VM* (USP VM) storage systems and provides general instructions for operating the USP V and USP VM.

Please read this document carefully to understand how to use this product, and maintain a copy for reference purposes.

This preface includes the following information:

Notice: The use of the Hitachi Universal Storage Platform V and VM storage systems and all other Hitachi Data Systems products is governed by the terms of your agreement(s) with Hitachi Data Systems.

Safety and Environmental Notices

Federal Communications Commission (FCC) Statement

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

“EINE LEICHT ZUGÄNGLICHE TRENN-VORRICHTUNG, MIT EINER KONTAKT-ÖFFNUNGSWEITE VON MINDESTENS 3mm IST IN DER UNMITTELBAREN NÄHE DER VERBRAUCHERANLAGE ANZUORDNEN (4-POLIGE ABSCHALTUNG).”

Maschinenlärminformationsverordnung 3. GSGV, 18.01.1991: Der höchste Schalldruckpegel beträgt 70 db(A) oder weniger gemäß ISO 7779.

CLASS 1 LASER PRODUCT

WARNING: This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

WARNUNG: Dies ist ein Produkt der Klasse A. In nichtgewerblichen Umgebungen können von dem Gerät Funkstörungen ausgehen, zu deren Beseitigung vom Benutzer geeignete Maßnahmen zu ergreifen sind.

Intended Audience

This document is intended for system administrators, Hitachi Data Systems representatives, and authorized service providers who are involved in installing, configuring, and operating the Hitachi Universal Storage Platform V and/or Hitachi Universal Storage Platform VM storage systems.

This document assumes the following:

- The user has a background in data processing and understands RAID storage systems and their basic functions.
- The user is familiar with the host systems supported by the Hitachi Universal Storage Platform V/VM.
- The user is familiar with the equipment used to connect RAID storage systems to the supported host systems.

Product Version

This document revision applies to USP V/VM microcode 60-02-4*x* and higher.

Document Revision Level

Revision	Date	Description
MK-96RD635-P	February 2007	Preliminary Release
MK-96RD635-00	May 2007	Initial Release, supersedes and replaces MK-96RD635-P
MK-96RD635-01	June 2007	Revision 1, supersedes and replaces MK-96RD635-00
MK-96RD635-02	September 2007	Revision 2, supersedes and replaces MK-96RD635-01
MK-96RD635-03	November 2007	Revision 3, supersedes and replaces MK-96RD635-02
MK-96RD635-04	April 2008	Revision 4, supersedes and replaces MK-96RD635-03

Source Document(s) for this Revision

- *Exhibit M1, DKC610I Disk Subsystem, Hardware Specifications*, revision 13
- *Exhibit M1, DKC615I Disk Subsystem, Hardware Specifications*, revision 5
- *Public Mode for RAID600*, R600_Public_Mode_2008_0314.xls

Changes in this Revision

- Added the 400-GB disk drive (Specifications at a Glance, Hard Disk Drives).
- Updated the maximum usable capacity values (Specifications at a Glance).
- Added a table of specifications for the disk drives (new Table 2-3).
- Updated the list of public system option modes (Table 3-1).
  - Added the following new modes: 545, 685, 689, 690, 697, 701, 704.
  - Modified the description of mode 467 as follows:
    - Changed the default from OFF to ON.
    - Added Universal Volume Manager to the list of affected functions.
    - Added a caution about setting mode 467 ON when using external volumes as secondary copy volumes.
    - Added a note about copy processing time and the prioritization of host I/O performance.
  - Removed mode 198.

Document Organization

The following table provides an overview of the contents and organization of this document. Click the chapter title in the left column to go to that chapter. The first page of each chapter provides links to the sections in that chapter.

Chapter	Description
Product Overview	Provides an overview of the Universal Storage Platform V/VM, including features, benefits, general function, and connectivity descriptions.
Architecture and Components	Describes the Universal Storage Platform V/VM architecture and components.
Functional and Operational Characteristics	Discusses the functional and operational capabilities of the Universal Storage Platform V/VM.
Troubleshooting	Provides troubleshooting guidelines and customer support contact information for the Universal Storage Platform V/VM.
Units and Unit Conversions	Provides conversions for standard (U.S.) and metric units of measure associated with the Universal Storage Platform V/VM.
Acronyms and Abbreviations	Defines the acronyms and abbreviations used in this document.
Index	Lists the topics in this document in alphabetical order.

Referenced Documents

Hitachi Universal Storage Platform V/VM documentation:

- Table 1-3 lists the user documents for Storage Navigator-based software.
- Table 1-4 lists the user documents for host- and server-based software.
- Table 3-5 lists the configuration guides for host attachment.
- Other referenced USP V/VM documents:
  - *USP V Installation Planning Guide*, MK-97RD6668
  - *USP VM Installation Planning Guide*, MK-97RD6679

IBM® documentation:

- *Planning for IBM Remote Copy*, SG24-2595
- *DFSMSdfp Storage Administrator Reference*, SC28-4920
- *DFSMS MVS V1 Remote Copy Guide and Reference*, SC35-0169
- *OS/390 Advanced Copy Services*, SC35-0395
- *Storage Subsystem Library, 3990 Transaction Processing Facility Support RPQs*, GA32-0134
- *3990 Operations and Recovery Guide*, GA32-0253
- *Storage Subsystem Library, 3990 Storage Control Reference for Model 6*, GA32-0274

Document Conventions

The terms “Universal Storage Platform V” and “Universal Storage Platform VM” refer to all models of the Hitachi Universal Storage Platform V and VM storage systems, unless otherwise noted.

This document uses the following icons to draw attention to information:

Icon	Meaning	Description
	Note	Calls attention to important and/or additional information.
	Tip	Provides helpful information, guidelines, or suggestions for performing tasks more effectively.
	Caution	Warns the user of adverse conditions and/or consequences (e.g., disruptive operations).
	WARNING	Warns the user of severe conditions and/or consequences (e.g., destructive operations).
	DANGER	Dangers provide information about how to avoid physical injury to yourself and others.
	ELECTRIC SHOCK HAZARD!	Warns the user of electric shock hazard. Failure to take appropriate precautions (e.g., do not touch) could result in serious injury.
	ESD Sensitive	Warns the user that the hardware is sensitive to electrostatic discharge (ESD). Failure to take appropriate precautions (e.g., grounded wrist strap) could result in damage to the hardware.

Convention for Storage Capacity Values

Physical storage capacity values (e.g., disk drive capacity) are calculated based on the following values:

1 KB = 1,000 bytes
1 MB = $1,000^2$ bytes
1 GB = $1,000^3$ bytes
1 TB = $1,000^4$ bytes
1 PB = $1,000^5$ bytes

Logical storage capacity values (e.g., logical device capacity) are calculated based on the following values:

1 KB = 1,024 bytes
1 MB = $1,024^2$ bytes
1 GB = $1,024^3$ bytes
1 TB = $1,024^4$ bytes
1 PB = $1,024^5$ bytes
1 block = 512 bytes

Getting Help

If you need to call the Hitachi Data Systems Support Center, make sure to provide as much information about the problem as possible, including:

- The circumstances surrounding the error or failure.
- The exact content of any message(s) displayed on the host system(s).
- The exact content of any message(s) displayed by Storage Navigator.
- The service information messages (SIMs), including reference codes and severity levels, displayed by Storage Navigator and/or logged at the host.

The Hitachi Data Systems customer support staff is available 24 hours/day, seven days a week. If you need technical support, please call:

- United States: (800) 446-0744
- Outside the United States: (858) 547-4526

Comments

Please send us your comments on this document. Make sure to include the document title, number, and revision. Please refer to specific section(s) and paragraph(s) whenever possible.

- **E-mail:** doc.comments@hds.com
- **Fax:** 858-695-1186
- **Mail:**
  Technical Writing, M/S 35-10
  Hitachi Data Systems
  10277 Scripps Ranch Blvd.
  San Diego, CA 92131

Thank you! (All comments become the property of Hitachi Data Systems Corporation.)

1

Product Overview

This chapter provides an overview of the Universal Storage Platform V and VM storage systems.

- ☐ Universal Storage Platform V Family
- ☐ New and Improved Capabilities
- ☐ Specifications at a Glance
- ☐ Software Products

Universal Storage Platform V Family

The Hitachi Universal Storage Platform™ V family, the industry's highest performing and most scalable storage solution, represents the first implementation of a large-scale, enterprise-class virtualization layer combined with thin provisioning software, delivering virtualization of internal and external storage into one pool. Users realize the consolidation benefits of external storage virtualization with the efficiencies, power, and cooling advantages of thin provisioning in one integrated solution.

The Universal Storage Platform V family, which includes the USP V floor models and the rack-mounted USP VM, offer a wide range of storage and data services, including thin provisioning with Hitachi Dynamic Provisioning™ software, application-centric storage management and logical partitioning, and simplified and unified data replication across heterogeneous storage systems. The Universal Storage Platform V family enables users to deploy applications within a new framework, leverage and add value to current investments, and more closely align IT with business objectives.

The Universal Storage Platform V family is an integral part of the Services Oriented Storage Solutions architecture from Hitachi Data Systems. These storage systems provide the foundation for matching application requirements to different classes of storage and deliver critical services such as:

- Business continuity services
- Content management services (search, indexing)
- Non-disruptive data migration
- Volume management across heterogeneous storage arrays
- Thin provisioning
- Security services (immutability, logging, auditing, data shredding)
- Data de-duplication
- I/O load balancing
- Data classification
- File management services

For further information on storage solutions and the Universal Storage Platform V and VM storage systems, please contact your Hitachi Data Systems account team.

New and Improved Capabilities

The Hitachi Universal Storage Platform V and VM storage systems offer the following new and improved capabilities as compared with the TagmaStore Universal Storage Platform and Network Storage Controller:

- **NEW! Hitachi Dynamic Provisioning™**

  Hitachi Dynamic Provisioning is a new and advanced thin-provisioning software product that provides “virtual storage capacity” to simplify administration and addition of storage, eliminate application service interruptions, and reduce costs.

- **Cache capacity**

  The USP V supports up to 256 GB (128 GB for TagmaStore USP).

- **Shared memory capacity**

  The USP V supports up to 32 GB (12 GB for TagmaStore USP).

  The USP VM supports up to 16 GB (6 GB for TagmaStore NSC).

- **Total storage capacity (internal and external storage)**

  The USP V supports up to 247 PB (32 PB for TagmaStore USP).

  The USP VM supports up to 96 PB (16 PB for TagmaStore NSC).

- **Aggregate bandwidth**

  The USP V provides an aggregate bandwidth of up to 106 GB/sec (81 GB/sec for TagmaStore USP).

- **Fibre-channel ports**

  The USP V supports up to 224 FC ports (192 for TagmaStore USP).

- **FICON® ports**

  The USP V supports up to 112 FICON ports (96 for TagmaStore USP).

  The USP VM supports up to 24 FICON ports (16 for TagmaStore NSC).

- **ESCON® ports**

  The USP V supports up to 112 ESCON ports (96 for TagmaStore USP).

- **Open-system logical devices**

  The USP VM supports up to 65,536 LDEVs (16,384 for TagmaStore NSC).

Specifications at a Glance

Specifications for the Universal Storage Platform V

Table 1-1 provides a brief overview of the USP V specifications.

Table 1-1 Specifications – Universal Storage Platform V

Controller	
Basic platform packaging unit: Integrated control/array frame and 1 to 4 optional array frames	
Universal Star Network Crossbar Switch	
Number of switches	8
Aggregate bandwidth	106 GB/sec
Aggregate IOPS	4.5 million
Cache Memory	
Boards	32
Board capacity	4 GB or 8 GB
Maximum	256 GB
Shared Memory	
Boards	8
Board capacity	4 GB
Maximum	32 GB
Front-End Directors (Connectivity)	
Boards	14
Fibre-channel host ports per board	8 or 16
Maximum fibre-channel host ports	224
Virtual host ports	1,024 per physical port
Maximum FICON host ports	112
Maximum ESCON host ports	112
Logical Devices (LDEVs)—Maximum Supported	
Open systems	65,536
Mainframe	65,536
Hard Disk Drives	
Type (fibre channel)	73 GB, 146 GB, 300 GB, 400 GB, 750 GB
Number of drives (minimum–maximum)	4–1152
Spare drives per system (minimum–maximum)	1–16

Internal Raw Capacity	
Minimum (73-GB disks)	82 TB
Maximum (750-GB disks)	850.8 TB
Maximum Usable Capacity—RAID-5	
Open systems (750-GB disks)	739.3 TB
Mainframe (400-GB disks)	374.3 TB
Maximum Usable Capacity—RAID-6	
Open systems (750-GB disks)	633.7 TB
Mainframe (400-GB disks)	318.5 TB
Maximum Usable Capacity—RAID-1+	
Open systems (750-GB disks)	423.9 TB
Mainframe (400-GB disks)	207.7 TB
External Storage Support	
Maximum internal and external capacity	247 PB
Virtual Storage Machines	32
Standard Back-End Directors	1-8
Operating System Support	
Mainframe: IBM OS/390®, MVS/ESA™, MVS/XA™, VM/ESA®, VSE/ESA™, z/OS, z/OS.e, z/VM®, zVSE™; Fujitsu MSP; Red Hat Linux for IBM S/390® and zSeries®	
Open Systems: Sun Solaris, HP-UX, IBM AIX®, Microsoft® Windows, Novell NetWare, Red Hat and SuSE Linux, VMWare ESX, HP Tru64, SGI IRIX, HP OpenVMS	

Specifications for the Universal Storage Platform VM

Table 1-2 provides a brief overview of the USP VM specifications.

Table 1-2 Specifications – Universal Storage Platform VM

Controller	
Single-rack configuration: controller and up to two disk chassis Optional second rack: up to two disk chassis	
Universal Star Network Crossbar Switch	
Number of switches	2
Aggregate bandwidth	13.3 GB/sec
Aggregate IOPS	1.2 million
Cache Memory	
Boards	8
Board capacity	4 or 8 GB
Maximum	64 GB
Shared Memory	
Boards	4
Board capacity	4 GB
Maximum	16 GB
Front-End Directors (Connectivity)	
Boards	3
Fibre-channel host ports per feature	8 or 16
Fibre-channel port performance	4 Gb/sec
Maximum number of fibre-channel host ports	48
Virtual host ports	1,024 per physical port
Maximum FICON host ports	24
Maximum ESCON host ports	24
Logical Devices (LDEVs)—Maximum Supported	
Open systems	65,536
Mainframe	65,536
Hard Disk Drives	
Capacity and (fibre channel)	73 GB, 146 GB, 300 GB, 400 GB, 750 GB
Number (minimum–maximum)	0–240
Spare drives per system (minimum–maximum)	1–16
Internal Raw Capacity	
Minimum (73-GB disks)	0 GB (146 GB)
Maximum (750-GB disks)	177 TB

Controller	
Maximum Usable Capacity—RAID-5	
Open systems (750-GB disks)	144.7 TB
Mainframe (400-GB disks)	73.3 TB
Maximum Usable Capacity—RAID-6	
Open systems (750-GB disks)	124 TB
Mainframe (400-GB disks)	62.4 TB
Maximum Usable Capacity—RAID-1+	
Open systems (750-GB disks)	87.1 TB
Mainframe (400-GB disks)	42.7 TB
External Storage Support	
Maximum internal and external capacity	96 PB
Virtual Storage Machines	8
Standard Back-End Director	1
Operating System Support	
Mainframe: IBM OS/390®, MVS/ESA™, MVS/XA™, VM/ESA®, VSE/ESA™, z/OS, z/OS.e, z/VM®, zVSE™; Fujitsu MSP; Red Hat Linux for IBM S/390® and zSeries®	
Open Systems: Sun Solaris, HP-UX, IBM AIX®, Microsoft® Windows, Novell NetWare, Red Hat and SuSE Linux, VMWare ESX, HP Tru64, HP OpenVMS	

Software Products

The Universal Storage Platform V and VM provide many advanced features and functions that increase data accessibility and deliver enterprise-wide coverage of online data copy/relocation, data access/protection, and storage resource management. Hitachi Data Systems' software products and solutions provide a full set of industry-leading copy, availability, resource management, and exchange software to support business continuity, database backup and restore, application testing, and data mining.

Table 1-3 lists and describes the Storage Navigator-based software for the Universal Storage Platform V and VM. Table 1-4 lists and describes the host/server-based software for the Universal Storage Platform V and VM.

NEW – Hitachi Dynamic Provisioning

Hitachi Dynamic Provisioning is a new and advanced thin-provisioning software product for the Universal Storage Platform V/VM that provides "virtual storage capacity" to simplify administration and addition of storage, eliminate application service interruptions, and reduce costs.

