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Hitachi Virtual Storage Platform
Hitachi ShadowImage® User Guide

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MK-90RD7024 -00

Hitachi Data Systems

Contents

Preface

This document provides information for setting up and operating Hitachi ShadowImage® In-System Replication software on the Hitachi Virtual Storage Platform storage system.

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

This preface includes the following information:

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 VSP storage system.

This document assumes the following:

- The user has a background in data processing and understands RAID storage systems and their basic functions.
- The user is familiar with the VSP storage system and has read the *Hitachi Virtual Storage Platform User and Reference Guide*.
- The user is familiar with the Storage Navigator software for VSP and has read the *Hitachi Storage Navigator User Guide*.
- The user is familiar with <PP-specific info. If none, omit this bullet>.

Product version

This document revision applies to Hitachi VSP microcode 70-01-0*x* or later.

Document revision level

Revision	Date	Description
MK-90RD7024 -00	October 2010	Initial release

Source document(s) for this revision

- Not applicable.

Changes in this revision

- Not applicable.

Referenced documents

Virtual Storage Platform:

- *Hitachi Command Control Interface User Guide*
- *Hitachi Copy-on-Write Snapshot User Guide*
- *Provisioning Guide for Mainframe Systems*
- *Hitachi TrueCopy® User Guide*
- *Hitachi Universal Replicator User Guide*

Document organization

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

Chapter/Appendix Title	Description
Chapter 1, Hitachi ShadowImage® In-System Replication software overview on page 1-1	Provides an overview of Hitachi ShadowImage.
Chapter 2, Requirements and planning on page 2-1	Describes system requirements and recommendations for planning a ShadowImage system.
Chapter 3, Sharing ShadowImage volumes on page 3-1	Discusses requirements, recommendations, and restrictions for using ShadowImage with other Hitachi software.
Chapter 4, Performing configuration operations on page 4-1	Provides information and instructions for configuring a ShadowImage system.
Chapter 5, Performing pair operations on page 5-1	Provides instructions for performing ShadowImage pair operations.
Chapter 6, Monitoring and maintaining the system on page 6-1	Provides information and instructions for checking the operational status of the ShadowImage.
Chapter 7, Troubleshooting on page 7-1	Provides information and instructions for troubleshooting the ShadowImage.
Appendix A, ShadowImage GUI reference on page A-1	Describes the ShadowImage windows and dialog boxes in Storage Navigator.

Document conventions

The term "Virtual Storage Platform" and "VSP" refer to all models of the Hitachi Virtual Storage Platform storage system, unless otherwise noted.

This document uses the following typographic conventions:

Convention	Description
Bold	Indicates text on a window, other than the window title, including menus, menu options, buttons, fields, and labels. Example: Click **OK**.
Italic	Indicates a variable, which is a placeholder for actual text provided by the user or system. Example: copy *source-file target-file* ***Note:*** Angled brackets (< >) are also used to indicate variables.
`screen/code`	Indicates text that is displayed on screen or entered by the user. Example: `# pairdisplay -g oradb`
< > angled brackets	Indicates a variable, which is a placeholder for actual text provided by the user or system. Example: `# pairdisplay -g <group>` ***Note:*** Italic font is also used to indicate variables.
[ ] square brackets	Indicates optional values. Example: [a | b] indicates that you can choose a, b, or nothing.

Convention	Description
{ } 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.
Underline	Indicates the default value. Example: [a | 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 the user of adverse conditions and/or consequences (e.g., disruptive operations).
	WARNING	Warns the user of severe conditions and/or consequences (e.g., destructive operations).

Convention for storage capacity values

Physical storage capacity values (e.g., 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

Logical capacity unit	Value
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 Hitachi Virtual Storage Platform 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://hdssupport.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 section(s) and paragraph(s) whenever possible.

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

1

Hitachi ShadowImage® In-System Replication software overview

ShadowImage uses local mirroring technology to create and maintain a full copy of any volume in the storage system.

This guide provides instructions for planning, pair operation, checking operational status, and troubleshooting.

- ☐ ShadowImage software
- ☐ How ShadowImage works
- ☐ Hardware and software components
- ☐ Initial, update copy operations

ShadowImage software

With ShadowImage software you create multiple copies of a data volume within the same storage system. ShadowImage backup volumes can be used as backups, with target host applications, data mining applications, and for testing — while the primary business operations continue to run at full capacity with the primary data volume.

How ShadowImage works

A pair is created when you:

- Select a volume that you want to duplicate. This will become the primary volume.
- Identify another volume to contain the copy. This will become the secondary volume.
- Associate the source and secondary volumes.
- Perform the initial copy.

During the initial copy, the primary volume remains available for read/write. After the copy is completed, subsequent write operations to the primary volume (P-VOL) are regularly duplicated to the secondary volume (S-VOL).

The P-VOL and S-VOL remain paired until they are split. When the pair is split, the primary volume continues to be updated, but data in the secondary volume remains as it was at the time of the split. The S-VOL contains a mirror image of the original volume at that point in time.

- S-VOL data is consistent and usable. It becomes available for read/write access by target host applications.
- Changes to the P-VOL and S-VOL are managed by differential bitmaps.
- The volumes can be paired again by re-synchronizing the update data from P-VOL-to-S-VOL, or from S-VOL-to-P-VOL, as circumstance dictates.

Hardware and software components

A typical configuration consists of a Hitachi Virtual Storage Platform storage system, a host connected to the storage system, ShadowImage software, a primary volume, a secondary volume or volumes, and interface tools for operating ShadowImage.

Interface tools include Hitachi Storage Navigator graphical user interface (GUI) and Hitachi Command Control Interface software (CCI).

A typical configuration is shown below.

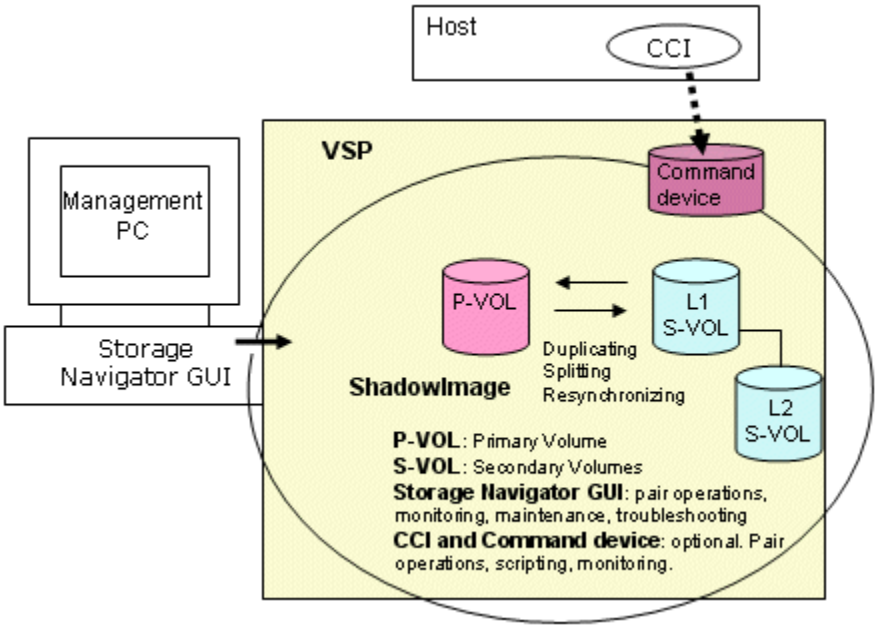


Figure 1-1 ShadowImage Configuration

Volume pairs (P-VOLs and S-VOLs)

A pair consists of the primary and secondary data volume and the volume. Each primary volume (P-VOL) can be paired with up to three secondary volumes (S-VOLs). Thus, you can create three pairs using one P-VOL.

During most operations, the P-VOL remains available to the host for I/O operations. When the P-VOL is updated, the new data, called differential data, is copied to the S-VOL regularly. Because S-VOLs are updated asynchronously, the P-VOL and S-VOL may not be identical. S-VOLs become available for host access only after the pair has been split or deleted.

Cascaded pairs

Each ShadowImage S-VOL can be further paired with a second level S-VOL. A first level (L1) S-VOL may be paired with two second level (L2) S-VOLs. Thus, up to nine S-VOLs can be available for one P-VOL.

L2 pairs are referred to as “cascaded pairs”.

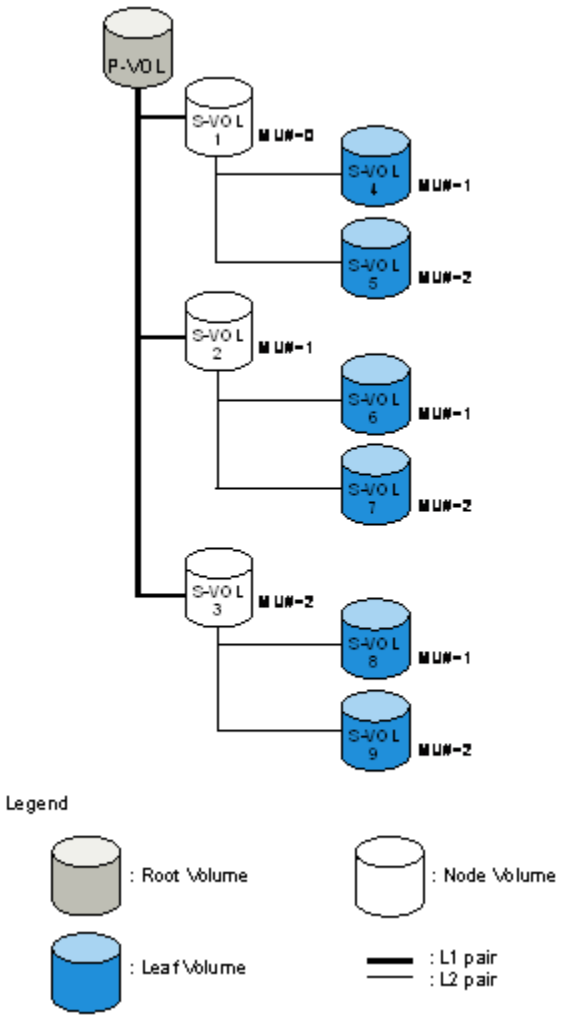


Figure 1-2 Structure of cascaded pairs

- The P-VOL of the L1 pair is the "root volume".
- An S-VOL of the L1 pair is a "node volume".
- A P-VOL of an L2 pair is an L1 S-VOL — a node volume.
- An S-VOL of an L2 pair is a "leaf volume".

ShadowImage cascaded pairs may be used as TrueCopy pairs. No distinction is made in TrueCopy between node and leaf volumes. Both are considered as S-VOLs.

Storage Navigator GUI

The Storage Navigator GUI communicates with the storage system's SVP over defined TCP/IP connections. Storage Navigator is LAN-attached to the system.

With the GUI, you enable the ShadowImage license key, configure the system, perform copy operations, and perform monitoring, maintenance, and troubleshooting.

Command Control Interface and consistency groups

Command Control Interface (CCI) can be used to perform most of the same operations as with Storage Navigator, but using a command line interface. Pair operation commands are issued directly from the host. ShadowImage pair operations can also be automated with CCI using scripts.

Using CCI, you can specify multiple pairs as a consistency group. With a consistency group, pair operations can be performed on multiple pairs at one time. This also allows you to change the pair status for all the pairs in a group.

Initial, update copy operations

When you create a pair, the system executes an initial copy. When the pair is created, the storage system asynchronously copies updates received by the P-VOL to the S-VOL.

The Initial Copy

When you create a pair, the initial copy is started by the system, and all the data in the P-VOL is copied to the S-VOL.

- Before the pair is created, the pair's status is SMPL.
- While the initial copy is in progress, the status is COPY.
- The status changes to PAIR when the initial copy is complete.

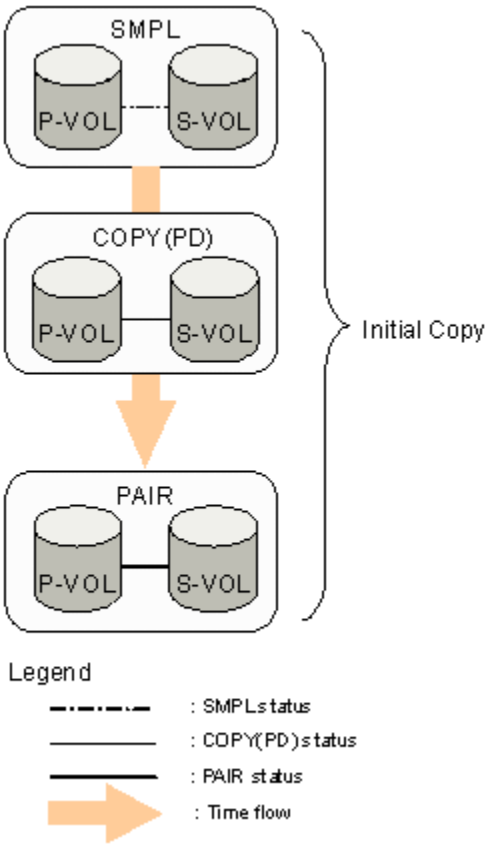


Figure 1-3 Initial copy operation

A P-VOL continues receiving updates from the host during the initial copy. When the initial copy is completed, update copy operations start.

The Update Copy

I/O sent to the P-VOL in PAIR status is marked as differential data and stored in bitmaps for transfer to the S-VOL. Update copy operations are performed periodically by the system. The timing of the update copy operation is based on the amount of differential data that accumulates and the elapsed time since the previous update.

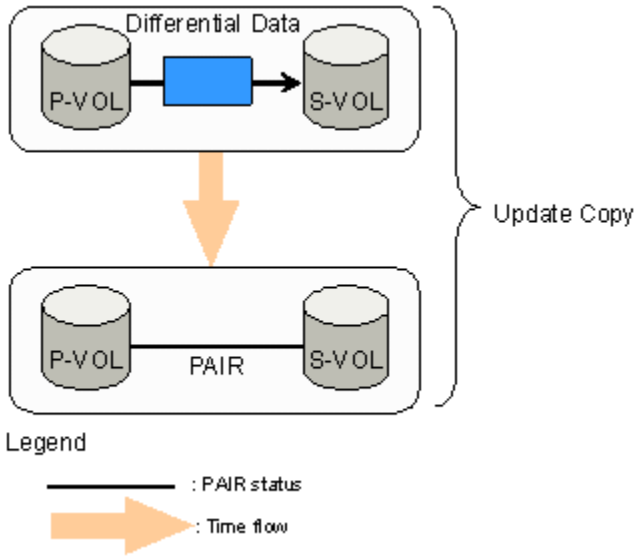


Figure 1-4 Update Copy

Data in the P-VOL and S-VOL may not be the same, even though pair status is PAIR. This can be true even though an update copy operation completed with no host I/Os. It can also be true with host I/O updates because update copying occurs asynchronously, and therefore later data exists in the P-VOL. You can insure that P-VOL and S-VOL data are the same at a certain point in time, by splitting pair.

Also, data in the P-VOL and the data in the S-VOL may not be the same if a copy operation is completed without no host I/O. As mentioned above, you make the P-VOL and S-VOL are the same by splitting the pair.

2

Requirements and planning

This chapter describes system requirements and recommendations for planning a ShadowImage system.

- ☐ System requirements
- ☐ License capacity requirements
- ☐ Planning pair volumes
- ☐ Planning for performance
- ☐ System options

System requirements

The following table shows minimum requirements for ShadowImage.

Table 2-1 System Requirements

Item	Requirement
ShadowImage license capacity	Based on purchased capacity. See License capacity requirements on page 2-3.
License key	Must be installed. See *Hitachi Storage Navigator User Guide* for instructions.
RAID level	RAID 1, RAID 5, RAID 6
Storage Navigator	If you use Storage Navigator, it is necessary to be in Modify mode to perform pair operations.
CCI	CCI requires a command device. Refer to the *Hitachi Command Control Interface User Guide* for more information.
Pair volumes	• Number of P-VOLs per S-VOL: one • Number of S-VOLs per P-VOL: For L1 pairs, a maximum of three S-VOLs per P-VOL. For L2 pairs, a maximum of two S-VOLs per P-VOL. (For information on pair-layers, see Cascaded pairs on page 1-3). • Volume Capacity. P-VOL and S-VOL must have the same capacity. • Supported Volume Types - Internal system volumes. - External volumes. Universal Volume Manager license required. - Custom-sized volumes. VLL required. Pair volumes must have same capacity and emulation type - LUSE volumes require LUSE license. ShadowImage S-VOLs must have the same size and structure as the P-VOL. For example, if the P-VOL is a LUSE volume in which volumes of 1 GB, 2 GB, and 3 GB are combined in this order, the S-VOL must also be a LUSE volume with volumes of 1 GB, 2 GB, and 3 GB combined in the same order. • MU number (mirror unit number). - For an L1 pair, use 0, 1, or 2. - For an L2 pair, use 1 or 2. • Sharing volumes with other software products is supported. See Sharing ShadowImage volumes on page 3-1. • The following cannot be used as pair volumes: - Universal Replicator journal volumes. - Virtual volumes (except Dynamic Provisioning volumes). - Pool volumes.
Maximum Number of Pairs	Per storage system: 16,384 pairs (when one S-VOL per P-VOL). Actual number is based on amount of additional shared memory. See Planning number of pairs on page 2-4 for further information. Maximum number of pairs decreases if LUSE volumes are used.

Item	Requirement
Consistency groups	• You can configure up to 128 consistency groups in a storage system, including ShadowImage consistency groups and Copy-on-Write Snapshot consistency groups. *Note*:ShadowImage for Mainframe pairs, and Copy-on-Write Snapshot pairs cannot co-exist in the same consistency group. • You can define up to 8,192 ShadowImage pairs in a consistency group. *Note*: LUSE volumes that contain *n* LDEVs should be counted as *n* volumes. See *Provisioning Guide for Open Systems* for more information. • A number (0–127) is assigned to each consistency group. You can specify a consistency group number when you create ShadowImage pairs, or if you do not specify a number, the storage system assigns a number automatically.

License capacity requirements

The total capacity of pair volumes must use less capacity than the maximum volume capacity licensed to you. Keep track of capacity requirements in order to keep volumes' total size within purchased capacity.

- P-VOLs, S-VOLs, and volumes that have been reserved for use as S-VOLs must have licensed capacity.
- Copy-on-Write Snapshot P-VOLs and pool volumes require the ShadowImage license capacity.
- The capacity of a volume used for multiple purposes is counted only once; there is no need to multiply the capacity by the number of purposes it is used for.
- When a Dynamic Provisioning volume is used as a ShadowImage P-VOL or S-VOL (including as a reserved volume), the capacity of the Dynamic Provisioning pool is added to the ShadowImage license capacity. The reason is because Dynamic Provisioning volumes are not updated in real time. As a result, some write requests may cause data excess, which is saved in the pool.

