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Hitachi Unified Storage VM Block Module
Hitachi High Availability Manager User Guide

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MK-92HM7052-02

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Contents

Preface

This guide describes and provides instructions for planning, configuring, operating, monitoring, maintaining, and troubleshooting Hitachi High Availability Manager software on the Hitachi Unified Storage VM (HUS VM) storage system.

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

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 HUS VM storage system.

Readers of this document should meet the following requirements:

- Data processing and RAID storage systems and their basic functions.
- The Unified Storage VM storage system and the *Hitachi Unified Storage VM Block Module Hardware User Guide*.
- The Storage Navigator software for the Unified Storage VM and the *Hitachi Storage Navigator User Guide*.
- Remote replication and disaster recovery configurations for enterprise storage data centers.

Product version

This document revision applies to HUS VM microcode 73-03-3*x* or later.

Release notes

The Hitachi Unified Storage VM Release Notes provide information about the HUS VM microcode (DKCMAIN and SVP), including new features and functions and changes. The Release Notes are available on the Hitachi Data Systems Portal: https://portal.hds.com

Document revision level

Revision	Date	Description
MK-92HM7052-00	October 2013	Initial Release.
MK-92HM7052-01	November 2013	Supersedes and replaces MK92HM7052-00.
MK-92HM7052-02	September 2014	Supersedes and replaces MK92HM7052-01.

Changes in this revision

- New restrictions for using High Availability Manager in a cluster environment added in Using HAM in a cluster system on page 7-1.

Referenced documents

HUS VM documentation:

- *Hitachi ShadowImage® User Guide*, MK-92HM7013
- *Hitachi TrueCopy® User Guide*, MK-92HM7018
- *Hitachi Universal Replicator User Guide*, MK-92HM7019
- *Hitachi Storage Navigator User Guide*, MK-92HM7016
- *Command Control Interface User and Reference Guide*, MK-92HM7010

Document conventions

This document uses the following typographic conventions:

Convention	Description
Bold	Indicates the following: • Text in a window or dialog box, such as menus, menu options,buttons, and labels. Example: On the **Add Pair** dialog box, click **OK**. • Text appearing on screen or entered by the user. Example: The **-split** option. • The name of a directory, folder, or file. Example: The **horcm.conf** file.
Italic	Indicates a variable, which is a placeholder for actual text provided by the user or system. Example: copy *source-file target-file* Angle brackets are also used to indicate variables.
`Monospace`	Indicates text that is displayed on screen or entered by the user. Example: `# pairdisplay -g oradb`
< > angle brackets	Indicates a variable, which is a placeholder for actual text provided by the user or system. Example: `# pairdisplay -g <group>` Italic is also used to indicate variables.
[ ] square brackets	Indicates optional values. Example: [a | b] indicates that you can choose a, b, or nothing.
{ } braces	Indicates required or expected values. Example: { a | b } indicates that you must choose either a or b.
| vertical bar	Indicates that you have a choice between two or more options or arguments. Examples: [a | b] indicates that you can choose a, b, or nothing. { a | b } indicates that you must choose either a or b.

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

Icon	Meaning	Description
	Tip	Provides helpful information, guidelines, or suggestions for performing tasks more effectively.
	Note	Calls attention to important and/or additional information.
	Caution	Warns users of adverse conditions and consequences, such as disruptive operations.
	WARNING	Warns users of severe conditions and consequences, such as destructive operations.

Conventions for storage capacity values

Physical storage capacity values (for example, disk drive capacity) are calculated based on the following values:

Physical capacity unit	Value
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
1 EB	$1,000^6$ bytes

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

Logical capacity unit	Value
1 KB	1,024 bytes
1 MB	1,024 KB or $1,024^2$ bytes
1 GB	1,024 MB or $1,024^3$ bytes
1 TB	1,024 GB or $1,024^4$ bytes
1 PB	1,024 TB or $1,024^5$ bytes
1 EB	1,024 PB or $1,024^6$ bytes
1 block	512 bytes

Accessing product documentation

The HUS VM user documentation is available on the Hitachi Data Systems Support Portal: https://hdssupport.hds.com. Please check this site for the most current documentation, including important updates that may have been made after the release of the product.

Getting help

The Hitachi Data Systems customer support staff is available 24 hours a day, seven days a week. If you need technical support, log on to the Hitachi Data Systems Support Portal for contact information:https://portal.hds.com

Comments

Please send us your comments on this document: doc.comments@hds.com. Include the document title, number, and revision. Please refer to specific sections and paragraphs whenever possible. All comments become the property of Hitachi Data Systems.)

Thank you!

1

High Availability Manager overview

HAM ensures high availability of host applications used in Hitachi Unified Storage VM Block Module (HUS VM) storage systems. HAM provides protection against the loss of application availability when input and output (I/O) failures occur in the primary storage system by automatically switching host applications from the primary storage system to the secondary storage system and by enabling recovery from the failures that caused the I/O failure.

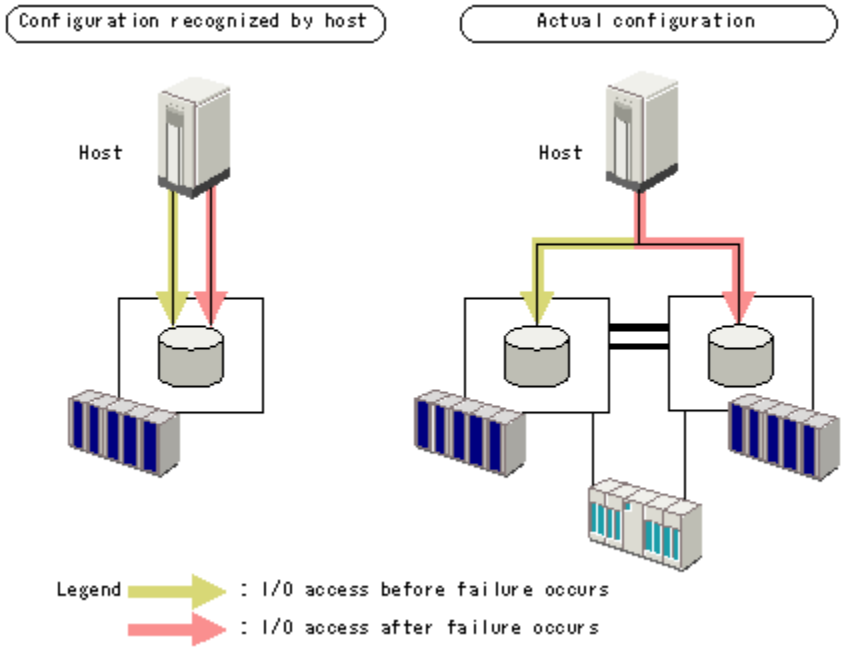
HAM is designed for recovery from on-site disasters such as power supply failure. TrueCopy is suited to large-scale disaster recovery.

How HAM works

HAM uses Hitachi TrueCopy® software to create a synchronous remote copy of a production volume. But where TrueCopy is suited to large-scale disaster recovery, HAM is intended for recovery from on-sight disasters such as power supply failure.

Because of this, HAM is configured differently than a typical TrueCopy configuration.

- The HAM primary and secondary storage systems are connected to the same host. When a HAM pair is created, the host sees the primary and secondary volumes as the same volume.
- HAM requires multipath software to be installed on the host. In the event that the host cannot access the production volume on the primary storage system, host I/O is redirected via the host multipath software to the secondary volume on the remote system. Failover is accomplished without stopping and restarting the application.



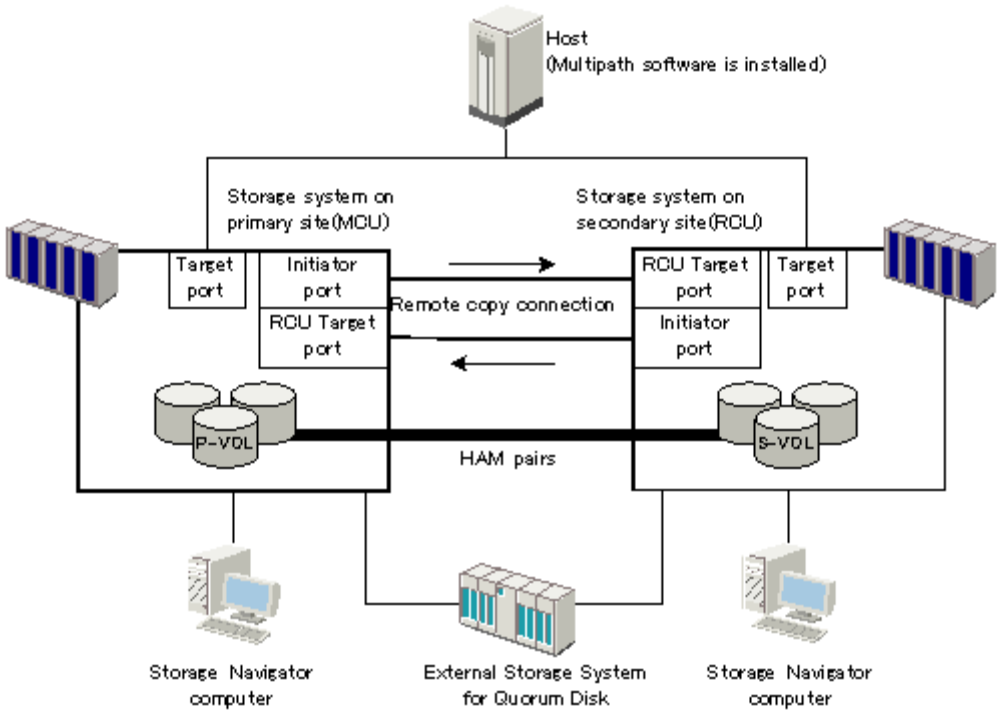
- HAM is used on open host systems only.
- A HAM pair consists of a primary data volume (P-VOL) on the primary storage system and a secondary data volume (S-VOL) on the secondary storage system (like TrueCopy). The S-VOL is the copy of the P-VOL.
- HAM uses a quorum disk located on an external storage system, which keeps track of consistency between the P-VOL and S-VOL. Consistency data is used in the event of an unexpected outage of the data path or primary storage system. In this case, the differential data in both systems is compared and, if the pairs are consistent, host operations continue on the secondary storage system.

HAM components

A typical configuration consists of two Hitachi Unified Storage VM Block Module storage systems installed at the primary and secondary sites. In addition, the HAM system consists of the following components:

- HAM and TrueCopy software, which are installed on both systems.
- A host server running a multipath software solution, qualified with HAM software, that is connected to both storage systems.
- Dedicated Fibre Channel data paths linking the primary and secondary storage systems, with Fibre Channel switches.
- A qualified external storage system to host the quorum disks. This storage system must be accessible to both the primary and secondary storage systems.
- The following interface tools for configuring and operating the pairs:
  - Hitachi Storage Navigator (SN) graphical user interface (GUI), located on a management LAN.
  - Command Control Interface (CCI), located on the host.

HAM components are illustrated in the following figure and described in more detail in the following topics.



HUS VM storage systems

HAM operations are conducted between Hitachi Unified Storage VM (HUS VM) and another storage system on the primary and secondary sites. The primary storage system consists of the main control unit (MCU) and service processor (SVP). The secondary storage system consists of the remote control unit (RCU) and SVP.

The primary storage system communicates with the secondary storage system over dedicated Fibre Channel remote copy connections.

Main and remote control units

Like TrueCopy, HAM replication relationships exist at the Logical Control Unit (LCU) level within the storage systems.

- Primary storage system LCUs containing the production volumes to be replicated are called MCUs (main control units).
- Secondary storage system LCUs containing the copy volumes are called remote control units (RCUs).

Normally the MCU contains the P-VOLs and the RCU contains the S-VOLs.

The MCU communicates with the RCU via the data path. You can simultaneously set P-VOL and S-VOL in the same storage system if the volumes are used by different pairs. In this case, the CU can function simultaneously as an MCU for the P-VOL and as an RCU for the S-VOL.

The MCU is often referred to as the primary storage system in this document; the RCU is often referred to as the secondary storage system.

Pair volumes

Original data from the host is stored in the P-VOL; the remote copy is stored in the S-VOL. Data is copied as it is written to the P-VOL; new updates are copied only when the previous updates are acknowledged in both primary and secondary volumes.

Once a pair is created, you can do the following:

- Split the pair, which suspends copy activity.
- Resynchronize the pair, which restores and maintains synchronization.
- Delete the pair, which removes the pair relationship, though not the data.

Data paths

The physical links between the primary and secondary storage systems are referred to as the "data path." These links include the Fibre Channel interface cables and switches. HAM commands and data are transmitted through the data path. The data path links the primary and secondary storage systems through two types of Fibre Channel ports, Initiator and RCU Target ports.

Because paths are one-directional, and HAM communicates in both directions, a minimum of two data paths are needed; however, Hitachi Data Systems requires a minimum of two in each direction for greater support and security of the data. A maximum of eight data paths in each direction are supported. Therefore, the maximum number of logical paths between any two storage systems is sixteen (eight forward and eight reverse).

Quorum disk

The quorum disk is a continuously updated volume that contains information about the state of data consistency between the P-VOL and S-VOL. The information is used by HAM in the event of failure to direct host operations to the secondary volume. The quorum disk is located in an externally attached storage system.

Multipath software

Multipath software distributes the loads among the paths to the current production volume. For HAM, the multipath software duplicates the paths between the host and P-VOL, so that the paths are in place between the host and the S-VOL also.

If a failure occurs in the data path to the primary storage system, or with the primary storage system, the multipath software transfers host operations to the S-VOL in the secondary storage system.

Storage Navigator GUI

You perform HAM tasks using the SN graphical user interface. SN is installed on a management computer. It communicates with the SVP of each storage system over defined TCP/IP connections.

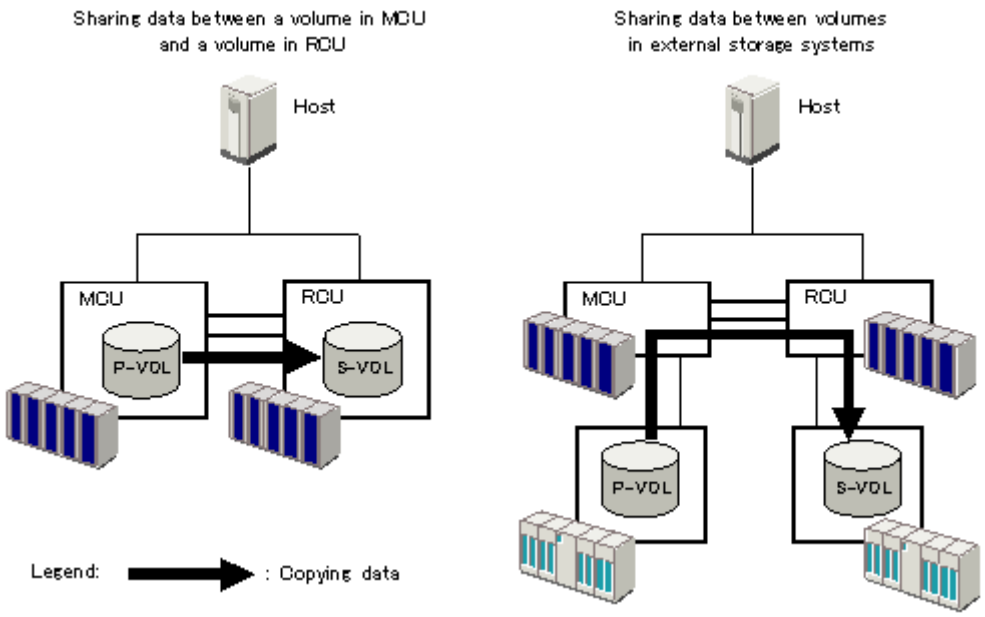
Command Control Interface (CCI)

You can run commands using CCI to perform pair tasks, which is installed on the host. You run commands from a command device on the host. Disaster recovery operations use a mix of SN and CCI.

Data replication

HAM supports data sharing between the following volumes:

- A volume in the primary HUS VM system and a volume in secondary HUS VM system.
- Volumes in external storage systems.
- A volume in the primary or secondary storage system and a volume in an external storage system.



Failover

A failover is an automatic takeover of operations from the primary storage system to the secondary storage system. This occurs when the primary storage system cannot continue host operations due to a failure in either the data path or the primary storage system. The multipath software in the host switches I/O to the remote system. A multipath software package that has been qualified with HAM must be installed on the host.

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System implementation planning and system requirements

Understanding the system planning process and the various requirements of HAM enables you to plan a system that functions properly and can be configured to meet your business needs over time.

- Sharing volumes with other Hitachi Data Systems software products

The workflow for planning High Availability Manager implementation

The process for planning your HAM implementation involves these two main tasks:

- Plan and configure the volume pairs, data path configurations, bandwidth sizing, RAID configuration.

  For more information, see the *Hitachi TrueCopy® User Guide*.

- Follow all of the HAM requirements and recommendations.

  There are major differences between HAM and TrueCopy. For example, use of the quorum disk and multipath software on the host are specific to HAM.

Note: Hitachi Data Systems strongly recommends that you contact Global Solutions Services for assistance in the planning and configuration of your Hitachi Data Systems system.

Required hardware

The following hardware is required for a HAM system:

- Storage systems must be installed on the primary and secondary sites.
- HAM pairs can be set up between two HUS VMs (73-03-0x-xx/xx or later).
- A host must be connected to both primary and secondary storage systems.
- An external storage system for the quorum disk.
- External storage system for data storage (optional).
- Data path connections between primary and secondary storage systems.
- A physical path connection between the primary storage system and the external system hosting the quorum disk.
- A physical path connection between the secondary storage system and the external system hosting the quorum disk.
- Path connections from host to primary and secondary storage systems. Multipath software must be installed on each host server for this purpose.
- If necessary, physical path connections between external storage and primary and/or secondary storage systems.

Multipath software

A multipath software package qualified with HAM is required on each host platform for failover support. Hitachi's multipath software, Dynamic Link Manager, supports the following host platforms:

- AIX
- Linux

- Solaris
- Windows. Requires host mode option 57 on the host group where Windows resides.
- VMware. Requires host mode option 57 on the host group where VMware resides.

Dynamic Link Manager manages I/O through a disk driver.For version information, contact your Hitachi Data Systems representative.

Storage system requirements

The requirements for the primary, secondary, and external storage systems must be met to ensure these systems function properly.

- Make sure that the primary, secondary, and external storage systems have their own independent sources of power.
- The HAM P-VOL and S-VOL must be located in different storage systems.
- Primary and secondary storage systems each require two initiator ports and two RCU target ports.
  - The initiator port sends HAM commands to the paired storage system. Initiator ports must be configured on the primary storage system for HAM operations. However, for disaster recovery, you should also configure initiator ports on the secondary storage system.
  - RCU Target port receives HAM commands and data. RCU target ports must be configured on the secondary storage system for HAM operations. You should also configure RCU target ports on the secondary storage system for disaster recovery.

  Additional microprocessors for replication links may be required based on replication workload.
- If you use switches, prepare them for both the primary and the secondary storage systems. Do not share a switch between the two. Using two independent switches provides redundancy in the event of failure in one.
- Secondary storage system cache should be configured to support remote copy workloads, as well as any local workload activity.
- Cache and non-volatile storage (NVS) must be operable for both the MCU and RCU. If not, the HAM **`Paircreate`** CCI command will fail.
- The required program products for HAM operations must be installed.

Licenses

The following Hitachi Data Systems software products must be installed on both the primary and secondary storage systems. Each product each requires a license key.

- High Availability Manager
- TrueCopy
- Universal Volume Manager

License capacity

A single HAM license must be purchased for each HUS VM system. The HAM license is not capacity based. The capacity of the TrueCopy license determines the capacity of HAM volumes that may be replicated. Review the TrueCopy license installed on your system to verify that it meets your requirements.

For example, when the license capacity for TrueCopy is 10GB, the volume capacity that can be used for HAM is up to 10GB. When 2GB out of 10GB of license capacity for TrueCopy is used, the volume capacity that can be used for HAM is up to the remaining 8GB.

For information on licenses and the actions to take for expired licenses and exceeded capacity, see the *Hitachi Storage Navigator User Guide*.

Pair volume requirements

Data in the P-VOL on the primary storage system is copied to the S-VOL on the secondary storage system. These two volumes are a pair.

The following are requirements for setting up P-VOLs and S-VOLs:

- LDEVs for the P-VOL and S-VOL must be created and formatted before creating a pair.
- The volumes must have identical block counts and capacity.
- A P-VOL can be copied to only one S-VOL; and an S-VOL can be the copy of only one P-VOL.
- Maximum number of pairs per storage system is 16,384.

  The number of HAM pairs that can be created depends on whether TrueCopy and/or Universal Replicator are used in the same storage system. HAM, TrueCopy, and Universal Replicator share the same bitmap areas used to manage differential data, which affects number of pairs. If one or both of these products are used, the maximum number of the HAM pairs allowed is than 16,384 and must be calculated.

  For instructions, see the topic on difference management in the *Hitachi TrueCopy® User Guide*.
- Multiple LU paths to each volume must be set using LUN Manager.

  For instructions, see the *Provisioning Guide*.
- If you are storing data in an external volume or volumes, make sure the external volumes are mapped to the primary or secondary storage system they support.
- If you plan to create multiple pairs during the initial copy operation, observe the following:
  - All P-VOLs must be in the same primary storage system, or in mapped external systems.
  - All S-VOLs must be in the same secondary storage system, or in mapped external systems.
  - You can specify the number of pairs to be created concurrently during initial copy operations (1 to 16).

For more information about the **System Option** dialog box, see the topic on changing option settings in the *Hitachi TrueCopy® User Guide*.

- During the initial pair operation in SN, you will select multiple P-VOLs on the primary storage system for pairing. After selecting the P-VOL, only the P-VOL with the lowest LUN appears in the subsequent **Paircreate** dialog box. To pair the other P-VOLs to the correct S-VOLs, observe the following:

  - In the **Paircreate** dialog box, you can select only one S-VOL. This should be the volume to be paired with the P-VOL that is shown.

  - S-VOLs for the remaining P-VOLs are assigned automatically by SN, according to their LUNs. If you are creating three P-VOLs, and you assign LUN001 as the S-VOL in the **Paircreate** dialog box, the remaining S-VOLs will be assigned incrementally by LUN (for example, LUN002 and LUN003).

  - Make sure that all S-VOLs to be assigned automatically are available, are numbered in an order that will pair them properly, and that they correspond in size to the P-VOLs.

  - If an S-VOL is not available for a P-VOL, the pair must be created individually.

Quorum disk requirements

Quorum disks store continually-updated information about data in HAM P-VOLs and S-VOLs for use during failover operations.

- All HAM pairs created between one MCU and one RCU must use the same quorum disk. Thus, The P-VOL and S-VOL for a pair must use the same quorum disk.
- A quorum disk must be located in an external storage system that is separate from the primary and secondary storage systems.
- Only external storage systems supported by Hitachi Universal Volume Manager can be used for the quorum disk. see the *Hitachi Universal Volume Manager User Guide* for a list of supported external systems.
- Multiple quorum disks can be created in one external storage system.
- The maximum number of quorum disks per external system is 128.
- The external system is not required to be dedicated to quorum disks exclusively.
- Quorum disk size requirements: 47 MB to 4 TB (96,000 blocks to 8,589,934,592 blocks).
- The quorum disk must not be expanded or divided by LUN Expansion or Virtual LUN.
- An LU path must not be configured to the quorum disk.

- Read/Write operations from the storage system to the quorum disk are for internal use. These operations are performed even when Write Pending operations reach 70%.

Caution: Quorum disks are used in a unique way in that they are shared with two storage systems. For data protection reasons, make sure not to share any other kind of volume with two storage systems.

Data path requirements and recommendations

Data is transmitted from the P-VOL to the S-VOL over the data path. Please observe the following requirements and recommendations:

- Data path requirements for HAM are the same as TrueCopy requirements.

  For more information, see the *Hitachi TrueCopy® User Guide*.
- Do not share the data paths with TrueCopy. Install independent data paths for HAM.
- Install at least two data paths from the primary storage system to the secondary storage system, and two data paths from the secondary storage system to the primary storage system. This allows data transfer to continue in the event of failure one path's cables or switches.
- Optical fibre cables are required to connect the primary and secondary storage system.
- Direct and switch connections are supported.
- Use target ports in the primary and secondary storage systems to connect with the host Fibre Channel ports.

  Initiator ports cannot be used for host connections.

  For more information about port attributes, see the topic on configuring host interface ports in the *Hitachi TrueCopy® User Guide*.
- The following table shows maximum, minimum, and recommended number of data paths, logical paths, and ports for HAM.

Category	Item	Min.	Max.	Recommended
Physical Data Paths	Path between primary/secondary systems and a host.	1	4	2 or more
	Data path from primary to secondary system.	1	8	2 or more
	Data path from secondary to primary system.	1	8	2 or more
	Path between primary/secondary systems and quorum disk.	1	8	2 or more
Logical Paths	From primary to secondary system.	1	8	2 or more
	From secondary to primary system.	1	8	2 or more
	Mapping path (path between primary/secondary system and quorum disk).	1	8	2 or more

Category	Item	Min.	Max.	Recommended
Ports	Secondary system target port that can be connected to an initiator port.	1	64	
	Initiator port that can be connected to a secondary system target port.	1	16	

Storage Navigator requirements

The following requirements must be met to ensure that you are able to use SN to manage the system:

- SN is required for HAM.
- You can connect a SN computer to both the primary and secondary storage system.
- You must have storage administrator authority to perform HAM tasks. If you do not, you will only be able to view HAM information.
- To perform any HAM task, make sure SN is in Modify Mode.

For more information, see the *Hitachi Storage Navigator User Guide*.

External storage systems

You can use Hitachi storage systems, original equipment manufacturer (OEM) storage systems, and other vendors' storage systems (such as IBM or EMC) as connectable external storage systems. Hosts will recognize these volumes as internal volumes of the HUS VM storage system.

When using external storage systems with HAM, please observe the following:

- Optional external storage systems may be used to store pair data.

  For supported external systems, see the *Hitachi Universal Volume Manager User Guide*.
- You can connect one external system per HAM P-VOL, and one per S-VOL.
- The maximum number of external systems that can be connected depends on the number of the external ports that can be defined for a storage system.

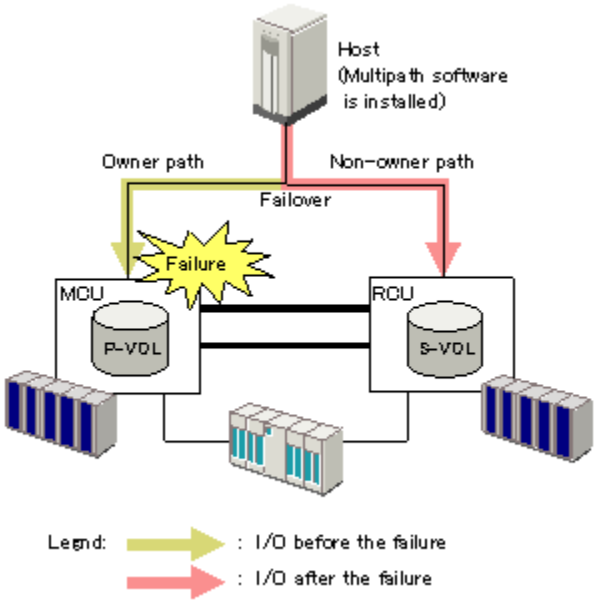
Planning failover

Automatic failover of host operations to the secondary storage system is part of the HAM system. Failover occurs when the primary storage system cannot continue I/O operations due to a failure. The multipath software in the host switches I/O to the secondary storage system.