Dynamic Provisioning allows storage to be allocated to an application without being physically mapped until it is used. This "just-in-time" provisioning de-couples the provisioning of storage to an application from the physical addition of storage capacity to the storage system to achieve overall higher rates of storage utilization. Dynamic Provisioning also transparently spreads many individual I/O workloads across multiple physical disks. This I/O workload balancing feature directly reduces performance and capacity management expenses by eliminating I/O bottlenecks across multiple applications.

For further information on Hitachi Dynamic Provisioning, please contact your Hitachi Data Systems account team, or visit Hitachi Data Systems online at www.hds.com.

Table 1-3 Storage Navigator-Based Software

Name	Description	Documents
Hitachi Storage Navigator Hitachi Storage Navigator Messages	Obtains system configuration and status information and sends user-requested commands to the storage systems. Serves as the integrated user interface for all Resource Manager components.	MK-96RD621 MK-96RD613
NEW: Hitachi Dynamic Provisioning	Provides "virtual storage capacity" to simplify administration and addition of storage, eliminate application service interruptions, and reduce costs. See Hitachi Dynamic Provisioning.	MK-96RD641
Hitachi TrueCopy Hitachi TrueCopy for IBM z/OS	Enables the user to perform remote copy operations between storage systems in different locations. TrueCopy provides synchronous and asynchronous copy modes for open-system and mainframe data.	MK-96RD622 MK-96RD623
Hitachi ShadowImage Hitachi ShadowImage for IBM z/OS	Allows the user to create internal copies of volumes for purposes such as application testing and offline backup. Can be used in conjunction with TrueCopy to maintain multiple copies of data at primary and secondary sites.	MK-96RD618 MK-96RD619
Hitachi Compatible Mirroring for IBM FlashCopy	Provides compatibility with the IBM FlashCopy mainframe host software function, which performs server-based data replication for mainframe data.	MK-96RD614
Hitachi Universal Replicator Hitachi Universal Replicator for IBM z/OS	Provides a RAID storage-based hardware solution for disaster recovery which enables fast and accurate system recovery, particularly for large amounts of data which span multiple volumes. Using UR, you can configure and manage highly reliable data replication systems using journal volumes to reduce chances of suspension of copy operations.	MK-96RD624 MK-96RD625
Hitachi Compatible Replication for IBM XRC*	Provides compatibility with the IBM Extended Remote Copy (XRC) mainframe host software function, which performs server-based asynchronous remote copy operations for mainframe LVIs.	MK-96RD610
Hitachi Copy-on-Write Snapshot	Provides ShadowImage functionality using less capacity of the storage system and less time for processing than ShadowImage by using "virtual" secondary volumes. COW Snapshot is useful for copying and managing data in a short time with reduced cost. ShadowImage provides higher data integrity.	MK-96RD607
Hitachi Universal Volume Manager	Realizes the virtualization of the storage system. Users can connect other storage systems to the USP V/VM and access the data on the external storage system over virtual devices on the USP V/VM. Functions such as TrueCopy and Cache Residency can be performed on the external data.	MK-96RD626
Hitachi Virtual Partition Manager	Provides storage logical partition and cache logical partition: ▪ Storage logical partition allows you to divide the available storage among various users to reduce conflicts over usage. ▪ Cache logical partition allows you to divide the cache into multiple virtual cache memories to reduce I/O contention.	MK-96RD629
Hitachi LUN Manager	Enables users to configure the fibre-channel ports and devices (LUs) for operational environments (for example, arbitrated-loop and fabric topologies, host failover support).	MK-96RD615
Hitachi SNMP Agent	Provides support for SNMP monitoring and management. Includes Hitachi specific MIBs and enables SNMP-based reporting on status and alerts. SNMP agent on the SVP gathers usage and error information and transfers the information to the SNMP manager on the host.	MK-96RD620
Audit Log	Provides detailed records of all operations performed using Storage Navigator (and the SVP).	MK-96RD606

Encrypted Communications	Allows users to employ SSL-encrypted communications with the Hitachi Universal Storage Platform V/VM.	MK-96RD631
Hitachi LUN Expansion	Allows open-system users to concatenate multiple LUs into single LUs to enable open-system hosts to access the data on the entire Universal Storage Platform V/VM using fewer logical units.	MK-96RD616
Hitachi Virtual LVI/LUN	Enables users to convert single volumes (LVIs or LUs) into multiple smaller volumes to improve data access performance.	MK-96RD630
Hitachi Cache Residency Manager	Allows users to “lock” and “unlock” data into cache in real time to optimize access to your most frequently accessed data.	MK-96RD609
Hitachi Compatible PAV	Enables the mainframe host to issue multiple I/O requests in parallel to single LDEVs in the USP V/VM. Compatible PAV provides compatibility with the IBM Workload Manager (WLM) host software function and supports both static and dynamic PAV functionality.	MK-96RD608
Hitachi LUN Security Hitachi Volume Security	Allows users to restrict host access to data on the USP V/VM. Open-system users can restrict host access to LUs based on the host’s world wide name (WWN). Mainframe users can restrict host access to LVIs based on node IDs and logical partition (LPAR) numbers.	MK-96RD615 MK-96RD628
Hitachi Database Validator*	Prevents corrupted data environments by identifying and rejecting corrupted data blocks before they are written onto the storage disk, thus minimizing risk and potential costs in backup, restore, and recovery operations.	MK-96RD611
Hitachi Data Retention Utility Hitachi Volume Retention Manager	Allows users to protect data from I/O operations performed by hosts. Users can assign an access attribute to each logical volume to restrict read and/or write operations, preventing unauthorized access to data.	MK-96RD612 MK-96RD627
Hitachi Performance Monitor	Performs detailed monitoring of storage system and volume activity.	MK-96RD617
Hitachi Volume Migration	Performs automatic relocation of volumes to optimize performance.	MK-96RD617
Hitachi Server Priority Manager*	Allows open-system users to designate prioritized ports (for example, for production servers) and non-prioritized ports (for example, for development servers) and set thresholds and upper limits for the I/O activity of these ports.	MK-96RD617
Volume Shredder	Enables users to overwrite data on logical volumes with dummy data.	MK-96RD630

* Please contact your Hitachi Data Systems account team for the latest information on the availability of these features.

Table 1-4 Host/Server-Based Software

Name	Description	Documents
Hitachi Command Control Interface	Enables open-system users to perform data replication and data protection operations by issuing commands from the host to the Hitachi storage systems. The CCI software supports scripting and provides failover and mutual hot standby functionality in cooperation with host failover products.	User and Reference Guide: MK-90RD011
Hitachi Cross-OS File Exchange Hitachi Code Converter	Enables users to transfer data between mainframe and open-system platforms using the FICON and/or ESCON channels, for high-speed data transfer without requiring network communication links or tape.	User's Guide: MK-96RD647 Code Converter: MK-94RD253
HiCommand Global Link Availability Manager	Provides simple, integrated, single-point, multipath storage connection management and reporting. Improves system reliability and reduces downtime by automated path health checks, reporting alerts and error information from hosts, and assisting with rapid troubleshooting. Administrators can optimize application performance by controlling path bandwidth (per host LUN load balancing), and keep applications online while performing tasks that require taking a path down by easily switching to and from alternate paths	User's Guide: MK-95HC106 Installation & Admin: MK-95HC107 Messages: MK-95HC108
Hitachi Dynamic Link Manager	Provides automatic load balancing, path failover, and recovery capabilities in the event of a path failure.	Concepts & Planning: MK-96HC144 For AIX: MK-92DLM111 For HP-UX: MK-92DLM112 For Linux: MK-92DLM113 For Solaris: MK-92DLM114 For Windows: MK-92DLM129
HiCommand Device Manager	Enables users to manage the Hitachi storage systems and perform functions (e.g., LUN Manager, ShadowImage) from virtually any location via the Device Manager Web Client, command line interface (CLI), and/or third-party application.	Web Client: MK-91HC001 Server Inst & Config: MK-91HC002 CLI: MK-91HC007 Messages: MK-92HC016 Agent: MK-92HC019
HiCommand Provisioning Manager	Designed to handle a variety of storage systems to simplify storage management operations and reduce costs. Works together with HiCommand Device Manager to provide the functionality to integrate, manipulate, and manage storage using provisioning plans.	User's Guide: MK-93HC035 Server: MK-93HC038 Messages: MK-95HC117
Hitachi Business Continuity Manager	Enables mainframe users to make Point-in-Time (PiT) copies of production data, without quiescing the application or causing any disruption to end-user operations, for such uses as application testing, business intelligence, and disaster recovery for business continuance.	Installation: MK-95HC104 Reference Guide: MK-95HC105 User's Guide: MK-94RD247 Messages: MK-94RD262
HiCommand Replication Monitor	Supports management of storage replication (copy pair) operations, enabling users to view (report) the configuration, change the status, and troubleshoot copy pair issues. Replication Monitor is particularly effective in environments that include multiple storage systems or multiple physical locations, and in environments in which various types of volume replication functionality (such as both ShadowImage and TrueCopy) are used.	Install & Config: MK-96HC131 Messages: MK-96HC132 User's Guide: MK-94HC093

HiCommand Tuning Manager	Provides intelligent and proactive performance and capacity monitoring as well as reporting and forecasting capabilities of storage resources.	Server Installation: MK-95HC109 Getting Started: MK-96HC120 Server Administration: MK-92HC021 User's Guide: MK-92HC022 CLI: MK-96HC119 Performance Reporter: MK-93HC033 Agent Admin Guide: MK-92HC013 Agent Installation: MK-96HC110 Hardware Agent: MK-96HC111 OS Agent: MK-96HC112 Database Agent: MK-96HC113 Messages: MK-96HC114
HiCommand Protection Manager	Systematically controls storage systems, backup/recovery products, databases, and other system components to provide efficient and reliable data protection using simple operations without complex procedures or expertise.	User's Guide: MK-94HC070 Console: MK-94HC071 Command Reference: MK-94HC072 Messages: MK-94HC073
HiCommand Tiered Storage Manager	Enables users to relocate data non-disruptively from one volume to another for purposes of Data Lifecycle Management (DLM). Helps improve the efficiency of the entire data storage system by enabling quick and easy data migration according to the user's environment and requirements.	Server: MK-94HC089 User's Guide: MK-94HC090 CLI: MK-94HC091 Messages: MK-94HC092
Hitachi Copy Manager for TPF	Enables TPF users to control DASD copy functions on Hitachi RAID storage systems from TPF through an interface that is simple to install and use.	Administrator's Guide: MK-92RD129 Messages: MK-92RD130 Operations Guide: MK-92RD131
Hitachi Cache Manager	Enables users to perform Cache Residency Manager operations from the mainframe host system. Cache Residency Manager allows you to place specific data in cache memory to enable virtually immediate access to this data.	User's Guide: MK-96RD646
Hitachi Dataset Replication for z/OS	Operates together with the ShadowImage feature. Rewrites the OS management information (VTOC, VVDS, and VTOCIX) and dataset name and creates a user catalog for a ShadowImage target volume after a split operation. Provides the prepare, volume divide, volume unify, and volume backup functions to enable use of a ShadowImage target volume.	User's Guide: MK-96RD648

2

Architecture and Components

This chapter describes the architecture and components of the Hitachi Universal Storage Platform V and VM storage systems:

- ☐ Hardware Architecture
- ☐ Hardware Components
- ☐ Control Panel and Emergency Power-Off Switch
- ☐ Intermix Configurations

Hardware Architecture

Figure 2-1 illustrates the hardware architecture of the Universal Storage Platform V storage system. Figure 2-2 illustrates the hardware architecture of the Universal Storage Platform VM storage system. As shown, the USP V and USP VM share the same hardware architecture, differing only in number of features (FEDs, BEDs, etc.), number of hard disk drives (HDDs), and power supply.