When your ShadowImage volumes exceed license capacity, you are allowed to use the volumes for additional 30 days. After that, ShadowImage operations can no longer be performed, except to delete pairs.

Planning pair volumes

You must create volumes for P-VOLs and S-VOLs prior to creating pairs. Review system requirements for pair volumes in System requirements on page 2-2. Also, the following options can be used:

- Before you create a pair, you can reserve a volume as an S-VOL. This insures that no I/O occurs in the reserved volume before creating a pair. Reserved volumes may only be used as S-VOLs.
- If you use CCI, you can place a group of pairs in a consistency group. Using the consistency group, you can perform pair operations on all the pairs in the group at the same time, including the At-Time Split operation

with which you can specify the split time. See the *Hitachi Command Control Interface User Guide* for information on setting up consistency groups and performing pair operations.

Planning number of pairs

This section provides instructions for calculating the number of system resources required for one ShadowImage pair. With this information you can calculate the maximum number of pairs allowed on your system.

When you create pairs, differential tables (tables managing differential bitmaps) and pair tables are required. These must be available in sufficient number to handle all the pairs you will create.

The number of differential and pair tables that are present in the system depends on additional shared memory that is installed. Therefore, you must insure that you have sufficient additional shared memory to handle the number of pairs.

The following table shows the number of differential and pair tables and the number of volumes allowed per additional shared memory. The maximum number of pairs is half the number of volumes shown, when P-VOLs and S-VOLs are in a one-to-one relationship.

For example, if additional shared memory is not installed, since the number of volumes is 16,384, then the number of pairs you can create is 8,192. This example assumes one S-VOL per P-VOL. If there are more S-VOLs than P-VOLs, then the number of allowed pairs decreases.

However, for Extension 1 and Extension 2, the maximum number of pairs is 16,384, regardless of the total number of system volumes.

Table 2-2 Differential Tables, Pair Tables and Additional Shared Memory

Additional Shared Memory for ShadowImage	Number of Diff. Tables	Number of Pair Tables	Number of System Volumes
Base (No additional shared memory)	26,176	8,192	16,384
Extension 1	104,768	16,384	65,536
Extension 2	209,600	16,384	65,536

You can determine the maximum number of pairs that can be created on your system by calculating the number of differential and pair tables your system needs to create ShadowImage pairs. This number must be equal to or less than the difference of the total number of differential and pair tables in the storage system, minus the number of tables being used by the other products (for example, Compatible FlashCopy® V2).

The following software products also use differential tables:

- Compatible FlashCopy® V2
- Volume Migration

- Copy-on-Write Snapshot

The following software products also use pair tables:

- Compatible FlashCopy® V2
- Volume Migration (using migration plans)

Calculations in the following sections assume only ShadowImage is used in the system.

Note: You can use CCI's inqraid command to query the number of the differential tables required when you create ShadowImage pairs. You can also query the number of the differential tables not used in the storage system by using this command. For details about the inqraid command, see the *Hitachi Command Control Interface User Guide*.

Calculating number of differential, pair tables

The emulation type of your volumes affects the number of differential and pair tables.

To calculate the number of differential and pair tables for OPEN-V

Total number of differential tables per pair = ((volume capacity KB ÷ 48) + (number of the control cylinders* × 15) ÷ (20,448**)

* See the following table.

** Number of the slots that can be managed by a differential table

Round up the total number to the nearest whole number. For example, if the number of the cylinders of the divided volume is 2,403,360 KB, the calculation of the total number of the differential tables is as follows.

(2,403,360 ÷ 48 + 8 × 15) ÷ 20,448 = 2.4545...

When you round up 2.4545 to the nearest whole number, it becomes 3. In this example, the total number of the differential tables for one pair is 3. Because one pair table is used for up to 36 differential tables, the total number of the pair tables for a pair in this example is 1.

To calculate the number differential and pair tables for OPEN-V

Total number of the differential tables per pair = (volume capacity KB ÷ 256) ÷ 20,448*

* Number of the slots that can be managed by a differential table

Round up the total number to the nearest whole number. For example, if the number of the cylinders of the divided volume is 3,019,898,880 KB, the calculation of the total number of the differential tables is as follows.

(3,019,898,880 ÷ 256) ÷ 20,448 = 576.9014...

When you round up 576.9014 to the nearest whole number, it becomes 577. In this example, the total number of the differential tables for one pair is 577. Because one pair table is used for up to 36 differential tables, the total number of the pair tables for a pair is 17. (Only OPEN-V can use more than one pair table per pair.)

Table 2-3 Control Cylinders per Emulation Type

Emulation Type	Number of Control Cylinders
OPEN-3	8 (5,760KB)
OPEN-8, OPEN-9	27 (19,440KB)
OPEN-E	19 (13,680KB)
OPEN-K	9 (6,480KB)
OPEN-L	7 (5,040KB)
OPEN-V	0 (0KB)

If the volume is divided by VLL, use the volume capacity after the division. Note that VLL operations cannot be performed on OPEN-L volumes.

Having determined the number of differential and pair tables required per pair on your storage system, you can now calculate the maximum number of pairs.

Calculating maximum number of pairs

Finding the number of pairs that can be created on your system depends on whether you use LUSE volumes or not. Two calculations are provided below, one without LUSE, and one with LUSE.

To calculate the maximum number of pairs allowed on your system without LUSE volumes

Use the following formula:

$\Sigma \{(\alpha) \times (\text{the number of ShadowImage pairs})\} \leq (\beta)$ and $\Sigma \{(\gamma) \times (\text{the number of ShadowImage pairs})\} \leq (\delta)$

where:

- (α): Required number of differential tables per pair (per previous calculation).
- (β): Number of differential tables available in the system (Table 2-2 Differential Tables, Pair Tables and Additional Shared Memory on page 2-4).
- (γ): The required number of pair tables per pair (per previous calculation).
- (δ): The number of pair tables available in the system (Table 2-2 Differential Tables, Pair Tables and Additional Shared Memory on page 2-4).

For example, if you are to create 10 pairs of OPEN-3 volumes and 20 pairs of OPEN-V volumes in a storage system that has 26,176 differential tables, you can use the equation as follows:

When the emulation type is OPEN-3, and if the capacity of the volume is 2,403,360 kB, the number of differential tables required for a pair will be 3, and the number of pair tables required for a pair will be 1. When the emulation type is OPEN-V, and if the capacity of the volume is 3,019,898,880 kB, the number of differential tables required for a pair will be 577, and the number of pair tables required for a pair will be 17.

If you apply these numbers in equation:

3 x 10 + 577 x 20 = 11,570 less-than-or-equal-to 26,167 and also

1 x 10 + 17 x 20 = 350 less-than-or-equal-to 8,192

Thus, 10 pairs of OPEN-3 volumes and 20 pairs of OPEN V volumes can be created.

To calculate the maximum number of pairs allowed on your system with LUSE volumes

$\Sigma[\Sigma \{(\alpha) \times (\text{the number of the volumes that forms LUSE volumes})\} \times (\text{the number of ShadowImage pairs})] \leq (\beta)$

and also

$\Sigma[\Sigma \{(\gamma) \times (\text{the number of the volumes that forms LUSE volumes})\} \times (\text{the number of ShadowImage pairs})] \leq (\delta)$

where:

- (α): Required number of differential tables that forms a LUSE volume.

  When you use LUSE volumes, each volume forming the LUSE volume uses the differential tables. For example, if you create a ShadowImage pair using LUSE volumes, which are created by combining two OPEN-V volumes, you need differential tables for two OPEN-V pairs.
- (β): Number of differential tables available in the system (Table 2-2 Differential Tables, Pair Tables and Additional Shared Memory on page 2-4).
- (γ): The required number of pair tables for each volume that forms a LUSE volume.
- (δ): The number of pair tables available in the system (Table 2-2 Differential Tables, Pair Tables and Additional Shared Memory on page 2-4).

For example, if you are to create 10 pairs of LUSE volumes consisting respectively of three OPEN-3 volumes in a storage system that has 26,176 differential tables, you can use the condition inequation as follows:

When the emulation type is OPEN-3, and if the capacity of the volume is 2,403,360 kB, the number of differential tables required for a pair is 3, and the number of pair tables required for a pair will be 1.

If you apply this number to the above-mentioned inequation:

```
(3 x  3) x  10 = 90 <= 26,176
```

and also

```
(1 x  3) x  10 = 30 <= 8,192
```

Therefore, you can see that 10 ShadowImage pairs, which are formed by three OPEN-3, volumes can be created.

Organizing volumes into P-VOLs and S-VOLs

Before creating pairs, it is necessary to prepare volumes for ShadowImage. The following table provides an example of volume information to prepare volumes.

Table 2-4 Volume Information for ShadowImage

CU	Port	GID: LUN	Pair Volume Type	Associated L1 S-VOLs	Associated L1 P-VOLs	Associated L2 S-VOLs	Associated L2 P-VOL
0	1A	0:00	L1 P-VOL	1B-0:00, 2A-0:00, 2B-0:00	NA	NA	NA
0	1A	0:01	L1 P-VOL	1B-0:01, 2A-0:01, 2B-0:01	NA	NA	NA
etc...	NA	NA	NA	NA	NA	NA	NA
0	1B	0:00	L1 S-VOL L2 P-VOL	NA	1A-0:00	3A-0:00, 3A-0:01	NA
0	1B	0:01	L1 S-VOL L2 P-VOL	NA	1A-0:00	3B-0:00, 3B-0:01	NA
etc...	NA	NA	NA	NA	NA	NA	NA
0	2A	0:00	L1 S-VOL L2 P-VOL	NA	1A-0:00	4A-0:00, 3B-0:01	NA
0	2A	0:01	L1 S-VOL L2 P-VOL	NA	1A-0:00	4B-0:00, 3B-0:01	NA
etc...	NA	NA	NA	NA	NA	NA	NA
0	3A	0:00	L2 S-VOL	NA	NA	NA	1B-0:00
0	3A	0:01	L2 S-VOL	NA	NA	NA	1B-0:00

Planning for performance

Pair operations affect I/O performance on the storage system. The following information is provided to help calibrate your system:

- Performance versus number of pairs. Compare the importance of performance with the number of pairs and copy pace (rate at which data is copied).
  - Assigning multiple S-VOLs to a P-VOL uses more system resources and lowers performance.

    - The slower the copy pace, the less impact on I/O performance; a fast pace has a greater impact on performance. (You assign copy pace during the create, split, and resync operations.)
- Load sharing on parity groups.
    - A parity group should contain an even distribution of P-VOLs and S-VOLs, rather than a concentration of one or the other.
    - When multiple pair operations are to be performed simultaneously, the pairs should be in different parity groups.
    - For copy pace, specify **Slower** when you create, split, or resynchronize.
    - When you need to perform a copy operation on multiple pairs on the same parity group, perform the operation on one pair at a time.
    - If the system is overloaded, increase parity groups, cache, and/or back-end directors(BEDs). Assign S-VOLs to newly installed parity groups.
- When using multiple software products simultaneously. If you are using more than one software product at the same time, ensure that your storage system is configured for optimal performance (for example, sufficient cache). Contact the Hitachi Data Systems Support Center. Concurrent use affects the performance and the operation of the other software products.
- When using AIX host servers. Best performance results when P-VOLs are located on one AIX host server and paired S-VOLs on another. The problem with using one AIX host server for both P-VOLs and S-VOLs is that during the paircreate or pairresync operation, the P-VOL and S-VOL have the same PVID. If the host server reboots when this is the case, it can mis-identify the volumes and identify the S-VOL as the P-VOL after rebooting.
- Preparing for resynchronization by Quick Restore. During a quick restore operation, in which the contents of the P-VOL and S-VOL are swapped, the RAID levels, HDD types, and Cache Residency Manager settings of the two volumes are also exchanged. To avoid performance impact, consider the following:
    - Both pair volumes should have the same RAID level and HDD type before performing the quick restore operation. You can resume the original RAID levels after the quick restore by again splitting the pair and performing the quick restore.
    - Set the same Cache Residency Manager settings (locations) for the P-VOL and S-VOL before the quick restore operation.

      Alternatively, you can release Cache Residency Manager settings before the quick restore operation, then reset them when the operation is completed.

      Refer to the *Performance Guide* for more information on settings.

Caution: Do not perform the Quick Restore when the P-VOL and S-VOL are in different CLPRs, otherwise the two volumes will be reversed when the operation completes.

System options

ShadowImage provides the following options.

Note: The Copy Threshold option must be enabled by your service representative. You can enable the Swap&Freeze and Host I/O Performance options using Storage Navigator.

- Swap&Freeze. This option alters the behavior of the quick restore operation. With Swap&Freeze, update copy operations are suppressed when the quick restore is completed and the pair is in PAIR status. Differential data is not copied to the new S-VOL. You use the Swap&Freeze option, when you want to remain the S-VOLs of a ShadowImage pair unchanged after the quick restore operation.
- Host I/O Performance. This option increases I/O performance while suppressing ShadowImage copy processing. This results in longer copy time.
- Copy Threshold. This option temporarily stops copy operations when the workload on the storage system is heavy. This is done to minimize degradation to host I/O performance during peak periods.

Note: The Copy Threshold option performs only when workload is heavy; The Host I/O Performance option suppresses copy operations at all times regardless of workload level.

When the Copy Threshold Option is enabled, it is effective for all of the following software:

- ShadowImage
- ShadowImage for Mainframe
- Compatible FlashCopy® V2
- Snapshot
- Volume Migration

3

Sharing ShadowImage volumes

ShadowImage volumes can be shared with other Hitachi software products. This chapter discusses requirements, recommendations, and restrictions for sharing these volumes.

- ☐ Open Volume Management
- ☐ Cache Residency Manager
- ☐ LUN Manager
- ☐ Data Retention Utility
- ☐ Volume Migration
- ☐ Universal Volume Manager
- ☐ TrueCopy
- ☐ Universal Replicator
- ☐ TrueCopy and Universal Replicator
- ☐ Dynamic Provisioning

Open Volume Management

Both LUSE and Virtual LUN volumes can be used as ShadowImage volumes.

- With LUSE volumes, the P-VOL and S-VOL must have the same configuration (the same LU capacity and the same number of LUs).
- With Virtual LUN volumes, the P-VOL and S-VOL must have the same capacity.

Cache Residency Manager

Volumes with Cache Residency Manager settings can be used as ShadowImage P-VOLs and S-VOLs.

Note: See the bullet on Quick Restore in Planning for performance on page 2-8 for important information about the operation and volumes with Cache Residency Manager settings.

LUN Manager

LUN Manager operations do not affect ShadowImage operations. Volumes that are under secure ports and/or that are assigned to World Wide Name (WWN) groups and/or LUN groups can also be assigned to ShadowImage pairs. Volumes that are assigned to ShadowImage pairs can also be used in LUN Manager operations, such as assignment to WWN groups, and/or LUN groups.

ShadowImage S-VOLs cannot be accessed by a host except when the pair is split.

Data Retention Utility

You can create ShadowImage pairs using volumes to which the following Data Retention Utility's access attributes are set:

- Read/Write
- Read Only (Volume)
- Protect

However, a volume with the S-VOL Disable attribute cannot be used as a ShadowImage S-VOL.

- The only ShadowImage operation you can perform on the ShadowImage S-VOL that has the S-VOL Disable attribute is the Delete operation.
- All operations can be performed on ShadowImage P-VOL that have the S-VOL Disable attribute.

Volume Migration

The following ShadowImage volumes can be assigned to migration volumes of Volume Migration:

- L1 P-VOL with up to two S-VOLs.

- L2 P-VOL with one S-VOL.
- Reserved volumes.

ShadowImage pairs must be deleted and any reserved ShadowImage S-VOLs must be un-reserved before assigning or reserving those volumes to Volume Migration migration volumes.

ShadowImage volumes cannot be used for destination volumes.

Migration, destination, and reserved volumes of Volume Migration cannot be used for ShadowImage pair operations. To perform a ShadowImage operations, the Volume Migration volumes must be released first.

Universal Volume Manager

If ShadowImage is used with Universal Volume Manager, you can create pairs to use the external volumes. For information about the external volumes, see the *Hitachi Universal Volume Manager User Guide*.

TrueCopy

TrueCopy volumes can be shared with ShadowImage volumes.

- You can share ShadowImage P-VOLs and S-VOLs with TrueCopy P-VOLs and S-VOLs. However, you cannot share a ShadowImage S-VOL with a TrueCopy S-VOL.
- When you share a ShadowImage P-VOL with a TrueCopy S-VOL, the write operation on the TrueCopy P-VOL takes more time. This is especially true when the ShadowImage pair is in the PSUS(SP) status because of the copying time needed for the ShadowImage pair.
- You can use both L1 and L2 pairs with TrueCopy volumes. Both node and leaf S-VOLs are considered secondary volumes by TrueCopy.
- The Quick Restore operation can be performed on a ShadowImage pair when the TrueCopy pair is suspended.

For details, see the section on sharing volumes with ShadowImage in the *Hitachi TrueCopy® User Guide*.

Universal Replicator

Universal Replicator volumes can be shared with ShadowImage volumes.

- ShadowImage P-VOLs can be shared with Universal Replicator P-VOLs and S-VOLs.
- ShadowImage S-VOLs cannot be shared with Universal Replicator S-VOLs.
- ShadowImage pair volumes may not share Universal Replicator journal volumes.
- You can use both L1 and L2 pairs with Universal Replicator volumes. Both node and leaf S-VOLs are considered secondary volumes by Universal Replicator.

- The Quick Restore operation can be performed on a ShadowImage pair when the Universal Replicator pair is suspended

For details, see the appendix on sharing ShadowImage volumes in the *Hitachi Universal Replicator User Guide*.

TrueCopy and Universal Replicator

A ShadowImage P-VOL can be shared with shared TrueCopy and Universal Replicator volumes in certain configurations, shown in the following figures.