- The multipath software automatically configures the path to the P-VOL as the owner path when you create a HAM pair.
- The path to the S-VOL is automatically configured as the non-owner path.

In the HAM system, the quorum disk stores the information about the state of data consistency between the P-VOL and S-VOL, which is used to check whether P-VOL or S-VOL contains the latest data. If the P-VOL and S-VOL are not synchronized due to a failure, the MCU and RCU determine which volume should accept host I/O based on the information stored in the quorum disk.

The following figure illustrates failover when a failure occurs at the MCU.



HAM also performs the following checks to detect failures:

- The RCU issues service information messages (SIMs) when the data path is blocked. The multipath software issues messages about the failure in the host-MCU paths.
- Health check of the quorum disk by the MCU and RCU. The primary or secondary storage system issues a SIM if a failure in the quorum disk is detected. Host operations will not switch to the S-VOL if the quorum disk fails. In this case, the failure must be cleared as soon as possible and the quorum disk recovered.
- If the multipath software detects a failure in the host-to-pair volume paths, the operation switches to a different available path and no SIM is issued. To stay informed about path status, monitor the path failure messages issued by the multipath software.
- The multipath software issues message when all host-MCU paths fail. These messages must then be checked and the cause corrected. If failover took place, host operations should be switched back to the primary storage system.

It is possible that maintenance operations require both storage systems to be powered off at the same time. In this case, the health checking periods would be shortened to prevent unexpected failover while both systems are powered off.

After failover, when a failure is corrected, you may continue operations on the S-VOL, though Hitachi Data Systems recommends switching them back to the P-VOL. To find which volume was originally a P-VOL, use the multipath software on the host to refer to path information, checking for the volume with the owner path. The owner path is set to the volume that you specified as a P-VOL when you created a HAM pair. The owner path never switches even if the P-VOL and S-VOL were swapped due to a failover.

Preventing unnecessary failover

Some applications issue the read command to the HAM S-VOL. When these applications are used, and when the number of read commands to the S-VOL reaches or exceeds the threshold (1,000 times per six minutes), HAM assumes that a P-VOL failure has occurred. This situation results in an unnecessary failover to the HAM S-VOL.

At this time, the Solaris VERITAS Volume Manager (VxVM) **`vxdisksetup`** command issues more read commands than allowed by the threshold.

You can prevent unnecessary failover by setting host mode option 48 to ON. Note that when this option is ON, the S-VOL responds slower to the read command.

Review system conditions and resulting behaviors related to host mode option 48 in the following table.

Table 2-1 System behavior for host mode option 48

Event	Behavior when OFF	Behavior when ON
Normal operation.	Failover occurs only when you run certain applications.	No failover, even when you run the applications.
The S-VOL receives more read commands than allowed by the threshold, and receives no write command.	• Updates from a host go to S-VOL, and S-VOL status becomes SSWS. • The S-VOL responds to the read command as quickly as the P-VOL responds.	• Updates from a host go to P-VOL, and S-VOL status remains PAIR. • The S-VOL responds slower to the read command than the P-VOL does. The S-VOL takes several milliseconds to respond.
The S-VOL receives one or more write commands.	• Updates from a host go to S-VOL, and S-VOL status becomes SSWS. • The S-VOL responds to the read command as quickly as the P-VOL responds.	Same as when option 48 is OFF.

For more information about setting host mode options, see the *Provisioning Guide*.

Sharing volumes with other Hitachi Data Systems software products

HAM volumes can be used as volumes for other Hitachi Data Systems software products, such as ShadowImage or Virtual LUN.

The following table shows the HAM volumes that can be shared with other software. Only those volumes listed can be shared.

Table 2-2 Volume types that can be shared with HAM volumes

Product	Volumes	Used as HAM P-VOL?	Used as HAM S-VOL?
LUN Manager	Volume where an LU path is defined	Yes	Yes
	Volume where no LU path is defined	No	No
	Volume where LUN security is applied	Yes	Yes
Open Volume Management	VLL volume	Yes	Yes
	System disk	No	No
LUN Expansion	LUSE volume	Yes	Yes
Volume Shredder	N/A	No	No
Dynamic Provisioning	DP-VOL (virtual volume)	Yes	Yes
	Pool volume	No	No
Universal Volume Manager	External volume (after mapping is finished)	Yes	Yes
ShadowImage	ShadowImage P-VOL	No	Yes
	ShadowImage S-VOL	No	No
	Reserved volume	No	No
Thin Image	Data volume, Virtual volume, Pool volume	No	No
TrueCopy	P-VOL, S-VOL	No	No
Universal Replicator	Primary data volume	No	No
	Secondary data volume	No	No
	Journal volume	No	No
Volume Migration (*1)	Source volume	No	No
	Target or reserved volume	No	No
Data Retention Utility	Volume with the Read/Write attribute	Yes	Yes
	Volume with attribute other than the above	No	No
Multiplatform Backup	N/A	No	No

Product	Volumes	Used as HAM P-VOL?	Used as HAM S-VOL?
*1: For information on using Volume Migration, contact the Hitachi Data Systems Support Center.			

The quorum disk cannot be used by other software products, except as follows:

- Virtual Partition Manager can allocate the CLPR (virtually partitioned cache) to the quorum disk when you map the quorum disk to the storage system.
- Performance Monitor can monitor usage or performance of the quorum disk.

The following topics clarify key information regarding the use of other software products.

Virtual Partition Manager

Virtually partition the cache (CLPR), and allocate the CLPR to the host that issues the I/O to the HAM pairs.

Cache Residency Manager

With Cache Residency Manager, you can improve data access performance by storing the HAM data in the storage system's cache memory.

Performance Monitor

- Performance Monitor is used to monitor usage or performance of the storage system. You can also show statistical I/O data of HAM and TrueCopy pairs.
- When Performance Monitor data collection results in a large amount of data, significant traffic on the HUS VM internal LAN can occur. To prevent time-outs while performing HAM operations on the SN computer, cancel Performance Monitor data collection activities.

LUN Manager

LU paths cannot be deleted after you create HAM pairs. To delete the LU path, you need to release the HAM pair first.

Open Volume Management

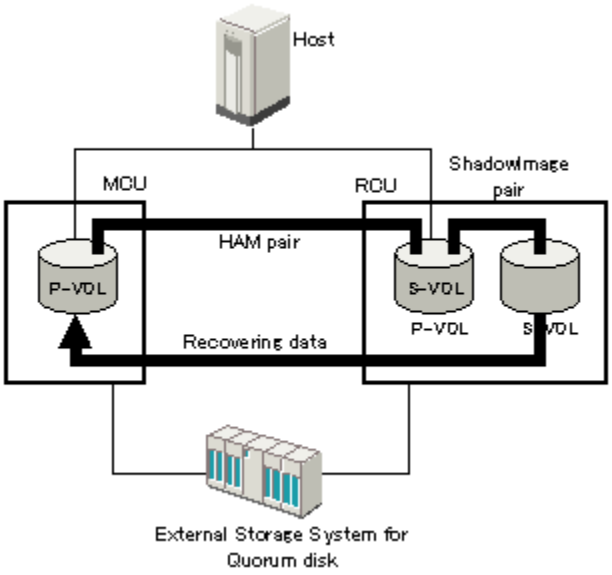
- VLL volumes can be assigned to HAM pairs, provided that the S-VOL has the same capacity as the P-VOL.
- To perform VLL operations on an existing HAM P-VOL or S-VOL, the pair must be released first to return the volume to the SMPL status.

LUN Expansion

LUSE volumes can be assigned to HAM pairs, provided that both P-VOL and S-VOL are LUSE volumes consisting of the same number of LDEVs, the same size, and the same structure.

Configurations with ShadowImage volumes

You can use the HAM S-VOL as a ShadowImage P-VOL. This configuration benefits the HAM pair if the P-VOL is logically destroyed. In this case, you can recover the data from the split ShadowImage S-VOL.



Configuring HAM with ShadowImage

You perform this configuration by creating a HAM pair, a ShadowImage pair, then splitting the ShadowImage pair.

1. Create the HAM pair. Make sure that pair status becomes PAIR.
2. Create the ShadowImage pair, using the HAM S-VOL as a ShadowImage P-VOL.
3. Split the ShadowImage pair and resume host operations on the HAM P-VOL.

3

System configuration

The HAM system configuration process is the first main task in the process of setting up the HAM system. It follows the planning of the system implementation and is based on the outcome of the system implementation planning effort. All of the configuration procedures must be completed before you can begin using the system.

The basic workflow for configuring the system configuration

The configuration process involves connecting the system hardware components, installing all required software, configuring the primary and secondary storage systems, setting up the quorum disk, and configuring host mode options.

Complete the configuration tasks in the indicated order and configure the components according to the configuration requirements.

Use the following process to configure HAM:

1. Connect the system hardware components.

   For more information, see Connecting the hardware components on page 3-2.
2. Install the required software.

   For more information, see Installing and configuring software on page 3-4.
3. Configure the primary and secondary storage systems (MCU and RCU).

   Configuring the primary and secondary storage systems on page 3-5.
4. Set up a quorum disk.

   For more information, see Configuring the quorum disks on page 3-6.
5. Add the quorum disk ID.

   For more information, see Adding the ID for the quorum disk to the storage systems on page 3-7.
6. Configure host mode options.

   For more information, see Configuring host mode options on page 3-8.

Connecting the hardware components

Connecting certain hardware components of the system is the first main task in the system configuration. Completion of this task ensures that the data paths required for normal system operation are set up and ready for use.

During this task, you and Hitachi Data Systems representatives connect the following system components:

- The host to the primary and secondary HUS VM systems.
- The primary to the secondary storage system.
- The external system that has the quorum disk to the primary and secondary storage systems.
- Any optional external storage systems to the primary and/or secondary storage systems.
- Initiator ports (primary storage system) to the RCU Target ports (secondary storage system).

Prerequisites

Before you begin, make sure you have:

- Completed the system implementation (see System implementation planning and system requirements on page 2-1).

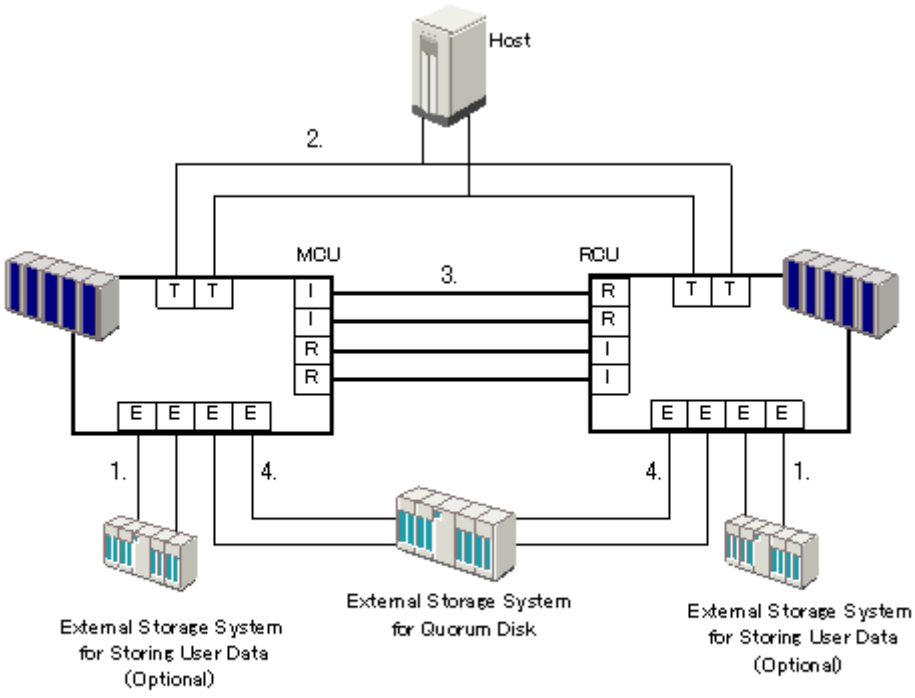
The workflow for connecting the hardware components

Use the following process to connect the hardware components for a HAM system:

1. If you have external storage for storing pair data, connect the external systems to the external ports on the HUS VM systems.
2. Connect the host to the primary and secondary storage systems using target ports on the HUS VM systems.
3. Make the connections for the data path between the primary and secondary storage systems by doing the following:
   - Connect the initiator ports on the primary storage system to the RCU Target ports on the secondary storage system.
   - Connect the initiator ports on the secondary storage system to the RCU Target ports on the primary storage system.
4. Connect the quorum disk to the primary and secondary storage systems using external ports on the HUS VM systems.

Caution: For data protection reasons, make sure that quorum disks are not shared by two storage systems.

The following figure shows these connections.



Legend: T: a Target port, R: an RCU Target port, I: an Initiator port, E: an External port

Installing and configuring software

Installing and configuring the system software is the second main task in the system configuration. Completion of this task ensures that all of the software required for normal system operation is installed and ready for use. This task involves installing multipath software and CCI on the host and installing the main system software on the primary and secondary storage systems.

Additional documentation

To ensure that you use the correct steps to install the software, refer to the installation instructions in the following documentation during the installation process:

- The documentation for the multipath software.
- The *Hitachi Storage Navigator User Guide*.
- The *Command Control Interface Installation and Configuration Guide*.

Prerequisites

Before you begin, make sure you have:

- Connected the system hardware components (see Connecting the hardware components on page 3-2).

- The required software for HAM is installed (see System implementation planning and system requirements on page 2-1).

Caution: Make sure that you install the software in the order described in the procedure. If you do not, you may have to uninstall and reinstall the software.

The workflow for installing and configuring High Availability Manager

Use the following process to install and configure HAM and the required software:

1. Install multipath software on the host.
2. Using the multipath software, set the path health-checking period to three minutes.
3. Install the following required software on the primary and secondary storage systems using SN:
   - High Availability Manager
   - TrueCopy
   - Universal Volume Manager
4. Install CCI on the hosts.

Configuring the primary and secondary storage systems

Configuring the primary and secondary storage systems (MCU and RCU) is the third main task in the system configuration. Completion of this task ensures that the systems are configured to enable the communication and data transfer between the systems that is essential to normal system operation. Part of this task is setting up the logical paths between the systems.

This task involves setting port attributes You can set the number of pairs the system creates concurrently (at the same time) during this task This task involves installing multipath software and CCI on the host and installing the main system software on the primary and secondary storage systems.

Additional documentation

To ensure that you use the correct steps to configure the systems, refer to these instructions in the following documentation during the configuration process:

- Setting the number of volumes to be copied concurrently in the *Hitachi TrueCopy® User Guide*.
- Defining port attributes in the *Hitachi TrueCopy® User Guide*.
- Configuring storage systems and defining logical paths in the *Hitachi TrueCopy® User Guide*.

- Details about mapping the primary and secondary storage systems to the external system that contains the in the *Provisioning Guide* and *Hitachi Universal Volume Manager User Guide*.
- Details about CLPR in the *Hitachi Virtual Partition Manager User Guide*.
- Details about external path groups in the *Hitachi Universal Volume Manager User Guide*.

Prerequisites

Before you begin, make sure you have:

- Installed the multipath and system software (see Installing and configuring software on page 3-4).

Workflow

Use the following process to configure the primary and secondary storage systems:

1. Stop Performance Monitor, if it is running, to avoid performance impact on the TCP/IP network.
2. Set the port attributes for HAM.
3. Configure the primary and secondary storage systems and establish logical paths between the primary and secondary HUS VM systems.

Configuring the quorum disks

Configuring the quorum disk is the third main task in the system configuration. Completion of this task ensures that the disk is configured to be able to determine which pair volume has the latest (most current) data when automatic failover is required.

This task involves configuring the disk and configuring port parameters for the disk on the primary and secondary storage systems.

Caution: For data protection reasons, make sure that the disk is not shared by two storage systems.

Note: If a support personnel has changed the system configuration on the MCU and RCU where HAM pairs have been created, you will need to format the volume in the external storage system for the quorum disk and redefine the quorum disk.

Prerequisites

Before you begin, make sure you have:

- Installed the multipath and system software (see Configuring the primary and secondary storage systems on page 3-5).

Procedure

1. In the external storage system, prepare a volume for use as the quorum disk and specify any required system options.

2. Using the **External** attribute, configure the ports on the primary and secondary storage systems that are connected to the disk.
3. Set the paths from the disk to the primary and secondary storage systems to **Active**.
4. Using SN's **Ports/Host Groups** and **External Storages** windows, map the primary and secondary storage systems to the disk by doing the following:
   - Configure at least two cross-system paths between the primary storage system and quorum disk, and two between the secondary storage system and the quorum disk.
   - Specify the these external volume parameters:

     - Emulation type: OPEN-V.

     - Number of LDEVs: 1.

     - Cache mode: This parameter is not used for quorum disks. Either Enable or Disable can be specified.

     - Inflow control: Select Disable. Data will be written in the cache memory.

     - CLPR: If you partition cache memory, specify the CLPR that the quorum disk uses.

     - **LDKC:CU:LDEV number:** The number is used to identify the quorum disk for the primary and secondary storage systems.
5. In the **External Path Groups** tab in SN, configure port parameters for the primary and secondary storage systems by specifying the following values:
   - **QDepth:** This is the number of Read/Write commands that can be issued (queued) to the quorum disk at a time.

     The default is 8.
   - **I/O TOV:** This is the timeout value to the quorum disk from the primary and secondary storage systems. The value must be less than the time-over value from the application.

     Recommended: 15 seconds

     Default: 15 seconds
   - **Path Blockade Watch:** This is the time that you want the system to wait after the quorum disk paths are disconnected before the quorum disk is blocked.

     Recommended: 10 seconds; Default: 10 seconds.

Adding the ID for the quorum disk to the storage systems

Adding the ID for the quorum disk is the fourth main task in the system configuration. Completion of this task ensures that the primary and secondary storage systems to which the disk has been mapped can recognize the disk.

Prerequisites

Before you begin, make sure you have:

- Configured the quorum disk (see Configuring the quorum disks on page 3-6).

Procedure

To ensure that the quorum disk ID is added correctly, make sure that:

- You complete the procedure on the primary and secondary storage systems.
- You use the same ID for the disk on both systems.

1. Delete any data in the external volume that you assigned to be the quorum disk.
2. Access the MCU or RCU in SN, then click **Actions > Remote Copy > TrueCopy > Quorum Disk Operation**.
3. Make sure that you are in the modify mode.
4. In the **Quorum Disk Operation** window, right-click the quorum disk ID that you want to add, then click **Add Quorum Disk ID**.
5. In **Add Quorum Disk ID** dialog box, from the **Quorum Disk** drop-down menu, select the LDKC:CU:LDEV number that you specified when mapping the external volume. This is the volume that will be used for the quorum disk.
6. From the **RCU** drop-down menu, select the CU that is to be paired with the CU on the current storage system. The list shows the RCU serial number, LDKC number, controller ID, and model name registered in CU Free.
7. Click **Set**. The settings are shown in the **Preview** area.
8. Verify your settings. To make a correction, select the setting, right-click, and click **Modify**.
9. Click **Apply** to save your changes.

Configuring host mode options

Configuring host mode options is the last main task in the system configuration. Completion of this task ensures that the host mode option setting are correct. The settings vary depending on the whether the system is a standard or cluster implementation.

Prerequisites

Before you begin, make sure you have:

- Added the ID for the quorum disk to the storage systems (see Adding the ID for the quorum disk to the storage systems on page 3-7).

Procedure

Use the following host mode options for your system:

- If using VMware or Windows, set host mode option 57 on the host group where VMware or Windows reside.
- If using software that uses a SCSI-2 Reservation, set host mode option 52 on the host groups where the executing node and standby node reside.

For more information on host mode options, see the *Provisioning Guide*.

4

Working with volume pairs

A number of tasks must be performed on volume pairs as part of your normal HAM system maintenance activities, when troubleshooting system issues, or when taking action to recover from failure.

Workflow for HAM volume pairs

You perform several different types of tasks with volume pairs as part of your system maintenance and recovery activities.

The different types of tasks include:

- Checking pair status.
- Creating pairs.
- Releasing pairs.
- Resynchronizing pairs.
- Splitting pairs.

All of the different pair-related tasks can be performed using SN or CCI.

Reasons for checking pair status

Pair status information indicates the current state or condition of the pair.

There are two main reasons for checking the current status of a volume pair. One is to verify the status of the pair while you run pair CCI commands during normal system maintenance or failure recovery. The other reason is to check the status of pairs as part of your normal system monitoring activities to ensure they are working properly.

When to check pair status?

You should check the status of volume pairs whenever you run pair CCI commands and as part of your normal system monitoring activities.

When you run pair CCI commands, you check pair status:

- Before you run a pair CCI command.
- During pair changes. Check pair status to see that the pairs are operating correctly and that data is updating from P-VOLs to S-VOLs in PAIR status, or that differential data management is happening in Split status.

Note: You can perform a pair task can only be completed if the pair is in a status that permits the task. Checking the status before you run a CCI command lets you verify that the pair is in a status that permits the task.

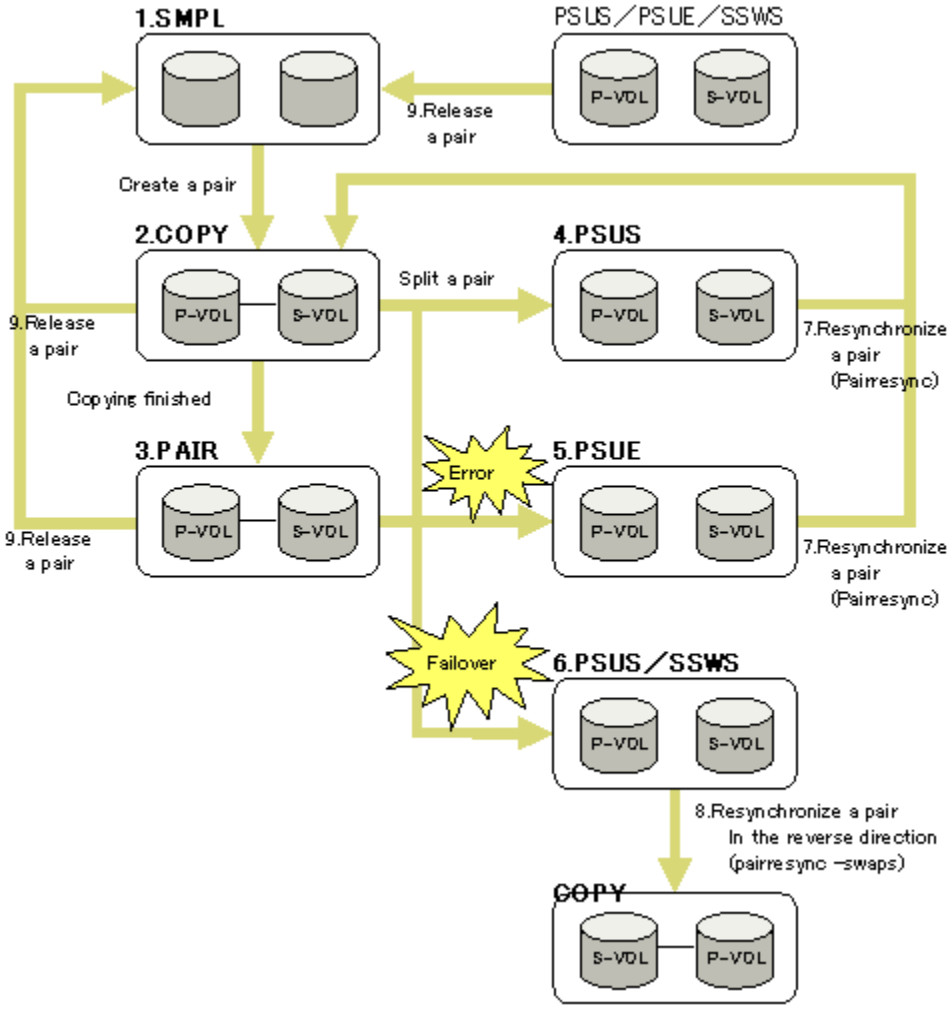
How pair status reflects system events and use

The storage system records information about the current status of HAM pairs. You can check the current status of any volume pair at any time.

Status changes occur for the following reasons:

- Automatic system events, such as errors or failover situations.
- Administrator actions, such as creating, releasing, or deleting pairs.

The following figure shows HAM pair status before and after pair creation, splitting pairs, various errors, and after releasing a pair.



1. When a volume is not in a HAM pair, its status is SMPL.
2. When you create a HAM pair using SMPL volumes, the status of the P-VOL and the S-VOL changes to COPY while the system copies the data.
3. A stable synchronized pair has the status PAIR.
4. When you split a pair, the status of the P-VOL and the S-VOL changes to PSUS (pair suspended-split, split by command).
5. When the MCU cannot maintain in synch the P-VOL and the S-VOL because of an error, the status of the P-VOL and the S-VOL changes to PSUE (pair suspended-error, split due to an error). If the MCU cannot communicate with the RCU, the status of the S-VOL stays PAIR.
6. When a failover occurs in the storage system, the status of the S-VOL changes to SSWS, and the status of the P-VOL changes to PSUS.
7. When you resynchronize the pair in PSUS or PSUE status (see No.4 and No.5), the status of the P-VOL and the S-VOL changes to COPY.
8. When you resynchronize the pair with the S-VOL in SSWS status (see No.6), (using the CCI **`pairresync -swaps`** command on the S-VOL), the P-VOL and the S-VOL swap, and the pair status changes to COPY.

9. When you release a pair, the status of the P-VOL and the S-VOL changes to SMPL.

What pairs information can you view and where is it?

You can monitor the following information for pairs:

- Percentage of synchronization (Sync. column)
- Pair details (**Detailed Information** dialog box)
  - Pair status
  - Split types
  - Suspend types

Where to find the information

You can view all information about pairs in the GUI. If you configured the system to send email notifications, you can monitor those particular events remotely.

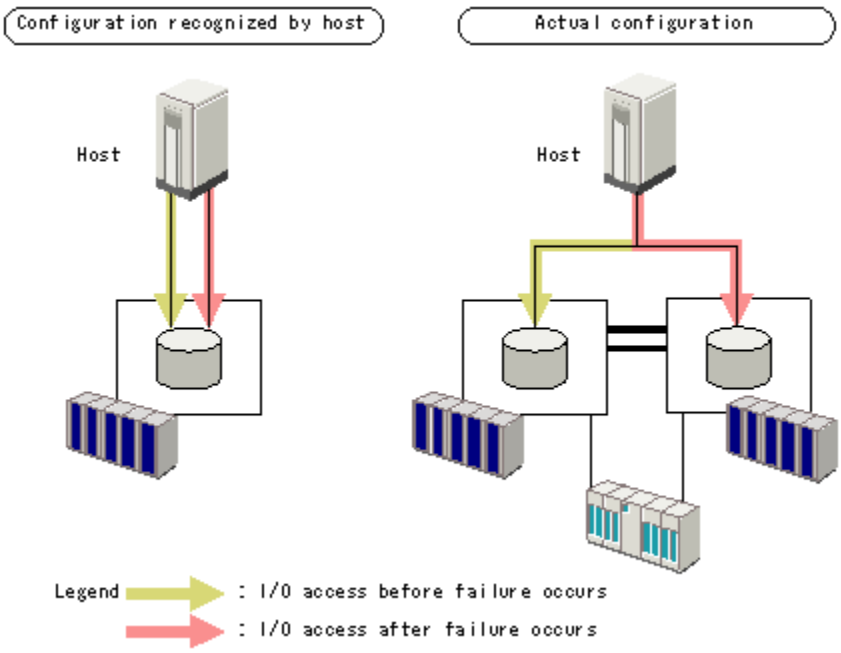
When a pair is in PSUS, SSWS, or PSUE status, the primary storage system generates SIMs (service information messages). You can check SIMs in SN's **Alerts** window.