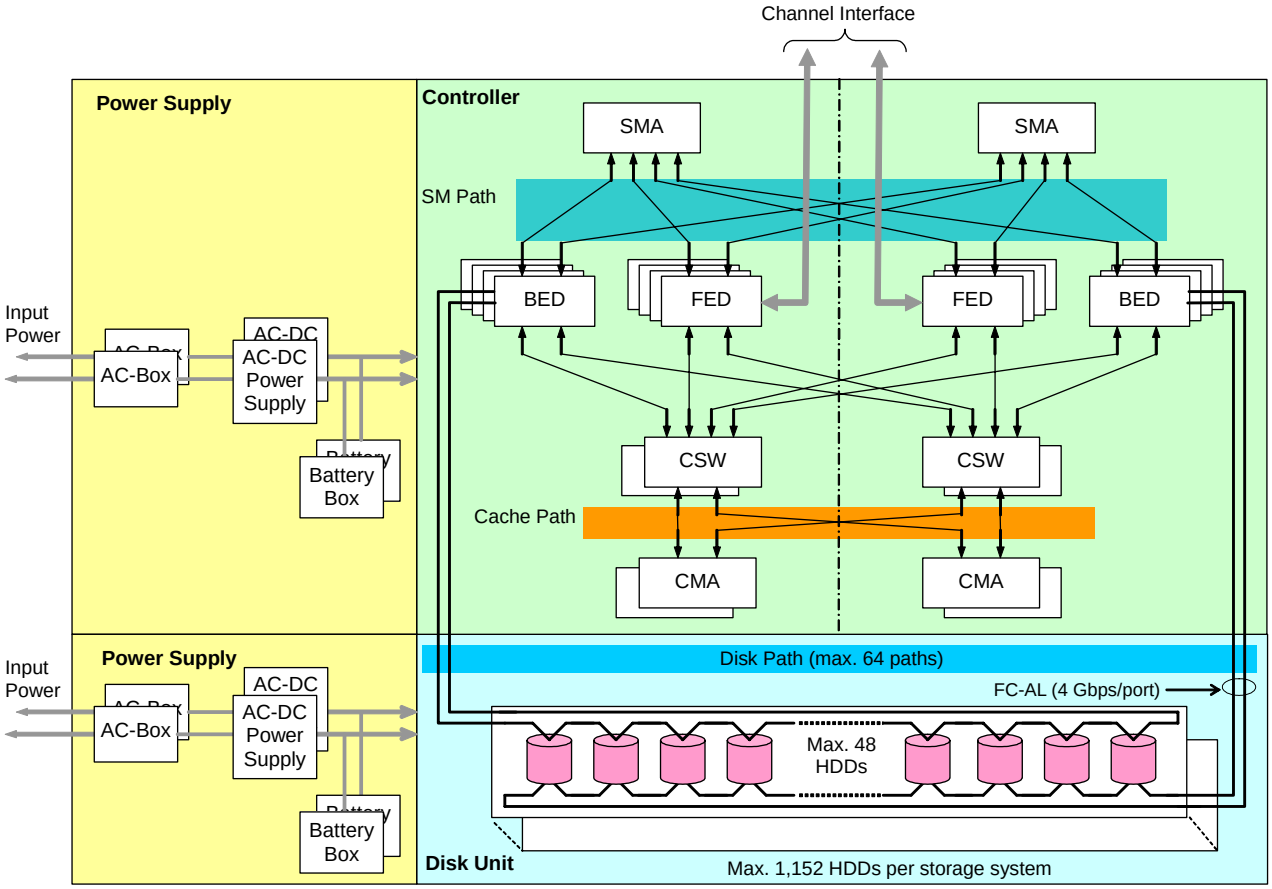


Figure 2-1 Universal Storage Platform V Hardware Architecture

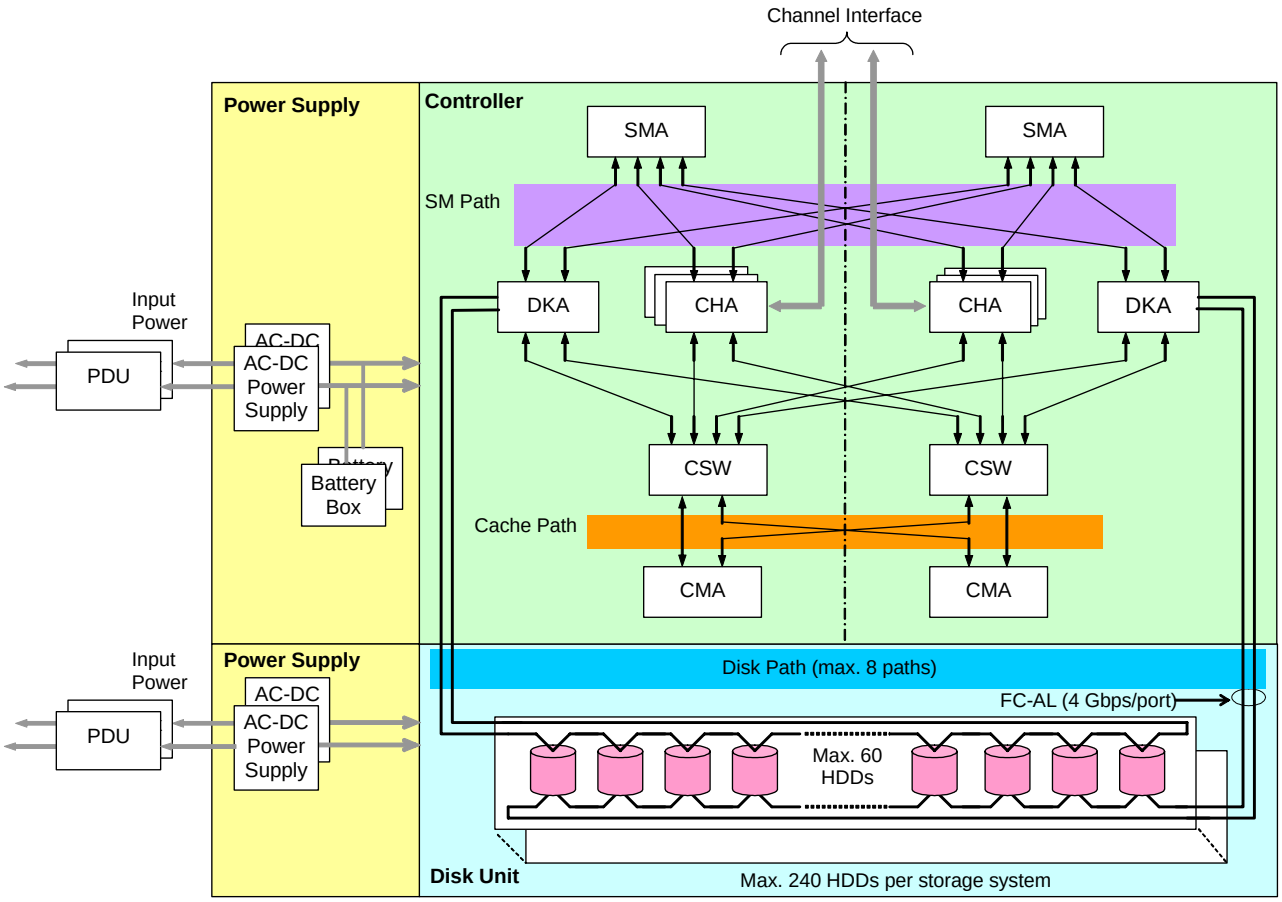


Figure 2-2 Universal Storage Platform VM Hardware Architecture

Multiple Data and Control Paths

The Universal Storage Platform V/VM employs the proven Hi-Star™ crossbar switch architecture, which uses multiple point-to-point data and command paths to provide redundancy and improve performance. Each data and command path is independent. The individual paths between the front-end or back-end directors and cache are steered by high-speed cache switch cards (CSWs). The USP V/VM does not have any common buses, thus eliminating the performance degradation and contention that can occur in bus architecture. All data stored on the USP V/VM is moved into and out of cache over the redundant high-speed paths.

Storage Clusters

Each controller consists of two redundant controller halves called storage clusters. Each storage cluster contains all physical and logical elements (for example, power supplies, channel adapters, disk adapters, cache, control storage) needed to sustain processing within the storage system. Both storage clusters should be connected to each host using an alternate path scheme, so that if one storage cluster fails, the other storage cluster can continue processing for the entire storage system.

The front-end and back-end directors are split between clusters to provide full backup. Each storage cluster also contains a separate, duplicate copy of cache and shared memory contents. In addition to the high-level redundancy that this type of storage clustering provides, many of the individual components within each storage cluster contain redundant circuits, paths, and/or processors to allow the storage cluster to remain operational even with multiple component failures. Each storage cluster is powered by its own set of power supplies, which can provide power for the entire storage system in the event of power supply failure. Because of this redundancy, the USP V/VM can sustain the loss of multiple power supplies and still continue operation.

The redundancy and backup features of the USP V/VM eliminate all active single points of failure, no matter how unlikely, to provide an additional level of reliability and data availability.

Hardware Components

The USP V/VM hardware includes the controller, disk unit, and power supply components. Each component is connected over the cache paths, shared memory paths, and/or disk paths. The USP V/VM controller is fully redundant and has no active single point of failure. All components can be repaired or replaced without interrupting access to user data.

The main hardware components of the USP V and VM storage systems are:

- Shared Memory
- Cache Memory
- Host Channels and Front-End Directors
- Back-End Directors and Array Domains
- Hard Disk Drives
- Service Processor
- Power Supplies
- Batteries

Shared Memory

The nonvolatile shared memory contains the cache directory and configuration information for the USP V/VM storage system. The path group arrays (for example, for dynamic path selection) also reside in the shared memory. The shared memory is duplexed, and each side of the duplex resides on the first two shared memory cards, which are in clusters 1 and 2. In the event of a power failure, shared memory is protected for at least 36 hours by battery backup.

The Universal Storage Platform V can be configured with up to 32 GB of shared memory, and the Universal Storage Platform VM can be configured with up to 16 GB of shared memory. The size of the shared memory is determined by several factors, including total cache size, number of logical devices (LDEVs), and replication function(s) in use. Any required increase beyond the base size is automatically shipped and configured during the installation or upgrade process.

Cache Memory

The Universal Storage Platform V can be configured with up to 256 GB of cache, and the Universal Storage Platform VM can be configured with up to 64 GB of cache memory. All cache memory in the USP V/VM is nonvolatile and is protected for at least 36 hours by battery backup.

The Universal Storage Platform V and VM storage systems place 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.

The cache is divided into two equal areas (called cache A and cache B) on separate cards. Cache A is in cluster 1, and cache B is in cluster 2. The Universal Storage Platform V/VM places all read and write data in cache. Write data is normally written to both cache A and B with one channel write operation, so that the data is always duplicated (duplexed) across logic and power boundaries. If one copy of write data is defective or lost, the other copy is immediately destaged to disk. This “duplex cache” design ensures full data integrity in the unlikely event of a cache memory or power-related failure.

Note: Mainframe hosts can specify special attributes (for example, cache fast write (CFW) command) to write data (typically sort work data) without write duplexing. This data is not duplexed and is usually given a discard command at the end of the sort, so that the data will not be destaged to the disk drives.

Front-End Directors and Host Channels

The Universal Storage Platform V and VM support all-mainframe, all-open-system, and multiplatform configurations. The front-end directors (FEDs) process the channel commands from the hosts and manage host access to cache. In the mainframe environment, the front-end directors perform CKD-to-FBA and FBA-to-CKD conversion for the data in cache.

Each front-end director feature (pair of boards) is composed of one type of host channel interface: fibre-channel, FICON, or Extended Serial Adapter (ExSA) (compatible with ESCON protocol). The channel interfaces on each board can transfer data simultaneously and independently.

The FICON and fibre-channel FED features are available in shortwave (multimode) and longwave (single mode) versions. When configured with shortwave features, the USP V/VM can be located up to 500 meters (2750 feet) from the host. When configured with longwave features, the USP V/VM can be located up to ten kilometers from the host(s).

- **FICON.** The FICON features provide data transfer speeds of up to 4 Gbps and have 8 ports per feature (pair of boards).

  Note: FICON data transmission rates vary according to configuration:

  S/390 Parallel Enterprise Servers - Generation 5 (G5) and Generation 6 (G6) only support FICON at 1 Gbps.

  z800 and z900 series hosts have the following possible configurations:

  – FICON channel will operate at 1 Gbps ONLY.

  – FICON EXPRESS channel transmission rates will vary according to microcode release. If microcode is 3G or later, the channel will auto-negotiate to set a 1-Gbps or 2-Gbps transmission rate. If microcode is previous to 3G, the channel will operate at 1 Gbps ONLY.

  For further information on FICON connectivity, refer to the *Mainframe Host Attachment and Operations Guide* (MK-96RD645), or contact your Hitachi Data Systems representative.

- **ESCON**. The ExSA features provide data transfer speeds of up to 17 MB/sec and have 8 ports per feature (pair of boards). Each ExSA channel can be directly connected to a CHPID or a serial channel director. Shared serial channels can be used for dynamic path switching. The USP V/VM also supports the ESCON Extended Distance Feature (XDF).

- **Fibre-Channel.** The fibre-channel features provide data transfer speeds of up to 4 Gbps and can have either 8 or 16 ports per feature (pair of boards). The USP V/VM supports shortwave (multimode) and longwave (single-mode) versions of fibre-channel ports on the same adapter board.

  Note: Fiber-channel connectivity is also supported for IBM mainframe attachment when host FICON channel paths are defined to operate in fiber-channel protocol (FCP) mode.

Table 2-1 lists the specifications and configurations for the front-end directors and specifies the number of channel connections for each configuration.

Table 2-1 Front-End Director and Channel Specifications

Parameter	Specifications
Number of front-end director features	USP V: 1 – 8, 14 when FEDs are installed in BED slots USP VM: 1 – 3
Simultaneous data transfers per FED pair: FICON ExSA (ESCON) Fibre-channel	 8 8 8, 16
Maximum data transfer rate: FICON ExSA (ESCON) Fibre-channel	 400 MB/sec (4 Gbps) 17 MB/sec 400 MB/sec (4 Gbps)
Physical interfaces per FED pair: FICON ExSA (ESCON) Fibre-channel	 8 8 8, 16
Max. physical FICON interfaces per system	USP V: 112 USP VM: 24
Max. physical ExSA interfaces per system	USP V: 112 USP VM: 24
Max. physical FC interfaces per system	USP V: 224 USP VM: 48
Logical paths per FICON port	2105 emulation: 65,536 (1024 host paths × 64 CUs) 2107 emulation: 261,120 (1024 host paths x 255 CUs)
Logical paths per ExSA (ESCON) port	512 (32 host paths × 16 CUs) *
Max. FICON logical paths per system	2105 emulation: 131,072 2107 emulation: 522,240
Max. ExSA (ESCON) logical paths per system	8,192
Maximum LUs per fibre-channel port	2048
Maximum LDEVs per storage system	USP V: 130,560 (256 LDEVs x 510 CUs) USP VM: 65,280

*__Note:__ When the number of devices per CHL image is limited to a maximum of 1024, 16 CU images can be assigned per CHL image. If one CU includes 256 devices, the maximum number of CUs per CHL image is limited to 4.

Back-End Directors and Array Domains

The back-end director (BED) features control the transfer of data between the disk drives and cache. The BEDs are installed in pairs for redundancy and performance. The USP V can be configured with up to eight BED pairs, providing up to 64 concurrent data transfers to and from the disk drives. The USP VM is configured with one BED pair, which provides eight concurrent data transfers to and from the disk drives.

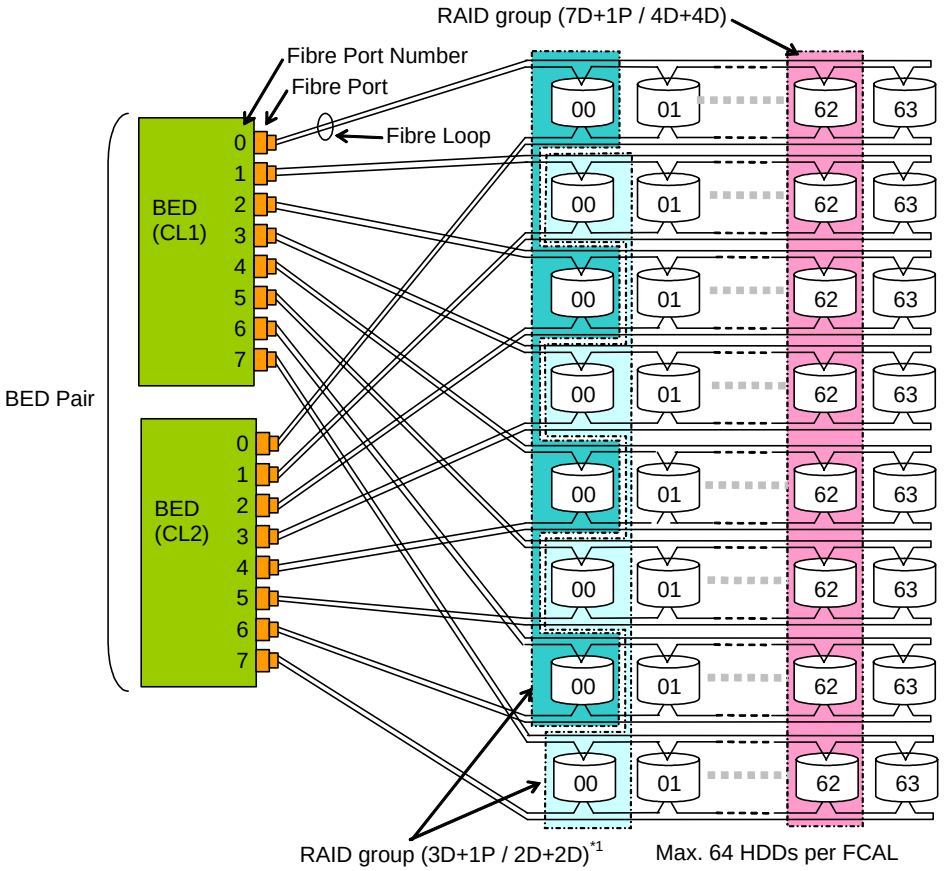
The disk drives are connected to the BED pairs by fibre cables using an arbitrated-loop (FC-AL) topology. Each BED pair has eight independent fibre back-end paths controlled by eight back-end microprocessors. Each dual-ported fibre-channel disk drive is connected through its two ports to each board in a BED pair over separate physical paths for improved performance as well as redundancy.

Table 2-2 lists the BED specifications. Each BED pair contains eight buffers (one per fibre path) that support data transfer to and from cache. Each dual-ported disk drive can transfer data over either port. Each of the two paths shared by the disk drive is connected to a separate board in the BED pair to provide alternate path capability. Each BED pair is capable of eight simultaneous data transfers to or from the HDDs.

Table 2-2 BED Specifications

Parameter	Specifications
Number of back-end director features	USP V: 1 – 8 USP VM: 1
Back-end paths per BED feature	8
Back-end paths per storage system	USP V: 8 – 64 USP VM: 8
Back-end array interface type	Fibre-channel arbitrated loop (FC-AL)
Back-end interface transfer rate (burst rate)	400 MB/sec (4 Gbps)
Maximum concurrent back-end operations per BED feature	8
Maximum concurrent back-end operations per storage system	USP V: 64 USP VM: 8
Back-end (data) bandwidth	USP V: 68 GB/sec USP VM: 8.5 GB/sec

Figure 2-3 illustrates a conceptual array domain. All functions, paths, and disk drives controlled by one BED pair are called an “array domain.” An array domain can contain a variety of LVI and/or LU configurations. RAID-level intermix (all RAID types) is allowed within an array domain (under a BED pair) but not within an array group.



*1: A RAID group (3D+1P/2D+2D) consists of fibre port number 0, 2, 4, and 6, or 1, 3, 5 and 7.

Figure 2-3 Conceptual Array Domain

Hard Disk Drives

The Universal Storage Platform V/VM uses disk drives with fixed-block-architecture (FBA) format. Table 2-3 lists and describes the currently available hard disk drives: 72 GB, 146 GB, 300 GB, 400 GB, and 750 GB.

Table 2-3 Disk Drive Specifications

Disk Drive Size	Formatted Capacity*	Revolution Speed	Interface	Interface Data Transfer Rate (maximum)
72 GB	71.50 GB	15,000 rpm	FC	400 MB/s
146 GB	143.76 GB	15,000 rpm	FC	400 MB/s
300 GB	288.20 GB	10,000 rpm	FC	200 MB/s
300 GB	288.20 GB	15,000 rpm	FC	400 MB/s
400 GB	393.85 GB	10,000 rpm	FC	400 MB/s
750 GB	738.62 GB	7,200 rpm	SATA	300 MB/s

* The storage capacity values for the disk drives (raw capacity) are calculated based on the following values: 1 KB = 1,000 bytes, 1 MB = $1,000^2$ bytes, 1 GB = $1,000^3$ bytes, 1 TB = $1,000^4$ bytes.

Each disk drive can be replaced non-disruptively on site. The USP V/VM utilizes diagnostic techniques and background dynamic scrubbing that detect and correct disk errors. Dynamic sparing is invoked automatically if needed. For an array group of any RAID level, any spare disk drive can back up any other disk drive of the same rotation speed and the same or lower capacity anywhere in the storage system, even if the failed disk and the spare disk are in different array domains (attached to different BED pairs). The USP V/VM can be configured with up to 16 spare disk drives. The standard configuration provides one spare drive for each type of drive installed in the storage system. The Hi-Track monitoring and reporting tool detects disk failures and notifies the Hitachi Data Systems Support Center automatically, and a service representative is sent to replace the disk drive.