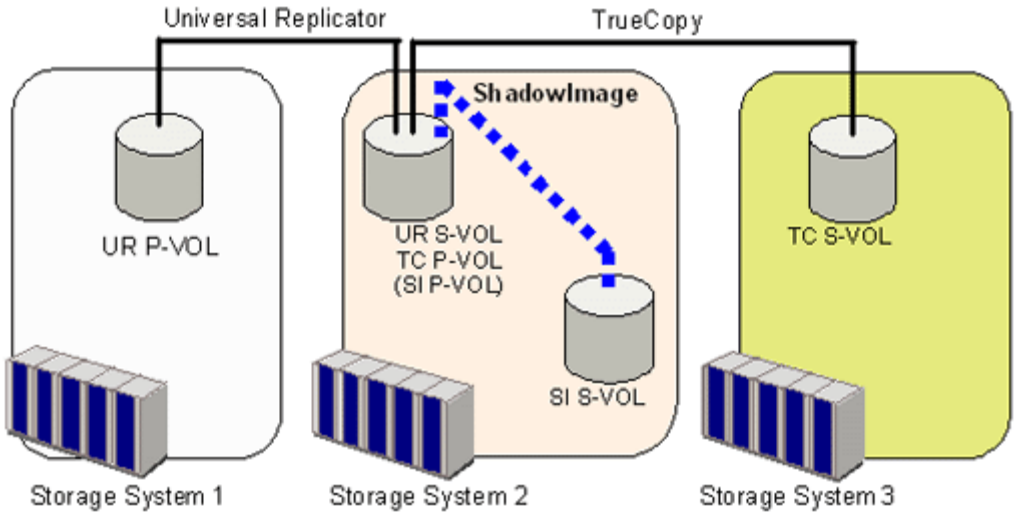


Figure 3-1 UR, TC, and SI Shared Volume Configuration 1

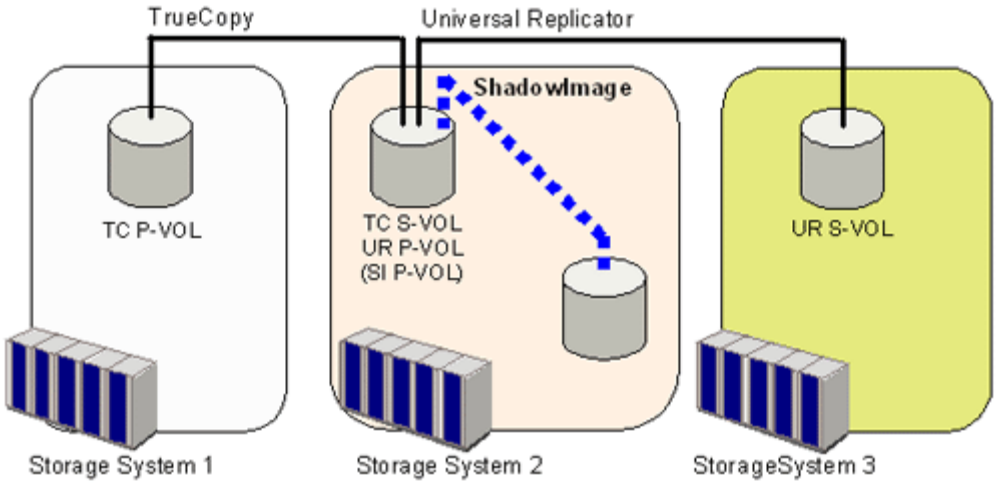


Figure 3-2 UR, TC, and SI Shared Volume Configuration 2

All ShadowImage operations, with the following exceptions, can be performed in the TrueCopy and Universal Replicator secondary sites, irrespective of TrueCopy pair status. The Universal Replicator delta resync pair's status must be HOLD or HLDE.

- The Reverse Copy can only be performed only when the TrueCopyTrueCopyand Universal Replicator pair status is PSUE.

- The Quick Restore can not be performed.

VSP currently does not support the configuration where TrueCopy volumes can be used as Universal Replicator volumes or vice versa. For information about when this configuration will be supported, call the Support Center.

Dynamic Provisioning

Dynamic Provisioning volumes can be used with ShadowImage P-VOLs and S-VOLs. Dynamic Provisioning can also be used with ShadowImage reserved volumes. The following restrictions apply:

- Dynamic Provisioning volumes should be shared with both the ShadowImage P-VOL and S-VOL, rather than one or the other.
- If a Dynamic Provisioning volumes is shared with only the P-VOL, or only the S-VOL, the Quick Resync operation cannot be performed To perform the Quick Resync, both P-VOL and S-VOL must be shared with Dynamic Provisioning volumes.
- Sharing a Dynamic Provisioning volume with only the S-VOL is also not not recommended because the S-VOL consumes the same amount of the pool capacity as the P-VOL.
- You cannot perform ShadowImage pair operations while you increase the Dynamic Provisioning volume capacity.
- The maximun size of a Dynamic Provisioning volume that can be used as a ShadowImage P-VOL, S-VOL, and reserve volume is 4 TB.

4

Performing configuration operations

This chapter provides configuration information and instructions.

- ☐ Configuration workflow
- ☐ Set up primary and secondary volumes
- ☐ Reserve S-VOLs
- ☐ Set Host I/O Performance option

Configuration workflow

Setup for ShadowImage consists of the following:

- Making certain that primary and secondary volumes are set up correctly.
- Reserving volumes for use as S-VOLs. (Optional.)
- Setting the HOST I/O Performance option, which boosts I/O performance though copy time slows as a result. (Optional.)

Set up primary and secondary volumes

The primary and secondary volumes must be set up prior to making copies. Insure that the volumes you plan to use meet the requirements for pair volumes in Planning pair volumes on page 2-3.

Reserve S-VOLs

This is an optional feature that allows you to reserve SMPL volumes for use as S-VOLs. The system rejects write I/Os to reserved volumes (except in PSUS status).

Prerequisite Information

Volumes to be reserved must be:

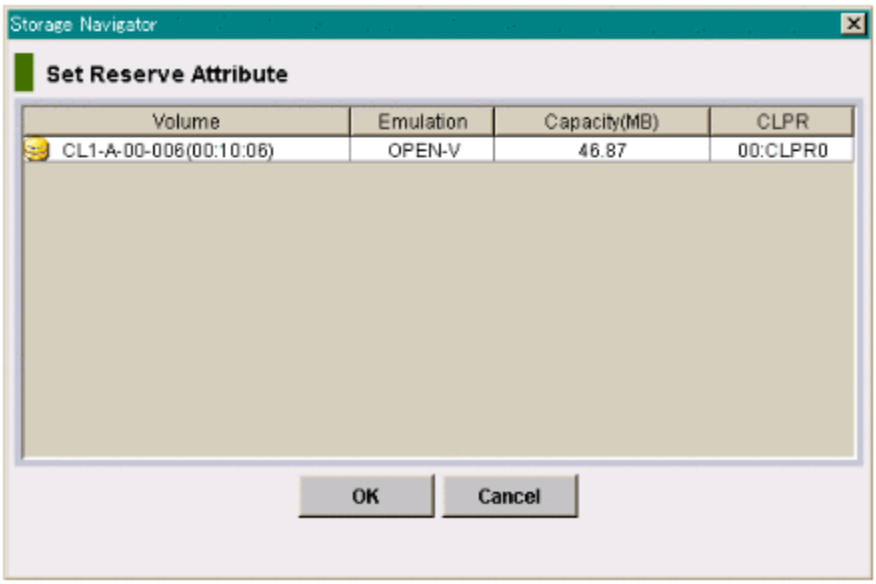
- In SMPL status
- Unreserved and unpaired

To reserve a volume

1. Select the volume or volumes that you want to reserve offline from the host.
2. Click **Actions** > **Local Copy > ShadowImage/Copy-on-Write Snapshot > Pair Operation** to open the **Pair Operation** window.
3. Change to Modify mode by clicking the  icon.
4. In the tree, select the appropriate port or host group for the volumes you want to reserve.

   Related volumes display in the volume list.
5. To show only SMPL, unreserved volumes, click **Display Filter,** then clear the **Reserve** and **Pair** check boxes, select **Non-Pair**, and click **OK**.
6. In the volume list, right-click the desired SMPL volume(s), then click **Change Reserve** from the menu.

   The Set Reserve Attribute dialog box displays.



7. Confirm your selections, then click **OK**.

   The selected volumes display in the Preview List.

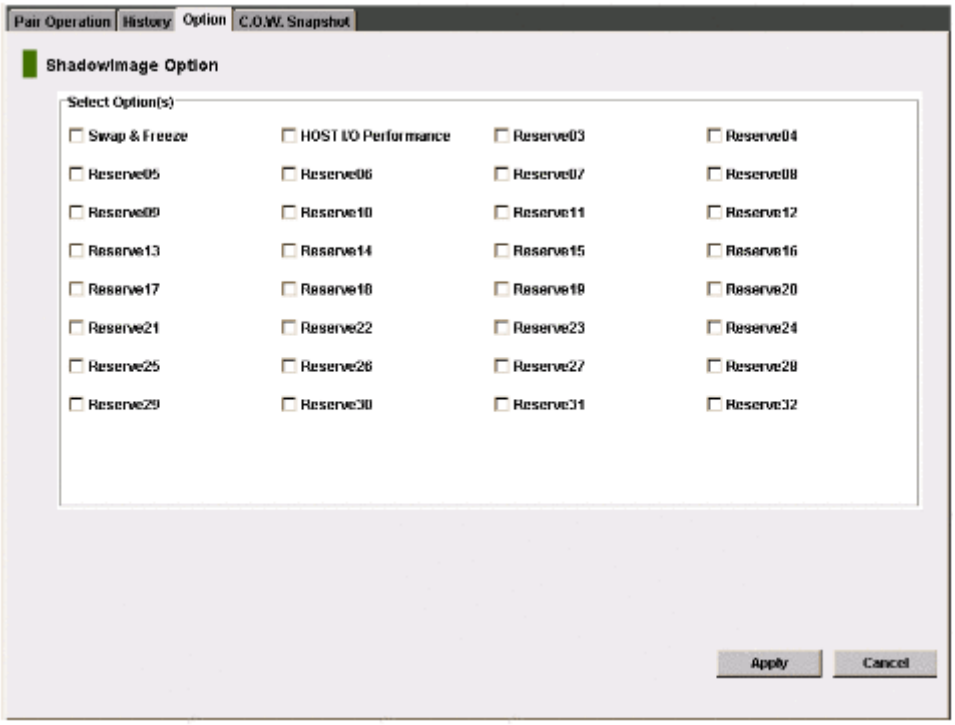
8. When ready, on the Pair Operations window click **Apply**.

Set Host I/O Performance option

This option is meant to improve host I/O responses. When the option is used, the storage system suppresses ShadowImage copying operations, thus slowing them.

To set the Host I/O Performance option

1. Click **Actions** > **Local Copy > ShadowImage/Copy-on-Write Snapshot** > **Option** to open the **Option** window.
2. Change to Modify mode by clicking the  icon.
3. In Storage Navigator, click **ShadowImage/Options** from the **Go** menu.



4. In the **ShadowImage Option** window, select the **Host I/O Performance** box.
5. Click **Apply**.

5

Performing pair operations

This chapter provides instructions for performing pair operations using Storage Navigator.

Pair operations workflow

A typical pair-operations workflow consists of the following:

- Check pair status. Each operation requires a pair to have a specific status. You also check pair status to insure than an operation completed successfully.
- Create the pair, in which the S-VOL becomes a duplicate of the P-VOL. With ShadowImage, you have the option for creating the pair and immediately splitting it in order to access the S-VOL.
- Split the pair, which separates the primary and secondary volumes and allows use of S-VOL data by secondary applications.
- Re-synchronize the pair, in which the S-VOL is again updated from the P-VOL.
- Delete the pair, in which the pair relationship between the pair volumes is ended, though the data remains.

Check pair status

Every pair operation requires the pair to have a specific status. When you want to perform a pair operation, check pair status to insure that you can proceed successfully.

- For pair status definitions and instructions for finding pair status, see Monitoring the system on page 6-2.
- When you have L2 pairs, besides checking pair status, you will also check whether an operation is possible given the status of related L1 and L2 pairs. For information, see Operations permitted for L1, L2 pairs on page 6-3.

Create pairs

When you create the initial copy, data in the P-VOL is copied to the S-VOL. During the operation, the P-VOL can receive updates from the host. When the initial copy is completed, the updated data in the P-VOL—differential data—is copied to the S-VOL periodically (update copy).

ShadowImage provides an option for creating the pair and immediately splitting it for instant access the S-VOL. If you are interested in this operation, see Split, create and split pairs on page 5-5 for instructions.

You can create pairs for L1 or L2. Instructions for both procedures are included in this section.

Prerequisite Information

- Make sure that your volumes are set up for pairing. See Planning pair volumes on page 2-3 for details.
- When the P-VOL is used with another pair, the pair status of the existing pairs must be PAIR.
- When the P-VOL is not used with another pair, both P-VOL and S-VOL must be in SMPL status.

- Because pair creation affects performance on the host, observe the following:
  - Create a pair when I/O load is light.
  - Limit the number of pairs that you create simultaneously.
- When a pair is created, the processor blade allocated to the LDEV used for the S-VOL is also allocated to the processor blade for the P-VOL.

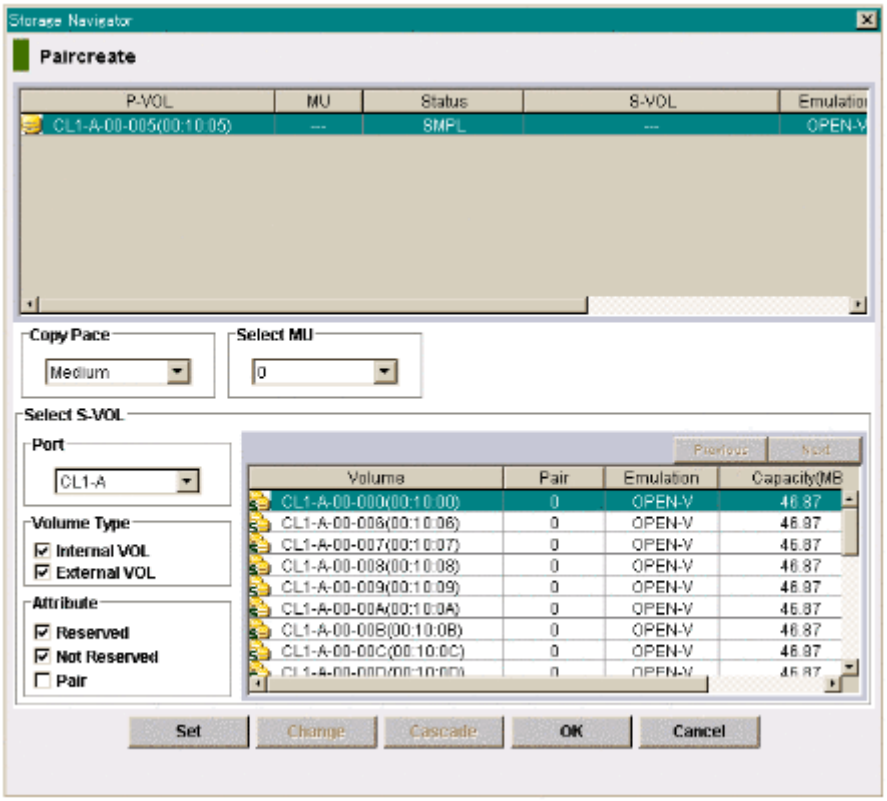
WARNING: The ShadowImage paircreate operation overwrites all existing data on the S-VOL. The user is responsible for backing up the data on the S-VOLs before creating ShadowImage pairs.

To create an L1 and/or L2 pair

1. Click **Actions** > **Local Copy > ShadowImage/Copy-on-Write Snapshot** > **Pair Operation** to open the **Pair Operation** window.
2. Change to Modify mode by clicking the  icon.
3. In the tree, select the port or host group where the volumes to be P-VOLs are located.

   Related volumes display in the volume list.
4. In the volume list, select the volumes that will be the P-VOLs. Make sure not to select reserved volumes.

   If you are creating an L2 pair, select an existing L1 pair.
5. Right-click your selection(s) and select **Paircreate**.



6. In the **Paircreate** dialog box, verify that the desired P-VOLs display in the pair list. To remove a volume, right-click and select the **Delete**.
7. Select the P-VOL that you want to pair.

   If you are creating an L2 pair, select an existing L1 pair. The L1 S-VOL becomes the L2 P-VOL.
8. In **Copy Pace**, select the pace at which data is to be copied, **Slower**, **Medium**, or **Faster**. System performance is affected by the pace you select, less-so for Slower, more-so for Faster.

Note: When the Preview List already contains some newly-configured pairs that have not yet been applied to the system, and then in the Add Pair dialog box you specify a different copy pace for new pairs being created, then the copy pace for the pairs in the Preview List will change. The latest copy pace specified in the Add Pair dialog box is always reflected to the pairs in the Preview list. Therefore, to maintain the initial copy pace for the earlier pairs, click Apply before creating new pairs with a different copy pace.

9. Select an **MU** number for the pair. Use 0, 1, or 2 for an L1 pair; use 1, 2 for an L2 pair.
10. Display the volumes available for S-VOLs by selecting the following filters from the **Select S-VOL** box:
    - Select a **Port** to display associated volumes.
    - Select a **Volume Type** to display internal or external volumes. You can select both if desired.
    - Select an **Attribute** to display volumes previously reserved as S-VOLs, or volumes that are not reserved. You can select both if desired.
    - You can also filter by existing pairs that may be used for creating L2 pairs (**Pair** check box).
11. Select the volume to be the S-VOL from the volume list in the Select S-VOL box.
12. Do one of the following:
    - If creating an L1 pair, click **Set**. This places the volume as the S-VOL in the pair list.

      - You can add a second or third S-VOL to the same L1 P-VOL by repeating steps 8-11.

      - To create another pair with a new P-VOL, repeat steps 7-11.
    - If creating an L2 pair, click **Cascade**. This places a new L2 pair in the pair list.

      To add a second L2 pair, repeat steps 8-11.
13. If you need to change an S-VOL, highlight the pair then select the new volume in the S-VOL list and click **Change**. The changed pair displays in the pair list.
14. Click **OK** when finished creating pairs.

    The Pair Operation window re-appears.

15. Review the information in the **Preview** list. To change a selection, right-click it, select **Modify**, and make your changes.
16. Click **Apply** to commit the pairs(s) to the system.

Split, create and split pairs

Update copying continues until the pair is split. After the pair is split, updates continue to the P-VOL but not to the S-VOL; data in the S-VOL is ensured at the time of the split. All update data are stored in the differential bitmap for use when resynchronizing the pair.

Note: The P-VOL and S-VOL are synchronized only when the pair status changes from COPY(SP) or PSUS(SP) to PSUS. Due to the ShadowImage asynchronous update copy operations, this status transition can take several minutes.