How hosts see volume pairs

When you create a HAM pair, the host sees the primary and secondary volumes as the same volume.

The following figure shows:

- The configuration as seen by the host.
- The actual configuration with primary and secondary volumes.



Checking pair status

Use SN to view the current status of volume pairs.

1. In the SN main window, click **Actions > Remote Copy > TrueCopy > Pair Operation**.
2. In the **Pair Operation** window tree, select the CU group, CU, port, or the host group where the HAM pair belongs.

   The list shows TrueCopy and HAM pairs.
3. You can complete the following tasks:
   - To make sure data is current and review the status information in the **Status** column, click **File/Refresh**.
   - To filter the list to show only HAM pairs, open the **Display Filter** window.
   - To view pair status details, right-click the HAM pair and click **Detail**.

   You can complete the following tasks in the **Detailed Information** dialog box:
   - See information about other volumes. Click **Previous** or **Next**.
   - Edit the current information for the pair. Click **Update**.
   - Close the dialog box. Select the **Refresh the Pair Operation window after this dialog box closes** option to update the information in the **Pair Operation** window based on the updated information on the **Detailed Information** dialog box. Click **Close**.

Pair status values

When checking pair status in SN, click **File/Refresh** to verify that the data is current.

In SN, the pair status is shown in the `[pair status in Storage Navigator/pair status in CCI]` format. If the pair status name in SN and the pair status name in CCI are the same, the pair status name in CCI is not shown.

The following table lists HAM pair status and whether the volumes can be accessed. The accessibility to P-VOL or S-VOL depends on the pair status and VOL Access. You can see VOL Access in the **Pair Operation** window or the **Detailed Information** dialog box.

Pair Status		VOL Access		Description	Access to	
P-VOL	S-VOL	P-VOL	S-VOL		P-VOL	S-VOL
SMPL	SMPL	Blank	Blank	The volume is not assigned to a HAM pair.	Read/write	Read/write
COPY	COPY	Access (No Lock)	Blank	The initial copy operation for this pair is in progress. This pair is not yet synchronized.	Read/write	Not accessible

Pair Status		VOL Access		Description	Access to	
P-VOL	S-VOL	P-VOL	S-VOL		P-VOL	S-VOL
PAIR	PAIR	Blank	Blank	The pair is synchronized. The system reads and writes updates from the host to the P-VOL and duplicates them in the S-VOL.	Read/write	Read/write*
	SSUS	Blank	Access (Lock)	The I/O operation to S-VOL or the swapping and suspending operation was successful. If the pair status of the S-VOL is SSWS, the S-VOL is accessible. The most recent data is on the S-VOL.	Not Accessible	Read/write
		Blank	Blank	Pair failed to get the lock at swapping and suspended command (**pairsplit -RS** command). Status of the SSUS was forcibly changed. If the pair status of the S-VOL is SSWS, the S-VOL is accessible. Data on the S-VOL might be old.	Not accessible	Read/write
	PSUS	Blank	Access (Lock)	After the status of the S-VOL was changed to SSWS, you ran **pairsplit-RB** command to rollback. Suspend the pair and resynchronize. After a rollback, do not access the P-VOL or S-VOL until resynchronization is finished. Data on P-VOL might be old.	Not accessible	Not accessible
		Blank	Blank	After the status of the S-VOL was forcibly changed to SSWS, you ran the **pairsplit-RB** command to rollback. Suspend the pair and resynchronize. After a rollback, do not access the P-VOL or S-VOL until resynchronization is finished. Data on P-VOL might be old.	Not accessible	Not accessible

Pair Status		VOL Access		Description	Access to	
P-VOL	S-VOL	P-VOL	S-VOL		P-VOL	S-VOL
PSUS (see Suspend types (PSUE status) on page 4-10	PSUS	Access (Lock)	Blank	This HAM pair is not synchronized because the user has split the pair (**pairsplit -r** command). The P-VOL data is up-to-date.	Read/ write. Read-only can be set with the option pairsplit-r)	Not accessible.
		Blank	Blank	After the status of the S-VOL was forcibly changed to SSWS, you ran the **pairsplit -RB** command to rollback. After a rollback, do not access the P-VOL or S-VOL until resynchronization is finished. Data on P-VOL might be old.	Not accessible	Not accessible
		Blank	Access (Lock)		Not accessible	Not accessible
	SSWS	Blank	Access (Lock)	The HAM pair is not synchronized because a failover has occurred. The data on S-VOL is the latest.	Not accessible	Read/write
		Blank	Blank	The user has performed a swap and suspend operation (pairsplit-RS). Data on S-VOL may be old.	Not accessible	Read/Write
		Access (Lock)	Blank	After the user performed a suspend operation (pairsplit -r), the user performed swap and suspend operations (pairsplit-RS). Data on S-VOL may be old.	Read/ Write	Read/Write
	SMPL	Access (Lock)	Blank	The user has released the pair from RCU (pairsplit -S). This HAM pair is not synchronized.	Read/ Write	Read/Write

Pair Status		VOL Access		Description	Access to	
P-VOL	S-VOL	P-VOL	S-VOL		P-VOL	S-VOL
PSUE (see Suspend types (PSUE status) on page 4-10	PSUE	Access (No Lock)	Blank	This HAM pair is not synchronized because the MCU suspended the HAM pair with an error. Data in the P-VOL is up to date.	Read/ Write	Not accessible
	PAIR	Access (Lock)	Blank			
	SSWS	Access (No Lock)	Blank	After the pair was suspended by a failure, the user performed the swapping and suspending command (**pairsplit -RS**). If the pair status of the S-VOL is SSWS, the S-VOL is accessible. Data on the S-VOL might be old.	Read/ Write	Read/Write
		Access (Lock)	Blank			
	PSUS	Access (No Lock)	Blank	After the HAM pair was suspended due to an error, the user performed the swapping and suspending operation (pairsplit-RS) and performed the rollback operation (pairsplit -RB). After the rollback, do not access either the P-VOL or the S-VOL until the resync operation is finished. The data on the P-VOL might be old.	Not accessible	Not accessible
		Access (Lock)	Blank			
PDUB	PDUB	Access (Lock)	Blank	The HAM pair consists of LUSE volumes. The status of the pair is COPY or PAIR. The status of at least one LUSE volumes is SMPL or PSUE.	Read/write	Read Only (Not accessible in case of COPY or PSUE)
* If an S-VOL in PAIR status accepts write I/O, the storage system assumes that a failover occurred. Then the S-VOL changes to SSWS status and the P-VOL usually changes to the PSUS status.						

The following table describes pair status in CCI.

Item	Description
SMPL	The volume is not assigned to a HAM pair.
COPY	The initial copy for a HAM pair is in progress, but the pair is not synchronized yet.
PAIR	The initial copy for a HAM pair is completed, and the pair is synchronized.
PSUS	Although the paired status is retained, the user split the HAM pair, and update of S-VOL is stopped. This status only applies to SVOL. While the pair is split, the storage system keeps track of updates to P-VOL.
SSUS	Although the paired status is retained, the user split the HAM pair, and update of S-VOL is stopped. This status only applies to P-VOL. If the pair is split with the option of permitting update of S-VOL specified, the storage system keeps track of updates to S-VOL.

Item	Description
PSUE	Although the paired status is retained, update of S-VOL is stopped because of an error status. PSUE is the same as PSUS (SSUS) in terms of symptom; the difference is that PSUE is caused by an internal error.
PDUB	This status is shown only for pairs using LUSE. Although the paired status is retained, the pair status transition is suspended because of an error in some LDEVs within LUSE.
SSWS	The paired status is retained. Processing for resync with P-VOL and S-VOL swapped (**horctakeover** command) is in progress.

Split types (PSUS status)

Split types are shown in the **Detailed Information** dialog box; they specify the reason a pair is split.

When you split a pair, the pair status changes to PSUS and the system stops updates to the S-VOL. You can set an option to block updates to the P-VOL also while the pair is split. This results in the P-VOL and S-VOL staying synchronized.

If the P-VOL accepts write I/O while the pair is split, the primary storage system records the updated tracks of the P-VOL as differential data. This data is copied to the S-VOL when the pair is resynchronized.

The following table lists PSUS types.

Split type	Applies to	Description
P-VOL by Operator	P-VOL	The user split the pair from the primary storage system using the P-VOL Failure on the **Suspend Type** option for **Suspend Kind**. The S-VOL split type is PSUS-by MCU.
S-VOL by Operator	P-VOL S-VOL	The user split the pair from the primary or secondary storage system using the S-VOL on the **Suspend Type** option for **Suspend Kind**. Or, the pair is split because of a failover in the storage system.
by MCU	S-VOL	The secondary storage system received a request from the primary storage system to split the pair. The P-VOL split type is PSUS-P-VOL by Operator or PSUS-S-VOL by Operator.
Delete pair to RCU	P-VOL	The primary storage system detected that the S-VOL status changed to SMPL because the user released the pair from the secondary storage system. The pair cannot be resynchronized because the S-VOL does not have the PSUS/PSUE status.

Suspend types (PSUE status)

Suspend types are shown in the **Detailed Information** dialog box; they specify why the pair was suspended by the system.

The primary storage system suspends a pair when the following conditions occur:

- The user has released the pair from the secondary storage system.

- An error condition related to the secondary storage system, the S-VOL, or the update copy operation.
- Communications with the secondary storage system have stopped.

When a pair is suspended, the primary storage system stops sending updates to the S-VOL, even though host applications may continue updating the P-VOL. The primary storage system records the P-VOL's updated tracks as differential data. This data is copied to the S-VOL when the error condition is cleared and the pair is resynchronized.

P-VOL/S-VOL differential data is not retained if a primary or secondary storage system is powered off and its backup batteries are fully discharged while the pairs are suspended. In this unlikely case, the primary storage system performs the equivalent of an entire initial copy operation when the pairs are resynchronized.

For descriptions of suspend types and the troubleshooting steps to resolve them, see Suspended volume pair troubleshooting on page 8-4.

Volume pair creation

A volume pair consists of primary and secondary volume whose data is synchronized until the pair is split. During the initial copy, the P-VOL remains available to the host for read/write.

Creating a HAM pair

There are two basic steps involved in creating a HAM pair. They are:

- Performing the initial copy.
- Verifying that the host recognizes both the P-VOL and S-VOL as a single volume.

Prerequisites

Make sure you have configured the pair (see System configuration on page 3-1).

Procedure

When creating the pair, make sure that:

- LDEVs for the primary and secondary volumes:
  - Are created and formatted.
  - Have identical block counts.
  - Are in SMPL status.
- The S-VOL must be offline; the P-VOL can be online.
- You copy each volume's port number, host group number (GID), and LUN. This is needed during the procedure.
- You copy the CU Free RCU from which you will assign the secondary volume. Copy the serial number, LDKC number, controller ID, model name, path group ID, and the channel type.

- You assign a quorum disk to the HAM pairs during the initial copy procedure. The pairs created between the same primary and secondary storage system must be assigned the same quorum disk.
- The initial copy parameters you specify during the procedure cannot be successfully changed after a pair is created. If you attempt to change or delete them, the **Pair Operation** window and **Detailed Information** dialog box shows misleading and inaccurate information.
- If you are creating multiple pairs in one operation, all pairs are assigned the same parameters and the same quorum disk ID.

1. Access the MCU in SN, then click **Actions > Remote Copy >TrueCopy > Pair Operation**.
2. Make sure that you are in the modify mode.
3. In the **Pair Operation** window tree, select the CU group, CU, port, or host group where the primary volume or volumes are located. The volumes available to be paired are shown in the volume list.
4. Right-click a volume that you want as a P-VOL and select **Paircreate** and HAM from the menu.
   - You can create more than one pair at one time by selecting then right-clicking more than one volume. The related secondary volumes must be in the same secondary storage system.
   - Volumes with the pair icon  are already used as primary data volumes.
5. In the **Paircreate(HAM)** dialog box, the volume you selected for pairing is shown for **P-VOL**. If you selected multiple volumes, the volume with the lowest LUN is shown.

Note: When a P-VOL or S-VOL appears in a dialog box, it is identified by port number, GID, LUN (LDKC number: CU number: LDEV number), CLPR number, and CLPR name of the LU.

- A # at the end of the string indicates an external volume.
- An X t the end of the string indicates a Dynamic Provisioning virtual volume.

From the **S-VOL** drop-down menus, select the volume that you want to pair with the shown P-VOL. Select the port number, GID, and LUN. This will become the secondary volume (S-VOL).

- If you are creating multiple pairs, select the S-VOL for the P-VOL shown for **P-VOL**. The S-VOLs for the remaining group of P-VOLs will be automatically assigned according to the LUN.

  For example, if you are creating three pairs, and you select LUN001 as the S-VOL, the remaining S-VOLs for the other P-VOLs will be LUN002 and LUN003.

6. From the **RCU** drop-down menu, select the remote system where the S-VOL is located. The list shows all registered CU Free RCUs, which are shown by serial number, LDKC number, controller ID, model name, path group ID, and channel type. The system you select must be the same for all pairs being created in this operation.

7. The **P-VOL Fence Level** is automatically set to Never. The P-VOL will never be fenced, or blocked from receiving host read/write.

Note: In the **Initial Copy Parameters** area, remember that the parameters you specify cannot be changed after a pair or pairs are created. To make changes to the parameters specified below, you will need to release and recreate the pair.

8. From the **Initial Copy** drop-down menu, specify whether to copy data or not copy during the paircreate operation:
   - Select **Entire Volume** to copy P-VOL data to the S-VOL (default).
   - Select **None** to set up the pair relationship between the volumes but to copy no data from P-VOL to S-VOL. You must be sure that the P-VOL and S-VOL are already identical.
9. From the **Copy Pace** drop-down menu, select the desired number of tracks to be copied at one time (1-15) during the initial copy operation. The default setting is 15. If you specify a large number, such as 15, copying is faster, but I/O performance of the storage system may decrease. If you specify a small number, such as 3, copying is slower, but the impact on I/O performance is lessened.
10. From the **Priority** drop-down menu, select the scheduling order for the initial copy operations. You can enter between 1-256. The highest priority is 1, the lowest priority is 256. The default is 32.

    For example, if you are creating 10 pairs and you specified in the **System Option** window that the maximum initial copies that can be made at one time is 5, the priority you assign here determines the order that the 10 pairs are created.
11. From the **Difference Management** drop-down menu, select the unit of measurement for storing differential data. You can select Auto, Cylinder, or Track.

    With **Auto**, the system decides whether to use Cylinder or Track. This is based on the size of the volume.
    - If VLL is used, the number of cylinders set for VLL is applied.
    - If the pair volume has 10,019 or more cylinders, Cylinder is applied.
    - If the pair volume has less than 10,019 cylinders, Track is applied.
12. From the **Quorum Disk ID** drop-down menu, specify the quorum disk ID that you want to assign to the pair or pairs.
13. Click **Set**. The settings are shown in the **Preview** area.
14. In the **Preview** list, check the settings. To change a setting, right-click and select **Modify**. To delete a setting, right-click and select **Delete**. When satisfied, click **Apply**. This starts pair creation and initial copying if specified.

Verifying host recognition of a new pair

The final steps in creating new pairs is to make sure the host recognizes the pair and to verify the path configuration from the host to the pair. With HAM, the host recognizes both P-VOL and S-VOL as a single volume.

To verify host recognition of the HAM P-VOL and S-VOL

1. Using CCI, make sure the HAM pair is created with the `-fe` option of the pairdisplay command.
2. Make sure pair status is PAIR, and that **Type** on the Storage Navigator **Pair Operation** window displays “HAM” for the primary and secondary storage systems. (Until Type = HAM, application I/Os cannot be taken over in case of a failover.)
3. Either reboot the host or use the host operating system's device recognition command.

   For more information, see the documentation provided with the system.

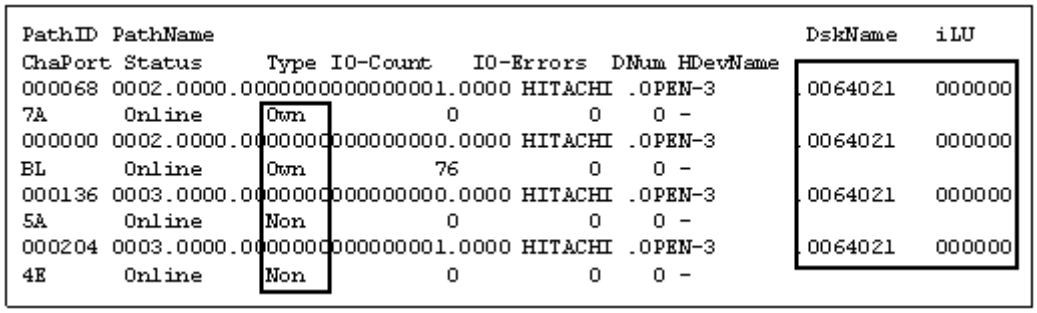
   - For Linux host operating systems, make sure that the HAM pair’s status is PAIR before rebooting. If the host reboots when the HAM pair is not in the PAIR status, a check condition might be reported to the host.
   - For Solaris host operating systems, make sure the HAM pair status is PAIR before performing the following operations, otherwise a failure can occur:

     - An online operation on a path you are not allowed to access.
     - Rebooting the host.
     - Dynamic addition of the host device.
     - Opening the host device.

     If a path becomes offline, change the HAM pair status to PAIR and then perform the online operation for the offline path.
4. Check path configuration to the P-VOL and S-VOL using the multipath software command on the host. Set the owner and non-owner paths to the P-VOL.

   For more information about the multipath software commands, see the documentation provided with the multipath software.

The following figure shows an example of how the Hitachi Dynamic Link Manager shows path configuration information. In this example, there are four configuration paths to a single volume in the primary storage system. Two of the paths are owner paths (Own), and two paths are non-owner paths (Non).



PathID	PathName						DskName	iLU
ChaPort	Status	Type	IO-Count	IO-Errors	DNum	HDevName		
000068	0002.0000.0000000000000001.0000					HITACHI .OPEN-3	0064021	000000
7A	Online	Own	0	0	0	-		
000000	0002.0000.0000000000000000.0000					HITACHI .OPEN-3	0064021	000000
BL	Online	Own	76	0	0	-		
000136	0003.0000.0000000000000000.0000					HITACHI .OPEN-3	0064021	000000
5A	Online	Non	0	0	0	-		
000204	0003.0000.0000000000000001.0000					HITACHI .OPEN-3	0064021	000000
4E	Online	Non	0	0	0	-		

How multipath software shows storage serial number for pairs

If you use HUS VMs on the primary and the secondary sites, multipath software shows the serial number of the primary storage system for both the P-VOL and the S-VOL. The storage system is shown as HUS VM.

Splitting pairs

When the pair is synchronized, data written to the P-VOL is copied to the S-VOL. This continues until the pair is split.When you split a pair, the pair status changes to PSUS and updates to the S-VOL stop.

You can set an option to block updates to the P-VOL while the pair is split. This results in the P-VOL and S-VOL staying synchronized.

If the P-VOL accepts write I/O while the pair is split, the primary storage system records the updated tracks as differential data. This data is copied to the S-VOL when the pair is resynchronized.

The pair can be made identical again by resynchronizing the pair.

Note: You can split a pair from either the P-VOL or S-VOL.

Prerequisites

The pair must be in PAIR status.

Procedure

1. Access the MCU or RCU in SN, then click **Actions > Remote Copy > TrueCopy > Pair Operation**.

   You do not need to vary the P-VOL offline.
2. Make sure that you are in the modify mode.
3. In the **Pair Operation** window tree, select the CU group, CU, port, or host group where the pair volume is located.
4. In the volume list, right-click the pair to be split and click **Pairsplit-r** from the menu. You can split more than one pair by selecting then right-clicking more than one volume.
5. In the **Pairsplit-r** dialog box, information for the selected volume is shown for **Volume**. When more than one volume is selected, the volume with the lowest LUN is shown.

   From the **Suspend Kind** drop-down menu, specify whether or not to continue host I/O writes to the P-VOL while the pair is split. (If you are running the CCI command from the S-VOL, this item is disabled.)

   - Select **P-VOL Failure** not to allow write I/O to the P-VOL while the pair is split, regardless of the P-VOL fence level setting. Choose this setting if you need to maintain synchronization of the HAM pair.
   - Select **S-VOL** to allow write I/O to the P-VOL while the pair is split. The P-VOL will accept all subsequent write I/O operations after the split. The primary storage system will keep track of updates while the

pair is split. Choose this setting if the P-VOL is required for system operation and you need to keep the P-VOL online while the pair is split.

6. Click **Set**. The settings are shown in the **Preview** area.
7. In the **Preview** list, check the settings. To change a setting, right-click and select **Modify**. When satisfied, click **Apply**. The primary storage system will complete all write operations in progress before splitting the pair, so that the pair is synchronized at the time of the split.
8. Verify that the operation is completed successfully by checking the **Status** column. The status should be PSUS.

Resynchronizing pairs

When you resynchronize a split pair, the volume that was not being updated—usually the S-VOL—is synchronized with the volume that was being updated by the host—usually the P-VOL.

Pair status during resynchronization changes to COPY. It changes again to PAIR when the operation is complete.

The method for performing this operation differs according to whether the P-VOL or the S-VOL is accepting write I/O from the host. Check the VOL Access column in the **Pair Operation** window to see which volume is online.

- Pairs must be in PSUS or PSUE when the P-VOL is receiving I/O. If status is PSUE, clear the error before resynchronizing. The operation can be performed using the SN procedure below.
- When the S-VOL is receiving host I/O, pair status must be SSWS. The operation is performed by running the CCI **`pairresync-swaps`** command.

Note: If you want to resynchronize the pair that has been released from the S-VOL side, do not use this procedure. Instead, complete the following:

1. Release the pair from the P-VOL side by running the **`pairsplit-S`** CCI command.
2. Create the pair from the P-VOL side using the **Paircreate(HAM)** dialog box, making sure to set the appropriate initial copy option (**Entire Volume** or **None**).

1. Access the MCU in SN, then click **Actions > Remote Copy > TrueCopy > Pair Operation**.
2. Make sure that you are in the modify mode.
3. In the **Pair Operation** window tree, select the CU group, CU, port, or host group where the P-VOL is located.
4. In the volume list, right-click the P-VOL in the pair to be resynchronized and click **Pairresync**.

   In the **Pairresync** dialog box, **P-VOL Fence Level** is automatically set to **Never**. The volume receiving updates from the host will never be fenced, or blocked, from receiving host read/write.

5. In the **Pairresync** dialog box, from the **Copy Pace** drop-down menu, select the desired number of tracks to be copied at one time (1-15) during the copy operation. The default setting is 15. If you specify a large number, such as 15, copying is faster, but I/O performance of the storage system may decrease. If you specify a small number, such as 3, copying is slower, but the impact on I/O performance is lessened.
6. From the **Priority** drop-down menu, select the scheduling order for the copy operations. This applies when multiple pairs are being resynchronized. You can enter between 1-256. The highest priority is 1, the lowest priority is 256. The default is 32.
7. Click **Set**.
8. In the **Preview** list, check the settings. To change a setting, right-click and select **Modify**. When satisfied, click **Apply**.

Update the pair status by clicking **File/Refresh**, then confirm that the operation is completed with a status of PAIR.

Reverse resynchronization

After a failover, when the S-VOL is receiving updates from the host instead of the P-VOL, you can resynchronize the P-VOL with the S-VOL by running the CCI **`pairresync-swaps`** command. Copy direction is from S-VOL-to-P-VOL.

The P-VOL and S-VOL are swapped in this operation: the secondary storage system S-VOL becomes the P-VOL; the primary storage system P-VOL becomes the S-VOL.

The **`pairresync -swaps`** command is the only supported method for reverse resynchronizing HAM pairs.

Prerequisite information

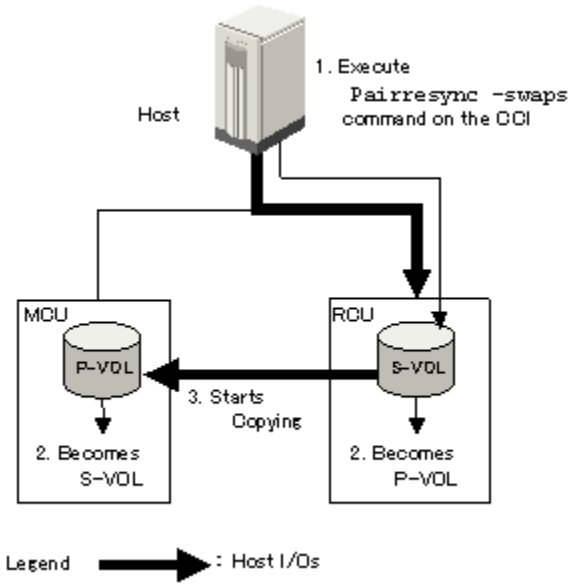
- Make sure that:
  - All errors are cleared.
  - Pair status is SSWS.
- ***Important***: If a pair is shared by multiple hosts with VMware, access to the pair must be managed uniformly. Otherwise, the pair can become inaccessible to one of the hosts. Before performing this procedure, see the section on Recovery for pairs shared by multiple hosts with VMware on page 6-21.

Procedure

1. Run the CCI **`pairresync -swaps`** command on the S-VOL.

   The data in the RCU S-VOL is copied to the MCU P-VOL. Also, the P-VOL and S-VOL is swapped. The MCU P-VOL becomes the S-VOL, and the RCU S-VOL becomes the P-VOL.
2. When the operation completes, verify that the pair is in PAIR status.

The following figure shows the swapping of a HAM P-VOL and S-VOL.



Releasing a pair

You can release a pair when you no longer need to keep the P-VOL and S-VOL synchronized. You can release a single pair or multiple pairs using the same procedure.

When you release a pair from the P-VOL, the primary storage system stops copy operations and changes pair status of both P-VOL and S-VOL to SMPL. The system continues to accept write I/O to the P-VOL volume, but does not keep track of the updates as differential data.

When you release a pair from the S-VOL, the secondary storage system changes S-VOL status to SMPL, but does not change P-VOL status. When the primary storage system performs the next pair operation, it detects that S-VOL status as SMPL and changes P-VOL status to PSUS. The suspend type is `Delete pair to RCU`.

Tip: Best Practice: Release a pair from the P-VOL. If the pair has a failure and cannot be released from the P-VOL, then release it from the S-VOL.

1. Verify that the P-VOL has the latest data using one of the following methods:
   - On the secondary storage system, open the **Pair Operation** window. Check that the **Volume Access** column for the S-VOL is blank (must not show **Access Lock**).
   - Use the multipath software command to check if the P-VOL path (owner path) is online.
2. Vary the S-VOL path offline using the multipath software command.
3. Access the MCU in SN, then click **Actions > Remote Copy > TrueCopy > Pair Operation**.
4. Make sure that you are in the modify mode.

5. In the **Pair Operation** window tree, select the CU group, CU, port, or host group where the P-VOL is located.
6. Right-click the pair to be released and click **Pairsplit-S**.
7. In the **Pairsplit-S** dialog box, **Delete Pair by Force** drop-down menu, select one of the following:
   - **Yes**: The pair will be released even if the primary storage system cannot communicate with the secondary storage system. This option can be used to free a host waiting for a response from the primary storage system, thus allowing host operations to continue.
   - **No**: The pair will be released only if the primary storage system can change pair status for both P-VOL and S-VOL to SMPL.

   When the status of the pair to be released is SMPL, the default setting is Yes and it cannot be changed. If the status is other than SMPL, the default setting is No.
8. Click **Set**.
9. Click **Apply**.
10. Verify that the operation completes successfully (changes to SMPL status).
11. The device identifier for one or both pair volumes changes when the pair is released. Therefore you should enable host recognition of the S-VOL, using one of the following methods:
    - Run the device recognition command provided by the operating system on the host.