Note: The spare disk drives are used only as replacements and are not included in the storage capacity ratings of the storage system.

Service Processor

The Universal Storage Platform V/VM includes a built-in custom PC called the *service processor* (SVP). The SVP is integrated into the controller and can only be used by authorized Hitachi Data Systems personnel. The SVP enables the Hitachi Data Systems representative to configure, maintain, service, and upgrade the storage system. The SVP also provides the Storage Navigator functionality, and it collects performance data for the key components of the USP V/VM to enable diagnostic testing and analysis. The SVP is connected with a service center for remote maintenance of the storage system.

Note: The SVP does not have access to any user data stored on the Universal Storage Platform V/VM.

Power Supplies

Each storage cluster is powered by its own set of redundant power supplies, and each power supply is able to provide power for the entire system, if necessary. Because of this redundancy, the Universal Storage Platform V/VM can sustain the loss of multiple power supplies and still continue to operate. To make use of this capability, the USP V/VM should be connected either to dual power sources or to different power panels, so if there is a failure on one of the power sources, the USP V/VM can continue full operations using power from the alternate source.

The AC power supplied to the USP V/VM is converted by the AC-DC power supply to supply 56V/12V DC power to all storage system components. Each component has its own DC-DC converter to generate the necessary voltage from the 56V/12V DC power that is supplied.

Batteries

The Universal Storage Platform V/VM uses nickel-hydrogen batteries to provide backup power for the control and operational components (cache memory, shared memory, FEDs, BEDs) as well as the hard disk drives. The configuration of the storage system and the operational conditions determine the number and type of batteries that are required.

Control Panel and Emergency Power-Off Switch

Control Panel

Figure 2-4 shows the location of the control panel on the USP V, and Figure 2-5 shows the location of the control panel on the USP VM. Table 2-4 describes the items on the USP V/VM control panel. To open the control panel cover, push and release on the point marked PUSH.

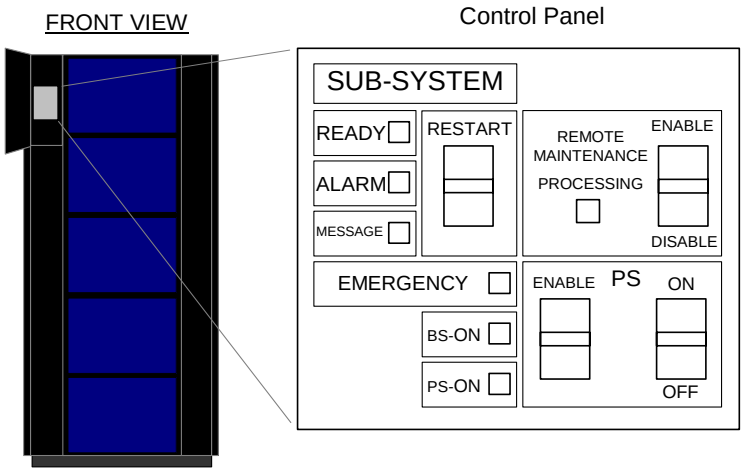


Figure 2-4 Location of Control Panel on the USP V

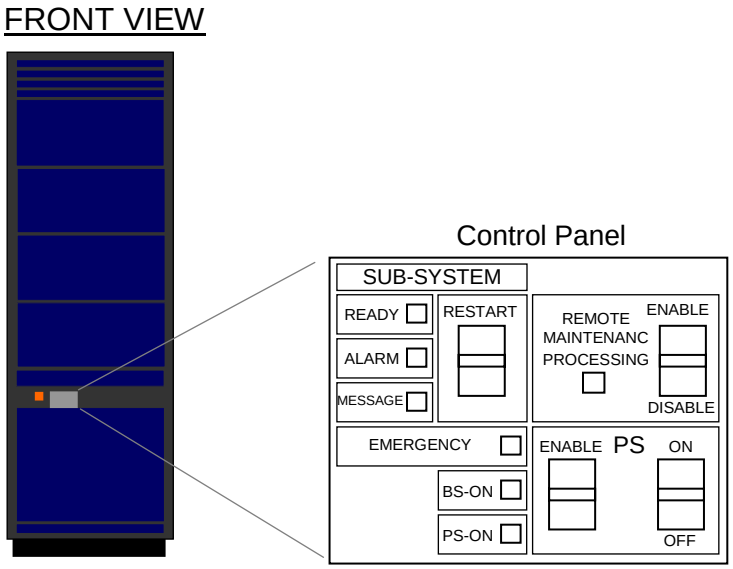


Figure 2-5 Location of Control Panel on the USP VM

Table 2-4 Control Panel (USP V and USP VM)

Name	Type	Description
SUBSYSTEM READY	LED (Green)	When lit, indicates that input/output operation on the channel interface is possible. Applies to both storage clusters.
SUBSYSTEM ALARM	LED (Red)	When lit, indicates that low DC voltage, high DC current, abnormally high temperature, or a failure has occurred. Applies to both storage clusters.
SUBSYSTEM MESSAGE	LED (Amber)	**On**: Indicates that a SIM (Message) was generated from either of the clusters. Applied to both storage clusters. **Blinking**: Indicates that the SVP failure has occurred.
SUBSYSTEM RESTART	Switch	Used to un-fence a fenced drive path and to release the Write Inhibit command. Applies to both storage clusters.
REMOTE MAINTENANCE PROCESSING	LED (Amber)	When lit, indicates that remote maintenance activity is in process. If remote maintenance is not in use, this LED is not lit. Applies to both storage clusters.
REMOTE MAINTENANCE ENABLE/DISABLE	Switch	Used for remote maintenance. While executing remote maintenance (the REMOTE MAINTENANCE PROCESSING LED in item 5 is blinking), when switching from ENABLE to DISABLE, remote maintenance is interrupted. If the remote maintenance function is not used, this switch is ineffective. Applies to both storage clusters.
BS-ON	LED (Amber)	Indicates input power is available.
PS-ON	LED (Green)	Indicates that storage system is powered on. Applies to both storage clusters.
PS SW ENABLE	Switch	Used to enable the PS ON/ PS OFF switch. To be enabling the PS ON/ PS OFF switch, turn the PS SW ENABLE switch to the ENABLE position.
PS ON / PS OFF	Switch	Used to power storage system on/off. This switch is valid when the PS REMOTE/LOCAL switch is set to LOCAL. Applies to both storage clusters.
EMERGENCY	LED (Red)	This LED shows status of EPO switch on the rear door. OFF: Indicates that the EPO switch is off. ON: Indicates that the EPO switch is on.

Emergency Power-Off Switch

Figure 2-6 shows the location of the emergency power-off (EPO) switch on the USP V (top right corner of the back side of controller frame). Figure 2-7 shows the location of the EPO switch on the USP VM (next to the control panel on the primary rack). Use the EPO switch only in case of an emergency.

To power off the USP V/VM storage system in case of an emergency, pull the EPO switch up and then out towards you, as illustrated on the switch. The EPO switch must be reset by service personnel before the storage system can be powered on again.

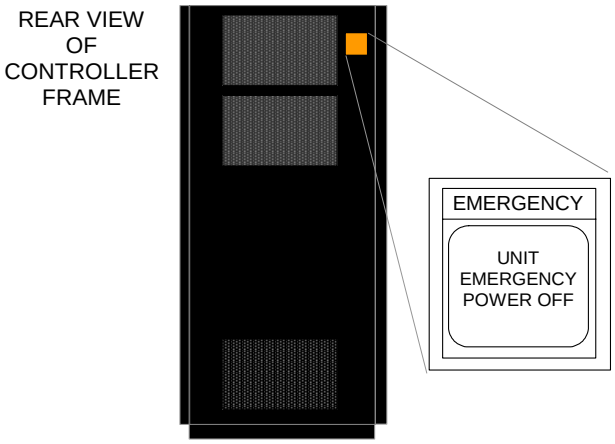


Figure 2-6 Location of EPO Switch on the USP V

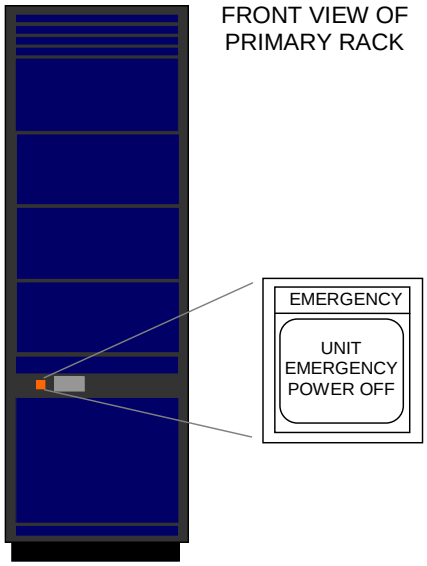


Figure 2-7 Location of EPO Switch on the USP VM

Intermix Configurations

RAID-Level Intermix

RAID technology provides full fault-tolerance capability for the disk drives of the Universal Storage Platform V/VM. The cache management algorithms enable the USP V to stage up to one full RAID stripe of data into cache ahead of the current access to allow subsequent access to be satisfied from cache at host channel transfer speeds.

The Universal Storage Platform V supports RAID-1, RAID-5, RAID-6, and intermixed RAID-level configurations, including intermixed array groups within an array domain. Figure 2-8 illustrates an intermix of RAID levels. All types of array groups (RAID-5 3D+1P, 7D+1P; RAID-1 2D+2D, 4D+4D; RAID-6 6D+2P) can be intermixed under one BED pair.

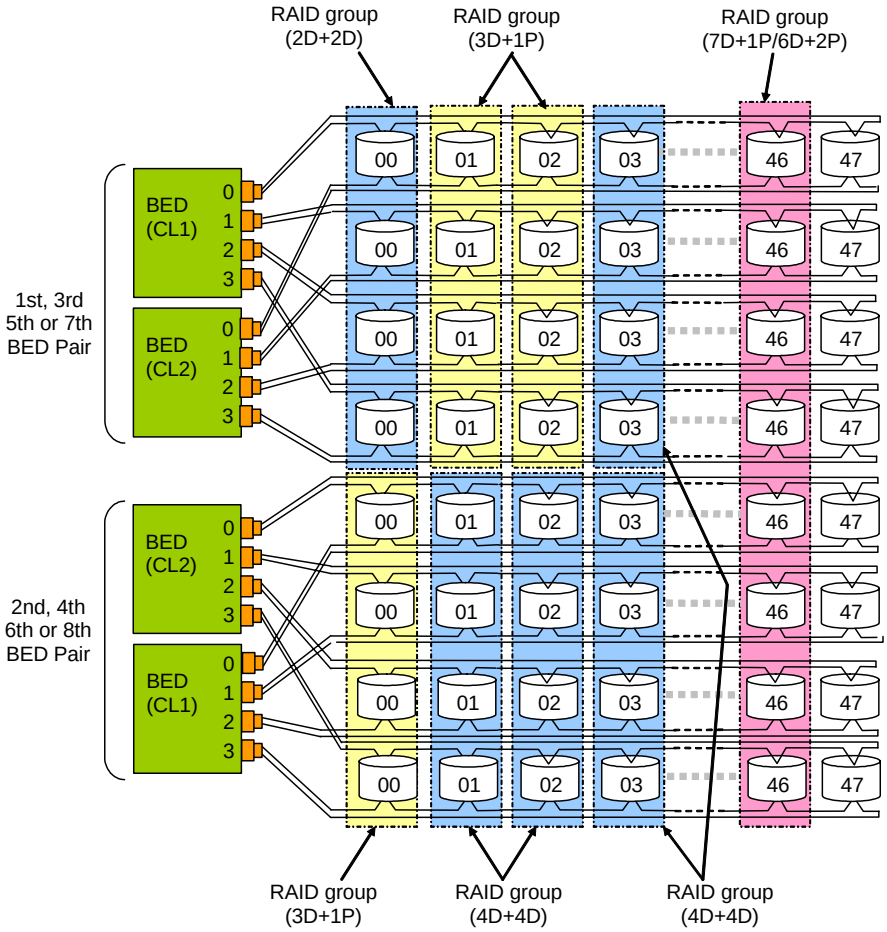


Figure 2-8 Sample RAID Level Intermix

Hard Disk Drive Intermix

All hard disk drives (HDDs) in one array group (parity group) must be of the same capacity and type. Different HDD types can be attached to the same BED pair. All HDDs under a single BED pair must operate at the same data transfer rate (200 or 400 MB/sec), so certain restrictions apply. For example, when an array group consisting of HDDs with 200 MB/sec transfer rate is intermingled with an array group consisting of HDDs with 400 MB/sec transfer rate, both array groups operate at 200 MB/sec.

Device Emulation Intermix

Figure 2-9 illustrates an intermix of device emulation types. The Universal Storage Platform V supports an intermix of all device emulations on the same BED pair, with the restriction that the devices in each array group have the same type of track geometry or format.

The Virtual LVI/LUN function enables different logical volume types to coexist. When Virtual LVI/LUN is not being used, an array group can be configured with only one device type (for example, 3390-3 *or* 3390-9, not 3390-3 and 3390-9). When Virtual LVI/LUN is being used, you can intermix 3390 device types, and you can intermix OPEN-*x* device types, but you cannot intermix 3390 and OPEN device types.

Note: For the latest information on supported LU types and intermix requirements, please contact your Hitachi Data Systems account team.

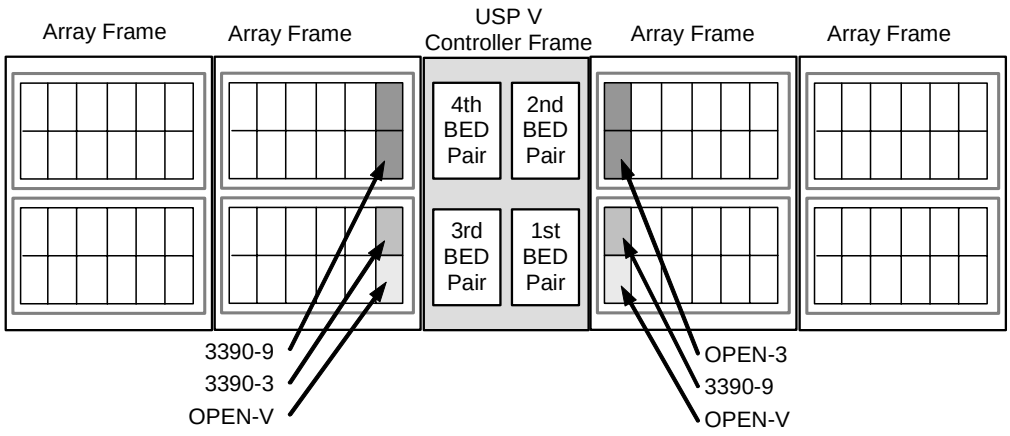


Figure 2-9 Sample Device Emulation Intermix

3

Functional and Operational Characteristics

This chapter discusses the functional and operational capabilities of the USP V.

RAID Implementation

This section provides an overview of the implementation of RAID technology on the Universal Storage Platform V:

- Array Groups and RAID Levels
- Sequential Data Striping
- LDEV Striping Across Array Groups

Array Groups and RAID Levels

The array group (also called parity group) is the basic unit of storage capacity for the USP V. Each array group is attached to both boards of a BED pair over 16 fibre paths, which enables all disk drives in the array group to be accessed simultaneously by the BED pair. Each array frame has two canister mounts, and each canister mount can have up to 128 physical disk drives.

The USP V supports the following RAID levels: RAID-1, RAID-5, RAID-6, and RAID1+0 (also known as RAIDA). RAID-0 is not supported on the USP V. When configured in four-drive RAID-5 parity groups (3D+1P), ¾ of the raw capacity is available to store user data, and ¼ of the raw capacity is used for parity data.

RAID-1. Figure 3-1 illustrates a sample RAID-1 (2D+2D) layout. A RAID-1 (2D+2D) array group consists of two pair of disk drives in a mirrored configuration, regardless of disk drive capacity. A RAID-1 (4D+4D) group* combines two RAID-1 (2D+2D) groups. Data is striped to two drives and mirrored to the other two drives. The stripe consists of two data chunks. The primary and secondary stripes are toggled back and forth across the physical disk drives for high performance. Each data chunk consists of either eight logical tracks (mainframe) or 768 logical blocks (open systems). A failure in a drive causes the corresponding mirrored drive to take over for the failed drive. Although the RAID-5 implementation is appropriate for many applications, the RAID-1 option on the USP V is ideal for workloads with low cache-hit ratios.