If you want the S-VOLs you are intending to split to be identical to the P-VOLs, stop all write operations to the P-VOLs before splitting the pairs. This ensures that there are no updates to the P-VOLs while the split operations are synchronizing the S-VOLs to the P-VOLs.

Four options are available when splitting a pair:

- Steady split, which is 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.
- Quick split, in which the pair is immediately split so that the S-VOL is immediately available for read and write I/O. Any remaining differential data is copied to the S-VOL in the background.
- At-Time Split, in which all pairs in a consistency group are split at the same time. Split time indicates the time when you want to mirror P-VOL data in the S-VOLs. CCI is required.
- Create and simultaneously split an L1 or L2 pair. This allows you to access S-VOLs as soon as possible

Prerequisite information

- Pair status must be one of the following:
  - PAIR when splitting an existing pair
  - SMPL when creating and immediately splitting an L1 pair
  - PSUS for the L1 pair, when creating and immediately splitting an L2 pair
- For a split operation on an existing pair to complete faster, stop host access to the P-VOL.

To split a pair, or to create and split a pair

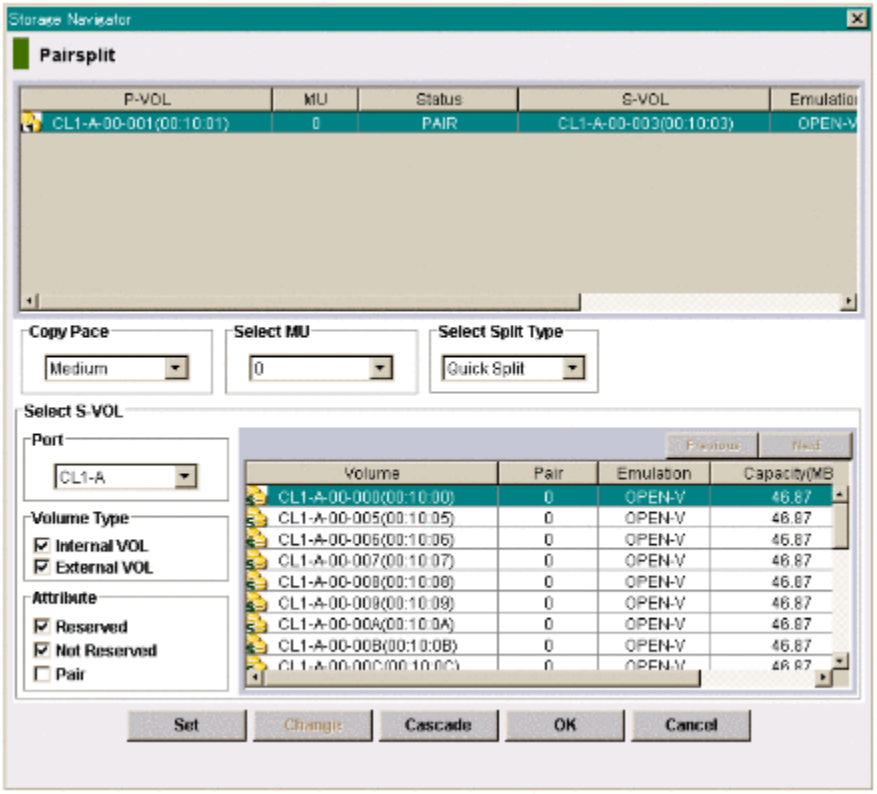
1. Click **Actions** > **Local Copy** > **ShadowImage/Copy-on-Write Snapshot** > **Pair Operation** to open the **Pair Operation** window.
2. Change to Modify mode by clicking the  icon.

3. In the tree, select the port or host group where the pairs or volumes are located.

   Related volumes display in the volume list. If a volume is already paired, pair information also displays.

4. Select one of the following:
   - The pair or pairs to be split.
   - When you create and split an L2 pair, the operation is begun using the L1 pair. Select the SMPL volumes or pair with which you will create and split a new pair.

5. Right-click the selection and click **Pairsplit** from the menu.



6. In the Pairsplit dialog box, proceed as follows:
   - Make sure that the pair or pairs that you want to split displays.
   - Select the SMPL volume to be the P-VOL in an L1 pair-create-and-split operation.
   - Select the L1 pair whose S-VOL will be the P-VOL in an L2 pair create and split operation.

7. From **Copy Pace**, select the pace at which the pair(s) are to be split, **Slower**, **Medium**, or **Faster**. Copy Pace affects the host I/O performance: a slower pace minimizes impact, a faster pace has the greatest impact. The pace you select is used for all pairs in the operation.

8. For pairs being created and split, select an **MU** number. For L1 pairs, use 0, 1, or 2. For L2 pairs, use 1 or 2.

- You cannot select an MU number for an L2 pair that is being used in the associated L1 pair.
- You cannot select an MU number that is being used for a Copy-on-Write Snapshot pair.

9. From **Select Split Type**, select one of the following:
   - **Steady Split**: Any remaining differential data between P-VOL and S-VOL is copied to the S-VOL before the split. Read and write access to the S-VOL is available only when the operation completes.
   - **Quick Split**: Read and write access to the S-VOL is available immediately. Any remaining differential data between P-VOL and S-VOL is copied to the S-VOL in the background.
10. If you are splitting an existing pair or pairs, click **OK** and go to the last two steps in this procedure.

    If you are creating and splitting a pair, continue to the next step.
11. Display the volumes available for S-VOLs by selecting the following filters from the **Select S-VOL** box:
    - Select a **Port** to display associated volumes.
    - Select a **Volume Type** to display internal or external volumes. You can select both if desired.
    - Select an **Attribute** to display volumes previously reserved as S-VOLs, or volumes that are not reserved. You can select both if desired.
    - You can also filter by existing pairs that may be used for creating L2 pairs (**Pair** check box).
12. Select the volume to be the S-VOL from the volume list in the **Select S-VOL** box.
13. Do one of the following:
    - To create and split an L1 pair, click **Set**. This adds the pair to the Volume List as an L1 pair.
    - To create and split an L2 pair, click **Cascade**. This adds the pair to the Volume List as an L2 pair.
14. To replace an S-VOL in the volume/pair list, select the pair, select the desired S-VOL in the **Select S-VOL** box., and click **Change**.
15. To complete the operation, click **OK**.

    The Pair Operation window re-appears.
16. Review the information in the **Preview** list. To change a selection, right-click it, select **Modify**, and make your changes.
17. Click **Apply** to commit the operation to the system.

Splitting consistency group pairs with At-Time Split

Using CCI, you can split all the ShadowImage pairs in a consistency group at a specified time. This is done using the At-Time Split feature.

Prerequisite Information

- On registering split time:
  - When you registered the Split time, you can only perform Suspend or Delete pair operations. Split time is rejected if the Paircreate, Split, or Resync operation is performed. If you want to perform one of these operations, reset the registration of the Split time.
  - The specified Split time is reset when power is switched off.
  - The operation is performed when the read/write request—with a time stamp past the specified Split time—is received. The Split operation may be delayed if no read/write request is issued. When I/O does not occur, the Split operation is performed by the storage system timer.
  - If the Split time is registered, and if there is a pair in the consistency group that cannot be split completely during the Split operation, the status of this pair remains the same as before the Split operation.

Note: The At-Time Split option is disabled if pair operations are performed from Storage Navigator following the creation of the pairs in CCI. Thus, At-Time Split operates correctly only when all pair operations are performed using CCI.

To perform the At-Time Split operation

1. Define a consistency group for the ShadowImage pairs that will be split using At-Time Split.
2. Specify the At-Time Split option, then create the pairs.
3. Split the pairs in the consistency group. The pairs will be split simultaneously.

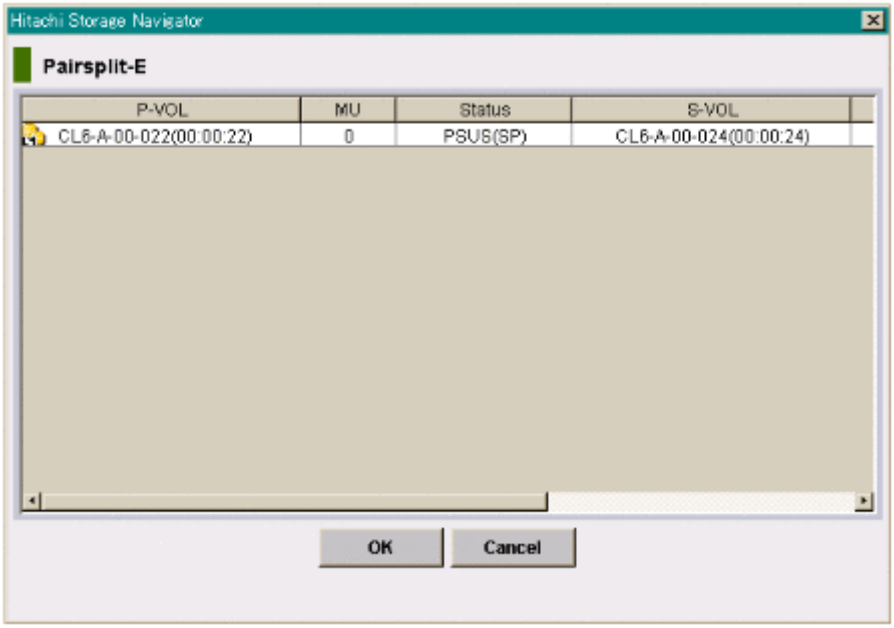
Suspend pair creation

When you suspend the creation of pairs (initial copy to the S-VOL), pair status becomes PSUE. The S-VOL continues accepting write I/O operations from the P-VOL and marks the entire P-VOL track as difference data. When a pairresync operation is performed on a suspended pair, the pair status becomes COPY(RS), and the entire P-VOL is copied to the S-VOL. While the pairresync operation for a split pair can be very fast, the pairresync operation for a suspended pair takes as long as the initial copy operation.

The storage system automatically suspends a pair when it detects an error condition related to an update copy operation, or when it cannot keep the pair mirrored.

To suspend pair(s)

1. Click **Actions** > **Local Copy** > **ShadowImage/Copy-on-Write Snapshot** > **Pair Operation** to open the **Pair Operation** window.
2. Change to Modify mode by clicking the  icon.
3. Go to the **Pair Operation** window, and select the desired port or host group in the Tree to filter the volumes displayed in the Volume List.



4. Select the pair(s) that you want to suspend (or the volume(s) whose pairs you want to suspend), right-click the selected pair(s) to display the menu, and select the **Pairsplit-E** command to open the **Pairsplit-E** dialog box.
5. On the **Pairsplit-E** dialog box, select the pair(s) you want to suspend, and click **OK** to reflect the settings to the **Preview** List on the **Pair Operation** window.

   To remove pair(s) from the list, select the unneeded pair(s), right-click while selecting the pair(s), and then select the **Delete** command from the menu that displays by right-clicking.
6. Repeat steps 4 and 5 to suspend additional pairs in the **Pair Operation** window.
7. On the **Pair Operation** window, click **Apply** to suspend the specified pair(s).

   The **Pair Operation** window displays the result(s) of the **Pairsplit-E** operation(s) (i.e., pair status changed to PSUE).

Resynchronize pairs

You resynchronize a pair that was split by a user or suspended by the system. Resynchronizing updates the S-VOL so that it is again paired with the P-VOL.

Caution: Resynchronizing the pair does not guarantee that P-VOL data is the same as S-VOL data. Data in the two volumes is the same only when the pair is split.P-VOLS-VOL.

- You can forward resync—from P-VOL to S-VOL, and reverse resync—from S-VOLto P-VOL.
  - You can perform a Normal Copy or a Quick Resync, in both directions.

    - The P-VOL remains accessible to hosts for both read and write operations during a Normal Copy operation. The S-VOL becomes inaccessible to hosts during a Normal Copy operation.
    - The P-VOL remains read-disabled during the Reverse Copy operation.
- In a forward Quick Resync from P-VOL to S-VOL, status changes to PAIR without actually resynchronizing the data in the S-VOL. Differential data is copied to the S-VOL when update copy operations are performed.
    - The P-VOL remains accessible to all hosts for both read and write operations during a quick resync operation.
    - In a forward Quick Resync you cannot be sure the data in the P-VOL and S-VOL is the same when there is no host I/O during the operation. You must split the pair to ensure that data is the same.
- In a reverse Quick Resync (called Quick Restore), the P-VOL and S-VOL are swapped. No actual data is copied, and the pair is placed in PAIR status.
    - The P-VOL and S-VOL are inaccessible during this operation. When the Reverse Copy operation completes, the P-VOL becomes accessible.
    - When differential data between P-VOL and S-VOL is small, the Reverse Copy operation may be completed faster than the Quick Restore operation.
- Performing LDEV maintenance work during the Quick Restore process increases the time required for completion.

Note: You can use PPRC to perform a Normal Resync operation on all pairs in a consistency group. To perform the Quick Resync, Reverse Copy, or Quick Restore with PPRC, you must run the desired command on one pair at a time.

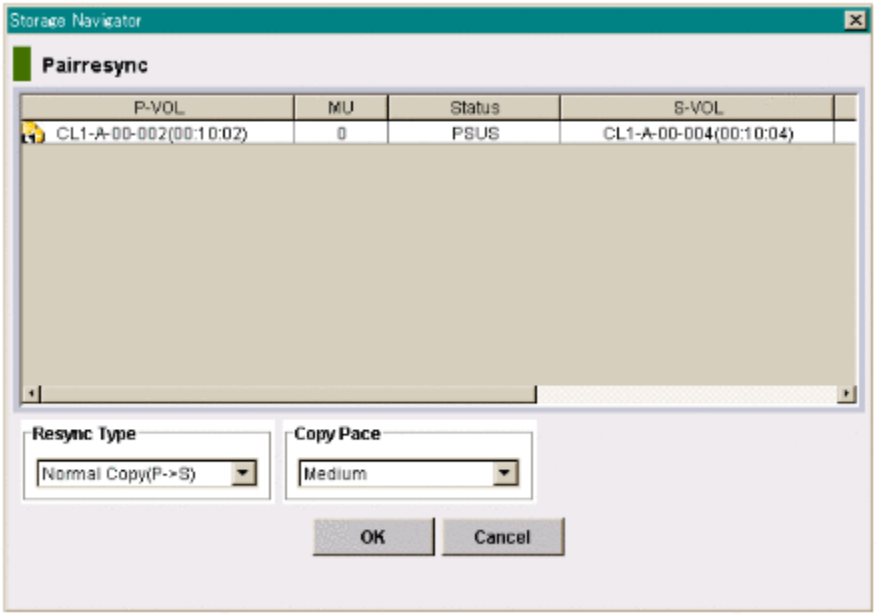
Prerequisite nformation

- For the Reverse Copy or Quick Restore operation, the pair must be in PSUS status.
- The pairresync normally takes less time when the pair is in PSUS status than for PSUE status. This is because the amount of differential data accumulated for a split pair is usually far less than the total amount of data in the P-VOL, which must be copied in full when the pair was suspended by the system.
- If you use the DKAs supporting encryption, you can create a ShadowImage pair by using an encrypted volume and a non-encrypted volume. For example, you can create the pair specifying an encrypted volume as the P-VOL and a non-encrypted volume as the S-VOL. In this case, data in the encrypted P-VOL will be copied as non-encrypted data in the non-encrypted S-VOL.
- If a pair was consists of encrypted and a non-encrypted volumes, and the Quick Restore is run, the P-VOL and S-VOL encryption statuses are reversed.

- With a Quick Restore, Storage Navigator may display outdated information. Click **File/Refresh** to insure the most up-to-date information.
- With a Quick Restore, to keep the P-VOL and S-VOL un-synchronized, enable the Swap&Freeze option before performing the Quick Restore. Update copy operations are then suppressed when the Quick Restore is completed, and the pair is in PAIR status.
- If a reverse or quick restore pairresync operation is performed on a pair whose P-VOL is also paired with other S-VOLs, the P-VOL and other S-VOLs are no longer synchronized.
- For Reverse Copy or Quick Restore operation, the following restrictions apply:
  - Neither Reverse Resync option can be performed on pairs in the PSUS status.
  - Pairs sharing the same P-VOL must be in PSUS or PSUE status.
  - If a Quick Format is being performed on either of the pair volumes, the Quick Restore operation cannot be performed.
  - If the pair shares a volume with TrueCopy or Universal Replicator, and the TrueCopy or Universal Replicator pair is not suspended, neither backward resync operation can be performed.
  - Quick Restore cannot be performed when ShadowImage and shared TrueCopy or Universal Replicator volumes include an external volume(s).
  - You cannot create a TrueCopy or Universal Replicator pair with a volume shared by ShadowImage during either backward resync operation.
  - When the Reverse Copy or Quick Restore operation is in progress, you cannot create, split, or resync any pair sharing the same P-VOL. You can delete or suspend the pairs, however.

To resynchronize a pair

1. If the S-VOL is online, set it offline. If you resynchronize S-VOL to P-VOL, set the P-VOL offline, too.
2. Click **Actions** > **Local Copy** > **ShadowImage/Copy-on-Write Snapshot** > **Pair Operation** to open the **Pair Operation** window.
3. Change to Modify mode by clicking the  icon.
4. In the tree, select the port or host group where the desired pairs are located.
5. In the volume list, select the pair(s) to be resynchronized, right-click, and select **Pairresync**.



6. In the Pairresync dialog box, select the **Resync Type** as follows:
   - **Normal Copy(P->S)** to resynchronize the pair(s) normally. All differential data is updated to the S-VOL.
   - **Quick Resync(P->S)** to immediately change pair status to PAIR. Resynchronization of data does not occur immediately. Differential data is copied during update copying.
   - **Reverse Copy(S->P)** to copy the S-VOL data to the P-VOL. All differential data is updated to the P-VOL. Not available for L2 pairs.
   - **Quick Restore(S->P)** to swap the P-VOL and S-VOL. Any differential data between the volumes is copied during update copying. Not available for L2 pairs.
7. From **Copy Pace**, select the pace at which the pair(s) are to be resynchronized, **Slower**, **Medium**, or **Faster**. **Copy Pace** affects the host I/O performance: a slower pace minimizes impact, a faster pace has the greatest impact. The pace you select is applied for all pairs in the operation.
8. Click **OK**.
9. In the Pair Operation window, review the information in the **Preview** list. To change a selection, right-click it, select **Modify**, and make any changes.
10. Click **Apply** to commit the operation to the system.

Make sure that pair status changes to PAIR before attempting any other operation.

Note: Note the following.