      For more information, see the following table.
    - Reboot the host.

Changing TrueCopy pairs to HAM pairs

You can convert a TrueCopy pair to a HAM pair.

Requirements

Make sure that the following requirements are met to ensure the pair can be changed correctly without errors or failures:

- HAM system requirements must be met.
- The microcode version of the primary and secondary storage systems must be DKCMAIN 73-03-0X-XX/XX or later.
- A quorum disk ID must be registered.
- The TrueCopy pair must not be registered to a consistency group.
- CU Free are specified on the primary and secondary storage systems when the TrueCopy pair was created.

- The P-VOL is in the primary storage system. If the S-VOL is in the primary storage system, run the **horctakeover** command on the S-VOL to reverse the P-VOL and the S-VOL of the pair.

Caution: If this operation fails, check TrueCopy pair options to make sure that they have not changed. A failure can cause unexpected changes, for example, the P-VOL fence level could change from **Data** to **Never**.

Procedure

1. Access the MCU in SN, then click **Actions > Remote Copy > TrueCopy > Pair Operation**.
2. Make sure that you are in the modify mode.
3. In the **Pair Operation** window tree, select a CU group, CU, port, or host group where the TrueCopy P-VOL belongs.
4. Split the TrueCopy pairs that you want to convert to HAM pairs.
5. On the **Pairsplit -r** dialog box, specify parameters you want and then click **Set**.
6. On the **Pair Operation** window, verify the setting for **Preview** and click **Apply**.
7. Verify that the pair status is PSUS.
8. In the list, select and right-click the TrueCopy P-VOL, and then click **Pairresync**.
9. In the **Pairresync** dialog box, use the following settings:
   - For **P-VOL Fence Level**, specify **Never**.
   - In **Change attribute to HAM**, specify **Yes**.
   - In **Quorum Disk ID**, specify a quorum disk ID for the HAM pair.
10. Click **Set**.
11. Verify settings in **Preview** pane, then click **Apply**.
12. Verify that the **Status** column shows **COPY** for the pair that you converted, and that the **Type** column shows **HAM**.

    To update the information in the window, click **File > Refresh**.
13. Access the secondary storage system, open the **Pair Operation** window, and verify that the **Type** column for the S-VOL is **HAM**.

Caution: Application I/Os cannot be taken over in case of a failover until the window shows **HAM** for the S-VOL. Before moving onto the next step, wait for a while and refresh the window to make sure HAM appears.

14. Make sure that the host recognizes the HAM pair.

    For more information about verifying host recognition for new pairs, see Verifying host recognition of a new pair on page 4-13.

Comparison of the CCI commands and Storage Navigator

You can perform many HAM pair tasks using the CCI. The following list compares CCI commands and SN functionality for operations that can be performed on HAM pairs:

- Though the host recognizes the HAM volumes as a single volume, CCI views the P-VOL and S-VOL as separate volumes.
- CCI shows the HAM pair, the TrueCopy pair, and the UR pair, according to the following table.

Pair Type	Display of Fence	Display of CTG	Display of JID
HAM pair	NEVER		Quorum Disk ID
TrueCopy pair	DATA	The CTG ID	
	STATUS	The CTG ID	
	NEVER	The CTG ID	
Universal Replicator pair	ASYNC	The CTG ID	The journal ID

- When running CCI commands on the S-VOL, make sure that you specify S-VOL information in the scripts.

The following table shows the supported CCI commands and corresponding SN tasks.

Type of task	Task	CCI command	SN window or dialog box
Configuration	Add the quorum disk ID.	N/A	**Add Quorum Disk ID** dialog box
Pair operations	Create a pair.	paircreate -jp <quorum disk ID> -f never paircreate -jq <quorum disk ID> -f never	**Paircreate** dialog box
	Split a pair.	pairsplit -r	**Pairsplit-r** dialog box
	Resynchronize a pair.	pairresync	**Pairresync** dialog box
	Resynchronize a pair (reverse direction).	pairresync -swaps pairresync -swapp	N/A
	Swap & suspend a pair.	pairsplit -RS	N/A
	Forcibly change the S-VOL status from SSWS to PSUS (rollback).	pairsplit-RB	N/A
	Swapping, suspending, and resynchronizing a pair (reverse direction).	horctakeover	N/A
	Change a TrueCopy pair to a HAM pair.	N/A	**Pairresync** dialog box

Type of task	Task	CCI command	SN window or dialog box
Maintenance	View pair status.	pairdisplay	**Pair Operation** window or **Detailed Information** dialog box
	Release pair.	pairsplit-S	**Pairsplit-S** dialog box
	Delete the quorum disk ID.	N/A	**Delete Quorum Disk ID** button

Note the following:

- You cannot run the **pairresync** command on a pair when the storage system cannot access the quorum disk due to a failure.
- To resynchronize a HAM pair, the fence level must be **Never**.
- After you run the **pairsplit -RS** command, the write command to the P-VOL will fail.
- You cannot run the following commands on HAM pairs: **pairresync -fg <CTGID>** and **pairsplit -rw**.

5

System maintenance

To ensure that the HAM system function properly and is able to provide robust and reliable high-availability protection for host applications, it is essential for you to be able to perform HAM system maintenance tasks.

- ☐ Applications used to perform maintenance tasks
- ☐ Related documentation
- ☐ The different types of maintenance tasks

Applications used to perform maintenance tasks

All of the typical maintenance tasks can be completed using SN or CCI.

Required Storage Navigator settings

You must be in Modify Mode in SN.

Related documentation

For more information about other system maintenance tasks, see the *Hitachi TrueCopy® User Guide*.

The different types of maintenance tasks

The following tasks can be performed.

Switching paths using multipath software

Before switching paths using multipath software, make sure that P-VOL and S-VOL status is PAIR. If the path is switched while the HAM pair is not in the PAIR status, I/O updates could be suspended or the host might read older data.

Vary the paths as follows:

- When both owner and non-owner paths are online, vary the owner path offline.
- When the owner path is offline and non-owner path is online, vary the owner path online.

Caution: When the HAM pair is in the PAIR status, if you vary the owner path online, non-owner paths on RCU may be changed to offline. Since no failure actually occurred in these paths, you should restore the status of the HAM pair to PAIR, and then vary the non-owner paths online.

I/O scheduled before making the owner paths online with the multipath software is issued to non-owner paths. According to circumstances, I/O scheduled after making owner paths online might be issued prior to I/O scheduled before making owner paths online. In this case, the check condition on I/O which is issued to non-owner paths may report to the host because the RCU HAM pair is in the PSUS status and the MCU HAM pair is in the SSWS status. I/O which is reported on the check condition are reissued to the owner path, and then ended normally. Non-owner paths which are reported on the check condition become offline due to failures.

Discontinuing HAM operations

You can discontinue HAM operations at any time.

Note: During the procedure, you must delete the external volume mapping of the quorum disk. If the HAM pair is still connected to the disk, you cannot delete the mapping. To ensure you can delete the mapping, before you delete the mapping, make sure you disconnect the quorum disk by running the **Disconnect External Volumes** command.

1. Using multipath software, vary the non-owner path to offline.
2. Release all HAM pairs from the primary storage system.
3. From the primary and secondary storage systems, verify that the pair status for all volumes is SMPL.

   If the status does not change to SMPL due to a failure of the remote copy connections, release all HAM pairs from the secondary storage system.
4. From the primary and secondary storage systems, delete all quorum disk IDs. The quorum disk becomes a normal external volume.
5. From the primary and secondary storage systems, disconnect the quorum disk by doing the following:
   a. Open the **External Storages** window.
   b. Select the quorum disk and specify the **Disconnect External Volumes** command.
6. From the primary and secondary storage systems, delete the external volume mapping of the quorum disk. In the **External Storages** window, select the quorum disk and specify the **Delete External Volumes** command.
7. Remove the cables between the host and secondary storage system, between the primary and secondary storage systems and the quorum disk.

To cause the host to recognize HUS VM S-VOLs as non-pair volumes, see Releasing a pair on page 4-18.

Quorum disk ID deletion

You delete a quorum disk ID during some normal maintenance activities and failure recovery. When you delete a disk ID, the system lists the quorum disk as an external volume and not as a pair.

Two procedures can delete a quorum disk ID. One is a standard deletion, and the second is a forced deletion. You use the forced deletion when access to the disk is blocked due to a failure in the disk or the path.

- Deleting quorum disk IDs (standard method) on page 5-4
- Deleting quorum disk IDs by system attribute (forced deletion) on page 5-4

Deleting quorum disk IDs (standard method)

You delete a quorum disk ID using the standard method if you are able to access the disk (access may be blocked if there is a disk failure or a path failure).

Requirements

To ensure that you delete the disk ID properly, make sure that:

- The disk is not being used by any HAM pair. If it is, you cannot delete the ID.
- You delete the ID on both the primary and secondary storage systems. The procedure is the same for both systems.
- The ID you delete on the systems is the same ID.

1. Access an MCU or RCU in SN and click **Actions > Remote Copy > TrueCopy > Quorum Disk Operation**.
2. On the **Quorum Disk Operation** window, make sure that you are in the modify mode.
3. In the quorum ID list, right-click the quorum disk ID that you want to delete, then click **Delete Quorum Disk ID**.
4. Confirm the operation in the **Preview** list, then click **Apply**.

If the quorum disk ID cannot be deleted, a failure might have occurred in the quorum disk. Do one of the following:

- Recover from the failure, then try to delete the ID again using this procedure.
- Forcibly delete the quorum disk (see Deleting quorum disk IDs by system attribute (forced deletion) on page 5-4).

Deleting quorum disk IDs by system attribute (forced deletion)

You can forcibly delete a quorum disk ID when access to the disk is blocked due to a failure in either the disk or path. This is done by turning a system option ON and then forcibly deleting the disk. This causes the disk to become a normal external volume.

Requirements

To ensure that you delete the disk ID properly, make sure that:

- The disk is not being used by any HAM pair. If it is, you cannot delete the ID.
- You delete the ID on both the primary and secondary storage systems. The procedure is the same for both systems.
- The ID you delete on the systems is the same ID.

1. On the primary storage system, release all HAM pairs using the quorum disk that you want to delete.

2. Call the Hitachi Data Systems Support Center and ask them to turn ON the appropriate system option on the storage system that cannot access the quorum disk.
3. On the primary and secondary storage system, delete the quorum disk ID from the **TrueCopy/Quorum Disk Operation** window in SN.
4. On the primary and secondary storage system, make sure that the ID is correctly deleted. If you deleted the wrong ID, register the ID again.
5. Call the Hitachi Data Systems Support Center and ask them to turn OFF the system option.

Recovery of accidently deleted quorum disks

If you forcibly deleted a quorum disk by mistake, you can recover the quorum disk. The procedure you use depends on whether the P-VOL or S-VOL was receiving host I/O when the disk was deleted.

You can use SN and CCI, or only CCI to complete the recovery procedures.

Tip: Some of the steps can be done using either SN or CCI. Typically, these steps can be completed more quickly using CCI.

The procedures are:

- Recovering the disk when the P-VOL was receiving host I/O at deletion on page 5-5
- Recovering the disk when the S-VOL was receiving host I/O at deletion on page 5-5

Recovering the disk when the P-VOL was receiving host I/O at deletion

Use this procedure to recover a disk that was accidentally deleted when the primary volume was receiving host I/O at the time of deletion.

1. Vary the host-to-S-VOL path offline using the multipath software.
2. Release all pairs that use the forcibly-deleted quorum disk.
3. Make sure the quorum disk ID is deleted from both primary and secondary storage systems.
4. On the primary and secondary storage system, add the quorum disk ID.
5. On the primary storage system, create the HAM pair.
6. On both the primary and secondary storage systems, make sure that **Type** shows **HAM**.

Recovering the disk when the S-VOL was receiving host I/O at deletion

Use this procedure to recovery a disk that was accidentally deleted when the secondary volume was receiving host I/O at the time of deletion.

1. Stop the I/O from the host.
2. Release all pairs using the forcibly-deleted quorum disk.
3. Make sure the quorum disk ID is deleted from both primary and secondary storage systems.

4. On the secondary storage system, create a TrueCopy pair. The data flow is from secondary to primary sites.

   To do this, specify the HAM S-VOL as a TrueCopy P-VOL.
5. Do one of the following:
   - If changing a TrueCopy pair to a HAM pair: When the copy operation is completed, run the **horctakeover** command on the TrueCopy S-VOL. This reverses the TrueCopy P-VOL and S-VOL.
   - If using CCI to create the HAM pair again: When the copy operation is completed, run the **pairsplit -S** command and release the TrueCopy pair.
   - If using SN: When the copy operation is completed, release the TrueCopy pair.
6. Using multipath software, vary the host-to-P-VOL path online.
7. On the primary and secondary storage systems, add the quorum disks.
8. Do one of the following:
   - If changing the TrueCopy pair to a HAM pair: From the primary system P-VOL using Storage Navigator, split the TrueCopy pair, then change the pair to a HAM pair. See Changing TrueCopy pairs to HAM pairs on page 4-19.
   - If creating the pair again:

     - If using CCI, run the **paircreate** command on the primary storage system.
   - If using SN, create the HAM pair on the primary storage system.
9. On the primary and secondary storage systems, make sure the volume type is **HAM**.

Planned outages for system components

As part of your normal system maintenance activities, you can perform planned outages by turning the power for system components on and off as needed.

The following are the types of components you can use to turn on and off power:

- Primary storage systems
- Secondary storage systems
- Quorum disks

Options for performing the planned outages

You do not have to use multiple procedures to perform a planned outage on multiple components. You can use a single procedure to perform all of the steps required to complete a planned outage for multiple components.

You can use a single procedure to perform a planned outage on:

- A quorum disk
- A primary storage system and the quorum disk connected to it

- A secondary storage system and the quorum disk connected to it
- A primary and secondary storage system and the disk connected to them

The procedures for performing planned outages

The following procedures contain all of the steps required to perform a planned outage. Use the procedure that fits the requirements for the planned outage.

Use one of the following:

- Performing planned outages (quorum disk only) on page 5-7.
- Performing planned outages (primary system and quorum disk) on page 5-9.
- Performing planned outages (secondary system and quorum disk) on page 5-10.
- Performing planned outages (both systems and quorum disk) on page 5-10.

Performing planned outages (quorum disk only)

The procedure you use for a planned outage of a quorum disk depends on whether the primary or secondary storage system is receiving host I/O updates.

Use one of the following:

- Performing outages when the P-VOL is receiving host I/O on page 5-7.
- Performing outages when the S-VOL is receiving host I/O on page 5-8.

Performing outages when the P-VOL is receiving host I/O

Use this procedure when the P-VOL is receiving host I/O updates. If you also need to power off and on the primary or secondary storage system connected to the disk, use one of the other procedures (see The procedures for performing planned outages on page 5-7).

1. Using multipath software, vary the non-owner path offline.
2. On the primary storage system, complete the following:
   a. Split the pair.
   b. Make sure the P-VOL is PSUS.
   c. Run the following command on the quorum disk:

      `Disconnect External Volumes`
3. On the secondary storage system, run the following command on the quorum disk:

   `Disconnect External Volumes`
4. Power off the quorum disk.
5. Power on the quorum disk.

6. On the secondary storage system, run the following command on the quorum disk:

   Reconnect External Volumes

7. On the primary storage system, complete the following:
   a. Run the following command on the quorum disk:

      Reconnect External Volumes

   b. Resynchronize the pair.
   c. Make sure the P-VOL status is PAIR.
8. Using multipath software, vary the non-owner path online.

Performing outages when the S-VOL is receiving host I/O

Use this procedure when the S-VOL is receiving host I/O updates. If you also need to power off and on the primary or secondary storage system connected to the disk, use one of the other procedures (see The procedures for performing planned outages on page 5-7).

1. On the secondary storage system, split the pair.
2. On the secondary storage system, make sure the P-VOL is in PSUS status.
3. On the primary storage system, run the following command on the quorum disk:

   Disconnect External Volumes

4. On the secondary storage system, run the following command on the quorum disk:

   Disconnect External Volumes

5. Power off the quorum disk.
6. Power on the quorum disk.
7. On the secondary storage system, run the following command on the quorum disk:

   Reconnect External Volumes

8. On the primary storage system, run the following command on the quorum disk:

   Reconnect External Volumes

9. On the secondary storage system, complete the following:
   a. Resynchronize the pair.
   b. Make sure the P-VOL status is PAIR.
10. Using multipath software, complete the following:
    a. vary the owner path online.
    b. Vary the non-owner path offline.
11. On the secondary storage system, make sure the P-VOL status is PSUS.
12. On the primary storage system, complete the following:
    a. Make sure the S-VOL status is SSWS.

b. Reverse the copy direction so that it is again from primary storage system P-VOL to secondary storage system S-VOL by running the following command on the S-VOL:

   pairresync -swaps

c. Make sure P-VOL and S-VOL status is PAIR.

13. If the non-owner path is offline, vary it online using the multipath software.

Performing planned outages (primary system and quorum disk)

1. Make sure the P-VOL and S-VOL status is PAIR.
2. Using multipath software, complete the following:
   a. Vary the owner path offline. *1
   b. Make sure that host I/O switches to the non-owner path (a failure occurred)
3. On the primary storage system, make sure that P-VOL status is PSUS.
4. On the secondary storage system, complete the following:
   a. Make sure that S-VOL status is SSWS.
   b. Run the following command on the quorum disk:

      Disconnect External Volumes

5. Power off the primary storage system.
6. Power off the quorum disk. *2
7. Power on the quorum disk. *2
8. Power on the primary storage system. *3
9. On the secondary storage system, complete the following:
   a. Run the following Universal Volume Manager command on the quorum disk:

      Reconnect External Volumes

   b. Run the following command on the S-VOL:

      pairresync -swaps

   c. Make sure that P-VOL and S-VOL status is PAIR.
10. Using the multipath software, complete the following:
    a. Vary the owner path online.
    b. Vary the non-owner path offline.
11. On the primary storage system, make sure that S-VOL status (original P-VOL) is SSWS.
12. On the secondary storage system, make sure that P-VOL status (original S-VOL) is PSUS.
13. On the primary storage system, complete the following:
    a. Run the following command on the S-VOL:

       pairresync -swaps

    b. Make sure that P-VOL and S-VOL are reversed to their original pair configuration and that status is PAIR.

14. (If the non-owner path is offline) Using the multipath software, vary it online.

*1: If you vary the owner path offline during I/O processing, the multipath software may display a message saying that the path is offline due to a path failure. In this case, you can ignore the message.

*2: Skip this step when you power off the primary storage system only.

*3: When the host operating system is Windows, the multipath software may return a host-to-P-VOL path failure when you power on the primary storage system. In this case, you can ignore the message. This happens because HAM blocks access to the primary storage system after the plug and play function automatically recovers the owner path to online.

Performing planned outages (secondary system and quorum disk)

Use this procedure to perform a planned outage of the secondary storage system and the quorum disk connected to the system.

1. Using multipath software, vary the non-owner path offline.
2. On the primary storage system, complete the following:
   a. Split the pair.
   b. Make sure that P-VOL status is PSUS.
   c. Run the following Universal Volume Manager command on the quorum disk:

      `Disconnect External Volumes`
3. Power off the secondary storage system.
4. Power off the quorum disk. If you are powering-off only the secondary storage system, skip this step.
5. Power on the quorum disk. If you are powering-off only the secondary storage system, skip this step.
6. Power on the secondary storage system.
7. On the primary storage system, complete the following:
   a. Run the following Universal Volume Manager command on the quorum disk:

      `Reconnect External Volumes`
   b. Resynchronize the pair.
   c. Make sure that P-VOL status is PAIR.
8. Using multipath software, vary the non-owner path online.

Performing planned outages (both systems and quorum disk)

Use this procedure to perform a planned outage of the primary storage system, the secondary storage system, and the disk connected the systems.

1. On the primary storage system, complete the following:
   a. Split the pair.
   b. Make sure that P-VOL status is PSUS.

2. Stop host I/O.
3. Using multipath software, vary the non-owner path offline.
4. Power off the primary storage system.
5. Power off the secondary storage system.
6. Power off the quorum disk.
7. Power on the quorum disk.
8. Power on the secondary storage system.
9. Power on the primary storage system.
10. Using multipath software, vary the owner path online.
11. Restart host I/O.
12. On the primary storage system, complete the following:
    a. Resynchronize the pair.
    b. Make sure that P-VOL status is PAIR.
13. Using multipath software, vary the non-owner path online.

6

Disaster recovery

On-site disasters, such as power supply failures, can disrupt the normal operation of your HAM system. Being able to quickly identify the type of failure and recover the affected system or component helps to ensure that you can restore high-availability protection for host applications as soon as possible.

Main types of failures that can disrupt your system

The main types of failures that can disrupt the system are power failures, hardware failures, connection or communication failures, and software failures. These types of failures can cause system components to function improperly or stop functioning.

System components typically affected by these types of failures include:

- Main control unit (primary storage system)
- Service processor (primary or secondary storage system)
- Remote control unit (secondary storage system)
- Volume pairs
- Quorum disks

The basic recovery process

The basic process for recovering from an on-site disaster is the same, regardless of the type of failure that caused the disruption in the system. The recovery process involves:

- Detecting failures
- Determining the type of failure
- Determining which recovery procedure to use
- Completing the recovery procedure.

System failure messages

The system automatically generates messages that you can use to detect failures and determine the type of failure that occurred. The messages contain information about the type of failure.

System information messages (SIM)	Generated by the primary and secondary storage systems
Path failure messages	Generated by the multipath software on the host

Detecting failures

Detecting failures is the first task in the recovery process. Failure detection is essential because you need to know the type of failure before you can determine which recovery procedure to use.

You have two options for detecting failures. You can check to see if failover has occurred and then determine the type of failure that caused it, or you can check to see if failures have occurred by using the SIM and path failure system messages.

- Option 1: Check for failover first on page 6-3
- Option 2: Check for failures only on page 6-4

Option 1: Check for failover first

You can use status information about the secondary volume and path status information to see if failover occurred. You can do this using SN, CCI, or multipath software.

Note: You need to determine the type of failure before you can determine which recovery procedure to use.

For more information, see Using system messages to check for failures on page 6-4.

- Using Storage Navigator to check for failover on page 6-3
- Using CCI to check for failover on page 6-3
- Using multipath software to check for failover on page 6-3

Using Storage Navigator to check for failover

If you are using SN, you use status information about the secondary volume to check to see if failover has occurred.

1. In the Pair Operation window, if the following values appear for the secondary volume, failover occurred:
   - Status is SSWS
   - Vol Access is Access (Lock)

Using CCI to check for failover

If you are using CCI, use the following procedure to obtain status information about the secondary volume to see if failover has occurred.

1. Run the **`pairdisplay`** command on the secondary storage system.
2. If the status value for the secondary volume is SSWS, failover occurred.

Using multipath software to check for failover

If you are using multipath software, check the path status information to see if failover has occurred.

1. Run the **`path status viewing`** command.
2. If the system returns the following status values for the owner and non-owner paths, failover occurred:
   - Owner path is offline
   - Non-owner path is online

Next steps

You need to determine the type of failure before you can determine which recovery procedure to use.

For more information, see Using system messages to check for failures on page 6-4.

Option 2: Check for failures only

You can use automatically generated system messages to see if failures have occurred and to determine the type of failure. These system messages contain information about the type of failure that occurred.

Based on these messages, you determine which recovery procedure to use.

For more information, see Determining which basic recovery procedures to use on page 6-4.

Using system messages to check for failures

Use the system information messages (SIM) and path failure system messages to check for failures and to determine the type of failure.

1. Check for system information messages from the primary or secondary storage system.
2. Check for path failure messages generated by the multipath software on the host.

Determining which basic recovery procedures to use

Determining which basic recovery procedures to use involves analyzing the information in the system information messages (SIM) and path failure system messages to identify the type of failure, then selecting the correct procedure based on the type of failure.

Each of the following basic types of failures uses a different set of recovery procedures:

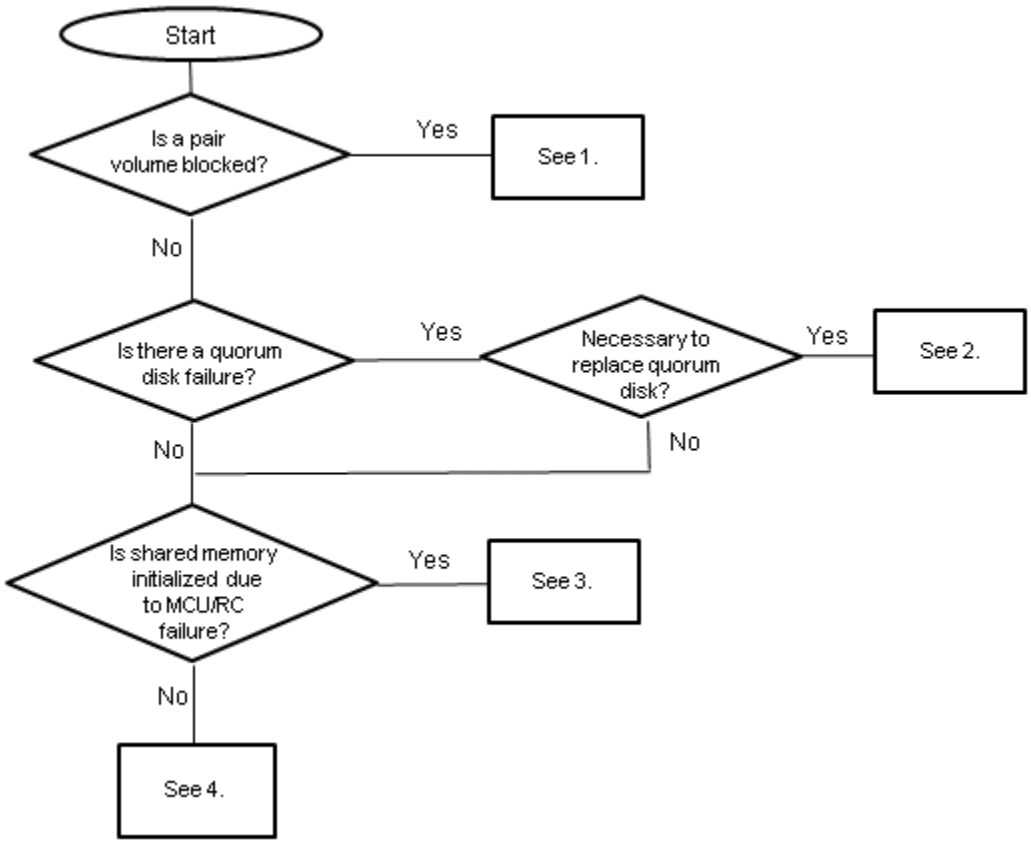
- Blocked volumes
- Quorum disk
- Power outage
- Resynchronization of volume pairs
- Owner or non-owner path failures

Selecting Procedures

Make sure you have identified the type of failure that occurred by using the system information messages (SIM) and path failure system messages.

For more information, see Using system messages to check for failures on page 6-4.

1. Analyze these failure messages to determine which basic type of failure occurred. The failure types are: blocked volumes, quorum disk, power outage, or failures that can be resolved by resynchronizing affected pairs.
2. Use the decision tree in the following figure to select the correct set of procedures. Use the links below the figure to go to the appropriate procedures.



1. Recovery from blocked pair volumes on page 6-5
2. Recovery from quorum disk failure on page 6-9
3. Recovery from power failure on page 6-12
4. Recovery using resynchronization on page 6-16

Recovery from blocked pair volumes

In most cases, a blocked volume pair results in automatic failover. This helps to ensure that host I/O continues and host applications remain available.