****Note for RAID-1(4D+4D):*** It is recommended that both RAID-1 groups within a RAID-1 (4D+4D) group be configured under the same BED pair.

RAID-1 using 2D + 2D and 3390-*x* LDEVs

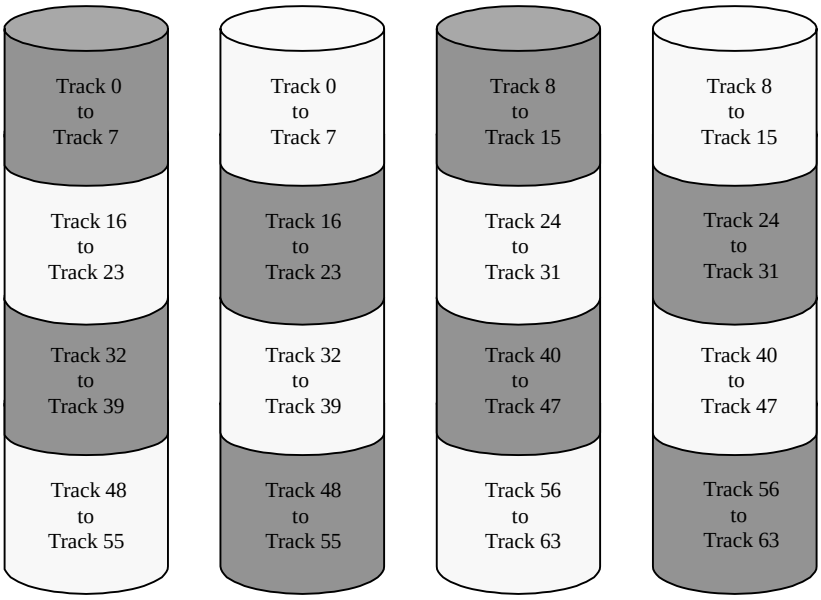


Figure 3-1 Sample RAID-1 2D + 2D Layout

RAID-5. A RAID-5 array group consists of four (3D+1P) or eight (7D+1P) disk drives. The data is written across the four (or eight) disk drives in a stripe that has three (or seven) data chunks and one parity chunk. Each chunk contains either eight logical tracks (mainframe) or 768 logical blocks (open). The enhanced RAID-5+ implementation in the USP V minimizes the write penalty incurred by standard RAID-5 implementations by keeping write data in cache until an entire stripe can be built and then writing the entire data stripe to the disk drives. The 7D+1P RAID-5 increases usable capacity and improves performance.

Figure 3-2 illustrates RAID-5 data stripes mapped over four physical drives. Data and parity are striped across each of the disk drives in the array group (hence the term “parity group”). The logical devices (LDEVs) are evenly dispersed in the array group, so that the performance of each LDEV within the array group is the same. Figure 3-2 also shows the parity chunks that are the “Exclusive OR” (EOR) of the data chunks. The parity and data chunks rotate after each stripe. The total data in each stripe is either 24 logical tracks (eight tracks per chunk) for mainframe data, or 2304 blocks (768 blocks per chunk) for open-systems data. Each of these array groups can be configured as either 3390-*x* or OPEN-*x* logical devices. All LDEVs in the array group must be the same format (3390-*x* or OPEN-*x*). For open systems, each LDEV is mapped to a SCSI address, so that it has a TID and logical unit number (LUN).

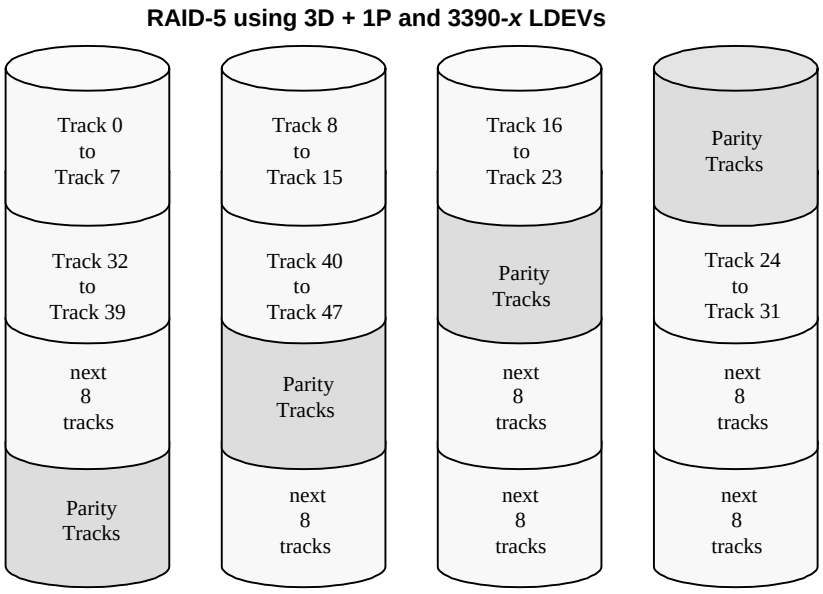


Figure 3-2 Sample RAID-5 3D + 1P Layout (Data Plus Parity Stripe)

RAID-6. A RAID-6 array group consists of eight (6D+2P) disk drives. The data is written across the eight disk drives in a stripe that has six data chunks and two parity chunks. Each chunk contains either eight logical tracks (mainframe) or 768 logical blocks (open).

In the case of RAID-6, data can be assured when up to two drives in an array group fail. Therefore, RAID-6 is the most reliable of the RAID levels.

Sequential Data Striping

The Universal Storage Platform V's enhanced RAID-5+ implementation attempts to keep write data in cache until parity can be generated without referencing old parity or data. This capability to write entire data stripes, which is usually achieved only in sequential processing environments, minimizes the write penalty incurred by standard RAID-5 implementations. The device data and parity tracks are mapped to specific physical disk drive locations within each array group. Therefore, each track of an LDEV occupies the same relative physical location within each array group in the storage system.

In a RAID-6 (dual parity) configuration, data is striped twice across four rows. RAID-6 uses two parity drives to prevent loss of data in the unlikely event of a second failure during a rebuild of a previous failure.

LDEV Striping Across Array Groups

In addition to the conventional concatenation of RAID-1 array groups (4D+4D), the Universal Storage Platform V supports LDEV striping across multiple RAID-5 array groups for improved LU performance in open-system environments. The advantages of LDEV striping are:

- Improved performance, especially of an individual LU, due to an increase in the number of HDDs that constitute an array group.
- Better workload distribution: in the case where the workload of one array group is higher than another array group, you can distribute the workload by combining the array groups, thereby reducing the total workload concentrated on each specific array group.

The supported LDEV striping configurations are:

- LDEV striping across two RAID-5 (7D+1P) array groups (see Figure 3-3). The maximum number of LDEVs in this configuration is 1000.
- LDEV striping across four RAID-5 (7D+1P) array groups (see Figure 3-4). The maximum number of LDEVs in this configuration is 2000.

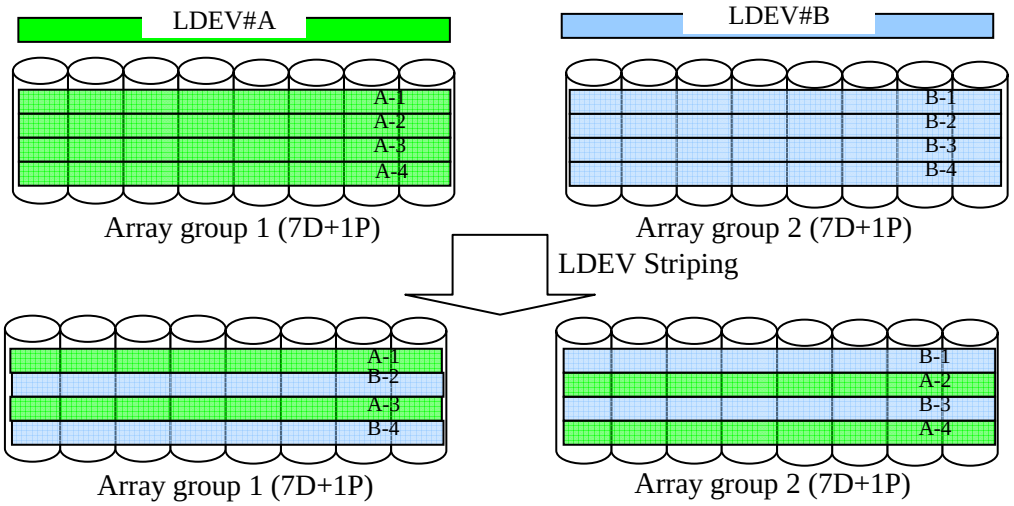


Figure 3-3 LDEV Striping Across 2 RAID-5 (7D+1P) Array Groups

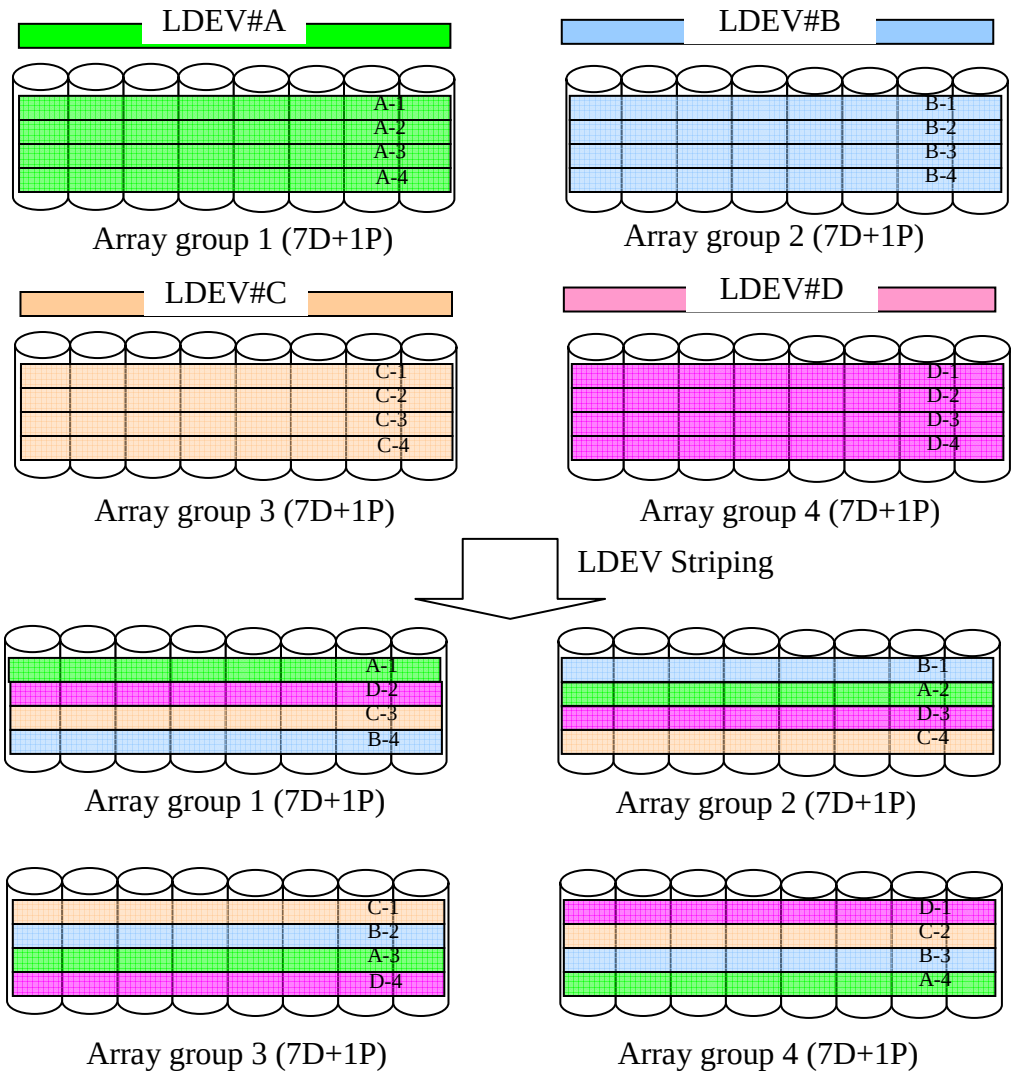


Figure 3-4 LDEV Striping Across 4 RAID-5 (7D+1P) Array Groups

All disk drives and device emulation types are supported for LDEV striping. LDEV striping can be used in combination with all USP V data management functions.

CU Images, LVIs, and LUs

CU Images

The Universal Storage Platform V/VM is configured with one control unit image for each 256 devices (one SSID for each 64 or 256 LDEVs) and supports a maximum of 510 CU images (255 in each logical disk controller, or LDKC).

The USP V/VM supports the following control unit (CU) emulation types:

- 3990-6, 3990-6E
- 2105, 2107

Note: The mainframe data management features of the USP V/VM may have restrictions on CU image compatibility.

For further information on CU image support, refer to the *Mainframe Host Attachment and Operations Guide* (MK-96RD645), or contact your Hitachi Data Systems account team.

Logical Volume Images

The Universal Storage Platform V/VM supports the 3390 (and 3380*) mainframe LVI types:

- 3390-3, -3R, -9, -L, and –M

  Note: The 3390-3 and 3390-3R LVIs cannot be intermixed in the same storage system.

- 3380-3, -F, -K

  Note: The use of 3380 device emulation is restricted to Fujitsu environments.

The LVI configuration of the USP V/VM storage system depends on the RAID implementation and physical disk drive capacities. The LDEVs are accessed using a combination of logical disk controller number (00-01), CU number (00-FE), and device number (00-FF). All control unit images can support an installed LVI range of 00 to FF.

Logical Units

The Universal Storage Platform V/VM is configured with OPEN-V LU types. The OPEN-V LU can vary in size from 48.1 MB to 4 TB. For information on other LU types (OPEN-3, OPEN-9), contact your Hitachi Data Systems representative.

For maximum flexibility in LU configuration, the USP V provides the Virtual LVI/LUN (VLL) and LUN Expansion (LUSE) features. Virtual LVI/LUN allows users to configure multiple LUs under a single LDEV, and LUN Expansion enables users to concatenate multiple LUs into large volumes. For further information on Virtual LVI/LUN and LUN Expansion, please refer to the *Virtual LVI/LUN User's Guide* (MK-96RD630) and *LUN Expansion User's Guide* (MK-96RD616).

Storage Navigator

The Hitachi Storage Navigator software communicates directly with the the Universal Storage Platform V and VM storage systems via a local-area network (LAN) to obtain storage system configuration and status information and send user-requested commands to the storage systems. Storage Navigator displays detailed storage system information and allows users to configure and perform operations on the Universal Storage Platform V/VM.

Storage Navigator is provided as a Java® applet program that can be executed on any machine that supports a Java Virtual Machine (JVM). A PC hosting the Storage Navigator software is called a *remote console*. Each time a remote console accesses and logs into the SVP of the desired storage system, the Storage Navigator applet is downloaded from the SVP to the remote console. Figure 3-5 illustrates remote console and SVP configuration for Storage Navigator.

For further information on Storage Navigator, refer to the *Storage Navigator User's Guide* (MK-96RD621).

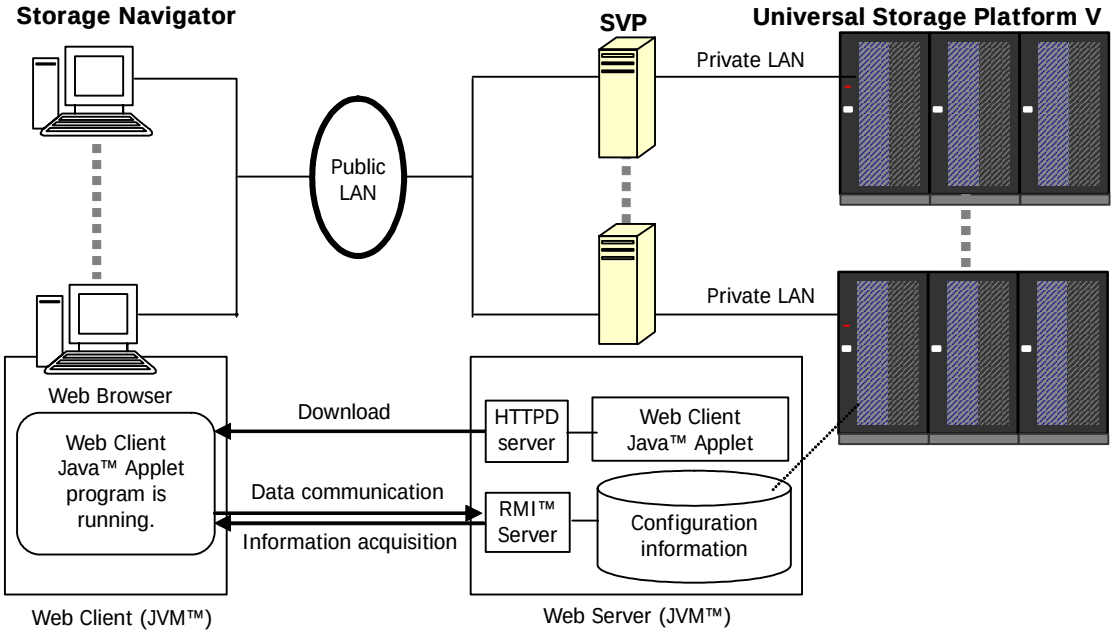


Figure 3-5 Storage Navigator and SVP Configuration

System Option Modes, Host Modes, and Host Mode Options

System Option Modes

To provide greater flexibility and enable the Universal Storage Platform V/VM to be tailored to unique customer operating requirements, additional operational parameters, or system option modes, are available. At installation, the modes are set to their default values (specified in below). Be sure to discuss these settings with your Hitachi Data Systems team. The system option modes can only be changed by a Hitachi Data Systems representative.