- If the reverse or quick restore operation ends abnormally, the pair status changes to PSUE. In this case, the P-VOL is read/write-enabled for all hosts but the data in the P-VOL is not guaranteed. The S-VOL remains write-disabled (read-only) and data is not guaranteed. The status of other pairs sharing the same P-VOL does not change.

Delete pairs

You can delete a pair when you no longer need it. When you delete a pair, the P-VOL and S-VOL return to their SMPL state, though their data remains intact. After deletion, both volumes are available for use in another pair.

Prerequisite information

- When a pair is created, the processor blade allocated to the P-VOL's LDEV is also allocated to the S-VOL's LDEV. When a pair is deleted, the processor blade that was originally allocated to the S-VOL'S LDEV is allocated to it again. If the original processor blade was removed, another processor blade is allocated.
- When you delete a pair, the status of the volumes changes to SMPL. However, before becoming SMPL, it first changes to SMPL(PD). You can check pair status in the Pair Operation window.

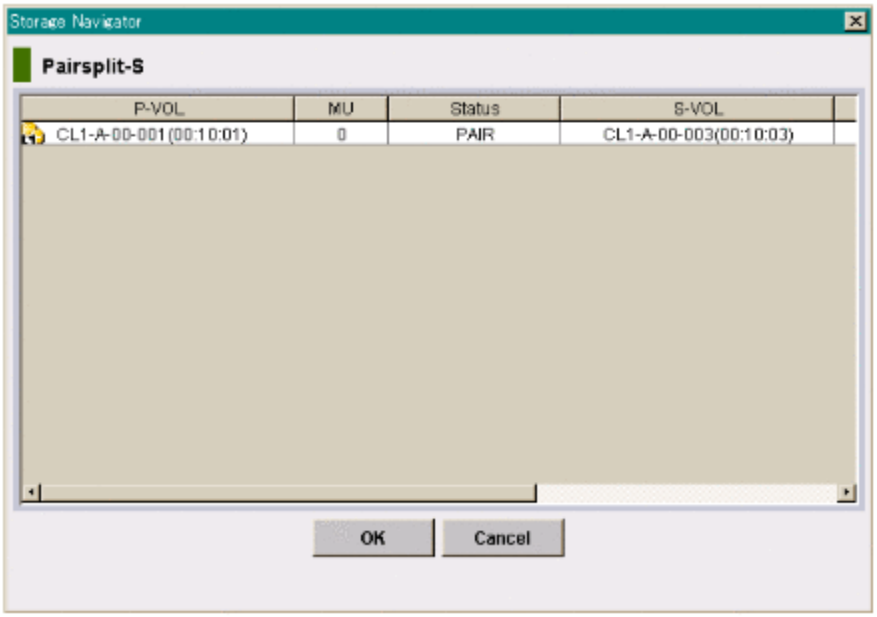
  To distinguish between SMPL and SMPL (PD) volumes using CCI, run the pairdisplay and Inqraid commands. The pairdisplay command shows status but cannot distinguish between SMPL and SMPL(PD); and the Inqraid shows whether a volume is being used by ShadowImage.

  - If the result of the pairdisplay command is SMPL, and the result of the Inqraid command is PVOL or SVOL, then ShadowImage is still using the pair and status is SMPL(PD).
  - If the result of the pairdisplay command is SMPL, and the result of the Inqraid command is not PVOL or SVOL, ShadowImage is not using the volumes. Therefore, status is confirmed as SMPL.
- After deleting a pair, wait 10 seconds—until volume status changes from SMPL(PD) to SMPL—before performing tasks such as pair operation or event waiting. If you do not wait 10 seconds, the operation might end abnormally.

To delete a pair

1. To synchronize the P-VOL and S-VOL before deleting the pair:
   a. Wait until all write I/Os to the P VOL are complete
   b. Set the P-VOL offline
   c. Split the pair. This copies differential data to the S VOL.
2. Click **Actions** > **Local Copy** > **ShadowImage/Copy-on-Write Snapshot** > **Pair Operation** to open the **Pair Operation** window.
3. Change to Modify mode by clicking the  icon.

4. In the tree, select the appropriate port or host group. Related volumes and pairs display in the volume list.
5. Select the pair(s) you want to delete, right-click, and select **Pairsplit-S** from the menu.



6. If you selected a pair that you do not want to delete, select the pair on the Pairsplit-S dialog box, right-click, then click **Delete**. This removes the pair from the deletion list.
7. Click **OK**.

   The Pair Operation re-appears.
8. Review the information in the **Preview** list.
9. Click **Apply** to commit the operation to the system.

6

Monitoring and maintaining the system

This chapter provides information and instructions for monitoring and maintaining the ShadowImage system.

- ☐ Monitoring the system
- ☐ Maintaining the system

Monitoring the system

Monitoring helps you keep track of pairs and volumes and their current and past conditions. Monitoring should be an ongoing activity. This section provides information for monitoring the following:

- Pair status. Status definitions are included.
- Pair and pair volume details
- Status and other pair information for pairs in a consistency group
- S-VOL path information
- Number of pairs in the system, with remaining license capacity
- A pair's history of operations

Monitoring pair activity, status

Monitoring the ShadowImage system is necessary to maintain your pairs.

- Each operation requires a specific status or statuses. When you want to perform a pair command, first check the pair's status.
- Pair-status changes when an operation is performed. Check status to see that pairs are operating correctly and that status is changing to the appropriate state during and after the operation.

Monitoring using the Storage Navigator GUI is done at the user's discretion. Monitoring should be repeated frequently. Email notifications of problems in pair operations can be set up using the GUI.

To monitor pair status

1. In Storage Navigator, click **Actions > Local Copy > ShadowImage/ Copy-on-Write Snapshot >Pair Operation**.
2. Locate the pair whose status you want to review. Review pair status in the Status column.

You can view more details for the pair by right-clicking and selecting **Detail**. See Reviewing pair, volume details on page 6-5 for field information.

Pair status definitions

Pair status descriptions are provided below. When checking your pairs' status, click File/Refresh to make sure pair data is current.

Table 6-1 Pair Status Definitions

Status	Description	S-VOL Access
SMPL	The volume is not assigned to a pair. The system accepts read/write for SMPL volumes that are not reserved.	N/A
COPY(PD)	The paircreate operation has begun, the initial copy is in progress.* The system continues to accept read/write to the P-VOL, but stops write operations to the S-VOL. No update copy operations are performed.	Read only

Status	Description	S-VOL Access
PAIR	The initial copy operation is complete, the volumes are paired. The system begins update copy operations from P-VOL to S-VOL as needed. The P-VOL and S-VOL in PAIR status may not be identical.	Read only
COPY(SP)	The pairsplit operation in the steady split mode has begun. Any remaining differential data is copied to the S-VOL. When these updates are complete, the pair is split. The split S-VOL is identical to the P-VOL at the time of the split.	Read only
PSUS(SP)	The pairsplit operation in the quick split mode has begun. P-VOL differential data is copied to the S-VOL in the background. Pairs in PSUS(SP) status cannot be deleted.	Read and write. The S-VOL can be mounted.
PSUS	The pair is split. The system stops performing update copy operations. Write I/Os are accepted for S-VOLs. The system keeps track of updates to split P-VOLs and S-VOLs, so that the pair can be resynchronized quickly.	Read and write. The S-VOL can be mounted.
COPY(RS)	The pairresync operation has begun. The system does not accept write I/Os for COPY(RS) S-VOLs. When a split pair is resynchronized in normal mode, the system copies only P-VOL differential data to the S-VOL. When a PSUE (suspended) pair is resynchronized, the system copies the entire P-VOL to the S-VOL. No update copy operations are performed during the pairresync operation.	Read only
COPY(RS R)	The reverse pairresync operation has begun. The system does not accept write I/Os for COPY(RS R) S-VOLs. The system copies only S-VOL differential data to the P-VOL. No update copy operations are performed during the reverse or quick restore pairresync operation.	Read only
PSUE	The pair is suspended by the system. The system continues accepting read and write I/Os to the P-VOL. Update copy operations are stopped to a S-VOL. The system marks the entire P-VOL track map as difference data, meaning that the entire P-VOL is copied to the S-VOL when the PSUE pair is resynchronized.	Read only
* Starting time of the copy depends on the numbers of pairs and the system environment.		

Operations permitted for L1, L2 pairs

When you have cascaded pairs, the operations that may be performed depend on pair status on both layers.

Any operation, of course, requires that the pair's status is correct for that operation (see Pair status definitions on page 6-2). In addition, an operation depends on the following:

- For L1 operations, the status of the L2 pair.
- For L2 operations, the status of the L1 pair.
- Supported read/write on L1 and L2 S-VOLs.

Operations that are supported for these pair types and statuses are shown in the following tables.

Table 6-2 Supported L1 Pair Operations for Related L2 Status

L2 Pair Status	L1 Pair Operations				
	Paircreate	Pairsplit	Pairresync	Pairsplit-E	Pairsplit-S
COPY(PD)	Ok*	Ok	Ok	Ok	Ok
PAIR	Ok*	Ok	Ok	Ok	Ok
COPY(SP)	NO*	NO*	NO	Ok	Ok
PSUS(SP)	NO*	NO*	NO	Ok	Ok
PSUS	Ok*	Ok	Ok	Ok	Ok
COPY(RS)	Ok*	Ok	Ok	Ok	Ok
COPY(RS-R)	NO*	NO	--	--	--
PSUE	Ok*	Ok	Ok	Ok	Ok
* Not displayed in Storage Navigator.					

Table 6-3 Supported L2 Pair Operations for Related L1 Status

L1 Pair Status	L2 Pair Operations				
	Paircreate	Pairsplit	Pairresync *	Pairsplit-E	Pairsplit-S
COPY(PD)	Ok	NO	Ok	Ok	Ok
PAIR	Ok	NO	Ok	Ok	Ok
COPY(SP)	Ok	NO	Ok	Ok	Ok
PSUS(SP)	NO	NO	Ok	Ok	Ok
PSUS	Ok	Ok **	Ok	Ok	Ok
COPY(RS)	Ok	NO	Ok	Ok	Ok
COPY(RS-R)	Ok	NO	Ok	Ok	Ok
PSUE	Ok	Ok	Ok	Ok	Ok
* L2 pairs can only be resynchronized in Normal Copy or Quick Resync mode. Backward resynchronization (i.e., Reverse Copy or Quick Restore) cannot be performed. ** To split L2 pairs, the L1 pair must be in PSUS status.					

Table 6-4 Node Vol Read/Write per L1, L2 Pair Status

L1 Pair Status	L2 Pair Status						
	COPY(PD)	PAIR	COPY(SP)	PSUS(SP)	PSUS	COPY(RS)	PSUE
COPY(PD)	Read only	Read only	Read only	Read only	Read only	Read only	Read only
PAIR							
COPY(SP)							
PSUS(SP)	Read/ Write	Read/ Write	Read/ Write	Read/ Write	Read/ Write	Read/ Write	Read/ Write
PSUS							

L1 Pair Status	L2 Pair Status						
	COPY(PD)	PAIR	COPY(SP)	PSUS(SP)	PSUS	COPY(RS)	PSUE
COPY(RS)	Read only	Read only	Read only	Read only	Read only	Read only	Read only
COPY(RS-R)							
PSUE							

Table 6-5 Leaf Vol Read/Write per L2 Pair Status

L2 Pair Status						
COPY(PD)	PAIR	COPY(SP)	PSUS(SP)	PSUS	COPY(RS)	PSUE
Read only	Read only	Read only	Read/ Write	Read/ Write	Read only	Read only

Reviewing pair, volume details

You can review the data related to L1 and L2 pairs and their volumes. This includes volume capacity, pair status, P-VOL and S-VOL identifiers, and several other details.

Note: LDEVs for P-VOLs and S-VOL s listed in Storage Navigator may end in the following special symbols:

- A pound or gate symbol (#), which indicates an external volume (for example, 00:00:01#).
- The letter "X", which indicates that a virtual volume used by Dynamic Provisioning (for example, 00:00:01X).

To check pair and volume details

1. In Storage Navigator, click **Actions** > **Local Copy** > **ShadowImage/ Copy-on-Write Snapshot** > **Pair Operation**.
2. In the tree, select the port or host group where the pairs or volumes are located. Related volumes display in the volume list.
3. From the volume list, select and right-click the volume or pair whose information you want to see, then select **Detail** from the menu. The Detail dialog box displays. Field descriptions are provided below.

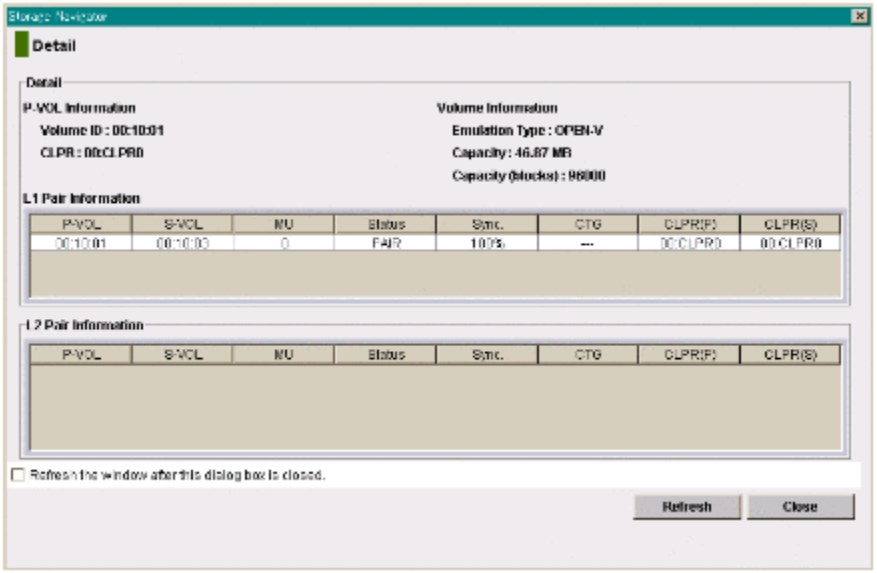


Table 6-6 Fields in Detail Dialog Box

Field	Description
P-VOL Information	Volume ID: Displays LUN information using LDKC number:CU number:LDEV number format. CLPR: Displays CLPR number:CLPR name.
Volume Information	Displays the volume's emulation type, capacity, and number of blocks.
Pair Information	• P-VOL: Displays LUN information using LDKC number:CU number:LDEV number format. • S-VOL: Displays LUN information using LDKC number:CU number:LDEV number format. • MU: The pair's MU number (mirror unit number). • Status: The status of the pair. • Sync.: Percentage that P-VOL and S-VOL are synchronized. • CTG: The consistency group number displays if the pair is registered in the group. If the pair is not registered to the consistency group, --- displays. • CLPR(P): The identifier for the P-VOL's cache logical partition (CLPR) displays in CLPR number:CLPR name format. • CLPR(S): The identifier for the S-VOL's cache logical partition (CLPR) displays in CLPR number:CLPR name format.
Refresh the window after this dialog box is closed.	If you select the check box, the information displayed in the Pair Operation window is updated after the Detail dialog box closes. If you do not select the check box, the information in the Pair Operation window is the same before and after you close the Detail dialog box.

Reviewing S-VOL path information

You can view path information for the S-VOL. You do this in the S-VOL Path dialog box.

To view S-VOL path information

1. In Storage Navigator, click **Actions** > **Local Copy** > **ShadowImage/ Copy-on-Write Snapshot** > **Pair Operation**.
2. In the tree, select the appropriate port or host group for the desired pair(s). Related volumes display.
3. Select a pair or pairs, right-click, and select **S-VOL** Path from the menu. The S-VOL Path dialog box displays. Field descriptions are provided below.

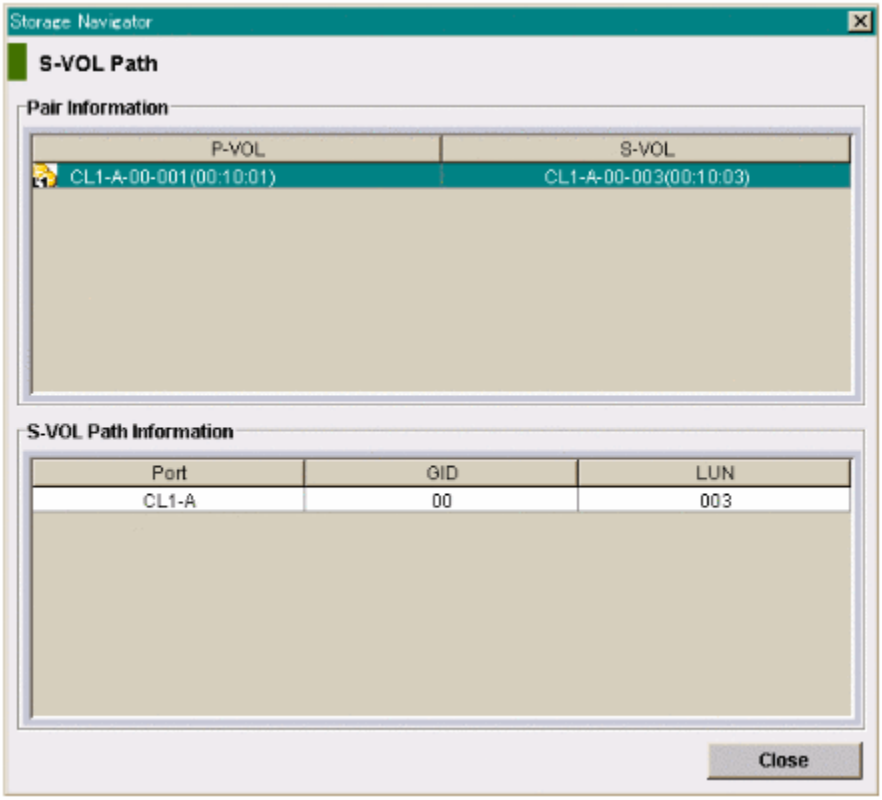


Table 6-7 Fields in S-VOL Path Dialog Box

Field	Description
Pair Information	P-VOL and S-VOL columns displays the following path information (examples below from P-VOL column): • Port ID (cluster name and channel number. For example: *CL3-D*) • Group number (GID) of the host group. For example: *00* • LU number. For example: *000* • LDKC number:CU number:LDEV number. For example: *00:14:00*
S-VOL Path Information	Port number, GID number, and LU number.

Reviewing pair, license information

You can check the current state of your pairs and licensed capacity. Do this using the Information dialog box.

To check remaining capacity

1. In Storage Navigator, click **Actions** > **Local Copy** > **ShadowImage/ Copy-on-Write Snapshot** > **Pair Operation**.
2. Right-click on the volume list, in any location, then select **Information** from the menu.