The process used to recover pair volumes from this failure varies depending on:

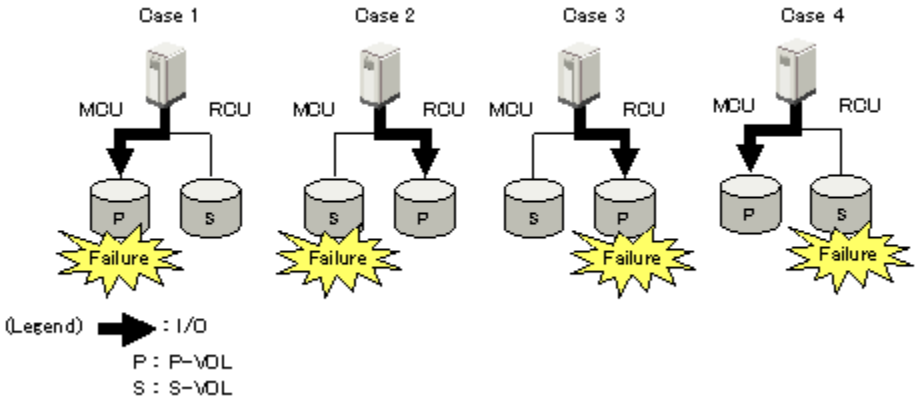
- Whether the volume is a primary or secondary volume.
- Whether the volume is in the primary or secondary storage system.

Depending on which systems and volumes are affected and whether failover occurred, the recovery process can involve:

- Releasing the pair
- Clearing the failure
- Clearing any other failures that may prevent normal host I/O

- Recreating the pair
- Restoring the original relationship of the volumes
- Restoring normal host I/O (or restarting host I/O)

The following figure shows the different volume failure scenarios that are possible with volume pairs.



1. Recovering from primary volume failure on the MCU on page 6-6.
2. Recovering from secondary volume failure on the MCU on page 6-7.
3. Recovering from primary volume failure on the RCU on page 6-8.
4. Recovering from secondary volume failure on the RCU on page 6-9.

Recovering from primary volume failure on the MCU

When this failure occurs, automatic system failover switches host I/O to the primary volume on the RCU. Recovering the volume from this failure involves releasing the pair, clearing the failure, recreating the pair, restoring the original relationship of the volumes, and restoring normal host I/O.

Note: If the failed volume is an external volume, contact the Hitachi Data Systems Support Center for assistance clearing the failure.

You use multipath software and either SN or CCI to complete the recovery procedure.

Tip: Some of the steps can be performed by using either SN or CCI. Typically, you can complete these steps quicker using CCI.

1. Using multipath software, make sure that the secondary storage system is receiving host I/O.
2. Stop I/O from the host.
3. On the primary storage system, run the **`Pairsplit-S`** CCI command on the P-VOL to release the HAM pair.
4. Clear the failure in the primary storage system P-VOL.
5. On the secondary storage system, create a TrueCopy pair from the original S-VOL to the P-VOL. Data flow is from the secondary to primary storage systems.

6. Continue by either changing the TrueCopy pair to a HAM pair (below) or recreating the HAM pair (next steps).

   If changing the TrueCopy pair to a HAM pair, complete this step. If using SN, go directly to the SN step.

   a. On the primary storage system, run the CCI **`horctakeover`** command on the new TrueCopy S-VOL. This reverses the relationship of the pair.
   b. On the primary storage system, split the TrueCopy pair using the Pairsplit-r dialog box.
   c. On the primary storage system, use SN's Pairresync dialog box to change the TrueCopy pair to a HAM pair. For more information, see Changing TrueCopy pairs to HAM pairs on page 4-19.

7. If recreating the HAM pair using CCI:
   a. On the secondary storage system, when the copy operation is completed, run the following command to release the TrueCopy pair:

      `pairsplit -S`

   b. On the primary storage system, run the following command to create the HAM pair:

      `paircreate`

8. If recreating the HAM pair using SN:
   a. On the secondary storage system, release the TrueCopy pair.
   b. On the primary storage system, create the HAM pair.
9. On the primary and secondary storage systems, make sure that **Type** shows **HAM**.
10. Using multipath software, vary the owner path online.
11. Restart I/O.

Recovering from secondary volume failure on the MCU

When this failure occurs, automatic system failover switches host I/O to the primary volume on the RCU. Recovering the volume from this failure involves releasing the pair, clearing the failure, recreating the pair, restoring the original relationship of the volumes, and restoring normal host I/O.

Note: If the failed volume is an external volume, contact the Hitachi Data Systems Support Center for assistance clearing the failure.

You use multipath software and either SN or CCI to complete the recovery procedure.

Tip: Some of the steps can be done using either SN or CCI. Typically, these steps can be completed more quickly using CCI.

1. Using multipath software, make sure that the secondary storage system is receiving I/O.
2. Stop I/O from the host.
3. On the secondary storage system, release the HAM pair by running the following CCI command on the P-VOL:

pairsplit-S

4. Clear the failure in the primary storage system P-VOL.
5. On the primary storage system, make sure that no other failures exist and that it is ready to accept host I/O.
6. On the secondary storage system, create a TrueCopy pair from the original S-VOL to the P-VOL. The data flow is from the secondary to primary storage system.
7. You can continue by either changing the TrueCopy pair to a HAM pair (below) or recreating the HAM pair (next step).

   If changing the TrueCopy pair to a HAM pair, complete this step on the primary storage system.

   a. On the primary system, use CCI to run the horctakeover command on the new TrueCopy S-VOL. This reverses the relationship and the copy flow from S-VOL to P-VOL.
   b. On the primary system, use SN to split the TrueCopy pair.
   c. On the primary system, perform the SN pair resync operation to change the TrueCopy pair to a HAM pair. See Changing TrueCopy pairs to HAM pairs on page 4-19.
8. If recreating the HAM pair:
   a. Using either CCI or SN, on the secondary storage system, release the TrueCopy pair (for CCI, use the **pairsplit -S** command.
   b. On the primary storage system, create the HAM pair.
9. On both systems, in SN, make sure that **Type** shows **HAM**.
10. Using multipath software, vary the owner path online.
11. Restart I/O.

Recovering from primary volume failure on the RCU

This failure occurs after automatic system failover switches host I/O to the primary volume on the RCU due to a failure of the primary volume on the primary storage system. Because both systems have volume failures, all host I/O stops. Recovering the volume from this failure involves releasing the pair, clearing the failure (and any failures on the primary storage system), recreating the pair, restoring the original relationship of the volumes, and restoring normal host I/O.

Note: If the failed volume is an external volume, contact the Hitachi Data Systems Support Center for assistance clearing the failure.

You use multipath software and SN to complete this task.

1. Make sure that I/O is stopped.
2. Using multipath software, vary the non-owner path offline.
3. On the secondary storage system, release the HAM pair by running the **Pairsplit-S** command on the P-VOL.
4. Clear the failure in the secondary storage system P-VOL.

5. If using CCI, on the primary storage system, run the **paircreate** command to create the HAM pair.
6. If using SN, on the primary storage system use a Paircreate (HAM) window to create the HAM pair.
7. Clear any failures on the primary storage system so that it can accept I/O.
8. On the primary storage system, create the pair (Paircreate(HAM)).
9. On both systems, make sure that **Type** shows **HAM**.
10. Using multipath software, vary the owner and non-owner paths online.
11. Restart host I/O.

Recovering from secondary volume failure on the RCU

When this failure occurs, automatic system failover switches host I/O to the primary volume on the RCU. Recovering the volume from this failure involves releasing the pair, clearing the failure, recreating the pair, and restarting host I/O. Unlike the other types of pair volume failures, host I/O is not interrupted and failover does not occur.

Note: If the failed volume is an external volume, contact the Hitachi Data Systems Support Center for assistance clearing the failure.

1. Using multipath software, make sure that the primary storage system is receiving host I/O.
2. Using multipath software, vary the non-owner path offline.
3. On the primary storage system, run the **Pairsplit-S** CCI command to release the pair.
4. Clear the failure in the secondary storage system S-VOL.
5. If using CCI, on the primary storage system, run the **paircreate** CCI command to create the HAM pair.
6. If using SN, on the primary storage system create the HAM pair using the Paircreate(HAM) dialog box.
7. On the primary storage system, create the pair (Paircreate(HAM)).
8. On both systems, make sure that **Type** shows **HAM**.
9. Using multipath software, vary the non-owner path online.
10. Restart host I/O.

Recovery from quorum disk failure

There are two basic methods for recovering from quorum disk failure. In some cases, the disk must be replaced. In other cases, you can recover from the failure by resynchronizing the pair volume that is connected to the disk.

- Replacement of quorum disks on page 6-10
- Recovery using resynchronization on page 6-16

Replacement of quorum disks

Replacement of a quorum disk is done when the disk fails and the external storage system that contains the disk cannot be recovered by resynchronizing the volume pair connected to the disk.

The procedure you use varies depending which system (primary or secondary) is receiving host I/O.

The procedures are:

- Replacing a quorum disk when the MCU is receiving host I/O on page 6-10
- Replacing a quorum disk when the RCU is receiving host I/O on page 6-11

Note: You can use the replacement procedures to replace a disk that is connected to one or more volume pairs.

Replacing a quorum disk when the MCU is receiving host I/O

Replacing the disk involves preparing the systems and the volume pair (or pairs) connected to the disk so that you can safely remove the failed disk and replace it. After it is replaced, you reconnect the systems to the disk, add the disk ID, and re-create the volume pair (or pairs).

When you replace a disk, data on the disk is erased and you cannot continue using HAM.

Caution: To prevent host I/O from stopping, make sure you complete the steps exactly as they are listed in the procedure.

1. Use the multipath software to vary the non-owner path offline.
2. On the primary storage system, release the pair by running the **pairsplit-S** CCI command on the P-VOL.
3. On the primary storage system, make sure that P-VOL status is SMPL.
4. On the primary storage system, delete the quorum disk ID. If a failure in the quorum disk prevents deletion, forcibly delete it.
5. On the secondary storage system, delete the quorum disk ID. You can forcibly delete it, if necessary.
6. On the primary storage system, run the `Disconnect External Volumes` command on the quorum disk. If the connection to the quorum disk cannot be released due to the failure of the quorum disk, skip the Disconnect External Volumes operation.
7. On the secondary storage system, run the Universal Volume Manager **`Disconnect External Volumes`** command on the quorum disk. If the connection to the quorum disk cannot be released due to the failure of the quorum disk, do not run this command.
8. Replace the quorum disk.
9. On both systems, run the **`Reconnect External Volumes`** command on the quorum disk.

10. On both systems, add the quorum disk ID.
11. On the primary storage system, run the **Paircreate(HAM)** command to create the HAM pair.
12. On both the primary and secondary storage systems, make sure that **Type** shows **HAM**.
13. Use the multipath software to vary the non-owner path online.

Replacing a quorum disk when the RCU is receiving host I/O

Replacing the disk involves preparing the systems and the volume pair (or pairs) connected to the disk so that you can safely remove the failed disk and replace it. After it is replaced, you reconnect the systems to the disk, add the disk ID, and re-create the volume pair (or pairs).

When you replace a disk, data on the disk is erased and you cannot continue using HAM.

Caution: To prevent host I/O from stopping, make sure you complete the steps exactly as they are listed in the procedure.

You can use SN or CCI to complete the recovery procedure.

Tip: Some of the steps can be done using either SN or CCI. Typically, you can complete these steps quicker using CCI.

1. Stop I/O from the host.
2. On the secondary storage system, run the **pairsplit-S** CCI command on the P-VOL to release the HAM pair.
3. On the secondary storage system, make sure that P-VOL status is SMPL.
4. On the secondary storage system, create a TrueCopy pair. The data flow is from secondary to primary storage system.
5. Perform one of the following operations:
   - If changing the TrueCopy pair to a HAM pair on the primary storage system: Run the CCI **horctakeover** command on the S-VOL. This reverses the relationship of the pair.
   - If using CCI to create a HAM pair again, on the primary storage system, run the **pairsplit** command on the S-VOL and release the TrueCopy pair.
   - If using SN, from the secondary storage system, release the TrueCopy pair.
6. On the primary storage system, delete the quorum disk ID.

   If the quorum disk ID cannot be deleted due to a disk failure, forcibly delete the quorum disk.
7. On the secondary storage system, delete the quorum disk ID.
8. On both systems, run the **Disconnect External Volumes** command on the quorum disk.

If the connection to the quorum disk cannot be released due to the failure of the quorum disk, skip the Disconnect External Volumes operation.

9. Replace the quorum disk.
10. On both systems, run the **`Reconnect External Volumes`** command on the quorum disk.
11. On both systems, add the quorum disk ID.
12. Perform one of the following operations:
    - If changing the TrueCopy pair to a HAM pair: use SN to split the TrueCopy pair, then change the pair to a HAM pair. See Changing TrueCopy pairs to HAM pairs on page 4-19.
    - If using CCI and are recreating the HAM pair: On the primary storage system, run the **`paircreate`** command to create the HAM pair.
    - If using SN and are recreating the HAM pair again: On the primary storage system, use the paircreate(HAM) dialog box to create a HAM pair.
13. On both the primary and secondary storage systems, make sure that **Type** shows **HAM**.
14. Use the multipath software to vary the owner path online.
15. Restart I/O.

Recovery from power failure

You can recover the primary storage system or secondary storage system from power failures that cause the system's backup batteries to discharge and cause the loss of differential data.

The recovery process varies depending on the type of system.

- Primary storage system recovery on page 6-12
- Secondary system recovery on page 6-14

Primary storage system recovery

There are two procedures you can use to recover the system following a power failure that results in the initialization of the system memory. Which task you use depends on whether or not host I/O updates have stopped. You must use the correct procedure to ensure the recovery is successful.

The tasks are:

- Recovering the system when the RCU is receiving host I/O updates on page 6-13.
- Recovering the system when host I/O updates have stopped on page 6-14.

Recovering the system when the RCU is receiving host I/O updates

Recovering the primary storage system from power failure, when host I/O updates continue after failover, involves the completion of tasks on both the primary storage system and secondary storage system. Because failover occurred, you must complete the steps required to restore the original relationship of the volumes.

You use multipath software and either SN or CCI to complete the recovery procedure.

Tip: Some of the steps can be done using either SN or CCI. Typically, you can complete these steps quicker using CCI.

1. Verify that the S-VOL has the latest data and is being updated. Open the Pair Operation window on the secondary storage system and check that the VOL Access column shows Access (Lock).
2. Stop I/O from the host.
3. On the secondary storage system, release the HAM pair.
4. On the secondary storage system, delete the quorum disk ID.
5. On the secondary storage system, create a TrueCopy pair. The data flow is from secondary to primary sites.
6. Format the quorum disk.
7. On the primary storage system, register the HAM secondary storage system to the primary storage system.
8. You can continue by either changing the TrueCopy pair to a HAM pair (below) or recreating the HAM pair (next steps).

   If changing the TrueCopy pair to a HAM pair, complete this step.

   a. When the TrueCopy operation finishes, run the **`horctakeover`** command on the primary storage system S-VOL to reverse the P-VOL and S-VOL.
   b. On the primary and secondary storage systems, add the quorum disk.
   c. Using SN, on the primary system, split the TrueCopy pair.
   d. Using SN, on the primary system, change the TrueCopy pair to a HAM pair. See Changing TrueCopy pairs to HAM pairs on page 4-19 for details.
9. If recreating the HAM pair using CCI:
   a. When the copy operation in Step 5 completes, release the TrueCopy pair.
   b. On the primary and secondary storage systems, add the quorum disk.
   c. On the primary storage system, run the **`paircreate`** command to create the HAM pair.
10. If recreating the HAM pair using SN:
    a. On the secondary storage system, release the TrueCopy pair.
    b. On the primary and secondary storage systems, add the quorum disk.

c. On the primary storage system, create the HAM pair.

11. On both the primary and secondary storage systems, make sure that **Type** shows **HAM**.
12. Using the multipath software, vary the owner and non-owner paths online.
13. Restart host I/O.

Recovering the system when host I/O updates have stopped

Recovering the primary storage system from power failure, when host I/O updates have stopped, involves the completion of tasks on both the primary storage system and secondary storage system.

You use multipath software and either SN or CCI to complete the recovery procedure.

Tip: Some of the steps can be performed using either SN or CCI. Typically, you can complete these steps quicker using CCI.

1. Verify that the P-VOL has the latest data by opening the Pair Operation window on the secondary storage system (S-VOL side) and checking that the VOL Access column is empty (blank).
2. On the secondary storage system, release the HAM pairs.
3. On the secondary storage system, delete the quorum disk ID.
4. Format the quorum disk.
5. On the primary storage system, register the HAM secondary storage system to the primary storage system.
6. On the primary and secondary storage systems, add the quorum disk.
7. On the primary storage system, create the HAM pair.
8. On both the primary and secondary storage systems, make sure that **Type** shows **HAM**.
9. Vary the owner and non-owner paths online using the multipath software.
10. Restart host I/O.

Secondary system recovery

There are two procedures you can use to recover the system after a power failure that results in the initialization of the system memory. The procedure you use depends on whether or not host I/O updates have stopped. You must use the correct procedure to ensure the recovery is successful.

The procedures are:

- Recovering the system when the P-VOL is receiving host updates on page 6-15.
- Recovering the system when host updates have stopped on page 6-15.

Recovering the system when the P-VOL is receiving host updates

Recovering the secondary storage system from power failure involves the completion of tasks on both the primary storage system and secondary storage system. Because failover does not occur, it is not necessary to complete the steps required to restore the original relationship of the volumes.

You use multipath software and either SN or CCI to complete the recovery procedure.

Tip: Some of the steps can be performed using either SN or CCI. Typically, these steps can be completed more quickly using CCI.

1. Verify that the P-VOL has the latest data and is being updated. Open the Pair Operation window on the primary storage system and check that the VOL Access column shows Access (Lock).
2. On the primary storage system, release the HAM pair.
3. On the primary storage system, delete the quorum disk ID.
4. Format the quorum disk.
5. On the secondary storage system, register the HAM primary storage system to the secondary storage system.
6. On the primary and secondary storage systems, add the quorum disk.
7. On the primary storage system, create the HAM pair.
8. On both the primary and secondary storage systems, make sure that **Type** shows **HAM**.
9. Using multipath software, vary the non-owner paths online.

Recovering the system when host updates have stopped

Recovering the secondary storage system from power failure when host I/O updates have stopped involves the completion of tasks on both the primary storage system and secondary storage system.

You use multipath software and either SN or CCI to complete the recovery procedure.

Tip: Some of the steps can be performed using either SN or CCI. Typically, you can complete these steps quicker using CCI.

1. Verify that the S-VOL has the latest data by opening the Pair Operation window on the primary storage system (P-VOL side) and checking that the VOL Access column is empty (blank).
2. On the primary storage system, release the HAM pairs.
3. On the primary storage system, delete the quorum disk ID.
4. On the secondary storage system, register the HAM primary storage system to the secondary storage system.
5. On the secondary storage system, create a TrueCopy pair. The data flow is from secondary to primary sites.

6. Format the quorum disk.
7. Continue by changing the TrueCopy pair to a HAM pair (below) or recreating the HAM pair (next steps).

   If changing the TrueCopy pair to a HAM pair, continue with this step. If using SN, go directly to the SN step, below.

   a. When the TrueCopy pair creation operation is completed, run the **horctakeover** CCI command on the primary storage system S-VOL. This reverses the P-VOL/S-VOL relationship; the S-VOL on the primary storage system now becomes the P-VOL.
   b. On the primary and secondary storage systems, add the quorum disk.
   c. Using SN, on the primary system, split the TrueCopy pair.
   d. Using SN, on the primary system, change the TrueCopy pair to a HAM pair. See Changing TrueCopy pairs to HAM pairs on page 4-19 for details.
8. If recreating the HAM pair using CCI:
   a. When the copy operation in Step 5 completes, release the TrueCopy pair.
   b. On the primary and secondary storage systems, add the quorum disk.
   c. On the primary storage system, run the **paircreate** command to create the HAM pair.
9. If recreating the HAM pair using SN:
   a. Make sure the TrueCopy pair creation operation completed, then release the TrueCopy pair.
   b. On the primary and secondary storage systems, add the quorum disk.
   c. On the primary storage system, create the HAM pair.
10. On both primary and secondary storage systems, make sure that **Type** shows **HAM**.
11. Using multipath software, vary the owner and non-owner paths online.
12. Restart host I/O.

Recovery using resynchronization

In some cases, you can resynchronize a HAM pair to recover a volume pair, quorum disk, or a volume pair and quorum disk from failure. The recovery process can only be used if certain conditions exist.

Required conditions

You can only use this method if all of the following conditions exist:

- The HAM volumes are not blocked.
- If there was a quorum disk failure, the disk does not need to be replaced.
- Data was not lost as a results of shared memory initialization caused by a power outage.

Determining which resynchronization recovery procedure to use

Determining which recovery procedure to use involves analyzing the information in the system information messages (SIM) and path failure system messages to determine if all of the conditions required to use resynchronization exist, then selecting the procedure to use.

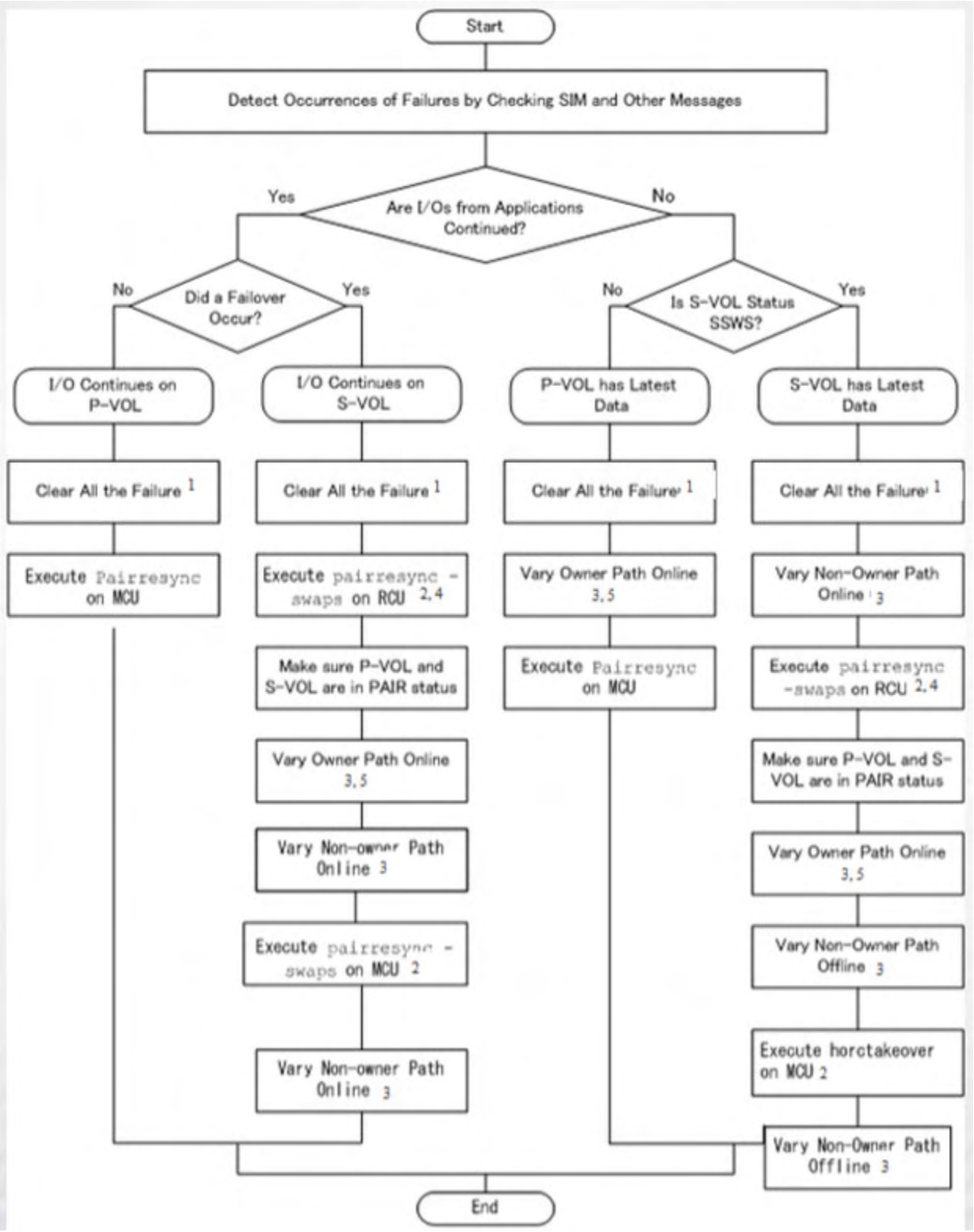
You select the procedure to use based on a number of factors, including the continuation of host I/O, failover, and the status of the secondary volume.

Prerequisites

Make sure you have identified the type of failure that occurred by using the system information messages (SIM) and path failure system messages.

For more information, see Using system messages to check for failures on page 6-4.

Note: The procedures for CCI and SN are the same.



Notes

1. If failures occur and you perform pair operations, host I/O may stop. Make sure that all failures are cleared.
2. Use CCI on the host.

3. Use multipath software on the host.
4. If a pair is shared by multiple hosts with VMWare, see important recovery information regarding the horctakeover or pairresync –swaps command in Recovery for pairs shared by multiple hosts with VMware on page 6-21.
5. If a pair is shared by multiple hosts with VMWare, see important recovery information regarding failover in Recovery for pairs shared by multiple hosts with VMware on page 6-21.

Procedure

1. Analyze the failure messages to determine if all conditions required for resynchronization exist:
   - The HAM volumes are not blocked.
   - If there was a quorum disk failure, the disk does not need to be replaced.
   - Data was not lost as a result of shared memory initialization caused by a power outage.
2. Use the decision tree in the flowchart to select the correct set of procedures. Use the links below to go to the appropriate procedures.

Related topics

- Recovering primary volume from ShadowImage secondary volume on page 6-19.

Recovering primary volume from ShadowImage secondary volume

In some cases, you can use resynchronization to recover the HAM P-VOL from a ShadowImage S-VOL located on the secondary storage system.

Prerequisites

Make sure you have analyzed the failure messages to determine if all of the conditions required to use resynchronization exist.

For more information, see Determining which resynchronization recovery procedure to use on page 6-17.

Procedure

1. Using multipath software, vary the owner path offline.
2. Swap and suspend the HAM pair using the CCI **`pairsplit -RS`** command.
3. Resynchronize the ShadowImage pair on the secondary storage system in the opposite direction, using the Quick Restore or Reverse Copy operations. The system copies the data in the ShadowImage S-VOL to the HAM S-VOL.
4. Split the ShadowImage pair by running the `pairsplit` command.

5. Resynchronize the HAM pair in the opposite direction using the `pairresync -swaps` command. The system copies the data in the S-VOL to the P-VOL.
6. Using multipath software, vary the owner path online.
7. Using multipath software, vary the non-owner path offline.
8. When the HAM P-VOL and S-VOL are in PAIR status, swap and suspend the pair using the **`pairsplit -RS`** command.
9. Resynchronize the HAM pair in the opposite direction using the **`pairresync -swaps`** command.
10. Using multipath software, vary the non-owner path online.

Recovering from path failures

You can recover an owner path, non-owner path, or both paths from failure by restoring the paths.

Caution: If failures occur in both the owner and non-owner paths, you must restore the paths in the correct order to prevent unexpected failover or failback. Make sure you restore the path to the storage system that resumes host operations before you restore the other path.

The following table lists whether failover or failback will occur based on the order in which you restore the paths (owner path first or non-owner path first).

