



Hitachi Universal Storage Platform V Hitachi Universal Storage Platform VM

Hitachi ShadowImage™ User's Guide

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Preface

This document describes and provides instructions for performing Hitachi ShadowImage operations on the Hitachi Universal Storage Platform V and Hitachi Universal Storage Platform VM (USP V/VM) storage systems.

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](#)
- [Product Version](#)
- [Document Revision Level](#)
- [Source Document\(s\) for this Revision](#)
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Intended Audience

This document is intended for system administrators, Hitachi Data Systems representatives, and Authorized Service Providers who are involved in installing, configuring, and operating the Hitachi Universal Storage Platform V and VM storage systems.

This document assumes the following:

- The user has a background in data processing and understands RAID storage systems and their basic functions.
- The user is familiar with the Universal Storage Platform V and/or VM storage system and has read the *Universal Storage Platform V/VM User and Reference Guide*.
- The user is familiar with the Storage Navigator software for the Universal Storage Platform V/VM and has read the *Storage Navigator User's Guide*.

Product Version

This document revision applies to USP V/VM microcode 60-08-0x.

Document Revision Level

Revision	Date	Description
MK-96RD618-P	February 2007	Preliminary Release
MK-96RD618-00	April 2007	Initial Release, supersedes and replaces MK-96RD618-P
MK-96RD618-01	May 2007	Revision 1, supersedes and replaces MK-96RD618-00
MK-96RD618-02	September 2007	Revision 2, supersedes and replaces MK-96RD618-01
MK-96RD618-03	November 2007	Revision 3, supersedes and replaces MK-96RD618-02
MK-96RD618-04	January 2008	Revision 4, supersedes and replaces MK-96RD618-03
MK-96RD618-05	March 2008	Revision 5, supersedes and replaces MK-96RD618-04
MK-96RD618-06	May 2008	Revision 6, supersedes and replaces MK-96RD618-05
MK-96RD618-07	August 2008	Revision 7, supersedes and replaces MK-96RD618-06
MK-96RD618-08	November 2008	Revision 8, supersedes and replaces MK-96RD618-07
MK-96RD618-09	June 2009	Revision 9, supersedes and replaces MK-96RD618-08
MK-96RD618-10	November 2009	Revision 10, supersedes and replaces MK-96RD618-09
MK-96RD618-11	February 2010	Revision 11, supersedes and replaces MK-96RD618-10
MK-96RD618-12	July 2010	Revision 12, supersedes and replaces MK-96RD618-11
MK-96RD618-13	December 2010	Revision 13, supersedes and replaces MK-96RD618-12
MK-96RD618-14	April 2011	Revision 14, supersedes and replaces MK-96RD618-13

Source Document(s) for this Revision

- MK-96RD618-14c-HDS

Changes in this Revision

- Added information about triggers for the change of pair status to PSUS ([Split Pair Operation](#)).
- Updated information about creating pairs and splitting pairs ([Performing Pair Creation and Pair Splitting](#)).
- Added information about system option modes (SOMs) and the SOMs for ShadowImage (new section [System Option Modes](#)).

Document Organization

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

Chapter	Description
Overview of ShadowImage	Provides an overview of the Hitachi ShadowImage software for the Hitachi Universal Storage Platform V and Hitachi Universal Storage Platform VM storage system.
About ShadowImage Operations	Describes ShadowImage operations.
Interoperability with Other Products and Functions	Describes ShadowImage support for concurrent operations with other data management functions.
Preparing for ShadowImage Operations	Describes requirements for using ShadowImage, installation procedure of ShadowImage, and calculation of the number of pairs that ShadowImage can create. Please read this chapter before you starts the ShadowImage operation.
Using the ShadowImage GUI	Describes the use of the ShadowImage graphical user interface. Please read this chapter before you start operations using ShadowImage.
Performing ShadowImage Operations	Provides instructions for performing ShadowImage operations using the ShadowImage software on Storage Navigator.
Troubleshooting	Provides troubleshooting information for ShadowImage and instructions for calling technical support.
Acronyms and Abbreviations	Defines the acronyms and abbreviations used in this document.
Index	Lists the topics in this document in alphabetical order.

Referenced Documents

Hitachi Universal Storage Platform V/VM:

- *Command Control Interface (CCI) User and Reference Guide*, MK-90RD011
- *LUN Manager User's Guide*, MK-96RD615
- *User and Reference Guide*, MK-96RD635
- *Storage Navigator User's Guide*, MK-96RD621
- *Universal Volume Manager User's Guide*, MK-94RD626
- *Copy-on-Write Snapshot User's Guide*, MK-95RD277
- *ShadowImage for z/OS User's Guide*, MK-96RD619
- *Compatible Mirroring for IBM FlashCopy User's Guide*, MK-94RD245
- *Cache Residency Manager User's Guide*, MK-96RD609
- *LUN Expansion User's Guide*, MK-96RD616
- *Dynamic Provisioning User's Guide*, MK-96RD641





Document Conventions

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

This document uses the following 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 .
<i>Italic</i>	Indicates a variable, which is a placeholder for actual text provided by the user or system. Example: copy <i>source-file target-file</i> 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.
{ } 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: [<u>a</u> b]