   The Information dialog box displays. Field descriptions are provided below.

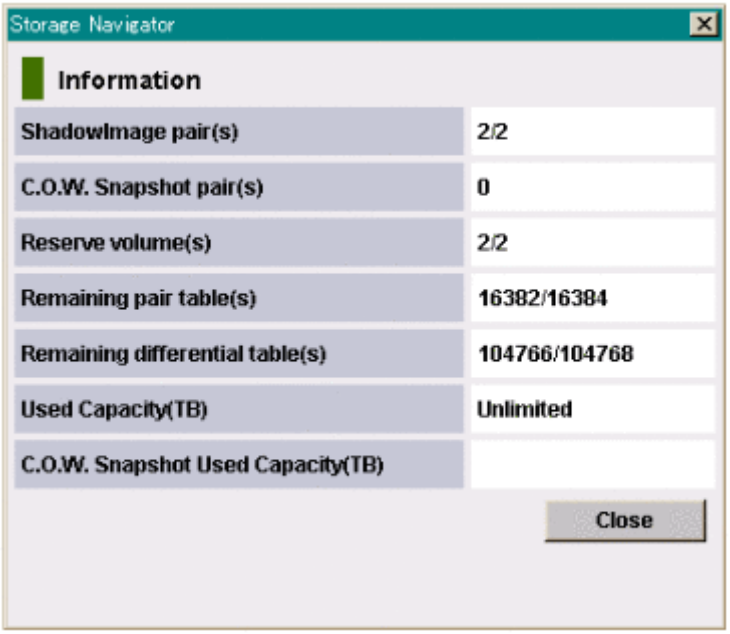


Table 6-8 Fields in the Information Dialog Box

Field	Description
ShadowImage pairs	Shows the number of ShadowImage pairs/and the total number of pair tables for ShadowImage and ShadowImage for Mainframe. For example: *12/12*. Notes: • The maximum number of pairs allowed in one storage system is 16,384, including migration plans and relationships. For example, if a system contains Copy-on-Write Snapshot pairs, migration plans of Volume Migration, and relationships of Compatible FlashCopy® V2, the maximum number of pairs allowed for ShadowImage would be 16,384 minus these. • Volume size also limits the number of pairs. For more information, see Planning number of pairs on page 2-4.
C.O.W. Snapshot pair(s)	Displays the number of Copy-on-Write Snapshot pairs.
Reserved volume(s)	Displays the number total number of reserved volumes for ShadowImage and ShadowImage for Mainframe.
Remaining pair table(s)	Displays the number of remaining pair tables in the storage system/and the total number of pair tables in the system. For more information, see Calculating number of differential, pair tables on page 2-5.

Field	Description
Remaining differential table(s)	Displays the number of remaining differential tables in the storage system/and the total number of differential tables in the system. For more information, see Calculating number of differential, pair tables on page 2-5.
Used volume (TB)	Displays license information used by ShadowImage, and the total license capacity reserved for ShadowImage. "Unlimited" displays when there is no limit on license capacity for ShadowImage.
C.O.W. Snapshot Used volume (TB)	Displays license information used by Copy-on-Write Snapshot, and the total license capacity reserved for Copy-on-Write Snapshot. "Unlimited" displays when there is no limit on license capacity for Copy-on-Write Snapshot.

Reviewing a pair's operation history

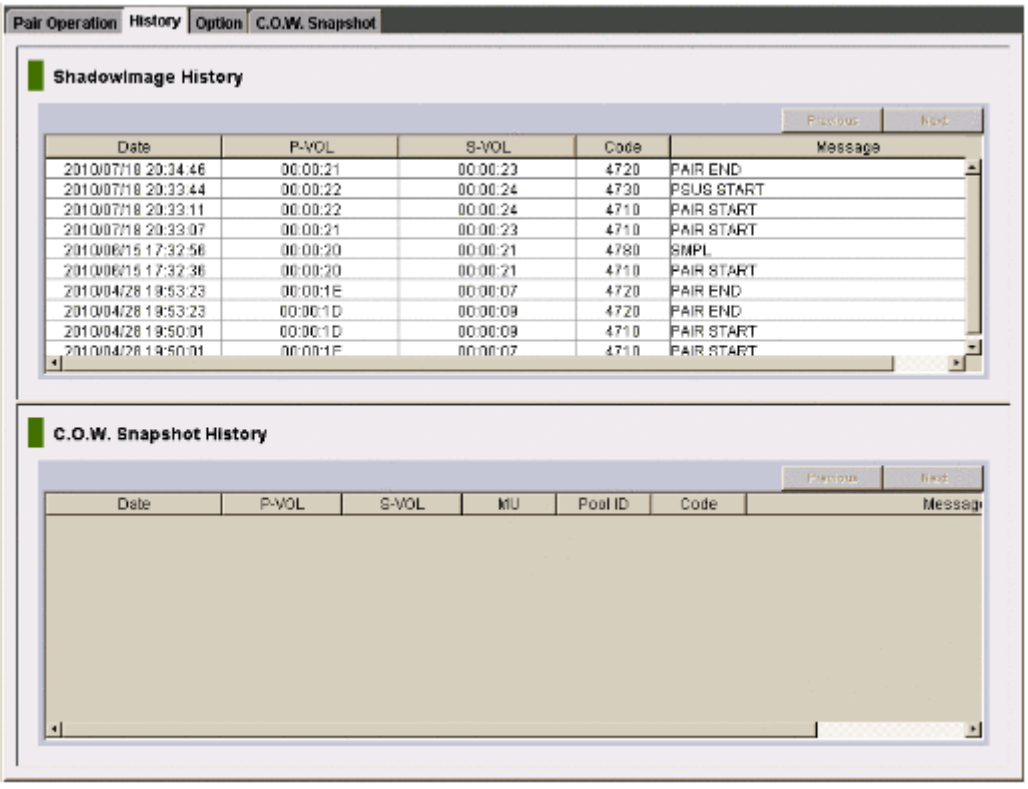
You can review the operations that have been performed on a pair using the History Window.

To see the history

1. Click **Actions** > **Local Copy** > **ShadowImage/Copy-on-Write Snapshot** > **History** to open the **History** window.

   If some of the pairs include LUSE volumes, or if the total number of the following pairs and migration plans is 500 or more in the storage system, you may need to wait for a while until the **History** window displays operation history.

   - ShadowImage pairs
   - ShadowImage for Mainframe pairs
   - Copy-on-Write Snapshot pairs
   - Version 2 relationships
   - Migration plans of Volume Migration



2. See the **ShadowImage History** list in the upper area of the **History** window.
3. To change the displaying order, click a column title in the list.

   The list will be sorted based on the items in the clicked column.

   - If there are more than 16,384 records of operations, the list will be divided into multiple pages and only the list which is currently displayed will be sorted.
   - If you click the same column title again, you can switch the sorting order (Ascending or Descending).
4. If the information on the list is not updated, click **File** and then **Refresh**. The list will be updated to the latest information.

   For operations involving the copying process, the **History** window does not display information about the operations until the copying process starts. If you perform an operation on a pair before the copying process starts, the **History** window will not display information about the operation.
5. If there are many records of operations, click the scroll button. The list scrolls and you will see the operation history that was not previously displayed.

   If you click and drag down the frame border that divides the **History** window into upper and lower panes, you can expand the display area of the list.
6. If there are more than 16,384 records of operations, click **Next**.

   The list displays subsequent records of operations.

- If you click the **Previous** button, the list switches to the previous page.
- If there are 16,384 or fewer records of operations, you cannot click **Previous** and **Next**.
- The storage system saves up to 524,288 records of latest operations.

Maintaining the system

Some maintenance tasks are a response to behavior discovered during system monitoring.You can also change certain settings to keep the system in tune with your changing requirements.

This section provides maintenance information and instructions for the following:

- Removing the reserve attribute
- Maintaining ShadowImage during system maintenance

Remove reserve attribute from a volume

You can remove the S-VOL reserve attribute from a volume.

Prerequisite Information

Before removing the reserve attribute from a volume, insure that the status is SMPL.

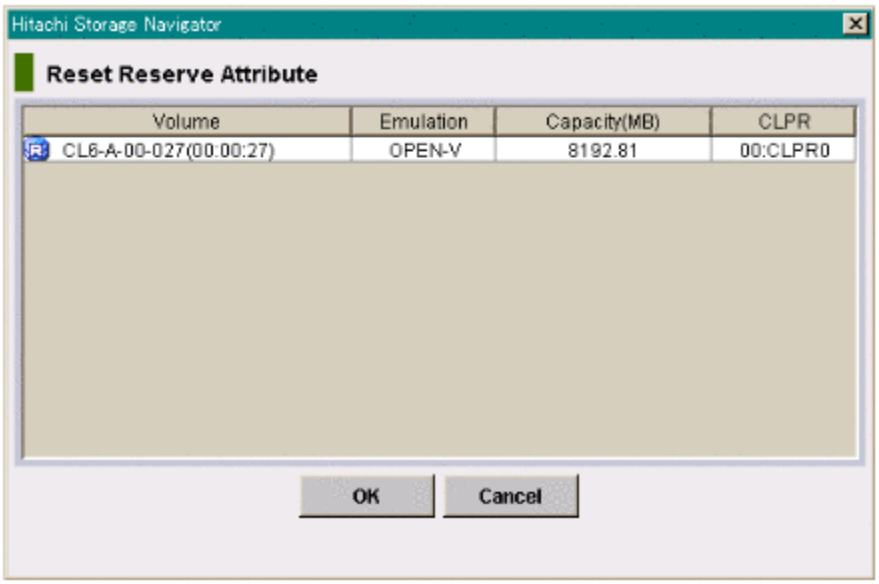
To remove the reserve attribute

1. In Storage Navigator, click **Actions** > **Local Copy** > **ShadowImage/ Copy-on-Write Snapshot** > **Pair Operation**.
2. Click  to change to the Modify mode.
3. In the tree, select the appropriate port or host group for the volumes you want to remove the reserve attribute from.

   Related volumes display in the volume list. To show only simplex, reserved volumes, click **Display Filter**, then do the following:

   a. Insure that the **Pair** attribute is cleared.
   b. Check **Reserve**.
   c. Click **OK**.
4. In the volume list, right-click the desired SMPL volumes, then click **Change Reserve** from the menu.

   The Reset Reserve Attribute dialog box displays.



5. Select the volume(s) from which you want to remove the attribute, then click **OK**.

   The selected volumes display in the Preview List.

6. To change a selection, right-click, select **Modify**, and make your changes.

7. When ready, on the Pair Operations window click **Apply**.

Pair operations during system, device maintenance

This section provides recommendations for pair operations when maintenance on the Virtual Storage Platform system and related devices are performed.

When maintaining physical and logical devices

Review the following to check whether pairs and pair operations are affected when maintenance is performed on physical and logical devices.

- If Virtual Storage Platform cache maintenance is performed during a period of high I/O usage, one or more pairs may suspend. Reduce the I/O load before performing cache maintenance.
- Physical devices that contain LDEVs used by ShadowImage can be maintained independently of pair operations and pair status. Maintenance does not affect ShadowImage.
- If a physical device failure occurs, copy pace is degraded but pair status remains the same as before the failure.
- If a physical device failure requires the system to utilize dynamic sparing or automatic correction copy, pair status is not be affected.
- If an LDEV failure occurs, the system suspends the pair.
- Maintenance is restricted for LDEVs used by a pair that is in the following statuses: COPY(PD), PAIR, PSUS, PSUS(SP), COPY(SP), COPY(RS), or COPY(RS R).

- Maintenance is also restricted for LDEVs in which the Reserve attribute is set for a volume.

  To maintain these LDEVs, suspend or delete the pair, and/or remove the S-VOL reserve attribute.

When switching power off

During pair operations, when you switch off the power-supply for the system, make sure of the following:

- Complete processing for an At-Time Split operation before switching off the power-supply.

  If this is not done and the status of some of the pairs in the consistency group is changed but not others, the At-Time Split processing may not resume when you power-on the power-supply. The status of some pairs may remain unchanged. Deleted the following lists, because shared memory volatilization is not supported.

7

Troubleshooting

This chapter provides information and instructions for troubleshooting the ShadowImage system.

- ☐ General troubleshooting
- ☐ Troubleshooting with CCI

General troubleshooting

The following table provides general troubleshooting information for ShadowImage pairs.

Table 7-1 General Troubleshooting

Error	Corrective Action
Storage Navigator hangs, or ShadowImage operations do not function properly.	• Make sure all ShadowImage requirements and restrictions are met. • Make sure the storage system is powered on and fully functional. • Check all input values and parameters to make sure that you entered the correct information on the ShadowImage windows (such as P-VOL and S-VOL IDs).
The volume pairs are not displaying correctly.	Make sure the correct volumes are selected.
A ShadowImage error message is displayed on Storage Navigator during an operation.	Select the failed volume in the Preview List on the Pair Operation window, right-click to display the menu, and then click Error Detail. See *Hitachi Storage Navigator Messages* for the list of error codes and corrective actions.
ShadowImage pair status is incorrect (or unexpected).	The pair may have been suspended or deleted from the UNIX/PC server host using CCI. If not, the Virtual Storage Platform detected an error condition during ShadowImage operations. Check the Storage Navigator error log. If necessary, call the Hitachi Data Systems Support Center for assistance.
There is a pinned track on a ShadowImage volume.	If a pinned track occurs on a ShadowImage or S-VOL, the system will suspend the pair. Contact your Hitachi Data Systems representative for assistance in recovering pinned tracks.

Troubleshooting with CCI

This section provides troubleshooting information for operations performed using CCI. The following describes CCI error codes and instructions for using them. Also, see Troubleshooting the At-Time Split operation on page 7-10.

When using CCI, you can identify the cause of an error by referring to either of the following:

- The log displayed on the CCI window
- The error code in the CCI operation log file. The default location for this file is:

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

  where `*` = instance number, and, `HOST` = host name

To find and interpret an error

1. Do one of the following:

- If using the CCI-window log, locate the error code you are investigating. An example error code in the CCI-window log is:

  ```
  It was rejected due to SKEY=0x05,
  ASC=0x20,SSB=0xB9E1,0xB901 on Serial#(64015)
  ```

- If using the operation log file, locate the error code you are investigating. An example error code in the log file is:

  ```
  11:06:03-37897-10413- SSB  = 0xb9a0,2089
  ```

2. Locate the SSB1 and SSB2 codes. In both examples above, these codes appear to the right of the equal symbol (=).
   - The **SSB1 code** consists of the alpha-numeric characters which are the last four digits *on the left of the comma* (,). Examples:

     `B9E1` in the CCI-window log

     `b9a0` in the operation log file

   - The **SSB2 code** consists of the alphanumeric characters which are last four digits *on the right of the comma* (,). Examples:

     0xB901 in the CCI-window log

     2089 in the operation log file

3. In the following table, locate the description of the SSB1/SSB2 error code combination.

For errors not described the table, call the Support Center.

Table 7-2 CCI Error Codes)

SSB2 code	Description
-	Error occurred in ShadowImage pair operation.
200d	Because the specified Dynamic Provisioning or Dynamic Tiering V-VOL was not associated with a pool, the pair operation was rejected.
201b	Because the status of the Universal Replicator pair was not PAIR, PSUS, or PSUE, the At-Time Split operation was rejected. The S-VOL of the Universal Replicator pair had been the P-VOL of the ShadowImage pair included in the consistency group on which the At-Time Split operation was performed.
2026	The quick restore operation was rejected because the cache mode of the specified P-VOL was different from the cache mode of the external S-VOL.
2047	Since the current microcode version does not support the specified P-VOL capacity, the pair operation is rejected.
2048	Since the current microcode version does not support the specified S-VOL capacity, the pair operation is rejected.
2060	The volume specified as a P-VOL was a volume of a Universal Replicator pair. Because the status of the Universal Replicator pair was invalid, the pair operation was rejected.
2061	The volume specified as an S-VOL was a volume of a Universal Replicator pair. Because the status of the Universal Replicator pair was invalid, the pair operation was rejected.

SSB2 code	Description
2067	Volumes of the specified pair were shared by TrueCopy and Universal Replicator. Therefore, the quick restore operation was rejected, or, the reverse copy operation was rejected because the status of the TrueCopy or Universal Replicator pair was not PSUS.
2068	Because the specified P-VOL or S-VOL was being shredded, the pair operation was rejected.
2072	The pair operation was rejected for one of the following reasons: • The P-VOL was also a Copy-on-Write Snapshot pool volume. • The P-VOL was also a Copy-on-Write Snapshot S-VOL (V-VOL). • The P-VOL was also a Copy-on-Write Snapshot P-VOL, and one of the following conditions held true. - While the Copy-on-Write Snapshot pair was restored, the create, split, or resync pair operation was performed on the ShadowImage pair. - The ShadowImage quick restore operation was performed. - A consistency group was defined for ShadowImage. - After the MU number used by a Copy-on-Write Snapshot pair was specified, the create, split, or resync pair operation was performed on the ShadowImage pair.
2073	The pair operation was rejected for one of the following reasons: • The S-VOL was also a Copy-on-Write Snapshot pool volume. • The S-VOL was also a Copy-on-Write Snapshot S-VOL (V-VOL). • The S-VOL was a Copy-on-Write Snapshot S-VOL pair, and one of the following conditions held true. - The Copy-on-Write Snapshot pair was being restored. - The ShadowImage quick restore operation was performed. - A create pair operation was performed on the ShadowImage pair.
2078	Because the specified P-VOL was also a Universal Replicator P-VOL for delta resync, one of the following errors occurred. • Because the Universal Replicator pair was not in the PSUS status, the reverse copy operation was rejected. • The quick restore operation was rejected.
2079	Because the specified P-VOL was also a Universal Replicator P-VOL for delta resync, the pair operation was rejected.
2086	Because the initialization process was being performed, the pair operation was rejected.
2089	Because the volume specified as a P-VOL was undergoing quick format, the quick restore operation was rejected.
208a	Because the volume specified as an S-VOL was undergoing quick format, the quick restore operation was rejected.
2093	The volume specified as a P-VOL was a TrueCopy S-VOL. Because the status of the TrueCopy pair was not Suspend, the Split operation was rejected.
2094	The volume specified as a P-VOL was a TrueCopy S-VOL. Because the consistency time of the consistency group is not equal to the consistency time of the TrueCopy pair, the Split operation was rejected.