Volume receiving host I/O	Order for restoring paths	Will failover or failback occur?
Primary system P-VOL	1. Owner path 2. Non-owner path	No.
	1. Non-Owner path 2. Owner path	Yes, if data in the S-VOL is newer than in the P-VOL, failover occurs after the non-owner path is restored. However, failover does not occur if data in the S-VOL is older. Check this by viewing the VOL Access column on the Pair Operation window for the P-VOL. If you see Access (Lock), then the P-VOL is receiving host I/O.
Secondary system P-VOL (original S-VOL)	1. Owner path 2. Non-owner path	Yes, failover occurs after the owner path is restored. However, if data in the primary storage system S-VOL is older, failover does not occur. Check the VOL Access column on the Pair Operation window for the secondary storage system P-VOL. If you see Access (Lock), then this volume is receiving host I/O.
	1. Non-Owner path 2. Owner path	No.

Allowing host I/O to an out-of-date S-VOL

If you attempt a recovery of a primary storage system, you might need to use the S-VOL to continue host operations, even though its data is older than the data on the P-VOL.

Contact the Hitachi Data Systems Support Center and ask to have the appropriate system option turned ON. This enables the S-VOL to receive host I/O.

Note: The system option applies to the whole storage system. You cannot set this option to an individual pair or pairs.

To continue using the pair after the failure has been cleared, release and re-create the pair. The storage system builds the initial copy from the P-VOL to the S-VOL.

Recovery for pairs shared by multiple hosts with VMware

When a pair is shared by multiple hosts with VMware, it is important that access to the pair is managed uniformly. Otherwise, the pair can become inaccessible to one of the hosts.

The following procedures are necessary for recovery using the horctakeover and pairresync swaps commands, and for failover. For more information regarding changing host access or status, see the *Hitachi Dynamic Link Manager User Guide* for your operating system.

Managing access for hortcakeover and pairresync swaps commands

1. Switch access from all hosts to the pair via owner paths to access via non-owner paths.
2. Confirm that the statuses of all owner paths are Online(s) using Hitachi Dynamic Link Manager. If a host whose owner path status is not Online(s), move the host's applications and the guest OS's to another host whose owner paths status are all Online(s), or consolidate the applications and guest OS's on the hosts in one host.
3. When all host access is via non-owner paths, execute the `shorctakeover` or `pairresync -swaps` command on the S-VOL.

Changing owner path status for failover

1. Change the status of all owner paths accessing the pair to Online(D).
2. Change Online(D) status to the Online status. Some paths may have changed from Online(D) to Online automatically.
3. If non-owner paths status has changed to Offline(E), change the status to Online.

Contacting the Hitachi Data Systems Support Center

The HDS customer support staff is available 24 hours a day, seven days a week. If you need to call the Hitachi Data Systems Support Center, please provide as much information about the problem as possible, including:

- The circumstances surrounding the error or failure.
- The content of any error messages displayed on the host systems.
- The content of any error messages displayed on SN.
- The SN configuration information (use the FD Dump Tool).
- The service information messages (SIMs), including reference codes and severity levels, displayed by SN.

If you need technical support, log on to the HDS Support Portal for contact information: https://hdssupport.hds.com.

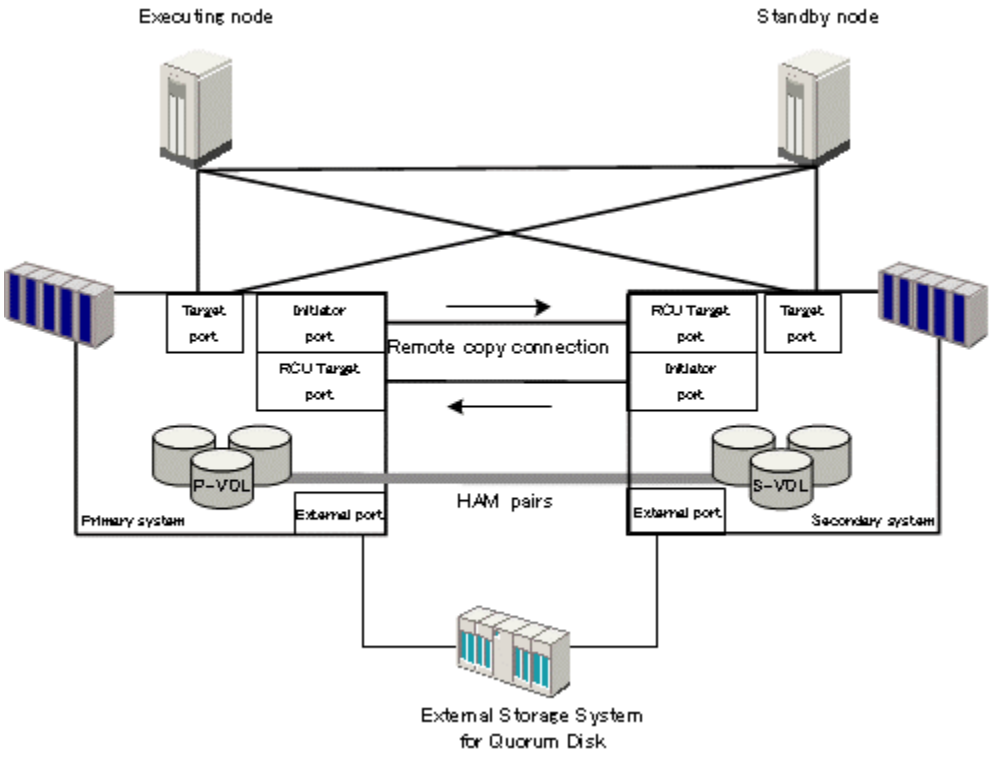
7

Using HAM in a cluster system

There are specific software and configuration requirements for using HAM in a cluster system.

Cluster system architecture

The following diagram shows the architecture of a typical implementation of a cluster system.



You connect an executing node and a standby node to MCU and RCU so that the nodes can access both MCU and RCU. A heartbeat network must be set up between the nodes.

If a failure occur in the executing node, operations are continued by a failover to the standby node.

Required software

The following software is required to use HAM in a cluster system:

- Software that uses a SCSI-2 Reservation with the hypervisor platform, Virtual Machine File System 5 (VMFS 5).
- Cluster software.

Supported cluster software

HAM supports the following types of cluster software:

Software	Operating systems
Microsoft Failover Cluster (MSFC)	• Windows Server® 2008 • Windows Server® 2008 R2
PowerHA (HACMP) 5.4.1 SP7	AIX 6.1 TL6

Configuration requirements

To ensure that HAM functions properly, make sure that:

- The same version of Hitachi Dynamic Link Manager is used in the MCU and RCU.

Restrictions

The following restrictions apply when using HAM in a cluster system:

- You cannot use HAM pair volumes for SAN boot.
- You cannot store OS page files in HAM pair volumes.
- For Windows Server® 2008 R2, HAM does not support Hyper-V function and Cluster Shared Volumes (CSV) function.
- If using MSFC or PowerHA (HACMP), disable host mode option 52.
- If using MSFC, specify Node and File Share Majority in Quorum Mode.
- If using MSFC, use only basic disks.
- If using PowerHA (HACMP), use enhanced concurrent volume groups.
- If using PowerHA (HACMP), specify no_reserve for hdisks attribute.
- If using software with SCSI-2 Reservation, and SCSI-2 Reservation is registered on the P-VOL, a pair cannot be created or resynchronized if SCSI-3 Persistent Reservation key information is also registered on the S-VOL.

  If SCSI-2 Reservation or SCSI-3 Persistent Reservation key information are not registered on the P-VOL, but SCSI-3 Persistent Reservation key information is registered on the S-VOL, the pair can be created or resynchronized, but it will then suspend because of host I/O.

  To perform these operations (including reverse resync), remove the host where the SCSI-3 Persistent Reservation key is registered, delete the key on the S-VOL, and then create or resynchronize the pair. If you cannot delete the key from the host, contact the Hitachi Data Systems Support Center.
- A cluster system cannot be configured if all of the following are used:
  - More than one VMware host
  - Windows 2008 as a guest OS
  - Microsoft Failover Cluster(MSFC) as a cluster software

Configuring the system

Use the following workflow for setting up and creating a HAM pair. Some steps vary, depending on whether you use cluster software or software with SCSI-2 Reservation. This is noted in the step.

1. Install and connect the hardware.
2. Set up a heartbeat network between an executing node and a standby node.

3. Install software.
4. Configure MCU and RCU.
5. Configure a quorum disk.
6. Configure host mode options. Host mode option 52 must be enabled for host groups when using software with SCSI-2 Reservation where an executing node and a standby node reside.

   Also, confirm that the volume to be used as the S-VOL does not have SCSI-2 Reservation and SCSI-3 Persistent Reservation. To check, see the section on host-reserved LUN windows in the *Provisioning Guide*.

   However, when using cluster software, do not enable host mode option 52.
7. Create the HAM pairs.

Note: If using software with SCSI-2 Reservation, create the HAM pairs specifying **Entire Volume** for **Initial Copy** in the **Paircreate(HAM)** dialog box. This setting results in a full initial copy; all of the P-VOL data is copied to the S-VOL.

However, if you need to create the pair without copying P-VOL data to the S-VOL, then create a TrueCopy pair and specify **None** for **Initial Copy**. When the pair is created, split it, then change to a HAM pair.

8. Configure a cluster.

   Fore more information, see the documentation for your software. If necessary, contact the Hitachi Data Systems Support Center.

Disaster recovery in a cluster system

Use the following workflow to recover from failure.

1. Confirm that the primary and secondary storage systems are operating normally.

   If a failure has occurred in one of the systems, use the appropriate disaster recovery procedure.
2. Confirm that the software is operating normally.

   If a failure has occurred in the software, see the software's documentation for recovery instructions.
3. Use the software to fail back from a standby node to an executing node.

8

Troubleshooting

HAM is designed to provide you with error messages so that you can quickly and easily identify the cause of the error and take corrective action. Many types of errors you encounter can be resolved by using fairly simple troubleshooting procedures.

Potential causes of errors

Errors can be caused by power, hardware, or software failures, the use of incompatible or unsupported software, firmware issues, incorrect configuration settings, communication errors, and factors that result in the suspension of volumes.

Is there an error messages for every type of failure?

Although many types of failures have error messages, some do not. Some failures are indicated by status information, incorrect display of system data, or interruptions in operation.

Where do you look for error messages?

If you are using SN, the SN GUI displays all HAM error messages and error codes. If you are using CCI, the CCI operation log file contains all HAM error messages.

Related topics

For more information about error messages and error codes that are displayed by SN, see *Hitachi Storage Navigator Messages*.

Basic types of troubleshooting procedures

The troubleshooting procedures you use to resolve issues you encounter depend on whether the error type. The main error types are general errors, suspended volume pairs, and data stored only in cache memory.

- Troubleshooting general errors on page 8-2
- Suspended volume pair troubleshooting on page 8-4
- Recovery of data stored only in cache memory on page 8-8

Troubleshooting general errors

Most of the errors that occur when using HAM are general errors. They can occur in different parts of the system and can be caused by power, hardware, or software failures, the use of incompatible or unsupported software, firmware issues, incorrect configuration settings, or communication errors.

The only type of error that is not a general error is a suspended volume pair.

The following table lists the general errors that can occur and the corrective action to take for each error.

Error	Corrective action
The SN computer hangs, or HAM does not function properly.	• Make sure that the problem is not being caused by the SN computer or Ethernet hardware or software. Restart the SN computer—this does not affect storage system operations. • Make sure that HAM requirements and restrictions are met. • Make sure that the primary and secondary storage systems are powered on and fully operational (NVS, cache). • Check all input values and parameters to make sure that you entered the correct information in SN (for example, secondary storage system S/N, path parameters, P-VOL and S-VOL IDs). • If you are using Performance Monitor, refrain from using it.
An initiator channel-enable LED indicator (on the HUS VM control panel) is off or flashing.	Please call the Hitachi Data Systems Support Center for assistance.
The status of the pairs and/or data paths are not shown correctly.	Make sure the correct CU is selected.
A HAM error message appears on the SN computer.	Resolve the error and then try the operation again.
The data path status is not Normal.	Check the path status on the **RCU Status** dialog box and resolve the error. For more information, see the *Hitachi TrueCopy® User Guide*.
Quorum disk failure	The primary or secondary storage system issues a SIM when a failure occurs in the quorum disk. After checking the SIM, review Disaster recovery on page 6-1, and specifically, see Recovery from quorum disk failure on page 6-9.
Paircreate or pairresync operation resulted in a timeout error.	• If the timeout error was caused by a hardware failure, a SIM is generated. Check the SIM, then call the Hitachi Data Systems Support Center. After you have corrected the problem, retry the operation. • If no SIM is generated, wait 5 or 6 minutes, then check the pair status. If the status is changed to PAIR, the operation completed after the timeout. If pair status did not change to PAIR, heavy workload might have prevented the operation from being completed. In this case, retry when the storage system has a lighter workload. • If a communication error between the SN computer and SVP occurs, correct the error. For more information about correcting error between the SN computer and SVP, see the *Hitachi Storage Navigator User Guide*.

Error	Corrective action
There is a pinned track on a HAM volume or the quorum disk.	See Recovery of data stored only in cache memory on page 8-8.
Cannot downgrade the firmware.	To downgrade the firmware to a version that does not support HAM, complete the steps described in Planned outages for system components on page 5-6, and then perform the downgrade.
Though no failure occurred, the P-VOL is offline, or host I/O switched to the S-VOL.	When the storage system has a heavy workload, the multipath software turns the P-VOL offline. This does not mean that there is a failure, it is an expected occurrence. You can reduce the possibility of this happening by adding additional parity groups, cache memory, and/or disk adapters. However, first make certain that no failure has occurred on the primary or secondary storage system, quorum disk, the host, or with cabling.

Suspended volume pair troubleshooting

A suspended volume pair is a pair in which normal data replication is not occurring between the primary and secondary volumes. Until the failure or condition that caused the suspension is resolved, production data on the primary volume is not copied to the secondary volume.

A number of failures or conditions can cause a volume pair to become suspended, including:

- Power supply failure
- Secondary storage system failure
- Communication failure between the primary and secondary storage systems
- I/O failures
- Quorum disk failure
- Incompatible host mode option settings
- Incomplete initial copy operation

The troubleshooting procedures you use to resolve suspended volume pairs depends on the interface you are using when the pair becomes suspended.

- When using SN
- When using CCI

The workflow for troubleshooting suspended pairs when using Storage Navigator

Use the following process to resolve suspended volume pairs when using SN:

- Checking the pair status on the **Detailed Information** dialog box.

- Following the troubleshooting steps based on the suspend type and the volume type (primary or secondary).

The following table lists the troubleshooting steps to use for each suspend type and volume type.

Suspend type	VOL Type	Error	Corrective action
PSUE, by RCU	P-VOL S-VOL	The primary storage system detected an error condition at the secondary storage system which caused the primary storage system to suspend the pair. The S-VOL suspend type is S-VOL Failure.	Clear the error condition at the secondary storage system or S-VOL, then resynchronize the pair from the primary storage system.
PSUE, S-VOL Failure	P-VOL S-VOL	The primary storage system detected an error during communication with the secondary storage system, or an I/O error during update copy. The suspend type for the S-VOL is usually S-VOL Failure.	Do the following: • Check data path status on the secondary storage system **Status** dialog box. Clear any errors. • Clear any error conditions on the secondary storage system or S-VOL. • After errors are cleared, resynchronize from the primary storage system.
PSUE, S-VOL Failure	P-VOL S-VOL	The primary storage system detected a failure in the quorum disk.	Do the following: • Recover the quorum disk failure by following the recovery procedure defined by the external storage system. • If SIMs related to Universal Volume Manager are issued, call the Hitachi Data Systems Support Center and follow the recovery procedure defined by the *Hitachi Universal Volume Manager User Guide*. After the failure is recovered, resynchronize the pair from the MCU (Pairresync). • Because of the quorum disk failure, the multipath software will show that the S-VOL is offline. Resynchronize the pair as described above, and then make the path to the S-VOL online with the multipath software.

Suspend type	VOL Type	Error	Corrective action
PSUE, S-VOL Failure	P-VOL S-VOL	The settings for host mode option 52 differ between ports on the primary and secondary storage systems.	Do one of the following: • If you do not use cluster systems, disable host mode option 52. • If you use cluster systems, enable host mode option 52 for host groups where an executing node and a standby node belong.
PSUE, MCU IMPL	P-VOL S-VOL	The primary storage system could not find valid control information in its nonvolatile memory during IMPL. This condition only occurs if the primary storage system is without power for more than 48 hours (for example, a power failure and fully discharged backup batteries).	Resynchronize the pair. This results in an initial copy operation.
PSUE, Initial Copy Failed	P-VOL S-VOL	The pair was suspended before the initial copy completed. Data on the S-VOL is not identical to data on the P-VOL.	Do the following: • Release the pair from the primary storage system. • Clear all error conditions at the primary storage system, P-VOL, secondary storage system, and S-VOL. • Restart the initial copy operation.

Troubleshooting suspended pairs when using CCI

The basic steps involved in resolving suspended volume pairs when using CCI include:

- Using the CCI operation log file to identify the cause of the error.
- Following the troubleshooting steps based on the SSB1 and SSB2 error codes (the codes are recorded in the log file).

Location of the CCI operation log file

The file is stored in the following directory by default:

/HORCM/log*/curlog/horcmlog_HOST/horcm.log.

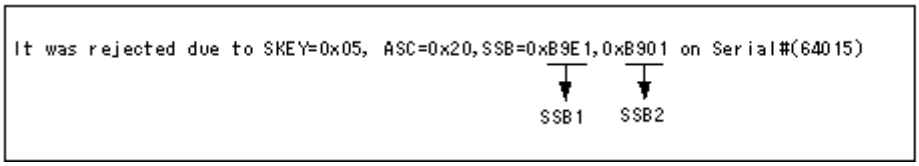
Where:

- * is the instance number.
- HOST is the host name.

Error codes appear on the right of the equal symbol (=).

Example log file

Two error codes are included in this example (B9E1 and B901).



The following table lists the codes for the errors that can occur when using CCI and the steps involved in troubleshooting the errors.

Error code (SSB1)	Error code (SSB2)	Description
2E31	9100	You cannot run the command because the user was not authenticated.
B90A	B901	A HAM pair cannot be created or resynchronized because HAM does not support the option, or the command cannot be accepted in the current pair status.
B90A	B902	A HAM pair cannot be created or resynchronized because the quorum disk is being blocked.
B90A	B904	Reservations that are set to the P-VOL by the host have been propagated to the S-VOL by HAM. The cause is one of the following: • The pair cannot be created because the reservations that were propagated earlier still remain in the volume. Wait then try again. • You cannot run the **horctakeover** and **pairresync -swaps** commands because the reservations that were propagated to the S-VOL remain in the volume. Wait then try the command again. If the error occurs again, release the LUN reservation by host, and then try the command again. For more information about how to release the LUN reservation by host, see the *Provisioning Guide*.
B90A	B980	A HAM pair cannot be created because the TrueCopy program product is not installed.
B90A	B981	A HAM pair cannot be created because the HAM program product is not installed.
B90A	B982	A HAM pair cannot be created or resynchronized because the specified quorum disk ID was not added to the secondary storage system.
B90A	B983	The specified value of the quorum disk ID is out of range.
B912	B902	A HAM pair cannot be suspended because of one of the following conditions: • HAM does not support the **pairsplit -rw** command. • The operation cannot be accepted in the current pair status.

Error code (SSB1)	Error code (SSB2)	Description
D004	CBEF	One of the following causes apply: • A HAM pair cannot be created or resynchronized because of one of the following causes: - The specified quorum disk ID is not added to secondary storage system. - The specified quorum disk ID does not match the quorum disk ID that the S-VOL uses. - The same quorum disk ID is assigned to different external volumes separately by the primary and secondary storage systems. - On the paired CU side, the specified quorum disk ID is configured to a different external volume. - The quorum disk is blocked, or the path between secondary storage system and the quorum disk has a failure. • The pair cannot be resynchronized using the Sync copy mode because the S-VOL has the HAM attribute.

Related topics

For more information about troubleshooting other types of errors, see the *Hitachi TrueCopy® User Guide*.

Recovery of data stored only in cache memory

When a hardware failure occurs while the storage system is running, data in cache memory may not be written to data drives. In this case, the data stored only in cache memory is referred to as a pinned track. Pinned tracks can occur on volume pair drives and on quorum disks. You can recover pinned tracks.

Pinned track recovery procedures

You can use one of the following procedures to recover pinned tracks from volume pairs and quorum disks. The procedure you use depends on the type of data drive:

- Recovering pinned tracks from volume pair drives on page 8-8.
- Recovering pinned tracks from quorum disks on page 8-9.

Recovering pinned tracks from volume pair drives

When you recover pinned tracks from volume pair drives, you release the volume pair before you recover the pinned track. This is required because the primary storage system automatically suspends the volume pair when a pinned track occurs on a P-VOL or S-VOL.

1. On the primary storage system, release the pair containing the volume with the pinned track.
2. Recover data from the pinned track.

For more information about recovering data from pinned tracks, see the pinned track recovery procedures for your operating system or contact your Hitachi Data Systems representative for assistance.

3. Connect to the primary storage system.
4. Resynchronize the pair using the Entire Volume initial copy option.

Recovering pinned tracks from quorum disks

When you recover pinned tracks from quorum disks, you release all volume pairs that use the disk before you recover the pinned track (the data in cache memory).

Note: Host tools cannot be used to recover a pinned track on the quorum disk.

1. Connect to the primary storage system and release all the pairs that use the quorum disk with the pinned track.
2. On the primary and secondary storage systems, delete the quorum disk ID. If you cannot release the ID, forcibly delete it.

   For more information about deleting quorum disk IDs by system attribute, see Deleting quorum disk IDs by system attribute (forced deletion) on page 5-4.
3. Format the quorum disk and recover data from the pinned track.

   For more information about recovering pinned tracks, see the recovery procedures for your operating system or contact your Hitachi Data Systems representative for assistance.
4. On the primary and secondary storage systems, add the quorum disk ID.
5. On the primary storage system, recreate the released volume pair (or pairs) using the Entire Volume initial copy option.

Contacting the Hitachi Data Systems Support Center

The HDS customer support staff is available 24 hours a day, seven days a week. If you need to call the Hitachi Data Systems Support Center, please provide as much information about the problem as possible, including the following:

- The circumstances surrounding the error or failure.
- The content of any error messages displayed on the host systems.
- The content of any error messages displayed on SN.
- The SN configuration information (use the FD Dump Tool).
- The service information messages (SIMs), including reference codes and severity levels, displayed by SN.

If you need technical support, log on to the HDS Support Portal for contact information: https://hdssupport.hds.com.

A

HAM GUI reference

This topic describes HAM windows, dialog boxes, items, and behaviors in SN.

In addition, information related to HAM systems also shown in the following windows and is documented in the *Hitachi TrueCopy® User Guide*:

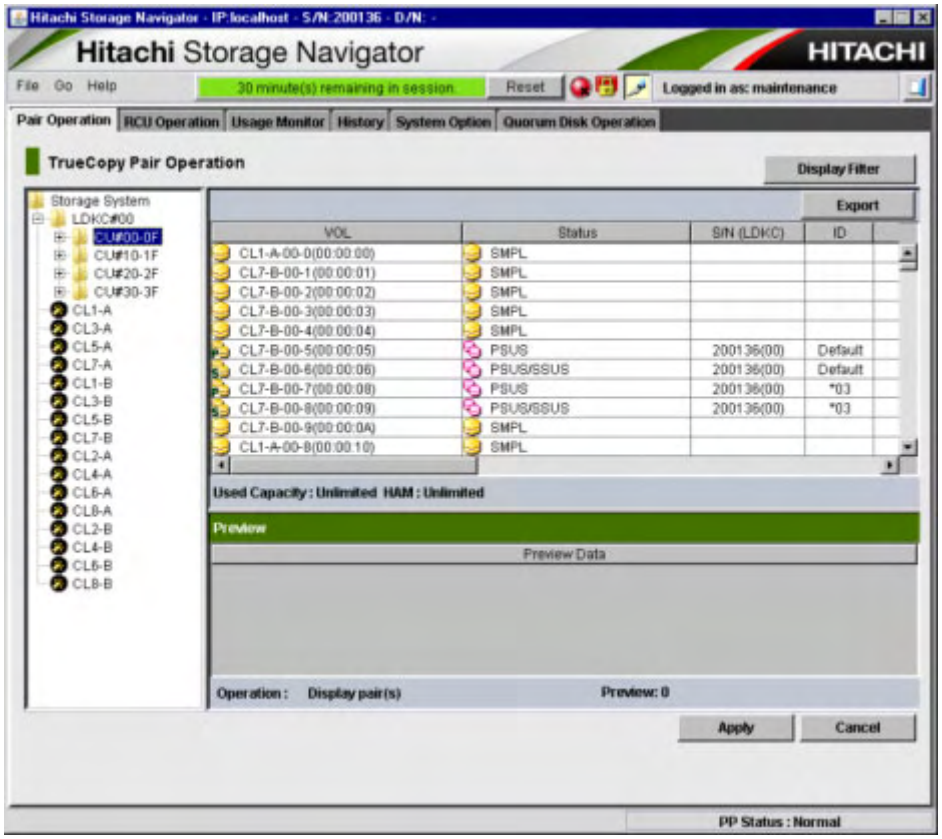
- The **RCU Operation** window
- The **Usage Monitor** window
- The **History** window
- The **System Option** window
- The **Quorum Disk Operation** window

Pair Operation window

Use this window to view HAM and TrueCopy pairs. Filter the list to show only HAM pairs by clicking **Display Filter**.

You can perform these procedures from the window:

- Creating a HAM pair on page 4-11
- Splitting pairs on page 4-15
- Resynchronizing pairs on page 4-16
- Releasing a pair on page 4-18
- Checking pair status on page 4-5



Item	Description
Tree	Shows the connected storage system, the LDKC, the CU grouping, the CUs, ports, and host groups. Select the desired CU grouping, CU( ), port ( ), or host group ( ) to shows related LUs. Only one CU grouping, CU, port, or host group can be selected.

Item	Description
List	Shows detailed pair information about the local storage system. To sort the items that are shown in ascending/descending order, click the column heading. To perform HAM operations such as creating/splitting/resynchronizing a HAM pair, right-click a row in the list. If a volume has multiple LU paths, each LU path appears in a separate row. However, when you select a CU group or a CU in the tree, only one LU path per volume is shown in the list. For more information about the list, see the following table.
Used Capacity	• Used Capacity: The capacity of the volume used in TrueCopy pairs. Licensed capacity is enclosed in parenthesis. • HAM: Unlimited is shown.
Display Filter	Click to open the **Display Filter** dialog box, from which you can narrow down the list of volumes. For more information about the **Display Filter** dialog box, see the *Hitachi TrueCopy® User Guide*.
Export	Saves HAM pair information currently in view, which matches settings in the **Display Filter** dialog box. Information is saved in a text file. You can use the file to review the progress of your HAM operations. For more information about this snapshot function, see the *Hitachi TrueCopy® User Guide*.
Preview	Shows the settings to be saved to the system when you click **Apply**. You can change or delete the settings by right-clicking.
Apply	Saves the operation or changes to the storage system. If an error occurs, an error code appears on the Error Code column in Preview. To show an error message, select one setting, right-click, and click Error Detail. After you see the error message, click OK to close the error message.
Cancel	Cancels all the settings in Preview.

The S/N, ID, and Fence columns can be blank while a HAM pair is in transition to the SMPL status. To show the latest information, refresh the window by clicking **File** and then **Refresh** on the menu bar of SN windows.