Table 3-1 lists the system option mode information for Universal Storage Platform V/VM microcode 60-02-48-00/00. Table 3-2 specifies the relationship between modes 503 and 269 for Storage Navigator operations. Table 3-3 specifies the relationship between modes 503 and 269 for SVP operations.

The system option mode information may change in future microcode releases. Contact your Hitachi Data Systems representative for the latest information on the USP V/VM system option modes.

Table 3-1 System Option Modes

Mode	Category	Function	Default	MCU/RCU
20	TrueCopy for z/OS	R-VOL read only function.	OFF	RCU
36	TrueCopy for z/OS	Setting default function (CRIT=Y) option for SVP panel (TCz).	OFF	MCU
64	TrueCopy for z/OS	Setting effective range of CGROUP.	OFF	MCU
80	ShadowImage for z/OS	Suppression of ShadowImage (and Business Continuity Manager) Quick Restore function.	OFF	–
87	ShadowImage	ShadowImage Quick Resync by CCI.	OFF	–
93	TrueCopy for z/OS Async	TrueCopy for z/OS Async throttling feature.	OFF	MCU
104	TrueCopy for z/OS	Changing default of CGROUP Freeze option.	OFF	MCU
114	TrueCopy for z/OS	Turning TCz Links Around option.	OFF	MCU/RCU
122	ShadowImage for z/OS	Suppression of ShadowImage for z/OS (and Business Continuity Manager) Quick Split and Resync function.	OFF	–
161	Open	Suppression of high speed micro-program exchange for CHT.	OFF	–
190	TrueCopy for z/OS	TCz – Allows you to update the VOLSER and VTOC of the R-VOL while the pair is suspended if both mode 20 and 190 are ON.	OFF	RCU

Mode	Category	Function	Default	MCU/RCU
269	Common	High-Speed Format for Virtual LVI/LUN (VLL) (available for all device emulation types). (1) High-Speed Format support: When redefining all LDEVs in an array group using VLL Volume Initialize or Make Volume operation, LDEV format, as the last process, will be performed in high speed. (2) Make Volume feature enhancement: The Make Volume operation (recreating new CVs after deleting all volumes in a VDEV) is now supported for all device emulation types. Mode 269 = ON: The High Speed format is available when performing VLL operations on Storage Navigator (or LDEV format (SVP Maintenance) for all LDEVs in a array group). Mode 269 = OFF: Only the low-speed format is available when performing VLL operations on Storage Navigator (and LDEV format operations on SVP Maintenance). ***Note:*** If mode 503 is ON, since the format processing is prevented, the High Speed Format function for VLL operations (mode 269 ON) is not available. For details on the relationship between modes 503 and 269, see Table 3-2 and Table 3-3 below. ***Note:*** Mode 269 is effective only when using the SVP to format the CVS.	OFF	–
278	Open	Tru64 (Host Mode 07) and OpenVMS (Host Mode 05) ***Caution:*** Host offline: Required	OFF	–
292	TrueCopy for z/OS	Issuing OLS when Switching Port When the mainframe host (FICON) is connected with the CNT-made FC switch (e.g., FC9000) and is using along with the TrueCopy for z/OS with Open Fibre connection, the occurrence of Link Incident Report for the mainframe host from the FC switch will be deterred when switching the CHT port attribute (including automatic switching when executing CESTPATH and CDELPATH in case of mode 114 = ON). Mode 292 = ON: When switching the port attribute, issue the OLS (100 ms) first, and then reset the Chip. Mode 292 = OFF: When switching the port attribute, reset the Chip without issuing the OLS.	OFF	MCU/RCU
305	Mainframe	Pre-labeling: Pre-label is added via SVP as tentative volume serial name into logical device formatting.	OFF	–
313	Open	OPEN-V Geometry For OPEN-V and setting Host Mode Option 16 ON or System Option Mode 313 ON, the same geometry shared by USP V and USP/NSC can be responded to the host. When changing Mode 313 or Host Mode Option 16, the connecting server should be powered off. ***Caution:*** Host offline: Required	OFF	–
316	Open	Auto Negotiation in fixed speed. If signal synchronizing has been unmatched for 2.6 seconds during Auto Negotiation, the fixed speed can be set as follows: Mode 316 = ON: 1 Gbps Mode 316 = OFF: 2 Gbps The mode should be set when a fixed speed of Auto Negotiation is needed though the transfer speed may slow down. The mode is available for CHT PCB.	OFF	–

Mode	Category	Function	Default	MCU/RCU
346	Open	If an HBA containing HP WWN being connected, the LUN Security function is operational by setting system option mode 346. Mode 346 = ON: LUN Security is operational without host mode setting restriction. Mode 346 = OFF: LUN Security is operational only when host mode 03 is set to ON. ***Note:*** For a new storage system, system option mode 346 ON can be set as the default setting. ***Caution:*** For a storage system in use, you must shut down the server in order to set mode 346 ON in this HBA configuration: 1. Shut down the server. 2. Set mode 346 to ON. 3. Power on the server. 4. Check whether any problems exist.	OFF	–
448	Universal Replicator Universal Replicator for z/OS	Mode 448 = ON: (Enabled) If the SVP detects a blocked path, the SVP assumes that an error occurred and immediately splits (suspends) the mirror. Mode 448 = OFF: (Disabled) If the SVP detects a blocked path and the path does not recover within the specified period of time, the SVP assumes that an error occurred and splits (suspends) the mirror. ***Note:*** The mode 448 setting takes effect only when mode 449 is set to OFF.	OFF	–
449	Universal Replicator Universal Replicator for z/OS	Detecting and monitoring path blockade between MCU and RCU of UR/URz. Mode 449 = ON: Detecting and monitoring of path blockade will NOT be performed. Mode 449 = OFF: Detecting and monitoring of the path blockade will be performed.	OFF	–
454	Virtual Partition Manager	When making a destage schedule for CLPRs, using the average workload of all the CLPRs or the highest workload of those of the CLPRs can be optional. Mode 454 = ON: The average workload of all the CLPRs is used to make the destage schedule. Mode 454 = OFF: The highest workload of those of the CLPRs is used to make the destage schedule. ***Note:*** The priority of the destage processing for a specific CLPR in the overloaded status decreases and the overloaded status is not released so that TOV (MIH) may occur.	OFF	–
459	ShadowImage for z/OS ShadowImage	When the secondary volume of an SI/SIz pair is an external volume, the transaction to change the status from SP-PEND to SPLIT is as follows: (1) Mode 459 = ON when creating an SI/SIz pair: The copy data is created in cache memory. When the write processing on the external storage completes and the data is fixed, the pair status will change to SPLIT. (2) Mode 459 = OFF when creating an SI/SIz pair Once the copy data has been created in cache memory, the pair status will change to SPLIT. The external storage data is not fixed (current spec).	OFF	–

Mode	Category	Function	Default	MCU/RCU
460	SM SVP	When turning off PS, the control information of the following software stored in shared memory will be backed up in SVP. After that, when performing volatile PS ON, the control information will be restored into shared memory from SVP. TrueCopy, TrueCopy for z/OS, ShadowImage, ShadowImage for z/OS, Volume Migration, FlashCopy, Universal Replicator, Universal Replicator for z/OS, COW Snapshot Setting Mode 460 to ON is required to enable the function. ***Note:*** This support only applies to the case of volatile PS ON after PS OFF. As usual, power outage, offline micro-program exchange, DCI and System Tuning are not supported. ***Note:*** Since PS-OFF/ON takes up to 25 minutes, when using power monitoring devices (PCI, etc.), it is required to take enough time for PS-OFF/ON.	OFF	–
464	TrueCopy for z/OS	SIM Report without Inflow Limit For TrueCopy for z/OS, the SIM report for the volume without inflow limit is available when mode 464 is set to ON. SIM: RC=490x-yy (x=CU#, yy=LDEV#)	OFF	MCU
466	UR/URz	For UR/URz operations it is strongly recommended that the path between main and remote storage systems have a minimum data transfer speed of 100 Mbps. If the data transfer speed falls to 10 Mbps or lower, UR operations cannot be properly processed. As a result, many retries occur and UR pairs may be suspended. Mode 466 is provided to ensure proper system operation for data transfer speeds of at least 10 Mbps. Mode 466 = ON: Data transfer speeds of 10 Mbps and higher are supported. The JNL read is performed with 4-multiplexed read size of 256 KB. Mode 466 = OFF: For conventional operations. Data transfer speeds of 100 Mbps and higher are supported. The JNL read is performed with 32-multiplexed read size of 1 MB by default. ***Note:*** The data transfer speed can be changed using the Change JNL Group options.	OFF	–
467	SI/SIz, FlashCopy, COW Snapshot, Volume Migration, Universal Volume Manager	For the following features, the current copy processing slows down when the percentage of “dirty” data is 60% or higher, and it stops when the percentage is 75% or higher. Mode 467 is provided to prevent the percentage from exceeding 60%, so that the host performance is not affected. ShadowImage, ShadowImage for z/OS, FlashCopy, Copy-on-Write SnapShot, Volume Migration, Universal Volume Manager Mode 467 = ON: Copy overload prevention. Copy processing stops when the percentage of “dirty” data reaches 60% or higher. When the percentage falls below 60%, copy processing restarts. Mode 467 = OFF: Normal operation. The copy processing slows down if the dirty percentage is 60% or larger, and it stops if the dirty percentage is 75% or larger. ***Caution:*** This mode must always be set to ON when using an external volume as the secondary volume of any of the above-mentioned replication products. ***Note:*** It takes longer to finish the copy processing because it stops for prioritizing the host I/O performance.	ON	–

Mode	Category	Function	Default	MCU/RCU
471	Common	SIMs that require action only by the user and not maintenance personnel are displayed on the Information of SVP and Storage Navigator and are not reported to maintenance personnel. This mode is provided for sites where it is required to report all SIMs to maintenance personnel. Mode 471 = ON: Report SIMs to maintenance personnel. Mode 471 = OFF: Not report SIMs to maintenance personnel.	OFF	–
474	Universal Replicator for z/OS	Reduce UR for z/OS initial copy time for better performance by using the TC for z/OS initial copy operation. Mode 474 = ON: For a suspended URz pair, a dedicated script can be used to create a TC z pair on the same P-VOL and S-VOL as the URz pair to shorten the initial copy time. Mode 474 = OFF: For a suspended URz pair, a dedicated script cannot be used to create a TC for z/OS pair on the same P-VOL and S-VOL of the UR for z/OS pair to shorten the UR for z/OS initial copy time.	OFF	MCU/RCU
481	OPEN	Display the detail of Identifier Type=1 of Inquiry P83 (for Windows Vista). Mode 481 = ON: Not display the detail of Identifier Type=1 of Inquiry Page 83. Mode 481 = OFF: Display the detail of Identifier Type=1 of Inquiry Page 83. ***Note:*** System option mode 312 must be OFF to use this mode.	OFF	–
484	TrueCopy for z/OS	Display the information of PPRC path QUERY in FC interface format. Previously, the PPRC path QUERY information was only displayed in ESCON interface format even when the path was FC link. When IBM host functions (e.g., PPRC, GDPS) are being used, mode 484 can be enabled to display the PPRC path QUERY information in FC interface format. Mode 484 = ON: Display information of PPRC path QUERY in FC interface format. Mode 484 = OFF: Display information of PPRC path QUERY in ESCON interface format.	OFF	MCU/RCU
491	ShadowImage ShadowImage for z/OS FlashCopy V1	Improve the performance of ShadowImage, ShadowImage for z/OS, and FlashCopy version 1. Mode 491 = ON: The option (Reserve 05) of SI/SIz is available. When this option is set to ON, copy operations (SI, SIz, FCv1) are increased from 64 processes to 128 processes for improved performance. Mode 491 = OFF: The option (Reserve 05) of SI/SIz is not available. The copy operations (SI, SIz, FCv1) are performed with 64 processes. ***Notes:*** ▪ Mode 491 requires at least three BED features. If there are less than three BED features, mode 491 is not effective. ▪ Enable mode 491 when the performance of ShadowImage, ShadowImage for z/OS, and/or is considered to be important. ▪ Do not enable mode 491 when host I/O performance is considered to be important. ▪ When mode 491 is ON, set mode 467 to OFF. If mode 467 is ON, the performance may not improve.	OFF	–

Mode	Category	Function	Default	MCU/RCU
493	Mainframe	The CUIR function requires that the SA_ID reported to the host is unique. The SA_ID value cannot be changed during online operations. To change the SA_ID value from normal to unique, set mode 493 to ON and then perform a power cycle*. Setting mode 493 to ON without performing a power cycle does not enable the function. *Power cycle includes PS-OFF/ON (volatile/non-volatile), start-up after breaker OFF/ON, or offline micro-program exchange. Mode 493 = ON: When mode 493 is ON and a power cycle is performed, a unique SA_ID value for each port is reported to the host. Mode 493 = OFF: When mode 493 is OFF and a power cycle is performed, and 2107 port is not set, normal SA_ID values are reported to the host. When 2107 emulation is set, the SA_ID value of mainframe PCB port remains unique even after setting mode 493 to OFF and then performing a power cycle. ***Caution:*** Power cycle is required.	OFF	–
494	Mainframe	Enables CUIR processing when replacing a FICON PCB. Mode 494 = ON: CUIR processing is available when replacing a FICON PCB, but only when mode 493 is ON and a power cycle* is performed to enable the SA_ID unique mode. *Power cycle includes PS-OFF/ON (volatile/non-volatile), start-up after breaker OFF/ON, or offline micro-program exchange. Mode 494 = OFF: CUIR processing is not available. ***Caution:*** Power cycle is required.	OFF	–
498	OPEN	One path performance improvement for the OPEN random read. Mode 498 = ON: One path performance improvement for the OPEN random read is available. Mode 498 = OFF: One path performance improvement for the OPEN random read is not available. ***Notes:*** ▪ When mode 498 is ON, the maximum performance of CHP is improved, which icreases the number of I/Os to the back-end (DKP, HDD, external initiator MP, external storage). Because of this, back-end performance must be checked to make sure it is sufficient. If back-end performance is insufficient, a timeout may occur due to a bottleneck in the back-end. ▪ When a bottleneck occurs in the back-end, the performance may be worse than when mode 498 is OFF.	OFF	–

Mode	Category	Function	Default	MCU/RCU
503	Common	For the Install CV, Make Volume, and Volume Initialize functions of Virtual LVI/LUN, after LDEVs are installed, LDEV format is suppressed, and a blocked LDEV is created. Also, VLL operations and the UVM Add LU and Delete LU operations are available even when an LDEV is blocked or being formatted. Mode 503 = ON: VLL operations with LDEV format suppressed are available, and VLL operations can be performed when an LDEV is blocked. Mode 503 = OFF: After LDEV installation using VLL, LDEV format is performed, and VLL operations cannot be performed when an LDEV is blocked. ***Notes:*** ▪ When mode 503 is ON, LDEV format processing is prevented, so the High Speed Format function for VLL operations (mode 269) is not available. For details about the relationship between mode 503 and mode 269, see Table 3-2 and Table 3-3 below. ▪ When a PDEV is blocked or a correction copy is in progress, VLL operations cannot be performed.	OFF	–
505	VPM	Speed up changing CLPR cache assignment, and reduce the processing time to a maximum of one minute per 1 GB. Mode 505 = ON: Speed up changing CLPR cache assignment (max 1 minute per 1 GB). Mode 505 = OFF: Speed of changing CLPR cache assignment is normal (max 5 minutes per 1 GB).	OFF	–
530	Universal Replicator for z/OS	When a UR for z/OS pair is in the duplex state, this option switches the display of Consistency Time (C/T) between the values at JNL restore completion and at JNL copy completion. Mode 530 = ON: C/T displays the value of when JNL copy is completed. Mode 530 = OFF: C/T displays the value of when JNL restore is completed. ***Note:*** At the time of Purge suspend or RCU failure suspend, the C/T of UR for z/OS displayed by Business Continuity Manager or Storage Navigator may show earlier time than the time shown when the pair was in the duplex state.	OFF	RCU
531	OPEN and mainframe	When PIN data is generated, the SIM currently stored in SVP is reported to the host. Mode 531 = ON: The SIM for PIN data generation is stored in SVP and reported to the host. Mode 531 = OFF: The SIM for PIN data generation is stored in SVP only, not reported to the host, the same as the current specification.	OFF	MCU/RCU
545	Mainframe	When creating the record #0 field, this option is used to allow the record #0 format with the WRFTK (x95) command in the case the CCHH of Count part transferred from the host differs from the CCHH of the currently accessed track address. Mode 545 = ON: The record #0 format is allowed. Mode 545 = OFF: The record #0 format is not allowed. ***Note:*** Use this mode when CU type 2107 is used, or INVALID TRACK FORMAT ERROR occurs on VM MINIDISK.	OFF	MCU