SSB2 code	Description
2097	The quick restore operation was rejected because of one of the following: • The P-VOL was also a Dynamic Provisioning V-VOL, but the S-VOL was a normal volume. • The P-VOL was a normal volume, but the S-VOL also a Dynamic Provisioning V-VOL.
209b	Because the emulation type of only one of volumes in the pair was OPEN-0V, the quick restore operation was rejected.
209c	Because the updated information about system configuration was being backed up, the quick restore operation on the volume was rejected.
209e	Because the volume specified as the P-VOL was a Mainframe Fibre Data Migration volume, the pair operation was rejected.
20a0	The specified pairs contain the TrueCopy asynchronous volumes. Because the CLPRs of the P-VOL and S-VOL of the specified pair were different, the quick restore operation was rejected.
20a2	Because the P-VOL was a Dynamic Provisioning or Dynamic Tiering V-VOL whose capacity was increasing, the create pair operation was rejected.
20a3	Because the S-VOL was a Dynamic Provisioning or Dynamic Tiering V-VOL whose capacity was increasing, the create pair operation was rejected.
20a9	Because the specified consistency group number was being used by Copy-on-Write Snapshot, the pair operation was rejected.
20aa	Because the volume specified as the P-VOL was a Dynamic Provisioning or Dynamic Tiering V-VOL and its zero data area was being discarded, the pair operation was rejected.
20ab	Because the volume specified as the S-VOL was a Dynamic Provisioning or Dynamic Tiering V-VOL and its zero data area was being discarded, the pair operation was rejected.
20b0	Because the volume specified as the P-VOL was a Dynamic Provisioning or Dynamic Tiering V-VOL and its capacity was increasing, the pair operation was rejected.
20b1	Because the volume specified as the S-VOL was a Dynamic Provisioning or Dynamic Tiering V-VOL and its capacity was increasing, the pair operation was rejected.
20b4	Because the volume specified as the P-VOL was a Dynamic Provisioning or Dynamic Tiering V-VOL, which was not associated with a pool, the pair operation was rejected.
20b5	Because the volume specified as the S-VOL was a Dynamic Provisioning or Dynamic Tiering V-VOL, which was not associated with a pool, the pair operation was rejected.
20b7	Because no LU path was defined to the volume specified as P-VOL, the pair operation was rejected.
20b8	Because no LU path was defined to the volume specified as S-VOL, the pair operation was rejected.
22f6	Because the volume specified as the P-VOL was a Compatible FlashCopy Version 2 S-VOL, the pair operation was rejected.
22f7	Because the volume specified as the S-VOL was a Compatible FlashCopy Version 2 P-VOL or S-VOL, the pair operation was rejected.

SSB2 code	Description
22f9	Because the volume specified as the S-VOL was a Compatible FlashCopy Version 2 P-VOL or S-VOL, the quick restore or the reverse copy operation was rejected.
2301	The pair operation was rejected because shared memory is not allocated or ShadowImage is not installed.
2302	Because the volume specified as the P-VOL or S-VOL was not the top volume of the LUSE volume, the pair operation was rejected.
2306	Because the LBA size of the specified P-VOL was not the same as the size of the specified S-VOL, the pair operation was rejected.
2309	Because the number of pairs exceeded the maximum number of pairs, the pair creation was rejected.
230A	Because the volume specified as the S-VOL was the P-VOL of the ShadowImage pair whose MU number is 0, the pair creation was rejected.
230B	Because the pair was being suspended or deleted, the pair operation was rejected.
2310	The pair operation was rejected due to one of the following causes. • Because the specified consistency group number had already been used for L1 pair, the pair creation was rejected • Because the specified consistency group number had already been used for L2 pair, the pair creation was rejected. • Because the volume specified as the P-VOL was the S-VOL of the pair which was being split by quick split, the pair creation was rejected. • Because the VLL setting of the P-VOL was different from that of the S-VOL, the quick restore operation was rejected. • Because the specified P-VOL and S-VOL were a FlashCopy pair, the pair operation was rejected. • Because the pair status of the specified P-VOL and S-VOL was PSUE, the quick restore operation or the reverse copy operation was rejected. • Because the specified P-VOL and the S-VOL was the L2 pair, the quick restore operation or the reverse copy operation was rejected. • The At-Time Split operation on a consistency group was rejected because some of the pairs in the consistency group were being resynchronized, split, or were already suspended. • Because the pair status of the P-VOL, the S-VOL, or both showed that the pair could not receive the issued command, the pair operation was rejected.
2312	Because the volume specified as the S-VOL was online to the host, the pair operation was rejected.
2314	Because the volume specified as the S-VOL was the S-VOL of another pair whose pair status was PSUS, the pair creation was rejected.
231F	Because the P-VOL of the specified pair was online to the host, the quick restore operation or the reverse copy operation was rejected.
2322	Because the necessary shared memory was not installed, or initialization was not completed, the pair operation was rejected.
2324	Because the number of slots of the volume specified as the P-VOL exceeded the upper limit, the pair operation was rejected.
2325	Because the number of slots of the volume specified as the S-VOL exceeded the upper limit, the pair operation was rejected.

SSB2 code	Description
2326	Because the volume specified as the P-VOL had already had three S-VOLs, the pair creation was rejected.
2327	Because the node volume specified as the P-VOL had already had two S-VOLs, the pair creation was rejected.
2328	Because the pair configuration exceeded the number of the layers of the cascade configuration, the pair operation was rejected.
2329	Because the volume specified as the S-VOL was the S-VOL of an existing pair, the pair operation was rejected.
232a	Because pairs that would exceed the license capacity were going to be created, the create pair operation was rejected.
232F	Because the volume specified as the P-VOL was allocated as the destination of the Volume Migration, the pair operation was rejected.
2331	The pair operation was rejected due to one of the following causes. • The volume specified as the P-VOL was a reserved volume. • The volume specified as the P-VOL was the source volume for Volume Migration. • The capacity of the specified P-VOL and the S-VOL was not the same.
2332	Because the volume specified as the P-VOL had already had three S-VOLs, the pair creation was rejected.
2333	Because the volume specified as the P-VOL was not the P-VOL of the existing pair, the pair operation was rejected.
2334	The pair operation was rejected due to one of the following causes. • Because the volume specified as the P-VOL had the emulation type that could not be handled by CCI, the pair operation was rejected. • Because the volume specified as the P-VOL was an intermediate volume, the At-Time Split operation was rejected.
2335	Because the volume specified as the S-VOL had the emulation type that could not be handled by CCI, the pair operation was rejected.
2336	Because the emulation type of the specified P-VOL was different from the emulation type of the S-VOL, the pair operation was rejected.
2337	The pair operation was rejected due to one of the following causes. • Because the volume specified as the P-VOL was an intermediate volume, the pair operation for the cascade configuration was rejected. • The pair operation was rejected because the specified P-VOL and S-VOL were LUSE volumes but the number of volumes composing the P-VOL did not match the number of volumes composing the S-VOL.
233A	Because the volume specified as the P-VOL was not a ShadowImage P-VOL, the pairresync was rejected.
233B	Because the volume specified as the S-VOL was a root volume, the pair operation was rejected.
233C	Because the volume specified as the S-VOL was a node volume, and the volume specified as the P-VOL was not the P-VOL for the specified S-VOL, the pair operation was rejected.
233D	Because the specified P-VOL and S-VOL were a L2 pair, and the L1 pair status was not PSUS, the pairsplit was rejected.
233E	Because the volume specified as the P-VOL was used as the TrueCopy P-VOL, the pair operation was rejected.

SSB2 code	Description
233F	Because the volume specified as the S-VOL was the TrueCopy P-VOL, and the pair status was not PSUS or PSUE, the pair operation was rejected.
2342	Because the volume specified as the S-VOL was the destination of the Volume Migration, the pair operation was rejected.
2343	Because the volume specified as the S-VOL had already been an S-VOL, the pair creation was rejected.
2344	Because the volume specified as the S-VOL for ShadowImage pair operations was not an S-VOL, the pair operation was rejected.
2346	The volume specified as an S-VOL was a TrueCopy P-VOL. Because the status of the TrueCopy pair was invalid, the pair operation was rejected.
2347	The volume specified as an S-VOL was a TrueCopy S-VOL. Because the status of the TrueCopy pair was invalid, the pair operation was rejected.
234a	Because the volume specified as the S-VOL was an intermediate volume, the pair creation for the cascade configuration was rejected.
234b	Because the volume specified as the S-VOL was the source volume of the Volume Migration, the pair operation was rejected.
2350	Because the specified P-VOL and the S-VOL for ShadowImage pair operations was not a pair, the pair operation was rejected.
2351	Because the volume specified as the P-VOL and the volume specified as the S-VOL was the same one, the pair operation was rejected.
2352	Because the specified P-VOL and S-VOL was online to the host, the quick restore operation or the reverse copy operation was rejected.
2353	Because the specified P-VOL and S-VOL was being split by using quick split, the pair deletion was rejected.
2354	Because the P-VOL and S-VOL was being split by using steady split, the pairresync operation was rejected.
2357	The pair creation was rejected because the volume specified as the S-VOL was the P-VOL of the splitting pair, or the P-VOL of the pair where the reverse copy operation or quick restore operation is being performed.
2358	Because the volume specified as the S-VOL was the P-VOL of the splitting pair, the pairresync operation was rejected.
235b	The volume specified as a P-VOL was a TrueCopy P-VOL. Because the status of the TrueCopy pair was not Suspend, the reverse copy or the quick restore operation was rejected.
235c	The volume specified as a P-VOL was a TrueCopy S-VOL. Because the status of the TrueCopy pair was not Suspend, the reverse copy or the quick restore operation was rejected.
235d	The volume specified as an S-VOL was a TrueCopy P-VOL. Because the status of the TrueCopy pair was not Suspend, the reverse copy or the quick restore operation was rejected.
236C	Because the volume specified as the P-VOL has S-VOL Disable attribute assigned by the Data Retention Utility, the quick restore operation or the reverse copy operation was rejected.
236D	Because the volume specified as the S-VOL has S-VOL Disable attribute assigned by the Data Retention Utility, the pair operation was rejected.
2370	Because the volume specified as the P-VOL was not mounted, the pair operation was rejected.

SSB2 code	Description
2371	Because the volume specified as the P-VOL was blocked or a system disk, the pair operation was rejected.
2372	Because the volume specified as the P-VOL was being formatted, the pair operation was rejected.
2373	Because the volume specified as the P-VOL was a command device, the pair operation was rejected.
2380	The operation was rejected for one of the following reasons: • Because the volume specified as the S-VOL was not mounted, the pair operation was rejected. • Because the MU number was 3 or more, the pair operation was rejected.
2381	Because the volume specified as the S-VOL was blocked or a system disk, the pair operation was rejected.
2382	Because the volume specified as the S-VOL was being formatted, the pair operation was rejected.
2383	Because the volume specified as the S-VOL was a command device, the pair operation was rejected.
2385	Because the volume specified as the P-VOL was a reserved volume for Volume Migration, the pair operation was rejected.
2386	Because the volume specified as the S-VOL was a reserved volume for Volume Migration, the pair operation was rejected.
2387	Because the volume specified as the P-VOL was the source volume for Volume Migration, the pair creation was rejected.
2394	Because the number of the pairs in a consistency group exceeded the definable maximum number of pairs, the registering of the pair in the consistency group was rejected.
2395	Because the pair sharing the specified P-VOL as the P-VOL was undergoing the reverse copy operation or the quick restore operation, the pair operation was rejected.
2396	Because the L1 pair sharing the specified P-VOL as the root volume was undergoing the reverse copy operation or the quick restore operation, the pair operation was rejected.
2397	Because the L2 pair sharing the specified P-VOL or S-VOL as the node volume was undergoing the reverse copy operation or the quick restore operation, the pair operation was rejected.
2398	Because the status of the specified pair was not PSUS or PSUE, the quick restore operation or the reverse copy operation was rejected.
2399	Because some of the pairs sharing the specified P-VOL as the P-VOL were not in PSUS or PSUE status, the quick restore operation or the reverse copy operation was rejected.
23A8	Because the volume specified as the P-VOL was specified as the P-VOL for XRC, the quick restore operation or the reverse copy operation was rejected.
23A9	Because the volume specified as the P-VOL was specified as the P-VOL for CC, the quick restore operation or the reverse copy operation was rejected.
23AA	Because the volume specified as the S-VOL was specified as the P-VOL for XRC, the pair operation was rejected.

SSB2 code	Description
23AB	Because the volume specified as the S-VOL was specified as the P-VOL for CC, the pair operation was rejected.
23AF	Because the specified consistency group number was being used by ShadowImage for z/OS, registering the pair in the consistency group was rejected.
23BB	Because the volume specified as the S-VOL could not be used as the S-VOL because of Volume Security settings, pair creation was rejected.
B911	The pair operation was rejected because the specified volume did not exist.
B912	The pair operation was rejected because the S-VOL specified at the pair operation did not exist.
B913	The pair operation was rejected because the mirror ID was invalid.

Troubleshooting the At-Time Split operation

If the At-Time Split function fails, the following problems will occur:

- When the pairsplit operation ends abnormally, the pairs in the consistency group are suspended (status = PSUE).
- When the host server is down or has failed, a consistency group with no ShadowImage pairs may be defined. If you execute the paircreate command with the At-Time Split option under such a condition, the paircreate command might be rejected.

In this case, proceed as follows:

1. Locate a consistency group number that is not used by any pairs on the Pair Operation window by sorting the CTG column.
2. Specify that consistency group number explicitly, and execute the paircreate command with the At-Time Split option using CCI on the host server.

When using a Universal Replicator S-VOL as a ShadowImage P-VOL, if the status of some pairs belonging to a consistency group cannot be changed, the CCI Pairsplit command can end abnormally with the error code EX_EWSTOT. This error indicates that a timeout has occurred. Probable reasons why the pair status cannot be changed are the following:

- The Universal Replicator pair belongs to a consistency group. The P-VOL and the S-VOL of this pair have the same contents. The journal volumes for this pair are full.
- The ShadowImage license is invalid.
- Volumes of the ShadowImage pair are blocked.
- The ShadowImage pair is in a status where the Pairsplit operation is unavailable. See Monitoring pair activity, status on page 6-2.
- The ShadowImage pair is a part of cascaded pairs. The other pairs in the cascaded pairs are in a status where the Pairsplit operation is unavailable. See Operations permitted for L1, L2 pairs on page 6-3.

- A volume in the ShadowImage pair is used as a TrueCopy or Universal Replicator volume. The TrueCopy or Universal Replicator pair is in a status where the Pairsplit operation is unavailable.

After these factors are removed, perform the pairresync operation, and execute the Pairsplit command.

ShadowImage GUI reference

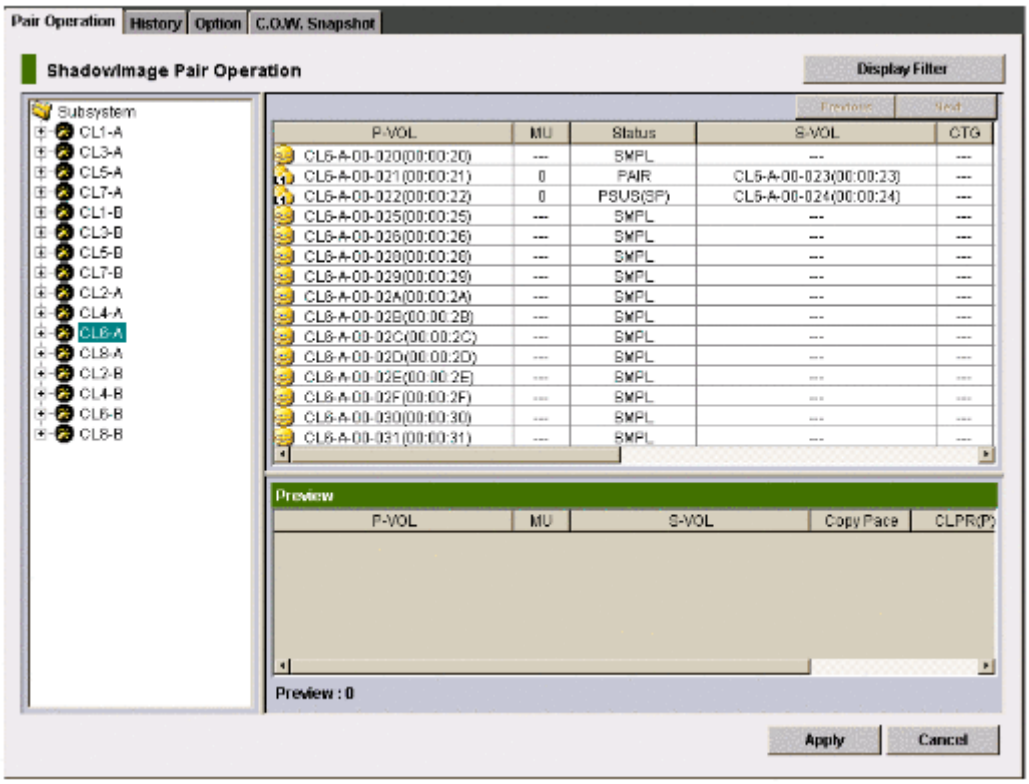
This topic describes the ShadowImage windows and dialog boxes in Storage Navigator.

- Pair Operation Window
- History Window
- Option Window

Pair Operation Window

The Pair Operation window displays ShadowImage volume and pair information for volumes associated with the selected port. From this window you can perform all ShadowImage operations.

Note: The Pair Operation window displays information about both ShadowImage and Copy-on-Write Snapshot pairs. This topic only explains the items related to the ShadowImage pairs. For details about the items related to the Copy-on-Write Snapshot pairs, see the *Hitachi Copy-on-Write Snapshot User Guide*.



P-VOLs and S-VOLs listed in Storage Navigator may end in special symbols. An LDEV number that ends with a pound or gate symbol (#) indicates an external volume (for example, 00:00:01#). An LDEV number that ends with a letter "X" indicates that a virtual volume used by Dynamic Provisioning (for example, 00:00:01X).