Item	Description
VOL	An icon shows whether the volume is assigned to a pair. •  : SMPL (not assigned to a pair). •  : P-VOL. •  : S-VOL. The LU path (a path from a host to a volume) information appears on the right of the icon, the port number, the host group number, and LUN (LDKC:CU:LDEV), separated by hyphens. The following symbols might appear at the end of the LDEV number: • # (e.g., 00:00:3C #): Indicates the volume is an external volume. For more information about external volumes, see the *Hitachi Universal Volume Manager User Guide*. • X (e.g., 00:00:3C X): Indicates the volume is a Dynamic Provisioning virtual volume. For more information about virtual volumes, see the *Provisioning Guide*.
Status	In the SN window, pair status is shown in the [`pair status in Storage Navigator format/ pair status in CCI`] format. If the pair status name in the Storage Navigator and the pair status name in CCI are the same, the pair status name in CCI is not shown. For more information, see the table of Pair status values on page 4-6.
S/N(LDKC)	Serial number of the paired storage system.
ID	SSID of the paired storage system, or Path group ID that you entered when registering the RCU.
Paired VOL	Information about the path from the host to the paired volume appears as port number, the host group number, and LUN (LDKC:CU:LDEV), separated by hyphens. The symbols used in the VOL column might appear at the end of the LDEV number.
Type	Pair type, HAM or TC.
Fence	The fence level, which is a TC setting. Does not apply for HAM pairs.
Diff	The unit of measurement used for storing differential data (by cylinder, track, or auto).
CTG	Shows nothing for HAM volumes.
Sync Rate	During the copy process, **Sync** shows the percentage of completion of the copy operation. During the split volume process, **Sync** shows the concordance ratio of the specified local volume.
Quorum Disk ID	The quorum disk ID assigned to the HAM pair.
VOL Access	Shows which pair volume is online and thus receiving I/O from the host. For more information, see Possible VOL Access values for pairs on page A-5.
CLPR	The number and name of the cache logical partition that the local volume belongs to.

You can to determine the volume that is receiving host I/O, which is the "online" volume by checking the **VOL Access** values in the **Pair Operation** window. The particular combination of values (one for the P-VOL and one for the S-VOL) indicates which volume is the online volume.

Possible VOL Access values for pairs

The following table lists the possible combinations of **VOL Access** values for a volume pair.

Pair status of P-VOL**	Pair Status of S-VOL**	VOL access of P-VOL	VOL access of S-VOL	Online volume
COPY	COPY	Access (No Lock)	Blank	P-VOL
PAIR	PAIR	Blank	Blank	P-VOL
	SSWS	Blank	Access (Lock)	S-VOL
		Blank	Blank	Any*
	PSUS	Blank	Access (Lock)	Any*
		Blank	Blank	Any*
PSUS	PSUS	Access (Lock)	Blank	P-VOL
		Blank	Blank	Any*
		Blank	Access (Lock)	Any*
	SSWS	Blank	Access (Lock)	S-VOL
		Blank	Blank	Any*
		Access (Lock)	Blank	Any*
	SMPL	Access (Lock)	Blank	P-VOL
PSUE	PSUE	Access (No Lock)	Blank	P-VOL
	PAIR	Access (Lock)	Blank	P-VOL
	SSWS	Access (No Lock)	Blank	Any*
		Access (Lock)	Blank	Any*
	PSUS	Access (No Lock)	Blank	Any*
		Access (Lock)	Blank	Any*
PDUB	PDUB	Access (Lock)	Blank	P-VOL

* The S-VOL pair status is forcibly changed to SSWS by the swap suspended operation, or else the S-VOL pair status is changed from SSWS to PSUS by the rollback operation. This status can be see when you try to use the volume that has the older data. You can use any one volume as an on-line volume.

** Storage Navigator pair statuses are shown in the format, SN status/CCI status. If the two statuses are the same, the CCI status is not shown. For more information on pair status definitions, see Pair status values on page 4-6.

Detailed Information dialog box

Use this dialog box to view details for the selected HAM pair.

Item	Description
P-VOL and S-VOL	• Port - GID – LUN(LDKC number: CU number: LDEV number). The following symbols might appear at the end of the LDEV number: - # (e.g., 00:00:3C #): Indicates the volume is an external volume. For more information about external volumes, see the *Hitachi Universal Volume Manager User Guide*. - X (e.g., 00:00:3C X): Indicates the volume is a Dynamic Provisioning virtual volume. For more information about virtual volumes, see the *Provisioning Guide*. • Emulation type. • Capacity in MB (to two decimal places). • The number of blocks.
CLPR	The CLPR number and name of the local volume.
Group Name	Host group name where the local volume is connected.
Pair Status	HAM pair status. The split/suspend type is shown as well, if the pair is split or suspended. For information about the HAM pair status, see Pair status values on page 4-6.

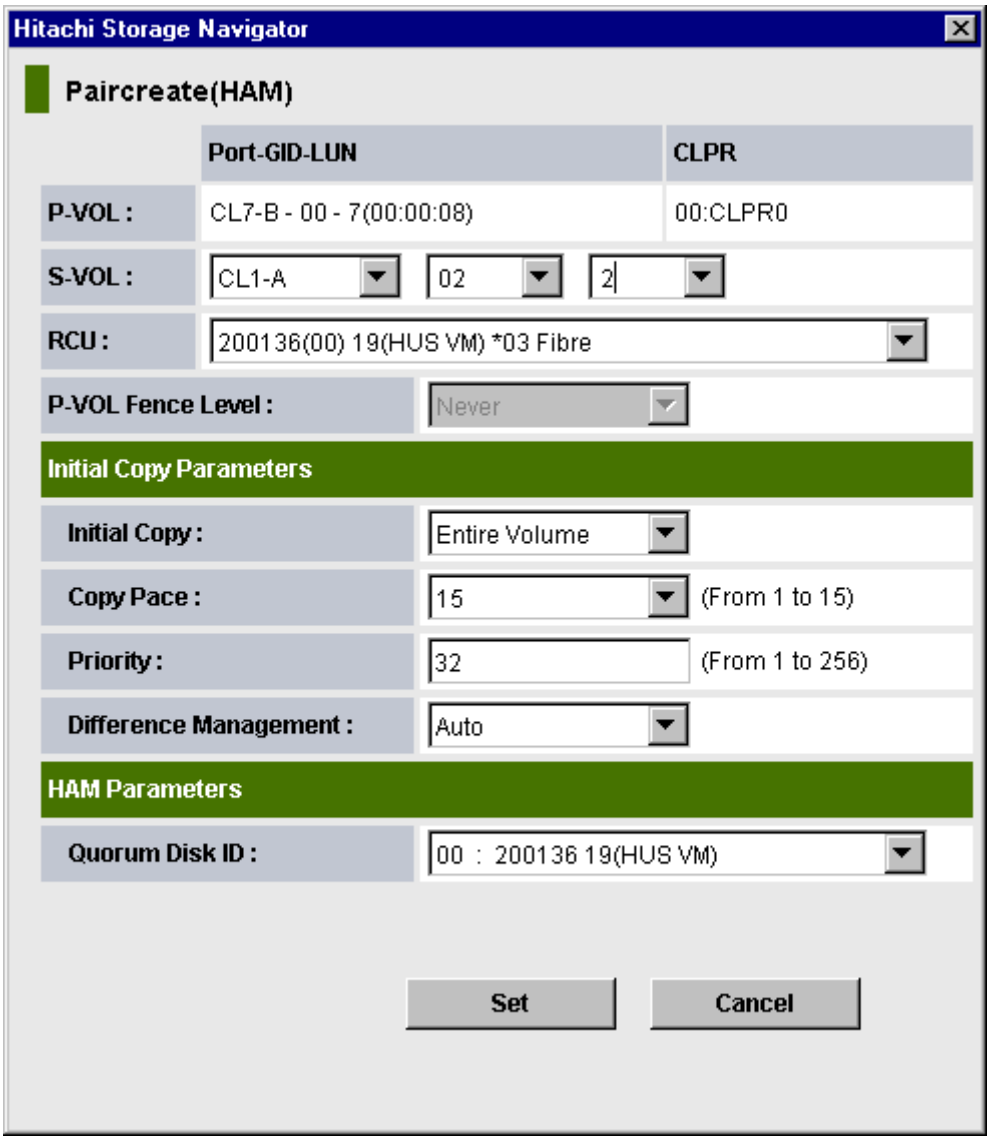
Item	Description
Pair Synchronized	The percentage of synchronization or consistency between the pair volumes. If you are viewing S-VOL information, the percentage for all pair statuses except COPY is shown. If you are viewing P-VOL information, the percentage for all pair statuses is shown. **Note:** If the operation is waiting to start, **(Queueing)** is shown.
S/N and ID	Serial number and path group ID of the paired storage system. If you selected a P-VOL to open this dialog box, the information about the RCU will appear. If you selected an S-VOL to open this dialog box, the information about the MCU will appear.
Controller ID	Controller ID and model name of the paired storage system. • HUS VM controller ID: 19
MCU-RCU Path	Channel type of the path interface between the storage systems.
Update Type	Pair type. HAM indicates that this pair is a HAM pair.
Copy Pace	1-15 tracks (disabled when the status becomes PAIR).
Initial Copy Priority	1-256 (disabled when the status becomes PAIR).
P-VOL Fence Level	Not used for HAM pairs.
S-VOL Write	Not Received appears; and write operations to the S-VOL are rejected.
Paired Time	Date and time that the pair was created.
Last Updated Time	Date and time that pair status was last updated.
Pair Copy Time	Time taken to copy pairs. The time shown for this item differs from the time shown in the **Copy Time on the History** window. The difference is as follows: • Pair Copy Time: Time from step 3 to 4 of the pair creating procedure. • Copy Time: Time from step 1 to 4 of the pair creating procedure. Pair Copy Time is determined by the following: 1. MCU receives a request to create a pair. 2. MCU receives a request to start the paircreate operation. 3. The paircreate operation is started according to the conditions of initial copy priority and maximum initial copy activities. 4. The paircreate operation is completed (the progress of the operation reaches 100%).
Difference Management	The unit of measurement used for storing differential data. Values: **Cylinder** or **Track**
Quorum Disk ID	The quorum disk ID assigned to the HAM pair.

Item	Description
VOL Access	Shows the online volume. For more information, see Possible VOL Access values for pairs on page A-5.
Sync CT Group	The Consistency group number for a Synchronous-C or Multi-C pair. If the consistency group number is bracketed ([1]), the consistency group consists of multiple primary and secondary storage systems.
Refresh the Pair Operation window after this dialog box is closed	Select to refresh the **Pair Operation** window after the **Detailed Information** dialog box closes.
Previous	Shows pair status for the pair in *the row above.
Next	Shows pair status for the pair in the row below.
Refresh	Updates the information.
Close	Closes the dialog box.

Paircreate(HAM) dialog box

Use this dialog box to create a pair.

For instructions, see Creating a HAM pair on page 4-11.



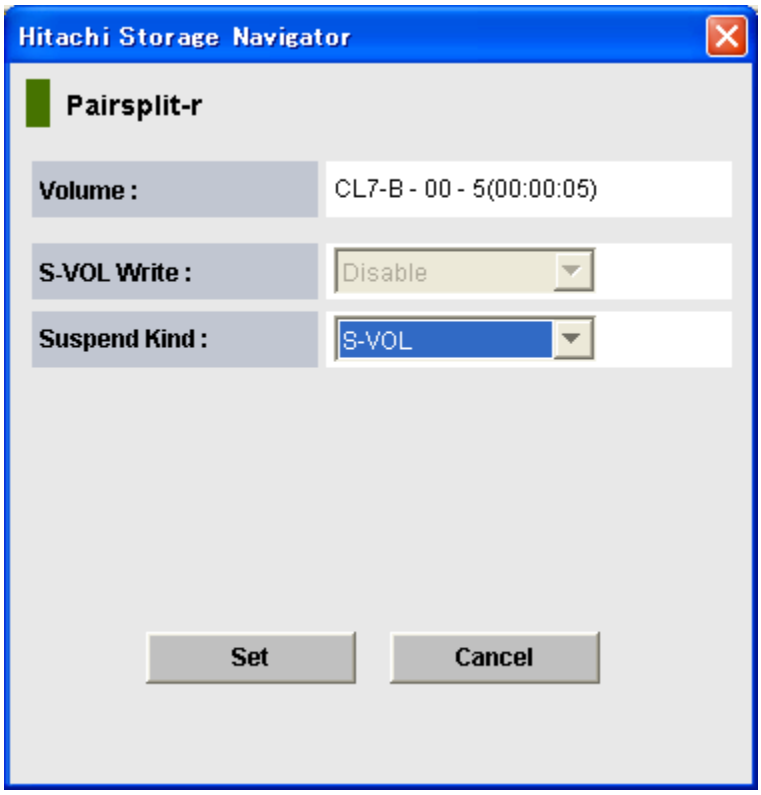
Item	Description
P-VOL	Shows the port number, host group number (GID), LUN(LDKC number: CU number: LDEV number), CLPR number, and CLPR name of the selected LU. This item shows the P-VOL with the lowest LUN when you create multiple pairs at a time. The following symbols might appear at the end of the LDEV number: • # (e.g., 00:00:3C #): Indicates the volume is an external volume. For more information about external volumes, see the *Hitachi Universal Volume Manager User Guide*. • X (e.g., 00:00:3C X): Indicates the volume is a Dynamic Provisioning virtual volume. For more information about virtual volumes, see the *Provisioning Guide*.

Item	Description
S-VOL	The port number, GID, and LUN for the pair's S-VOL. Port number entered directly can be specified with two characters, for example, 1A as CL1 A. Port number can be entered in lowercase and uppercase characters.
RCU	RCU for the pairs being created.
P-VOL Fence Level	Not used for HAM, Never is default, meaning P-VOL is never fenced.
Initial Copy Parameters	
Initial Copy	• Entire Volume: Copies all P-VOL data except alternative tracks used for diagnosis and not needed for the S-VOL. • None: Does not copy any P-VOL data to S-VOL.
Copy Pace	Desired number of tracks to be copied at one time (1-15) during the initial copy operation. The default setting is 15.
Priority	Scheduling order of the initial copy operations (1-256) if the number of requested initial copy operations is greater than the maximum initial copy activity setting on the **System Option** window. The highest priority is 1, the lowest priority is 256, and the default setting is 32.
Difference management	The unit of measurement used for storing differential data (by cylinder, track, or auto). The default setting is Auto.
HAM Parameters	
Quorum Disk ID	The quorum disk ID to be assigned to the HAM pairs. The list shows the quorum disk ID and the RCU information such as the serial number, controller ID, and model name.

Pairsplit-r dialog box

Use this dialog box to split a pair.

For instructions, see Splitting pairs on page 4-15.

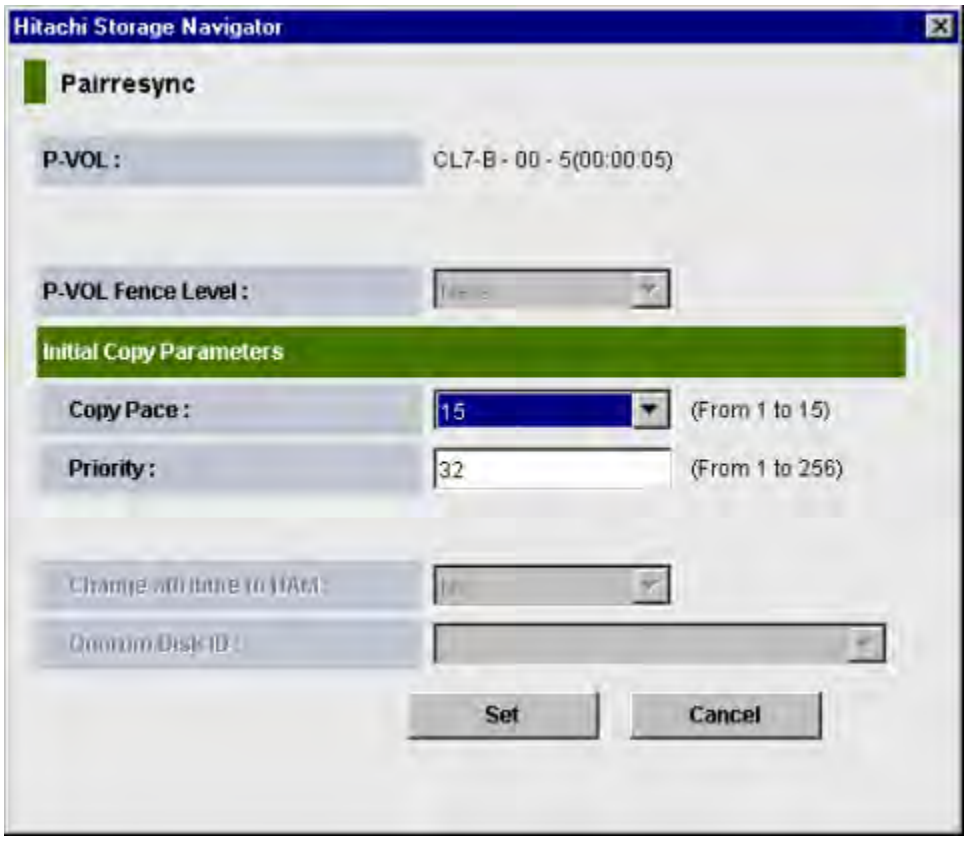


Item	Description
Volume	Port - GID – LUN (LDKC number: CU number: LDEV number) of the selected volume. The following symbols might appear at the end of the LDEV number: • # (e.g., 00:00:3C #): Indicates the volume is an external volume. For more information about external volumes, see the *Hitachi Universal Volume Manager User Guide*. • X (e.g., 00:00:3C X): Indicates the volume is a Dynamic Provisioning virtual volume. For more information about virtual volumes, see the *Provisioning Guide*.
S-VOL Write	Disable appears. The S-VOL of this pair will reject the write I/Os while the pair is being split.
Suspend Kind	Setting for whether or not the system continues host I/O writes to the P-VOL while the pair is split. (If you run the command from the S-VOL, this item is disabled.)

Pairresync dialog box

Use this dialog box to resynchronize a pair.

For instructions, see Splitting pairs on page 4-15.

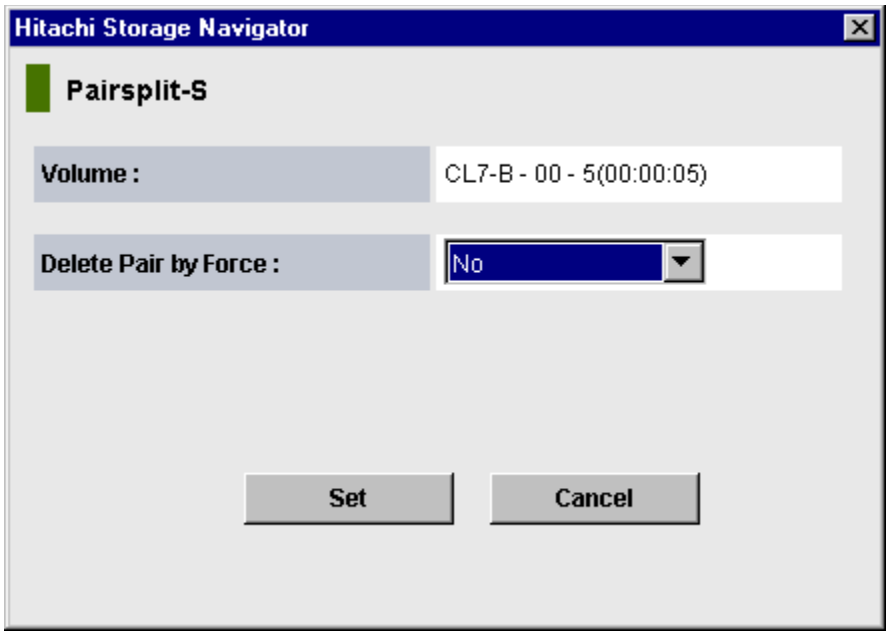


Item	Description
P-VOL	Port - GID – LUN (LDKC number: CU number: LDEV number) of the selected volume. The following symbols might appear at the end of the LDEV number: • # (e.g., 00:00:3C #): Indicates the volume is an external volume. For more information about external volumes, see the *Hitachi Universal Volume Manager User Guide*. • X (e.g., 00:00:3C X): Indicates the volume is a Dynamic Provisioning virtual volume. For more information about virtual volumes, see the *Provisioning Guide*.
P-VOL Fence Level	Not used for HAM, Never is default, meaning P-VOL is never fenced.
Copy Pace	The number of the tracks 1-15 for the resync operations (default = 15). Initial copy parameter.
Priority	Scheduling order for the resync operation (1-256, default = 32). Initial copy parameter.
Change attribute to HAM	• Yes: Changes a TrueCopy Sync pair to a HAM pair. • No: Does not change a TrueCopy Sync pair to a HAM pair. For more information, see Changing TrueCopy pairs to HAM pairs on page 4-19.
Quorum Disk ID	Used to specify a quorum disk ID when changing a TrueCopy Sync pair to a HAM pair. The list shows the quorum disk ID and the RCU information such as the serial number, controller ID, and model name.

Pairsplit-S dialog box

Use this dialog box to release a pair.

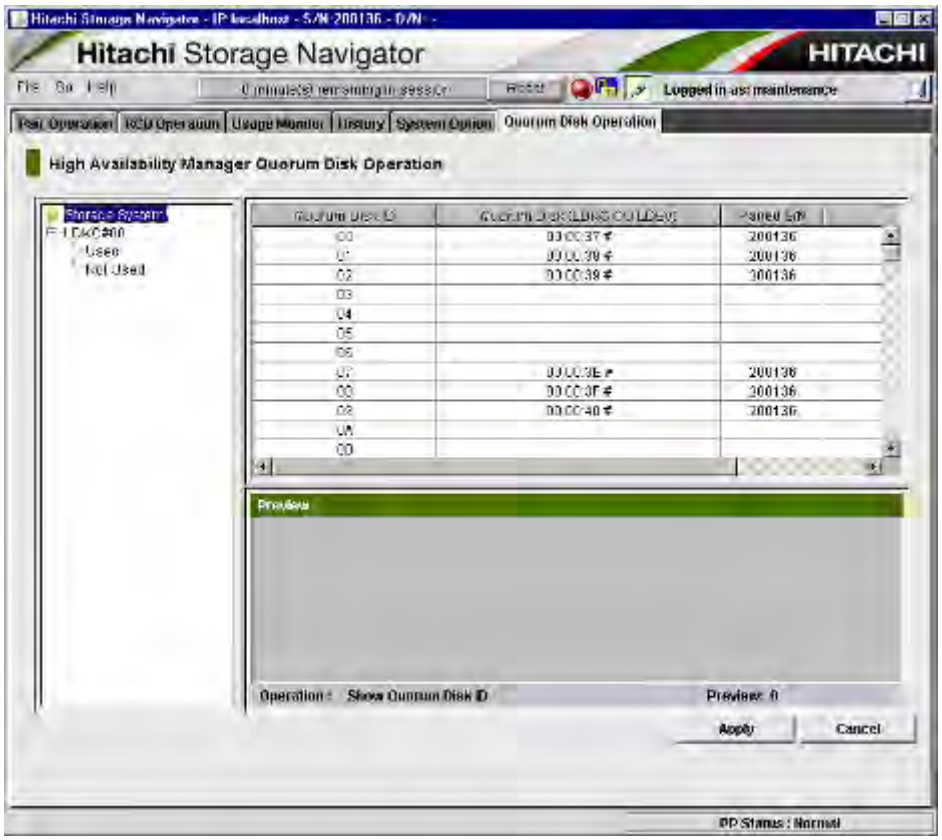
For instructions, see Releasing a pair on page 4-18.



Item	Description
Volume	Port - GID – LUN (LDKC number: CU number: LDEV number) of the selected volume. The following symbols might appear at the end of the LDEV number: • # (e.g., 00:00:3C #): Indicates the volume is an external volume. For more information about external volumes, see the *Hitachi Universal Volume Manager User Guide*. • X (e.g., 00:00:3C X): Indicates the volume is a Dynamic Provisioning virtual volume. For more information about virtual volumes, see the *Provisioning Guide*.
Delete Pair by Force	• **Yes:** The pair is released even if the primary storage system cannot communicate with the secondary storage system. • **No:** The pair is released only when the primary storage system can change pair status for both the P-VOL and S-VOL to SMPL. When the status of the pairs to be released is SMPL, the default setting is Yes (cannot be changed). Otherwise, the default setting is No.

Quorum Disk Operation window

Use this window to perform quorum disks operations.

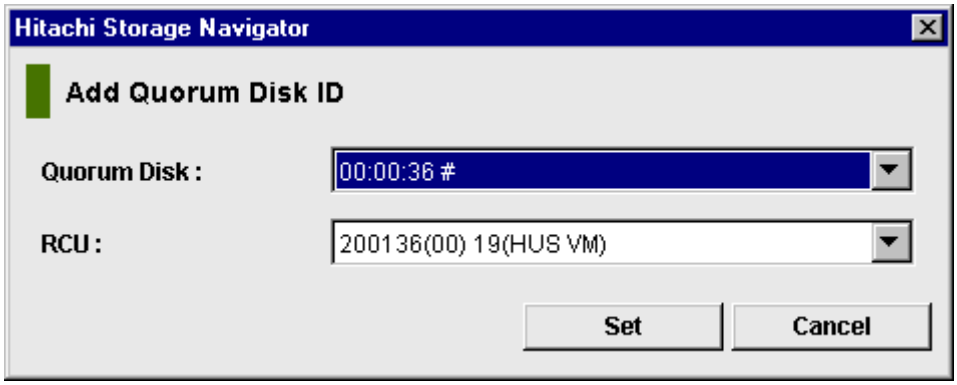


Item	Description
Tree	Shows the connected **Storage System**, **LDKC**, and **Used** and **Not Used**. • When **Storage System** or **LDKC** is selected, the associated quorum disk IDs show in the list area. • When **Used** or **Not Used** is selected, the used and unused quorum disk IDs in the system is shown in the list area.
List	The quorum disk ID list shows quorum disk information. You can sort the list by column in ascending or descending order. The list contains the following items: • Quorum Disk ID: Quorum disk ID. • Quorum Disk (LDKC:CU:LDEV): LDEV number for the quorum disk. # appears at the end of the LDEV number, indicating that the volume is an external volume. • Paired S/N: Serial number of the paired storage system. • Controller ID: Controller ID and model name of the paired storage system.
Preview	Shows any changes you have made. You can alter or delete changes by right-clicking a row in Preview.
Apply	When clicked, saves changes.
Cancel	When clicked, cancels changes.

Add Quorum Disk ID dialog box

Use this dialog box to add a quorum disk ID.

For instructions, see Adding the ID for the quorum disk to the storage systems on page 3-7.



Item	Description
Quorum Disk	Where the external volume to be used as a quorum disk is selected.
RCU	Where the paired CU is selected. The list shows the RCU information registered in CU Free. Multiple RCUs with the same serial number and controller ID, but different path group IDs, appear as one RCU.

Glossary

This glossary defines the special terms used in this document. Click the letter links below to navigate.

#

2DC

two-data-center. Refers to the local and remote sites, or data centers, in which TrueCopy (TC) and Universal Replicator (UR) combine to form a remote replication configuration.

In a 2DC configuration, data is copied from a TC primary volume at the local site to the UR master journal volume at an intermediate site, then replicated to the UR secondary volume at the remote site. Since this configuration side-steps the TC secondary volume at the intermediate site, the intermediate site is not considered a data center.

3DC

three-data-center. Refers to the local, intermediate, and remote sites, or data centers, in which TrueCopy and Universal Replicator combine to form a remote replication configuration.

In a 3DC configuration, data is copied from a local site to an intermediate site and then to a remote site (3DC cascade configuration), or from a local site to two separate remote sites (3DC multi-target configuration).