Mode	Category	Function	Default	MCU/RCU
676	Audit Log	Store an audit log on the system disk as specified by the user. Mode 676 = ON: Store an audit log onto the system disk. Mode 676 = OFF: Do not store an audit log onto the system disk.	OFF	–
677	OPEN and mainframe	This option is used not to perform SM backup for saving battery consumption after planned PS Off. Mode 677 = ON: Mode 677 is available only when Mode 460 is ON. When planned PS Off ends normally and the SM information is successfully saved in SVP, the following operations are performed according to the model: ▪ USP V, USP VM model: Battery is not used for SM backup. ▪ NSC model: BASE PCB is powered off. Mode 677 = OFF: Although planned PS Off ends normally, battery is used for SM backup. ***Note:*** This option is recommended when PS Off that exceeds the backup time is performed, or where NSC model is used.	OFF	MCU/RCU
685	OPEN and mainframe	This option treats the blocakde of cache module group as that of cache PCB to prevent performance degradation. Mode 685 = ON: Cache module group blockade is treated as Cache PCB blockade. Mode 685 = OFF: Cache module group blockade is treated as Cache PCB blockade when the blocked part reaches 75% of the Cache capacity. ***Notes:*** ▪ This mode must not be set to ON in the device containing only two Cache PCBs because the performance greatly degrades with the device where only two Cache PCBs are mounted since only one side of the cluster can be used due to the Cache PCB blockade. ▪ Since the failure of a cache module group is treated as the failure of a cache PCB, the unavailable cache capacity is the capacity of the entire PCB, instead of that of the failed module group.	OFF	MCU/RCU
689	TrueCopy and TrueCopy for z/OS	This option is used to prevent the initial copy operation when the Write Pending rate on RCU exceeds 60%. Mode 689 = ON: The initial copy operation is prevented when the Write Pending rate on RCU exceeds 60%. Mode 689 = OFF: The initial copy operation is not prevented when the Write Pending rate on RCU exceeds 60% (the same as before). ***Notes:*** ▪ This mode can be set online. ▪ The micro-programs on both MCU and RCU must support this mode. ▪ This mode should be set per customer's requests. ▪ If the Write Pending status long keeps 60% or more on RCU, it takes extra time for the initial copy to be completed by making up for the prevented copy operation.	OFF	MCU/RCU

Mode	Category	Function	Default	MCU/RCU
690	Universal Replicator and Universal Replicator for z/OS	This option is used to prevent Read JNL or JNL Restore when the Write Pending rate on RCU exceeds 60% as follows: ▪ When CLPR of JNL-Volume exceeds 60%, Read JNL is prevented. ▪ When CLPR of Data (secondary)-Volume exceeds 60%, JNL Restore is prevented. Mode 690 = ON: Read JNL or JNL Restore is prevented when the Write Pending rate on RCU exceeds 60%. Mode 690 = OFF: Read JNL or JNL Restore is not prevented when the Write Pending rate on RCU exceeds 60% (the same as before). ***Notes:*** ▪ This mode can be set online. ▪ This mode should be set per customer's requests. ▪ If the Write Pending status long keeps 60% or more on RCU, it takes extra time for the initial copy to be completed by making up for the prevented copy operation. ▪ If the Write Pending status long keeps 60% or more on RCU, the pair status may become Suspend due to the JNL-Vol being full.	OFF	RCU
697	TrueCopy Async, TrueCopy for z/OS Async, ShadowImage, ShadowImage for z/OS	This option prevents the SI Split command execution when the coordinated TCA pair status is Suspend, and its Consistency state is not guaranteed. Mode 697 = ON: SI Split is not executed when the coordinated TCA pair status is Suspend, and its Consistency state is not guaranteed. Mode 697 = OFF: SI Split is executed regardless of the pair status or Consistency state of the coordinated TCA. ***Note:*** This option should be applied only to prevent SI Split when the following conditions 1 and 2, or 1 and 3 are met. 1. TCA S-VOL and SI P-VOL coexist (for either mainframe or open). 2. The TCA that is coordinated with SI has not been in Suspend. 3. The TCA that is coordinated with SI is in Suspend, and its Consistency is not in the latest state.	OFF	MCU/RCU
701	Universal Volume Manager	This option is used to issue the Read command at the LU discovery operation using UVM. Mode 701 = ON: The Read command is issued at the LU discovery operation. Mode 701 = OFF: The Read command is not issued at the LU discovery operation. ***Notes:*** ▪ When the Open LDEV Guard attribute (VMA) is defined on an external device, set the system option to ON. ▪ When this option is set to ON, it takes longer time to complete the LU discovery. The amount of time depends on external storages. ▪ With this system option OFF, if searching for external devices with VMA set, the VMA information cannot be read.	OFF	–

Mode	Category	Function	Default	MCU/RCU
704	OPEN and mainframe	To reduce the chance of MIH, this option can reduce the priority of SI, VM, CoW Shapshot, Flash Copy or Resync copy internal IO requests so that host IO has a higher priority. This mode creates new work queues where these jobs can be assigned with a lower priority. Mode 704 = ON: Copy processing requested is registered into a newly created queue so that the processing is scheduled with lower priority than host I/O. Mode 704 = OFF: Copy processing requested is not registered into a newly created queue. Only the existing queue is used. Note: If the PDEV is highly loaded, the priority of Read/Write processing made by SI, VM, CoW Shapshot, Flash Copy or Resync may become lower. As a consequence the copy speed may be slower.	OFF	–

Table 3-2 Modes 503 and 269: Storage Navigator Operations

Mode 503	Operation	Target of Operation	Mode 269	
			ON	OFF
ON	Virtual LVI/LUN (CVS)	All LDEVs in a PG	No format	No format
	Virtual LVI/LUN (CVS)	Some LDEVs in a PG	No format	No format
	Format	PG is specified	No operation	No operation
	Format	All LDEVs in a PG	Low speed	Low speed
	Format	Some LDEVs in a PG	Low speed	Low speed
OFF	Virtual LVI/LUN (CVS)	All LDEVs in a PG	High speed	Low speed
	Virtual LVI/LUN (CVS)	Some LDEVs in a PG	Low speed	Low speed
	Format	PG is specified	No operation	No operation
	Format	All LDEVs in a PG	Low speed	Low speed
	Format	Some LDEVs in a PG	Low speed	Low speed

Table 3-3 Modes 503 and 269: SVP Operations

Mode 503	Operation	Target of Operation	Mode 269	
			ON	OFF
ON	PDEV Addition	-	High speed	High speed
	Virtual LVI/LUN (CVS)	All LDEVs in a PG	No format	No format
	Virtual LVI/LUN (CVS)	Some LDEVs in a PG	No format	No format
	Format	PG is specified	High speed	High speed
	Format	All LDEVs in a PG	High speed	Low speed
	Format	Some LDEVs in a PG	Low speed	Low speed
OFF	PDEV Addition	-	High speed	High speed
	Virtual LVI/LUN (CVS)	All LDEVs in a PG	High speed	Low speed
	Virtual LVI/LUN (CVS)	Some LDEVs in a PG	Low speed	Low speed
	Format	PG is specified	High speed	High speed
	Format	All LDEVs in a PG	High speed	Low speed
	Format	Some LDEVs in a PG	Low speed	Low speed

Host Modes and Host Mode Options

The Universal Storage Platform V/VM supports connection of multiple server hosts of different platforms to each of its ports. When your system is configured, the hosts connected to each port are grouped by host group or by target. For example, if Solaris and Windows hosts are connected to a fibre port, a host group is created for the Solaris hosts, another host group is created for the Windows hosts, and the appropriate host mode and host mode options are assigned to each host group. The host modes and host mode options provide enhanced compatibility with supported platforms and environments.

The host groups, host modes, and host mode options are configured using the LUN Manager software on Storage Navigator. For further information on host groups, host modes, and host mode options, refer to the *LUN Manager User's Guide* (MK-96RD615).

Mainframe Operations

Mainframe Compatibility and Functionality

In addition to full System-Managed Storage (SMS) compatibility, the Universal Storage Platform V and VM provide the following functionalities and support in the mainframe environment:

- Sequential data striping
- Cache fast write (CFW) and DASD fast write (DFW)
- Enhanced dynamic cache management
- Extended count key data (ECKD) commands
- Multiple Allegiance
- Concurrent Copy (CC)
- Peer-to-Peer Remote Copy (PPRC)
- FlashCopy
- Parallel Access Volume (PAV)
- Enhanced CCW
- Priority I/O queuing
- Red Hat Linux for IBM S/390® and zSeries®

Mainframe Operating System Support

Table 3-4 lists the mainframe operating systems currently supported by the Universal Storage Platform V and VM storage systems. Please contact your Hitachi Data Systems account team for the latest information on mainframe operating system support.

Table 3-4 Mainframe Operating System Support

Vendor	Operating System(s)	Document
IBM	OS/390	*Mainframe Host Attachment and Operations Guide*, MK-96RD645
	MVS/ESA, MVS/XA	
	VM/ESA, VSE/ESA	
	z/OS, z/OS.e, z/VM, z/VSE	
Red Hat	Linux for IBM S/390 and zSeries	
Fujitsu	MSP	

Mainframe Configuration

After physical installation of the Universal Storage Platform V or VM storage system has been completed, the user configures the storage system for mainframe operations with assistance as needed from the Hitachi Data Systems representative.

Please refer to the following user documents for information and instructions on configuring your USP V/VM storage system for mainframe operations:

- The *Mainframe Host Attachment and Operations Guide* (MK-96RD645) describes and provides instructions for configuring the USP V/VM for mainframe operations, including FICON and ESCON attachment, hardware definition, cache operations, and device operations.

  For detailed information on FICON connectivity, FICON/Open intermix configurations, and supported HBAs, switches, and directors for the USP V and VM, please contact your Hitachi Data Systems account team.

- The *Storage Navigator User's Guide* (MK-96RD621) provides instructions for installing, configuring, and using Storage Navigator to perform resource and data management operations on the USP V/VM storage system(s).

- The *Virtual LVI/LUN and Volume Shredder User's Guide* (MK-96RD630) provides instructions for converting single volumes (LVIs) into multiple smaller volumes to improve data access performance.

Open-Systems Operations

Open-Systems Compatibility and Functionality

The Universal Storage Platform V/VM supports and offers many features and functions for the open-systems environment, including:

- Multi-initiator I/O configurations in which multiple host systems are attached to the same fibre-channel interface
- Fibre-channel arbitrated-loop (FC-AL) and fabric topologies
- Command tag queuing
- Industry-standard failover and logical volume management software
- SNMP remote storage system management

The Universal Storage Platform V/VM's global cache enables any fibre-channel port to have access to any LU in the storage system. In the USP V/VM, each LU can be assigned to multiple fibre-channel ports to provide I/O path failover and/or load balancing (with the appropriate middleware support, such as HGLAM) without sacrificing cache coherency.

The user should plan for path failover (alternate pathing) to ensure the highest data availability. The LUs can be mapped for access from multiple ports and/or multiple target IDs. The number of connected hosts is limited only by the number of FC ports installed and the requirement for alternate pathing within each host. If possible, the primary path and alternate path(s) should be attached to different channel cards.

Open-Systems Host Platform Support

Table 3-5 lists the open-systems host platforms supported by the USP V/VM and the corresponding Configuration Guide for each host platform. The Configuration Guides provide information and instructions on configuring the USP V/VM disk devices for open-systems operations.

Table 3-5 Open-Systems Platforms and Configuration Guides

Platform	Configuration Guide
UNIX-Based Platforms	
IBM AIX *	MK-96RD636
HP-UX®	MK-96RD638
Sun Solaris	MK-96RD632
SGI IRIX	MK-96RD651
HP Tru64 UNIX	MK-96RD654
HP OpenVMS	MK-96RD653
PC Server Platforms	
Windows	MK-96RD639
Novell NetWare	MK-96RD652
Linux Platforms	
Red Hat Linux	MK-96RD640
SuSE Linux	MK-96RD650
VMware	MK-96RD649

*__Note:__ The AIX ODM updates are included on the Product Documentation Library (PDL) CDs that come with the Hitachi USP V and VM.

Open-Systems Configuration

After physical installation of the Universal Storage Platform V/VM has been completed, the user configures the storage system for open-systems operations with assistance as needed from the Hitachi Data Systems representative.

Please refer to the following user documents for information and instructions on configuring your USP V/VM storage system for open-systems operations:

- The *Configuration Guides for Host Attachment* (listed in Table 3-5 above) provide information and instructions on configuring the USP V/VM storage system and disk devices for attachment to the open-systems hosts.

  Note: The queue depth and other parameters may need to be adjusted for the USP V/VM devices. Refer to the appropriate Configuration Guide for queue depth and other requirements.

- The *Storage Navigator User's Guide* (MK-96RD621) provides instructions for installing, configuring, and using Storage Navigator to perform resource and data management operations on the USP V/VM storage system(s).

- The *Hitachi LUN Manager User's Guide* (MK-96RD645) describes and provides instructions for configuring the USP V/VM for host operations, including FC port configuration, LUN mapping, host groups, host modes and host mode options, and LUN Security.

  Each fibre-channel port on the USP V/VM provides addressing capabilities for up to 2,048 LUNs across as many as 255 host groups, each with its own LUN 0, host mode, and host mode options. Multiple host groups are supported using LUN Security.

- The *Hitachi SNMP Agent User and Reference Guide* (MK-96RD620) describes the SNMP API interface for the USP V/VM storage systems and provides instructions for configuring and performing SNMP operations.

- The *Virtual LVI/LUN and Volume Shredder User's Guide* (MK-96RD630) provides instructions for configuring multiple custom volumes (LUs) under single LDEVs on the USP V/VM storage system.

- The *LUN Expansion User's Guide* (MK-96RD616) provides instructions for configuring size-expanded LUs on the USP V/VM storage system by concatenating multiple LUs to form individual large LUs.

Battery Backup Operations

Figure 3-6 illustrates the two types of backup operations: backup mode and destage mode.

Backup Mode (USP V and VM)

When backup mode is chosen and a power failure occurs, storage system operations will continue normally for 200 milliseconds. If the power failure exceeds 200 ms, the storage system uses power from the batteries to back up the cache memory and shared memory for 36 hours or 48 hours, depending on the amount of cache memory.

Destage Mode (USP V only)

When destage mode is chosen and a power failure occurs, storage system operations will continue normally for 1 minute. If the power failure exceeds 1 minute, the storage system uses power from the batteries to destage the data from cache memory onto the disk drives and back up the cache memory and shared memory for 18 hours or 24 hours, depending on the amount of cache memory.

Destage mode requires the 56V battery option (DKC-F610I-ABX).