Main Components

Descriptions for the tree, volume list, and other panes are provided as follows:

Table A-1 Menu Commands

Field	Description
Tree	Located on the left side of the Pair Operation window. Allows you to select the desired port and host group. You can filter the volumes or volume pairs displayed in the Volume List on the upper right side of the Pair Operation window, by selecting a port or host group. No volume displays when you select Subsystem on the top of the Tree.
Volume list	Located on the right side of the Pair Operation window. Displays all available volumes. For details, See Volume List on page A-4.
Icons	Displays all available volumes and is on the upper right of the Pair Operation window. For details, See Volume List.  L1 pair  L2 pair  S-VOL  Reserved volume. In Preview list, this is a preview item.  Error. Displays in Preview list.  Port. Displays in Tree.  Host group. Displays in Tree.  SMPL volume. This icon indicates a volume in SMPL status when displayed in the Volume List.  Root. Displays in Tree.
Display Filter button	When clicked, the Display Filter dialog box appears. In it, you can filter the fields and volume types in the Volume List.
Previous list	Allows you to return to the previous page of the Volume List. Grayed out if the total number of volumes defined in the storage system is less than 1,024 volumes (maximum number of volumes that can be displayed on one page).
Next	Allows you to turn to the next page of the Volume List. Grayed out if the total number of volumes defined in the storage system is less than 1,024 volumes (maximum number of volumes that can be displayed on one page).
Preview list	Displays changes specified from the Pair Operation window, but are not yet applied to the storage system.
Apply	Applies changes shown in the in the Preview List to the storage system. If an error occurs during an operation, the failed operation will remain in the Preview List with an error icon ( ) displayed on the left of the operation name. For the entire list of ShadowImage error codes, see the *Hitachi Storage Navigator Messages*.
Cancel	Cancels the changes shown in the Preview List.

Volume List

The Volume List shows the installed volumes on the selected port, with system and pair information for each volume.

You can filter the information in the list to show what you want, including the types of volumes that display. See Display Filter dialog box on page A-6 for information.

The maximum number of volumes on one screen is 1,024. If you have more than this to view, use the Next button above the list.

Field descriptions on the volume list are the following:

Table A-2 Volume list

Field	Description
Message	A message displays when there is no volume or pair to display. If you see the message in the Volume List, click a different icon in the Tree on the left area of the Pair Operation window.
P-VOL	P-VOL information displays in AAA-BB-CCC(XX:YY:ZZ) format. • AAA is the port ID (cluster and channel number) • BB is the group number of host group • CCC is the LU number • XX:YY:ZZ is the LDKC number:CU number:LDEV number
MU	The MU number of the ShadowImage pair formed with the P-VOL. MU#s are mirror unit numbers. The storage system assumes the same numbers of P-VOLs as S-VOLs. For example, when a P-VOL is paired with three S-VOLs, though just one P-VOL exists, the system assumes that there are three P-VOLs. These "virtual" P-VOLs are mirror units, MUs.
Status	Pair status is displayed.
S-VOL	S-VOL information displays in AAA-BB-CCC(XX:YY:ZZ) format. • AAA is the port ID (cluster and channel number) • BB is the group number of host group • CCC is the LU number • XX:YY:ZZ is the LDKC number:CU number:LDEV number Only one path is listed, even for LUs with more than one. The path is connected to the first port configured for the path.
CTG	The S-VOL's consistency group number. If no consistency group is set for the S-VOL, dashes (---) display.
SvolMode	SvolMode. Indicates whether the S-VOL can be written to and/or read, or not. • W indicates S-VOL Write. S-VOL pair status is PSUS(SP) or PSUS, and the host writes to the S-VOL. • N indicates Hlde Mode: The S-VOL cannot be read in this mode. If both S-VOL-write and Hlde modes are on, W displays. If both modes are off, a dash (-) displays.

Field	Description
Copy Pace	Indicates the speed that data is copied according to the pair status. • Slower, Medium, or Faster displays if the pair status is COPY(PD), COPY(SP), PSUS(SP), COPY(RS), or COPY(RS-R). • Dashes (----) display if the pair status is none of the above. Note: When you create ShadowImage pairs by using Command Control Interface, the copy pace is set as follows. • When the track size is 1 or 2, Slower is set. • When the track size is 3, Medium is set. • When the track size is 4 to 15, Faster is set.
Sync	Indicates the percentage of pair synchronization, if applicable, according to the following pair statuses. • For SMPL, PSUE, and SMPL(PD), dashes (----) display. • For COPY(PD), COPY(SP), and PSUS(SP), the percentage of copied data displays. • For PAIR, PSUS, COPY(RS), and COPY(RS-R), the percentage of identical data in the P-VOL and S-VOL displays.
Emulation	The volume's emulation type.
Capacity (MB)	The volume's storage capacity displays in megabytes.
CLPR (P)	The P-VOL's cache logical partition displays.
CLPR (S)	The S-VOL's cache logical partition displays.

Preview List

The Preview List shows the operations and changes you have made from the Pair Operation window. You can review your changes, modify the operation or your changes, and apply them to the storage system.

The Preview List displays below the Volume List.

To modify an operation or change, right-click the row and select **Delete** or **Modify**. To see error messages, click **Error**.

Field descriptions on the Preview list are the following.

Table A-3 Preview list

Field	Description
P-VOL	P-VOL information displays in AAA-BB-CCC(XX:YY:ZZ) format. • AAA is the port ID (cluster and channel number) • BB is the group number of host group • CCC is the LU number • XX:YY:ZZ is the LDKC number:CU number:LDEV number
MU	The MU number of the ShadowImage pair formed with the P-VOL.
S-VOL	S-VOL information displays in AAA-BB-CCC(XX:YY:ZZ) format. • AAA is the port ID (cluster and channel number) • BB is the group number of host group • CCC is the LU number • XX:YY:ZZ is the LDKC number:CU number:LDEV number
Copy Pace	Indicates the speed that data is copied according to the pair status.
CLPR (P)	The P-VOL's cache logical partition displays.

Field	Description
CLPR (S)	The S-VOL's cache logical partition displays.
Error Code	If you click Apply and then the operations in the Preview list fail, an error code indicates the cause of the error.

Data in the status bar below the Preview List indicate the number of changes, the type of change (the operation), and any command options.

Pair Operations command menu

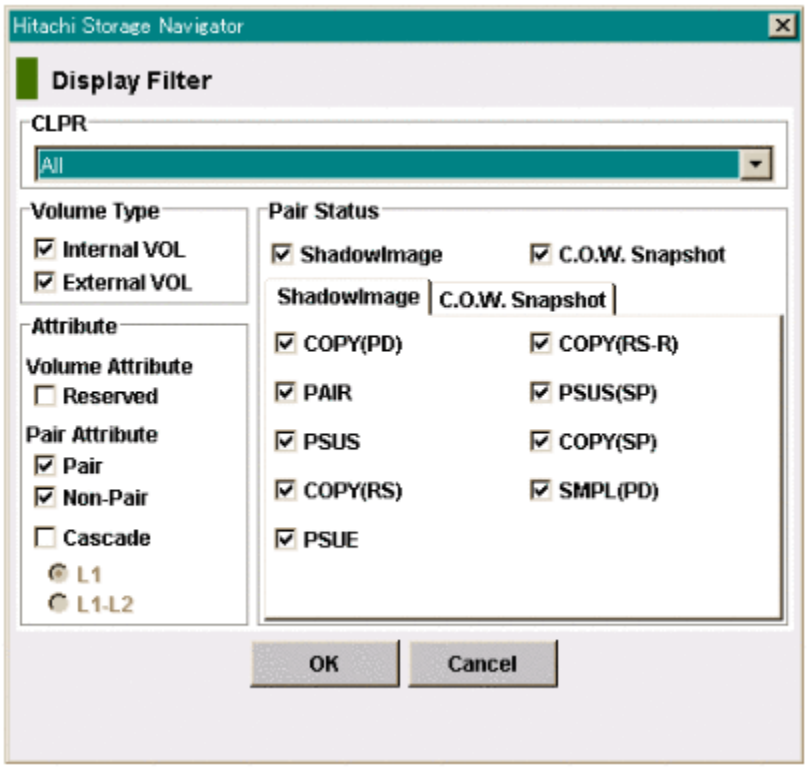
When you right-click a volume or pair, a menu displays. The following table describes the commands that display.

Table A-4 Menu Commands

Command	Description
Detail	Opens the Detail dialog box, which displays detailed information for the selected volume or pair.
Paircreate	Opens the Paircreate dialog box, in which you create new pairs.
Pairsplit	Opens the Pairsplit dialog box, in which you split pairs.
Pairresync	Opens the Pairresync dialog box, in which you resynchronize pairs.
Pairsplit-E	Opens the Pairsplit-E dialog box, in which you suspend pairs.
Pairsplit-S	Opens the Pairsplit-S dialog box, in which you delete pairs.
Change Reserve	Opens the Set/Reset Reserve Attribute dialog box, in which you set/reset the S-VOL reserve attribute.
S-VOL Path	Opens the S-VOL Path dialog box, which displays the S-VOL's port or host group.
Information	Opens the Information dialog box, which displays the number of pairs or reserved volumes.

Display Filter dialog box

With the Display Filter dialog box, you filter the volumes that display in the Volume List on the Pair Operations window. Click the **Display Filter** button in the Pair Operation window to see the dialog box.



The filter settings you select are effective in the current session only. They reset when you select another software product to display.

Table A-5 Display Filter dialog box

Field	Description
CLPR	Field where the cache logical partition (CLPR) is specified.
Volume Type	Field where internal or external volumes are specified. Both boxes are checked by default. Un-check the box you do not want.
Attribute	• Volume Attribute. If you select the Reserved check box, only reserved volumes display. Reserved volumes include volumes specified as S-VOLs. • Pair Attribute. You can select pair volumes, non-pair volumes, or cascade levels (L1 or L2).
Pair Status	Select the statuses of the pairs you want to see.

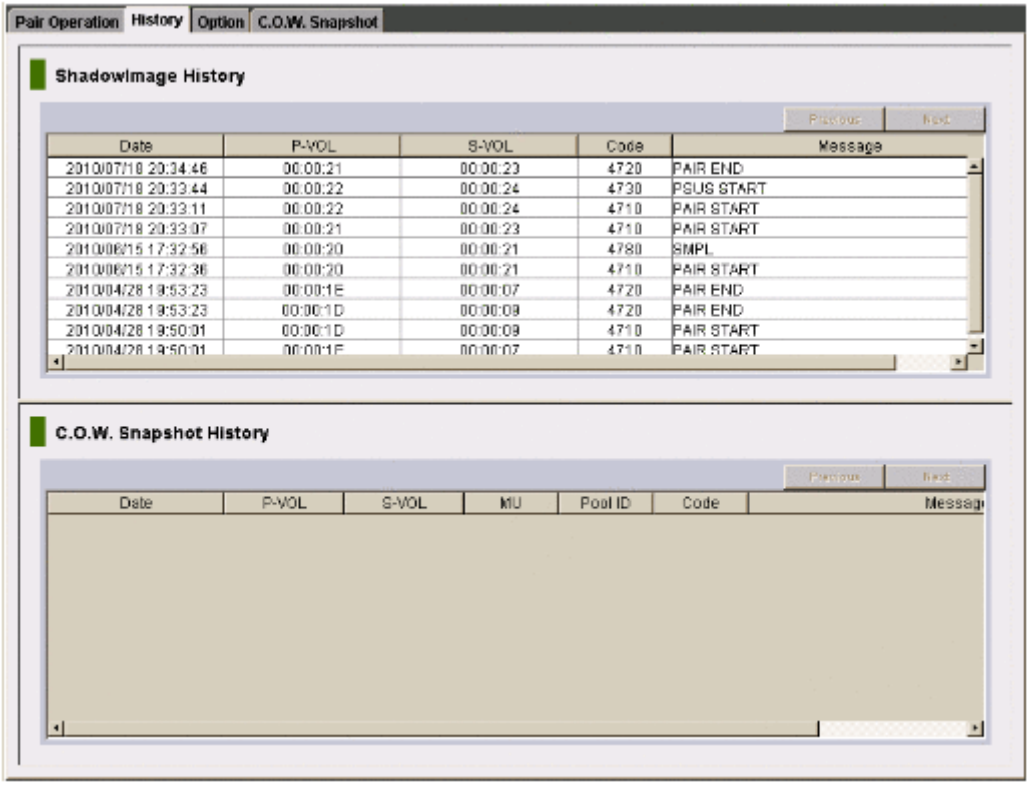
Note: If you select **Cascade**, you cannot select **Reserved**. If you select **L1-L2**, you cannot select any other check boxes.

If the check box of **ShadowImage** or **Copy-on-Write Snapshot** is not selected, all the check boxes in each tab will be grayed out.

History Window

The History window shows the history of operations performed on ShadowImage and Copy-on-Write Snapshot pairs and data associated with the operations.

- The upper pane shows ShadowImage history.
- The lower pane shows Copy-on-Write Snapshot history.



You can change the display order by clicking a column title. The list sorts based on the clicked column. Clicking a second time changes the order (ascending or descending.

Fields in the ShadowImage pane are described as follows:

Table A-6 History window

Field	Description
Date	Date and time of the operation.
P-VOL	The LDKC:CU:LDEV of the P-VOL used in the operation.
S-VOL	The LDKC:CU:LDEV of the S-VOL used in the operation.
Code	Displays ShadowImage reference codes. The codes refer to the messages shown in the following table.
Message	The description of the operation or part of an operation.

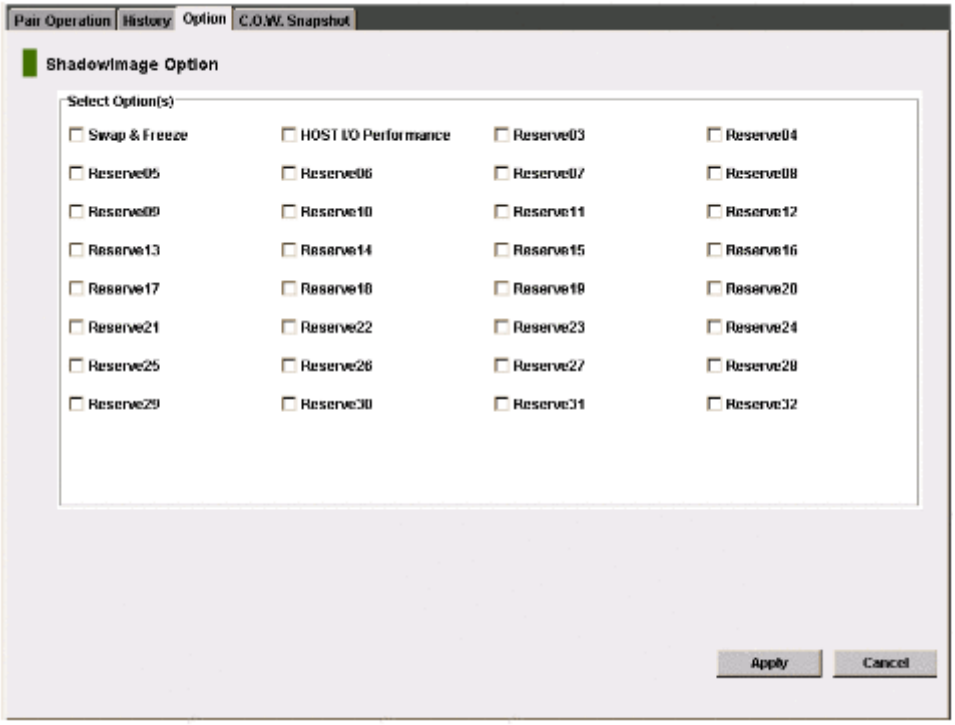
Table A-7 Reference Codes

Code	Message	Description
4710	PAIR START	The initial copy started.
4720	PAIR END	The initial copy ended, and the pair status changed to PAIR.
4730	PSUS START	The pair split started.

Code	Message	Description
4740	PSUS END	The pair split ended, and the pair status changed to PSUS.
4750	COPY(RS) START COPY(RS-R) START	Resynchronization of pairs started.
4760	COPY(RS) END COPY(RS-R) END	Resynchronization of pairs ended, and the pair status changed to PAIR.
4780	SMPL	The pair was deleted, and the pair status changed to SMPL.
4790	PSUE	The pair was suspended, and the pair status changed to PSUE.
47D0	COPY ABNORMAL END	A copy ended abnormally (reason other than above).
47E9	INITIALIZE START	Initialization started.
47EA	INITIALIZE END	Initialization ended normally.
47EB	INITIALIZE ENDED ABNORMAL	Initialization ended abnormally.

Option Window

You set the Swap&Freeze and the HOST I/O Performance options on the Option Window. For information on these options see System options on page 2-10.



- Click the check box to enable the option.
- Clear the check box to disable the option.
- Click **Apply** to commit the option to the system, otherwise click **Cancel**.

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

Operation that allows multiple pairsplit operations to be performed at a pre-determined time.

audit log

Files that store a history of the operations performed from Storage Navigator 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 ShadowImage 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 that allows a primary volume (P-VOL) to 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 Storage Navigator 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 (CCI) 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 group 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 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 journal groups in which data consistency is guaranteed. When performing copy operations between multiple primary and secondary systems, the journal groups 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 system(s).

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 an application and allows it to be used.

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 z/OS 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 z/OS 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 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 journal groups is called a "mirror". Each pair is assigned a mirror ID when it is created. The mirror ID identifies individual pair relationships between journal groups.

M-JNL

main journal

modify mode

The mode of operation of Storage Navigator that allows changes to the storage system configuration. 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 Hitachi Storage Navigator.

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 (P-VOL)

The volume in a copy pair that contains the original data to be replicated. The data on the P-VOL is duplicated synchronously or asynchronously on the secondary volume(s) (S-VOL).

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

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

P-site

primary site

P-VOL

See *primary volume (P-VOL)*.

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. This allows system configuration (such as defining a path or creating a TrueCopy pair) before the formatting is completed. To execute quick formatting, 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, which allows the user data to be accessed 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 Storage Navigator 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 z/OS, 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 (S-VOL)

The volume in a copy pair that is the copy of the original data on the primary volume (P-VOL). The following Hitachi products use the term "secondary volume": ShadowImage, TrueCopy, Universal Replicator, Universal Replicator for Mainframe, and High Availability Manager.

See also *primary volume (P-VOL)*.

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 Storage Navigator.

service processor (SVP)

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

severity level

Applies to service information messages (SIMs) and Storage Navigator 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; Storage Navigator

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 that is duplicated on the target volume (T-VOL). The following Hitachi products use the

term source volume: 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 ID. SSIDs are used for reporting information from the CU to the mainframe operating system. Each group of 64 or 256 volumes requires one SSID, so there are one or four SSIDs per CU image. The user-specified SSIDs are assigned during storage system installation and must be unique to all connected host operating environments.

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 (S-VOL)* or *source volume (S-VOL)*.

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 of the original data on the source volume (S-VOL). The following Hitachi products use the term T-VOL: ShadowImage for Mainframe, Dataset Replication, IBM FlashCopy.

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 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 Storage Navigator that allows viewing only of the storage system configuration. The two Storage Navigator modes are view mode and modify mode.

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.

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