A

alternate path

A secondary path (port, target ID, LUN) to a logical volume, in addition to the primary path, that is used as a backup in case the primary path fails.

array

Another name for a RAID storage system.

array group

See *RAID group*.

async

asynchronous

at-time split

Consistency group operation that performs multiple pairsplit operations at a pre-determined time.

audit log

Files that store a history of the operations performed from SN and the service processor (SVP), commands that the storage system received from hosts, and data encryption operations.

B

base emulation type

Emulation type that is set when drives are installed. Determines the device emulation types that can be set in the RAID group.

BC

business continuity

BCM

Business Continuity Manager

blade

A computer module, generally a single circuit board, used mostly in servers.

BLK, blk

block

bmp

bitmap

C

C/T

See *consistency time (C/T)*.

ca

cache

cache logical partition (CLPR)

Consists of virtual cache memory that is set up to be allocated to different hosts in contention for cache memory.

capacity

The amount of data storage space available on a physical storage device, usually measured in bytes (MB, GB, TB, etc.).

cascade configuration

In a 3DC cascade configuration for remote replication, data is copied from a local site to an intermediate site and then to a remote site using TrueCopy and Universal Replicator. See also *3DC*.

In a Business Copy Z cascade configuration, two layers of secondary volumes can be defined for a single primary volume. Pairs created in the first and second layer are called cascaded pairs.

cascade function

A ShadowImage function for open systems where a primary volume (P-VOL) can have up to nine secondary volumes (S-VOLs) in a layered configuration. The first cascade layer (L1) is the original ShadowImage pair with one P-VOL and up to three S-VOLs. The second cascade layer (L2) contains ShadowImage pairs in which the L1 S-VOLs are functioning as the P-VOLs of layer-2 ShadowImage pairs that can have up to two S-VOLs for each P-VOL.

See also *root volume*, *node volume*, *leaf volume*, *level-1 pair*, and *level-2 pair*.

cascaded pair

A ShadowImage pair in a cascade configuration. See *cascade configuration*.

shared volume

A volume that is being used by more than one replication function. For example, a volume that is the primary volume of a TrueCopy pair and the primary volume of a ShadowImage pair is a shared volume.

CCI

Command Control Interface

CFL

Configuration File Loader. A SN function for validating and running scripted spreadsheets.

CFW

cache fast write

CG

See *consistency group (CTG)*.

CTG

See *consistency group (CTG)*.

CH

channel

channel path

The communication path between a channel and a control unit. A channel path consists of the physical channel path and the logical path.

CHAP

challenge handshake authentication protocol

CL

cluster

CLI

command line interface

CLPR

cache logical partition

cluster

Multiple-storage servers working together to respond to multiple read and write requests.

command device

A dedicated logical volume used only by Command Control Interface and Business Continuity Manager to interface with the storage system. Can be shared by several hosts.

configuration definition file

Defines the configuration, parameters, and options of Command Control Interface operations. A text file that defines the connected hosts and the volumes and groups known to the Command Control Interface instance.

consistency group (CG, CTG)

A group of pairs on which copy operations are performed simultaneously; the pairs' status changes at the same time. See also *extended consistency group (EXCTG)*.

consistency time (C/T)

Shows a time stamp to indicate how close the target volume is to the source volume. C/T also shows the time stamp of a journal and extended consistency group.

controller

The component in a storage system that manages all storage functions. It is analogous to a computer and contains a processors, I/O devices, RAM, power supplies, cooling fans, and other sub-components as needed to support the operation of the storage system.

copy-on-write

Point-in-time snapshot copy of any data volume within a storage system. Copy-on-write snapshots only store changed data blocks, therefore the amount of storage capacity required for each copy is substantially smaller than the source volume.

copy pair

A pair of volumes in which one volume contains original data and the other volume contains the copy of the original. Copy operations can be synchronous or asynchronous, and the volumes of the copy pair can be located in the same storage system (local copy) or in different storage systems (remote copy).

A copy pair can also be called a volume pair, or just pair.

COW

copy-on-write

COW Snapshot

Hitachi Copy-on-Write Snapshot

CTG

See *consistency group (CTG)*.

CTL

controller

CU

control unit

currency of data

The synchronization of the volumes in a copy pair. When the data on the secondary volume (S-VOL) is identical to the data on the primary volume (P-VOL), the data on the S-VOL is current. When the data on the S-VOL is not identical to the data on the P-VOL, the data on the S-VOL is not current.

CYL, cyl

cylinder

cylinder bitmap

Indicates the differential data (updated by write I/Os) in a volume of a split or suspended copy pair. The primary and secondary volumes each have their own cylinder bitmap. When the pair is resynchronized, the cylinder bitmaps are merged, and the differential data is copied to the secondary volume.

D

DASD

direct-access storage device

data consistency

When the data on the secondary volume is identical to the data on the primary volume.

data path

The physical paths used by primary storage systems to communicate with secondary storage systems in a remote replication environment.

data pool

One or more logical volumes designated to temporarily store original data. When a snapshot is taken of a primary volume, the data pool is used if a data block in the primary volume is to be updated. The original snapshot of the volume is maintained by storing the to-be-changed data blocks in the data pool.

DB

database

DBMS

database management system

delta resync

A disaster recovery solution in which TrueCopy and Universal Replicator systems are configured to provide a quick recovery using only differential data stored at an intermediate site.

device

A physical or logical unit with a specific function.

device emulation

Indicates the type of logical volume. Mainframe device emulation types provide logical volumes of fixed size, called logical volume images (LVIs), which contain EBCDIC data in CKD format. Typical mainframe device emulation types include 3390-9 and 3390-M. Open-systems device emulation types provide logical volumes of variable size, called logical units (LUs), that contain ASCII data in FBA format. The typical open-systems device emulation type is OPEN-V.

DEVN

device number

DFW

DASD fast write

DHCP

dynamic host configuration protocol

differential data

Changed data in the primary volume not yet reflected in the copy.

disaster recovery

A set of procedures to recover critical application data and processing after a disaster or other failure.

disk array

Disk array, or just array, is another name for a RAID storage system.

disk controller (DKC)

The hardware component that manages front-end and back-end storage operations. The term DKC is sometimes used to refer to the entire RAID storage system.

DKC

disk controller. Can refer to the RAID storage system or the controller components.

DKCMAIN

disk controller main. Refers to the microcode for the RAID storage system.

DKP

disk processor. Refers to the microprocessors on the back-end director features of the Universal Storage Platform V.

DKU

disk unit. Refers to the cabinet (floor model) or rack-mounted hardware component that contains data drives and no controller components.

DMP

Dynamic Multi Pathing

DRU

Hitachi Data Retention Utility

DP-VOL

Dynamic Provisioning-virtual volume. A virtual volume with no memory space used by Dynamic Provisioning.

dynamic provisioning

An approach to managing storage. Instead of “reserving” a fixed amount of storage, it removes capacity from the available pool when data is actually written to disk. Also called thin provisioning.

E

EC

error code

emulation

The operation of the Hitachi RAID storage system to emulate the characteristics of a different storage system. For device emulation the mainframe host “sees” the logical devices on the RAID storage system as 3390-x devices. For controller emulation the mainframe host “sees” the control units (CUs) on the RAID storage system as 2105 or 2107 controllers.

RAID storage system operates the same as the storage system being emulated.

emulation group

A set of device emulation types that can be intermixed within a RAID group and treated as a group.

env.

environment

ERC

error reporting communications

ESCON

Enterprise System Connection

EXCTG

See *extended consistency group (ECTG)*.

EXG

external volume group

ext.

external

extended consistency group (EXCTG)

A set of Universal Replicator for Mainframe journals in which data consistency is guaranteed. When performing copy operations between multiple primary and secondary storage systems, the journals must be registered in an EXCTG.

external application

A software module that is used by a storage system but runs on a separate platform.

external port

A fibre-channel port that is configured to be connected to an external storage system for Universal Volume Manager operations.

external volume

A logical volume whose data resides on drives that are physically located outside the Hitachi storage system.

F

failback

The process of switching operations from the secondary path or host back to the primary path or host, after the primary path or host has recovered from failure. See also *failover*.

failover

The process of switching operations from the primary path or host to a secondary path or host when the primary path or host fails.

FBA

fixed-block architecture

FC

fibre channel; FlashCopy

FCA

fibre-channel adapter

FC-AL

fibre-channel arbitrated loop

FCIP

fibre-channel internet protocol

FCP

fibre-channel protocol

FCSP

fibre-channel security protocol

FIBARC

Fibre Connection Architecture

FICON

Fibre Connectivity

FIFO

first in, first out

free capacity

The amount of storage space (in bytes) that is available for use by the host systems.

FSW

fibre switch

FTP

file-transfer protocol

FV

fixed-size volume

FWD

fast-wide differential

G

GID

group ID

GUI

graphical user interface

H

HA

high availability

HACMP

High Availability Cluster Multi-Processing

HAM

Hitachi High Availability Manager

HDLM

Hitachi Dynamic Link Manager

HDP

Hitachi Dynamic Provisioning

HDS

Hitachi Data Systems

HDT

Hitachi Dynamic Tiering

HDvM

Hitachi Device Manager

HGLAM

Hitachi Global Link Availability Manager

H-LUN

host logical unit

HOMRCF

Hitachi Open Multi-RAID Coupling Feature. Another name for Hitachi ShadowImage.

HORC

Hitachi Open Remote Copy. Another name for Hitachi TrueCopy.

HORCM

Hitachi Open Remote Copy Manager. Another name for Command Control Interface.

host failover

The process of switching operations from one host to another host when the primary host fails.

host group

A group of hosts of the same operating system platform.

host mode

Operational modes that provide enhanced compatibility with supported host platforms. Used with fibre-channel ports on RAID storage systems.

host mode option

Additional options for fibre-channel ports on RAID storage systems. Provide enhanced functionality for host software and middleware.

HRC

Hitachi Remote Copy. Another name for Hitachi TrueCopy for IBM z/OS.

HRpM

Hitachi Replication Manager

HSCS

Hitachi Storage Command Suite. This suite of products is now called the Hitachi Command Suite.

HUR

Hitachi Universal Replicator

HXRC

Hitachi Extended Remote Copy. Another name for Hitachi Compatible Replication for IBM XRC.

I

iFCP

internet fibre-channel protocol

IML

initial microcode load; initial microprogram load

IMPL

initial microprogram load

initial copy

An initial copy operation is performed when a copy pair is created. Data on the primary volume is copied to the secondary volume.

initiator port

A fibre-channel port configured to send remote I/Os to an RCU target port on another storage system. See also *RCU target port* and *target port*.

in-system replication

The original data volume and its copy are located in the same storage system. ShadowImage in-system replication provides duplication of logical volumes; Copy-on-Write Snapshot in-system replication provides “snapshots” of logical volumes that are stored and managed as virtual volumes (V-VOLs).

See also *remote replication*.

intermediate site (I-site)

A site that functions as both a TrueCopy secondary site and a Universal Replicator primary site in a 3-data-center (3DC) cascading configuration.

internal volume

A logical volume whose data resides on drives that are physically located within the storage system. See also *external volume*.

IO, I/O

input/output

IOPS

I/Os per second

IP

internet protocol

IPL

initial program load

J

JNL

journal

JNLG

journal group

journal group (JNLG)

In a Universal Replicator system, journal groups manage data consistency between multiple primary volumes and secondary volumes. See also *consistency group (CTG)*.

journal volume

A volume that records and stores a log of all events that take place in another volume. In the event of a system crash, the journal volume logs are used to restore lost data and maintain data integrity.

In Universal Replicator, differential data is held in journal volumes on until it is copied to the S-VOL.

JRE

Java Runtime Environment

L

L1 pair

See *layer-1 (L1) pair*.

L2 pair

See *layer-2 (L2) pair*.

LAN

local-area network

layer-1 (L1) pair

In a ShadowImage cascade configuration, a layer-1 pair consists of a primary volume and secondary volume in the first cascade layer. An L1 primary volume can be paired with up to three L1 secondary volumes. See also *cascade configuration*.

layer-2 (L2) pair

In a ShadowImage cascade configuration, a layer-2 (L2) pair consists of a primary volume and secondary volume in the second cascade layer. An L2 primary volume can be paired with up to two L2 secondary volumes. See also *cascade configuration*.

LBA

logical block address

LCP

local control port; link control processor

LCU

logical control unit

LDEV

logical device

LDKC

See *logical disk controller (LDKC)*.

leaf volume

A level-2 secondary volume in a ShadowImage cascade configuration. The primary volume of a layer-2 pair is called a node volume. See also *cascade configuration*.

LED

light-emitting diode

license key

A specific set of characters that unlocks a software application so that you can use it.

local copy

See *in-system replication*.

local site

See *primary site*.

logical device (LDEV)

An individual logical data volume (on multiple drives in a RAID configuration) in the storage system. An LDEV may or may not contain any data and may or may not be defined to any hosts. Each LDEV has a unique identifier or “address” within the storage system composed of the logical disk controller (LDKC) number, control unit (CU) number, and LDEV number. The LDEV IDs within a storage system do not change.An LDEV formatted for use by mainframe hosts is called a logical volume image (LVI). An LDEV formatted for use by open-system hosts is called a logical unit (LU).

logical disk controller (LDKC)

A group of 255 control unit (CU) images in the RAID storage system that is controlled by a virtual (logical) storage system within the single physical storage system. For example, the Universal Storage Platform V storage system supports two LDKCs, LDKC 00 and LDKC 01.

logical unit (LU)

A logical volume that is configured for use by open-systems hosts (for example, OPEN-V).

logical unit (LU) path

The path between an open-systems host and a logical unit.

logical volume

See *volume*.

logical volume image (LVI)

A logical volume that is configured for use by mainframe hosts (for example, 3390-9).

LU

logical unit

LUN

logical unit number

LUNM

Hitachi LUN Manager

LUSE

Hitachi LUN Expansion; Hitachi LU Size Expansion

LV

logical volume

M

main control unit (MCU)

A storage system at a primary or main site that contains primary volumes of TrueCopy for Mainframe remote replication pairs. The MCU is configured to send remote I/Os to one or more storage systems at the secondary or remote site, called remote control units (RCUs), that contain the secondary volumes of the remote replication pairs. See also *remote control unit (RCU)*.

main site

See *primary site*.

main volume (M-VOL)

A primary volume on the main storage system in a TrueCopy for Mainframe copy pair. The M-VOL contains the original data that is duplicated on the remote volume (R-VOL). See also *remote volume (R-VOL)*.

master journal (M-JNL)

Holds differential data on the primary Universal Replicator system until it is copied to the restore journal (R-JNL) on the secondary storage system. See also *restore journal (R-JNL)*.

max.

maximum

MB

megabyte

Mb/sec, Mbps

megabits per second

MB/sec, MBps

megabytes per second

MCU

See *main control unit (MCU)*.

MF, M/F

mainframe

MIH

missing interrupt handler

mirror

In Universal Replicator, each pair relationship in and between journals is called a “mirror”. Each pair is assigned a mirror ID when it is created. The mirror ID identifies individual pair relationships between journals.

M-JNL

main journal

modify mode

The mode of operation of SN where you can change the the storage system configuration. The two SN modes are view mode and modify mode. See also *view mode*.

MP

microprocessor

MSCS

Microsoft Cluster Server

mto, MTO

mainframe-to-open

MU

mirror unit

multi-pathing

A performance and fault-tolerant technique that uses more than one physical connection between the storage system and host system. Also called multipath I/O.

M-VOL

main volume

N

node volume

A level-2 primary volume in a ShadowImage cascade configuration. The secondary volume of a layer-2 pair is called a leaf volume. See also *cascade configuration*.

NUM

number

NVS

nonvolatile storage

O

OPEN-V

A logical unit (LU) of user-defined size that is formatted for use by open-systems hosts.

OPEN-*x*

A logical unit (LU) of fixed size (for example, OPEN-3 or OPEN-9) that is used primarily for sharing data between mainframe and open-systems hosts using Hitachi Cross-OS File Exchange.

OS

operating system

OS/390

Operating System/390

P

pair

Two logical volumes in a replication relationship in which one volume contains original data to be copied and the other volume contains the copy of the original data. The copy operations can be synchronous or asynchronous, and the pair volumes can be located in the same storage system (in-system replication) or in different storage systems (remote replication).

pair status

Indicates the condition of a copy pair. A pair must have a specific status for specific operations. When an operation completes, the status of the pair changes to the new status.

parity group

See *RAID group*.

path failover

The ability of a host to switch from using the primary path to a logical volume to the secondary path to the volume when the primary path fails. Path failover ensures continuous host access to the volume in the event the primary path fails.

See also *alternate path* and *failback*.

PG

parity group. See *RAID group*.

physical device

See *device*.

PiT

point-in-time

point-in-time (PiT) copy

A copy or snapshot of a volume or set of volumes at a specific point in time. A point-in-time copy can be used for backup or mirroring application to run concurrently with the system.

pool

A set of volumes that are reserved for storing Copy-on-Write Snapshot data or Dynamic Provisioning write data.

pool volume (pool-VOL)

A logical volume that is reserved for storing snapshot data for Copy-on-Write Snapshot operations or write data for Dynamic Provisioning.

port attribute

Indicates the type of fibre-channel port: target, RCU target, or initiator.

port block

A group of four fibre-channel ports that have the same port mode.

port mode

The operational mode of a fibre-channel port. The three port modes for fibre-channel ports on the Hitachi RAID storage systems are standard, high-speed, and initiator/external MIX.

PPRC

Peer-to-Peer Remote Copy

Preview list

The list of requested operations on SN.

primary site

The physical location of the storage system that contains the original data to be replicated and that is connected to one or more storage systems at the remote or secondary site via remote copy connections. A primary site can also be called a “main site” or “local site”.

The term “primary site” is also used for host failover operations. In that case, the primary site is the host computer where the production applications are running, and the secondary site is where the backup applications run when the applications at the primary site fail, or where the primary site itself fails.

primary volume

The volume in a copy pair that contains the original data to be replicated. The data in the primary volume is duplicated synchronously or asynchronously on the secondary pairs.

The following Hitachi products use the term P-VOL: SN, Copy-on-Write Snapshot, ShadowImage, ShadowImage for Mainframe, TrueCopy, Universal Replicator, Universal Replicator for Mainframe, and High Availability Manager.

See also *secondary volume (S-VOL)*.

P-site

primary site

P-VOL

Term used for the primary volume in the earlier version of the SN GUI (still in use). See *primary volume*.

Q

quick format

The quick format feature in Virtual LVI/Virtual LUN in which the formatting of the internal volumes is done in the background. Use to configure the system (such as defining a path or creating a TrueCopy pair) before the formatting is completed. To quick format, the volumes must be in blocked status.

quick restore

A reverse resynchronization in which no data is actually copied: the primary and secondary volumes are swapped.

quick split

A split operation in which the pair becomes split immediately before the differential data is copied to the secondary volume (S-VOL). Any remaining differential data is copied to the S-VOL in the background. The benefit is that the S-VOL becomes immediately available for read and write I/O.

R

R/W, r/w

read/write

RAID

redundant array of inexpensive disks

RAID group

A redundant array of inexpensive drives (RAID) that have the same capacity and are treated as one group for data storage and recovery. A RAID group contains both user data and parity information, and the storage system can access the user data in the event that one or more of the drives within the RAID group are not available. The RAID level of a RAID group determines the number of data drives and parity drives and how the data is “striped” across the drives. For RAID1, user data is duplicated within the RAID group, so there is no parity data for RAID1 RAID groups.

A RAID group can also be called an array group or a parity group.

RAID level

The type of RAID implementation. RAID levels include RAID0, RAID1, RAID2, RAID3, RAID4, RAID5 and RAID6.

RCP

remote control port

RCU

See *remote control unit (RCU)*.

RD

read

RCU target port

A fibre-channel port that is configured to receive remote I/Os from an initiator port on another storage system.

remote console PC

A previous term for the personal computer (PC) system that is LAN-connected to a RAID storage system. The current term is SN PC.

remote control port (RCP)

A serial-channel (ESCON) port on a TrueCopy main control unit (MCU) that is configured to send remote I/Os to a TrueCopy remote control unit (RCU).

remote control unit (RCU)

A storage system at a secondary or remote site that is configured to receive remote I/Os from one or more storage systems at the primary or main site.

remote copy

See *remote replication*.

remote copy connections

The physical paths that connect a storage system at the primary site to a storage system at the secondary site. Also called data path.

remote replication

Data replication configuration in which the storage system that contains the original data is at a local site and the storage system that contains the copy of the original data is at a remote site. TrueCopy and Universal Replicator provide remote replication. See also *in-system replication*.

remote site

See *secondary site*.

remote volume (R-VOL)

In TrueCopy for Mainframe, a volume at the remote site that contains a copy of the original data on the main volume (M-VOL) at the main site.

restore journal (R-JNL)

Holds differential data on the secondary Universal Replicator system until it is copied to the secondary volume.

resync

“Resync” is short for resynchronize.

RF

record format

RIO

remote I/O

R-JNL

restore journal

RL

record length

RMI

Remote Method Invocation

rnd

random

root volume

A level-1 primary volume in a ShadowImage cascade configuration. The secondary volume of a layer-1 pair is called a node volume. See also *cascade configuration*.

RPO

recovery point objective

R-SIM

remote service information message

R-site

remote site (used for Universal Replicator)

RTC

real-time clock

RTO

recovery time objective

R-VOL

See *remote volume (R-VOL)*.

R/W

read/write

S

S#

serial number

S/N

serial number

s/w

software

SAID

system adapter ID

SAN

storage-area network

SATA

serial Advanced Technology Attachment

SC

storage control

SCDS

source control dataset

SCI

state change interrupt

scripting

The use of command line scripts, or spreadsheets downloaded by Configuration File Loader, to automate storage management operations.

SCSI

small computer system interface

secondary site

The physical location of the storage system that contains the primary volumes of remote replication pairs at the main or primary site. The storage system at the secondary site is connected to the storage system at the main or primary site via remote copy connections. The secondary site can also be called the “remote site”. See also *primary site*.

secondary volume

The volume in a copy pair that is the copy. The following Hitachi products use the term “secondary volume”: SN, Copy-on-Write Snapshot, ShadowImage, ShadowImage for Mainframe, TrueCopy, Universal Replicator, Universal Replicator for Mainframe, and High Availability Manager.

See also *primary volume*.

seq.

sequential

service information message (SIM)

SIMs are generated by a RAID storage system when it detects an error or service requirement. SIMs are reported to hosts and displayed on SN.

service processor (SVP)

The computer inside a RAID storage system that hosts the SN software and is used by service personnel for configuration and maintenance of the storage system.

severity level

Applies to service information messages (SIMs) and SN error codes.

SI

Hitachi ShadowImage

SIz

Hitachi ShadowImage for Mainframe

sidefile

An area of cache memory that is used to store updated data for later integration into the copied data.

SIM

service information message

size

Generally refers to the storage capacity of a memory module or cache. Not usually used for storage of data on disk or flash drives.

SM

shared memory

SMTP

simple mail transfer protocol

SN

serial number shown in SN

snapshot

A point-in-time virtual copy of a Copy-on-Write Snapshot primary volume (P-VOL). The snapshot is maintained when the P-VOL is updated by storing pre-updated data (snapshot data) in a data pool.

SNMP

simple network management protocol

SOM

system option mode

source volume (S-VOL)

The volume in a copy pair containing the original data. The term is used only in the earlier version of the SN GUI (still in use), for the following Hitachi products: ShadowImage for Mainframe, Dataset Replication, IBM FlashCopy.

space

Generally refers to the data storage capacity of a disk drive or flash drive.

SRM

Storage Replication Manager

SS

snapshot

SSB

sense byte

SSID

(storage) subsystem identifier. SSIDs are used as an additional way to identify a control unit on mainframe operating systems. Each group of 64 or 256 volumes requires one SSID, therefore there can be one or four SSIDs per CU image. For HUS VM, one SSID is associated with 256 volumes.

SSL

secure socket layer

steady split

In ShadowImage, a typical pair split operation in which any remaining differential data from the P-VOL is copied to the S-VOL and then the pair is split.

S-VOL

See *secondary volume* or *source volume (S-VOL)*. When used for secondary volume, S-VOL is only seen in the earlier version of the SN GUI (still in use).

SVP

See *service processor (SVP)*.

sync

synchronous

system option mode (SOM)

Additional operational parameters for the RAID storage systems that enable the storage system to be tailored to unique customer operating requirements. SOMs are set on the service processor.

T

target port

A fibre-channel port that is configured to receive and process host I/Os.

target volume (T-VOL)

The volume in a mainframe copy pair that is the copy. The term is used only in the earlier version of the SN GUI (still in use), for the following Hitachi products: ShadowImage for Mainframe, Dataset Replication, Compatible FlashCopy(R).

See also *source volume (S-VOL)*.

TB

terabyte

TC

Hitachi TrueCopy

TCz

Hitachi TrueCopy for Mainframe

TDEVN

target device number

TGT

target; target port

THD

threshold

TID

target ID

total capacity

The aggregate amount of storage space in a data storage system.

T-VOL

See *target volume (T-VOL)*.

U

update copy

An operation that copies differential data on the primary volume of a copy pair to the secondary volume. Update copy operations are performed in response to write I/Os on the primary volume after the initial copy operation is completed.

UR

Hitachi Universal Replicator

URz

Hitachi Universal Replicator for Mainframe

USP

Hitachi TagmaStore® Universal Storage Platform

USP V

Hitachi Universal Storage Platform V

USP VM

Hitachi Universal Storage Platform VM

UT

Universal Time

UTC

Universal Time-coordinated

V

V

version; variable length and de-blocking (mainframe record format)

VB

variable length and blocking (mainframe record format)

view mode

The mode of operation of SN where you can only view the storage system configuration. The two SN modes are view mode and modify mode on page Glossary-18.

virtual device (VDEV)

A group of logical devices (LDEVs) in a RAID group. A VDEV typically consists of some fixed volumes (FVs) and some free space. The number of fixed volumes is determined by the RAID level and device emulation type.

Virtual LVI/LUN volume

A custom-size volume whose size is defined by the user using Virtual LVI/Virtual LUN. Also called a custom volume (CV).

virtual volume (V-VOL)

The secondary volume in a Copy-on-Write Snapshot pair. When in PAIR status, the V-VOL is an up-to-date virtual copy of the primary volume (P-VOL). When in SPLIT status, the V-VOL points to data in the P-VOL and to replaced data in the pool, maintaining the point-in-time copy of the P-VOL at the time of the split operation.

When a V-VOL is used with Dynamic Provisioning, it is called a DP-VOL.

VLL

Hitachi Virtual LVI/LUN

VLVI

Hitachi Virtual LVI

VM

volume migration; volume manager

VOL, vol

volume

VOLID

volume ID

volser

volume serial number

volume

A logical device (LDEV), or a set of concatenated LDEVs in the case of LUSE, that has been defined to one or more hosts as a single data

storage unit. A mainframe volume is called a logical volume image (LVI), and an open-systems volume is called a logical unit. (LU).

volume pair

See *copy pair*.

V-VOL

virtual volume

V-VOL management area

Contains the pool management block and pool association information for Copy-on-Write Snapshot operations. The V-VOL management area is created automatically when additional shared memory is installed and is required for Copy-on-Write Snapshot operations.

Index

Hitachi Data Systems

Corporate Headquarters
2845 Lafayette Street
Santa Clara, California 95050-2639
U.S.A.
www.hds.com

Regional Contact Information

Americas
+1 408 970 1000
info@hds.com

Europe, Middle East, and Africa
+44 (0)1753 618000
info.emea@hds.com

Asia Pacific
+852 3189 7900
hds.marketing.apac@hds.com

Hitachi Data Systems

MK-92HM7052-02