Note: Destage mode is not supported in the following cases:

– When external storage is connected

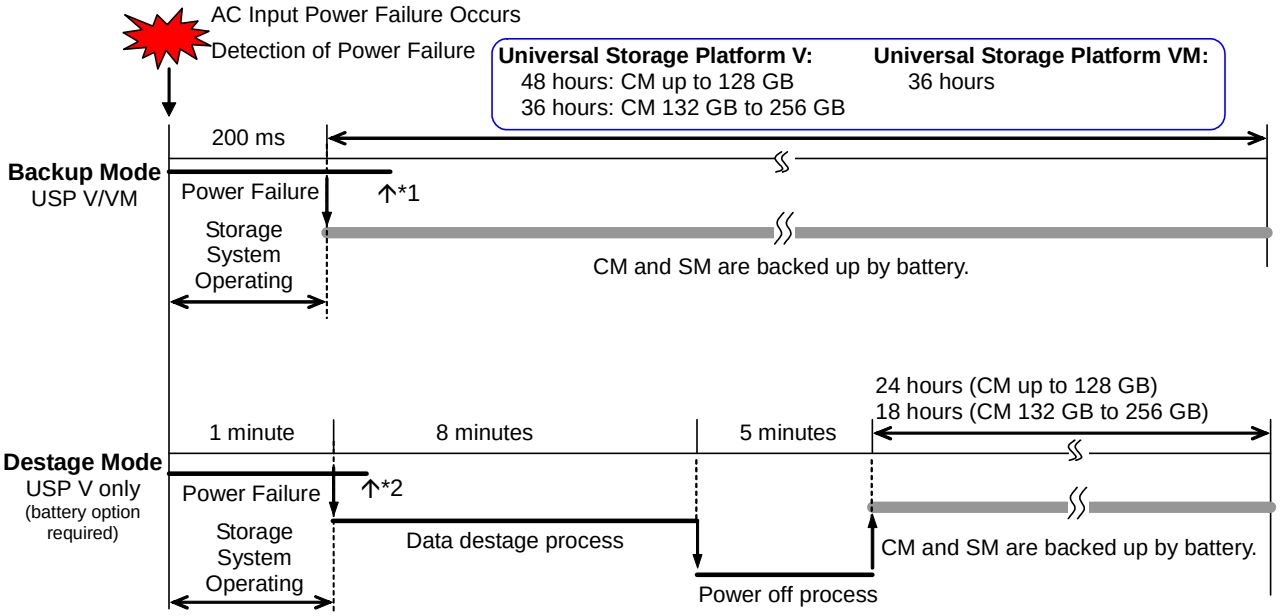
– When Cache Residency Manager BIND mode is applied.

Battery Charge

If the battery is not fully charged when a power failure occurs, the backup processes are affected as follows:

– Backup mode: The backup time becomes short (less than 36/48 hours).

– Destage mode: The destage process may not be possible until the battery charging is complete, and the backup time may also become short (less than 18/24 hours).



Notes:

4. When power is recovered after a failure while backup power is being supplied by battery, the storage system operates depending on the status of the Auto-Power-On JP on the Operator panel:

   ENABLE: The storage system is powered on automatically.
   DISABLE: The storage system is powered on by operating the Power ON/OFF switch or the PCI.

5. When power is recovered after a failure during the destage process, the destage and power-off processes are executed.

Figure 3-6 Battery Backup Processes for Power Failure

4

Troubleshooting

This chapter provides basic troubleshooting information for the Universal Storage Platform V/VM and instructions for calling technical support.

General Troubleshooting

The Hitachi Universal Storage Platform V and VM storage systems are not expected to fail in any way that would prevent access to user data. The READY LED on the control panel must be **ON** when the storage system is operating online.

Table 4-1 lists potential error conditions and provides recommended actions for resolving each condition. If you are unable to resolve an error condition, contact your Hitachi Data Systems representative, or call the Hitachi Data Systems Support Center for assistance.

Table 4-1 Troubleshooting

Error Condition	Recommended Action
Error message displayed.	Determine the type of error (refer to the SIM codes section. If possible, remove the cause of the error. If you cannot correct the error condition, call the Hitachi Data Systems Support Center for assistance.
General power failure.	Call the Hitachi Data Systems Support Center for assistance. ***WARNING:*** Do not open the Universal Storage Platform V control frame or touch any of the controls.
Fence message is displayed on the console.	Determine if there is a failed storage path. If so, toggle the RESTART switch, and retry the operation. If the fence message is displayed again, call the Hitachi Data Systems Support Center for assistance.
READY LED does not go on, or there is no power supplied.	Call the Hitachi Data Systems Support Center for assistance. ***WARNING:*** Do not open the Universal Storage Platform V control frame or touch any of the controls.
Emergency (fire, earthquake, flood, etc.)	Pull the emergency power-off (EPO) switch. You must call the Hitachi Data Systems Support Center to have the EPO switch reset.
ALARM LED is on.	If there is a temperature problem in the area, power down the storage system, lower the room temperature to the specified operating range, and power on the storage system. Call the Hitachi Data Systems Support Center for assistance with power off/on operations. If the area temperature is not the cause of the alarm, call the Hitachi Data Systems Support Center for assistance.

Service Information Messages

The Universal Storage Platform V and VM generate service information messages (SIMs) to identify normal operations (for example, TrueCopy pair status change) as well as service requirements and errors or failures. For assistance with SIMs, please call the Hitachi Data Systems Support Center.

SIMs can be generated by the front-end and back-end directors and by the SVP. All SIMs generated by the USP V/VM are stored on the SVP for use by Hitachi Data Systems personnel, logged in the SYS1.LOGREC dataset of the mainframe host system, displayed by the Storage Navigator software, and reported over SNMP to the open-system host. The SIM display on Storage Navigator enables users to remotely view the SIMs reported by the attached storage systems. Each time a SIM is generated, the amber Message LED on the control panel turns on. The Hi-Track remote maintenance tool also reports all SIMs to the Hitachi Data Systems Support Center.

SIMs are classified according to severity: service, moderate, serious, or acute. The service and moderate SIMs (lowest severity) do not require immediate attention and are addressed during routine maintenance. The serious and acute SIMs (highest severity) are reported to the mainframe host(s) once every eight hours.

Note: If a serious or acute-level SIM is reported, call the Hitachi Data Systems Support Center immediately to ensure that the problem is being addressed.

Figure 4-1 illustrates a typical 32-byte SIM from the USP V/VM. SIMs are displayed by reference code (RC) and severity. The six-digit RC, which is composed of bytes 22, 23, and 13, identifies the possible error and determines the severity. The SIM type, located in byte 28, indicates which component experienced the error.

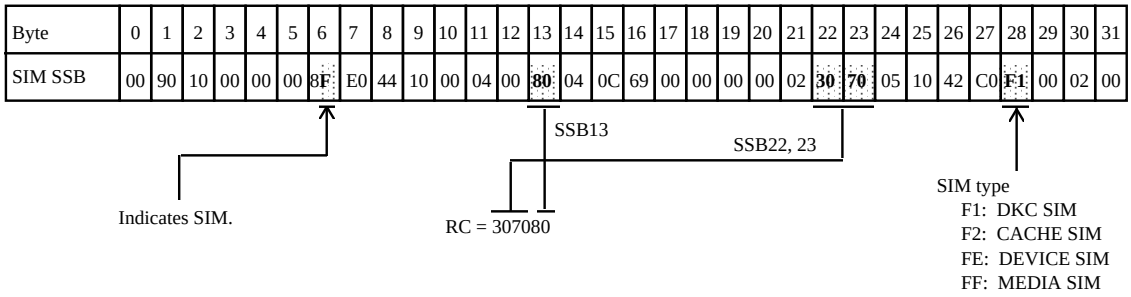


Figure 4-1 Typical SIM Showing Reference Code and SIM Type

Calling the Hitachi Data Systems Support Center

If you need to call the Hitachi Data Systems Support Center, make sure to provide as much information about the problem as possible, including:

- The circumstances surrounding the error or failure
- The exact content of any error messages displayed on the host system(s)
- The error code(s) displayed on the Storage Navigator
- The service information messages (SIMs) displayed on the Storage Navigator and the reference codes and severity levels of the recent SIMs

The Hitachi Data Systems customer support staff is available 24 hours/day, seven days a week. If you need technical support, please call:

- United States: (800) 446-0744
- Outside the United States: (858) 547-4526

A

Units and Unit Conversions

Table A-1 provides conversions for standard (U.S.) and metric units of measure associated with the Universal Storage Platform V/VM storage systems.

Table A-1 Conversions for Standard (U.S.) and Metric Units of Measure

From	Multiply By:	To Get:
British thermal units (BTU)	0.251996	Kilocalories (kcal)
British thermal units (BTU)	0.000293018	Kilowatts (kW)
Inches (in)	2.54000508	Centimeters (cm)
Feet (ft)	0.3048006096	Meters (m)
Square feet (ft^2)	0.09290341	Square meters (m^2)
Cubic feet per minute (ft^3/min)	0.028317016	Cubic meters per minute (m^3/min)
Pound (lb)	0.4535924277	Kilogram (kg)
Kilocalories (kcal)	3.96832	British thermal units (BTU)
Kilocalories (kcal)	1.16279×10^{-3}	Kilowatts (kW)
Kilowatts (kW)	3412.08	British thermal units (BTU)
Kilowatts (kW)	859.828	Kilocalories (kcal)
Millimeters (mm)	0.03937	Inches (in)
Centimeters (cm)	0.3937	Inches (in)
Meters (m)	39.369996	Inches (in)
Meters (m)	3.280833	Feet (ft)
Square meters (m^2)	10.76387	Square feet (ft^2)
Cubic meters per minute (m^3/min)	35.314445	Cubic feet per minute (ft^3/min)
Kilograms (kg)	2.2046	Pounds (lb)
Ton (refrigerated)	12,000	BTUs per hour (BTU/hr)
Degrees Fahrenheit (°F)	First subtract 32, then multiply: °C = (°F - 32) × 0.555556	Degrees Celsius (°C)
Degrees Celsius (°C)	First multiply, then add 32: °F = (°C × 1.8) + 32	Degrees Fahrenheit (°F)
Degrees Fahrenheit per hour (°F/hour)	0.555555	Degrees Celsius per hour (°C/hour)
Degrees Celsius per hour (°C/hour)	1.8	Degrees Fahrenheit per hour (°F/hour)

Acronyms and Abbreviations

A	ampere
ACP	array control processor (another name for back-end director)
ASTM	American Society for Testing and Materials
ATA	Advanced Technology Attachment standard
AVE	average
BC	business continuity
BED	back-end director
BS	basic (power) supply
BSA	bus adapter
BTU	British thermal unit
°C	degrees Celsius
ca	cache
CC	Concurrent Copy
CCI	Command Control Interface
CD	compact disk
CEC	Canadian Electroacoustic Community
CFW	cache fast write
CH	channel
CHA	channel adapter
CHIP	client-host interface processor (another name for front-end director)
CHL	channel
CHP	channel processor (MPs on the FED features) or channel path
CHPID	channel path identifier
CIFS	common internet file system
CKD	count key data
CL	cluster
CLI	command line interface
CLPR	cache logical partition
CMA	cache memory adapter
CPU	central processing unit
CSA	Canadian Standards Association
CSW	cache switch, cache switch card
CU	control unit
CV	custom volume

CVS	Custom Volume Size (another name for Virtual LVI/LUN)
DASD	direct access storage device
dB(A)	decibel (A-weighted)
DFDSS	Data Facility Dataset Services
DFSMS	Data Facility System Managed Storage
DFW	DASD fast write
DKA	disk adapter
DKC	disk controller (DKC610 = USP V, DKC615 = USP VM)
DKP	disk processor (microprocessors on the BED features)
DKU	disk unit
DLM	data lifecycle management
DNS	domain name system
dr	drive
DRAM	dynamic random access memory
DSF	Device Support Facilities
DTDS+	Disaster Tolerant Storage System Plus
ECKD	Extended Count Key Data
EOF	end of field
EMI	electromagnetic interference
EPO	emergency power-off
EREP	Error Reporting
ESA	Enterprise Systems Architecture
ESCON	Enterprise System Connection (IBM trademark for optical channels)
ESS	Enterprise Storage Server®
ExSA	Extended Serial Adapter
FAL	File Access Library (part of the Cross-OS File Exchange software)
FBA	fixed-block architecture
FC	fibre-channel
FC-AL	fibre-channel arbitrated loop
FCC	Federal Communications Commission
FCP	fibre-channel protocol
FCU	File Conversion Utility (part of the Cross-OS File Exchange software)
FDR	Fast Dump/Restore
FED	front-end director
FICON	Fiber Connection
F/M	format/message
FWD	fast wide differential
FX	Hitachi Cross-OS File Exchange
g	acceleration of gravity (9.8 m/s^2) (unit used for vibration and shock)
Gb	gigabit
GB	gigabyte (see Convention for Storage Capacity Values)
Gbps, Gb/s	gigabit per second
GLM	gigabyte link module
GLPR	global logical partition
GUI	graphical user interface
HACMP	High Availability Cluster Multi-Processing
HBA	host bus adapter
HCD	hardware configuration definition
HDLM	HiCommand Dynamic Link Manager

HDS	Hitachi Data Systems
HDU	hard disk unit
HGLAM	HiCommand Global Link Availability Manager
Hi-Star	Hierarchical Star Network
HSN	Hierarchical Star Network
HWM	high-water mark
Hz	Hertz
ICKDSF	A DSF command used to perform media maintenance
IDCAMS	access method services (a component of Data Facility Product)
IML	initial microprogram load
in.	inch(es)
IO, I/O	input/output (operation or device)
IOCP	input/output configuration program
JCL	job control language
KB	kilobyte (see Convention for Storage Capacity Values)
kcal	kilocalorie
kg	kilogram
km	kilometer
kVA	kilovolt-ampere
kW	kilowatt
LAN	local area network
lb	pound
LD	logical device
LDEV	logical device
LED	light-emitting diode
LPAR	logical partition
LCP	link control processor, local control port
LRU	least recently used
LU	logical unit
LUN	logical unit number, logical unit
LVI	logical volume image
LVM	logical volume manager, Logical Volume Manager
LW	long wavelength
m	meter
MB	megabyte (see Convention for Storage Capacity Values)
MIH	missing interrupt handler
mm	millimeter
MP	microprocessor
MPLF	Multi-Path Locking Facility
MR	magnetoresistive
ms, msec	millisecond
MVS	Multiple Virtual Storage (including MVS/ESA, MVS/XA)
NBU	NetBackup (a VERITAS software product)
NEC	National Electrical Code
NFS	network file system
NIS	network information service
NTP	network time protocol
NVS	nonvolatile storage

ODM	Object Data Manager
OEM	original equipment manufacturer
OFC	open fibre control
ORM	online read margin
OS	operating system
PAV	Parallel Access Volume
PB	petabyte (see Convention for Storage Capacity Values)
PC	personal computer system
PCI	power control interface
P/DAS	PPRC/dynamic address switching (IBM mainframe software function)
PDEV	physical device
PDL	Product Documentation Library
PG	parity group
PPRC	Peer-to-Peer Remote Copy (an IBM mainframe host software function)
PS	power supply
RAB	RAID Advisory Board
RAID	redundant array of independent disks
RAM	random-access memory
RC	reference code
RISC	reduced instruction-set computer
R/W	read/write
S/390	IBM System/390 architecture
SAN	storage-area network
SATA	serial Advanced Technology Attachment standard
SCSI	small computer system interface
SCP	state-change pending
sec.	second
seq.	sequential
SFP	small form-factor pluggable
SGI	Silicon Graphics, Inc.
SI	ShadowImage
SIM	service information message
SIz	ShadowImage for z/OS
SLPR	storage logical partition
SMA	shared memory adapter
SMS	System Managed Storage
SNMP	simple network management protocol
SSID	storage system identification
SVP	service processor
SW	switch, short wavelength
TB	terabyte (see Convention for Storage Capacity Values)
T&B	Thomas & Betts
TC	TrueCopy
TCz	TrueCopy for z/OS
TID	target ID
TPF	Transaction Processing Facility
TSO	Time Sharing Option (an IBM mainframe operating system option)
UCB	unit control block

UIM	unit information module
UL	Underwriters' Laboratories
μm	micron, micrometer
USP V	Hitachi Universal Storage Platform V
USP VM	Hitachi Universal Storage Platform VM
VA	volt-ampere
VAC	volts AC
VCS	VERITAS Cluster Server
VDE	Verband Deutscher Elektrotechniker
VDEV	virtual device
VM	Virtual Machine (an IBM mainframe system control program)
VOLID	volume ID
volser	volume serial number
VSE	Virtual Storage Extension (an IBM mainframe operating system)
VTOC	volume table of contents
W	watt
WLM	Workload Manager (an IBM mainframe host software function)
XA	System/370 Extended Architecture
XDF	Extended Distance Feature (for ExSA channels)
XRC	Extended Remote Copy (an IBM mainframe host software function)

Index

Hitachi Data Systems

Corporate Headquarters
750 Central Expressway
Santa Clara, California 95050-2627
U.S.A.
Phone: 1 408 970 1000
www.hds.com
info@hds.com

Asia Pacific and Americas
750 Central Expressway
Santa Clara, California 95050-2627
U.S.A.
Phone: 1 408 970 1000
info@hds.com

Europe Headquarters
Sefton Park
Stoke Poges
Buckinghamshire SL2 4HD
United Kingdom
Phone: + 44 (0)1753 618000
info.eu@hds.com

Hitachi Data Systems

MK-96RD635-04