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

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

Convention for Storage Capacity Values

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

- 1 KB = 1,000 bytes
- 1 MB = 1,000² bytes
- 1 GB = 1,000³ bytes
- 1 TB = 1,000⁴ bytes
- 1 PB = 1,000⁵ bytes

Logical storage capacity values (for example, logical device capacity) are calculated based on the following values:

- 1 KB = 1,024 (2¹⁰) bytes
- 1 MB = 1,024 KB or 1,024² bytes
- 1 GB = 1,024 MB or 1,024³ bytes
- 1 TB = 1,024 GB or 1,024⁴ bytes
- 1 PB = 1,024 TB or 1,024⁵ bytes
- 1 block = 512 bytes

Getting Help

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

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

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

Comments

Please send us your comments on this document: doc.comments@hds.com. Include the document title, number, and revision, and refer to specific section(s) and paragraph(s) whenever possible.

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

Overview of ShadowImage™

This chapter provides an overview of the Hitachi ShadowImage software for the Hitachi Universal Storage Platform V and Hitachi Universal Storage Platform VM (herein after referred to as USP V/VM) storage system:

- [Hitachi ShadowImage](#)
- [Business Benefits](#)
- [Feature Highlights](#)

Hitachi ShadowImage

Hitachi Data Systems provides innovative, storage-based technology solutions for enabling continuous business operations. By partnering with customers to understand key business challenges and requirements, Hitachi Data Systems is able to deliver robust, application-focused storage solutions that enhance operational efficiency and resilience.

An essential component of business continuity and risk mitigation strategies and optimized IT operations is the ability to replicate data quickly for critical application processing, testing and development of new applications, zero-downtime recovery, data migration, and necessary backup operations. The high-speed non-disruptive local mirroring technology of Hitachi ShadowImage In-System Replication software rapidly creates multiple copies of mission-critical information within Hitachi storage systems in mainframe and open-systems environments. ShadowImage keeps data RAID-protected and fully recoverable without affecting service or performance levels. Replicated data volumes can be split from the host applications and used for system backups, application testing, and data mining applications while business continues to run at full capacity.

ShadowImage provides heterogeneous replication between any storage systems within a virtualized storage pool managed by USP V/VM. Data that resides on an externally attached storage system can be moved from the source to a target data volume anywhere in the storage pool, including to another externally attached system. Using ShadowImage, you can migrate data volumes from one platform to another through USP V/VM and maximize the use of your storage infrastructure. By providing nondisruptive, high-speed data replication within any Hitachi storage system or within the virtualized storage pool, Hitachi ShadowImage software enables immediate use of data in decision support, software testing and development, and data protection operations.

This document describes and provides instructions for performing ShadowImage operations on USP V/VM using the Hitachi ShadowImage software on Storage Navigator. The licensed ShadowImage software displays the ShadowImage information and allows you to perform ShadowImage operations. For further information on Storage Navigator, see the *Storage Navigator User's Guide* (MK-96RD621).

Hitachi ShadowImage operations can also be performed from the open-systems host using the Hitachi Command Control Interface (CCI) software. For information and instructions on using CCI to perform ShadowImage operations, see the *Hitachi Command Control Interface (CCI) User and Reference Guide* (MK-90RD011).

If you use the BEDs 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.

Business Benefits

Ensure Business Continuity

- Shortens restart and recovery times with the consistency-group function, which provides multivolume, point-in-time copies for applications and databases that share or span multiple volumes
- Reduces recovery from data corruption time dramatically through the ShadowImage QuickRestore feature, which allows an immediate restore to a disk-resident, point-in-time data copy
- Replicates large data volumes without having an impact on service levels, timing out, or affecting performance levels

Improve Productivity and Processes

- Reduces testing and deployment time and increases the accuracy of application development by providing always-available copies of current production data
- Increases competitive advantage through the ShadowImage QuickSplit function by facilitating the sharing of and immediate access to time-critical information for decision support, populating data warehouses, performing analysis, or other data-mining operations
- Enables normal backup operations on a copy of up-to-date production data while critical applications continue to run unaffected
- Simplifies data migration between storage systems
- Reduce operational and capital costs
- Allows business to remain online during data center activities, eliminating the need for 24/7 resources to perform these tasks
- Maximizes the storage infrastructure by leveraging the virtualization capabilities of the USP V/VM
- Allows the use of cost-effective storage for enhanced data protection purposes

Feature Highlights

Consistency Groups. For USP V/VM storage systems, the ShadowImage software consistency-group function allows a user-defined group of ShadowImage volume pairs to be split simultaneously, with a single command. This copy method creates a consistent point-in-time copy of an entire system, database, or any related sets of volumes—a technique that can replicate data between a primary system and secondary systems anywhere in the world, with full data integrity.

About ShadowImage Operations

This chapter describes ShadowImage operations.

- [ShadowImage Components](#)
- [ShadowImage Operations](#)
- [Pair Status](#)
- [ShadowImage Options](#)

ShadowImage Components

System using ShadowImage usually contains the following components

- Pair of volumes (P-VOL and S-VOL)
- Licensed ShadowImage program product

Figure 2-1 shows a typical ShadowImage configuration using Storage Navigator.

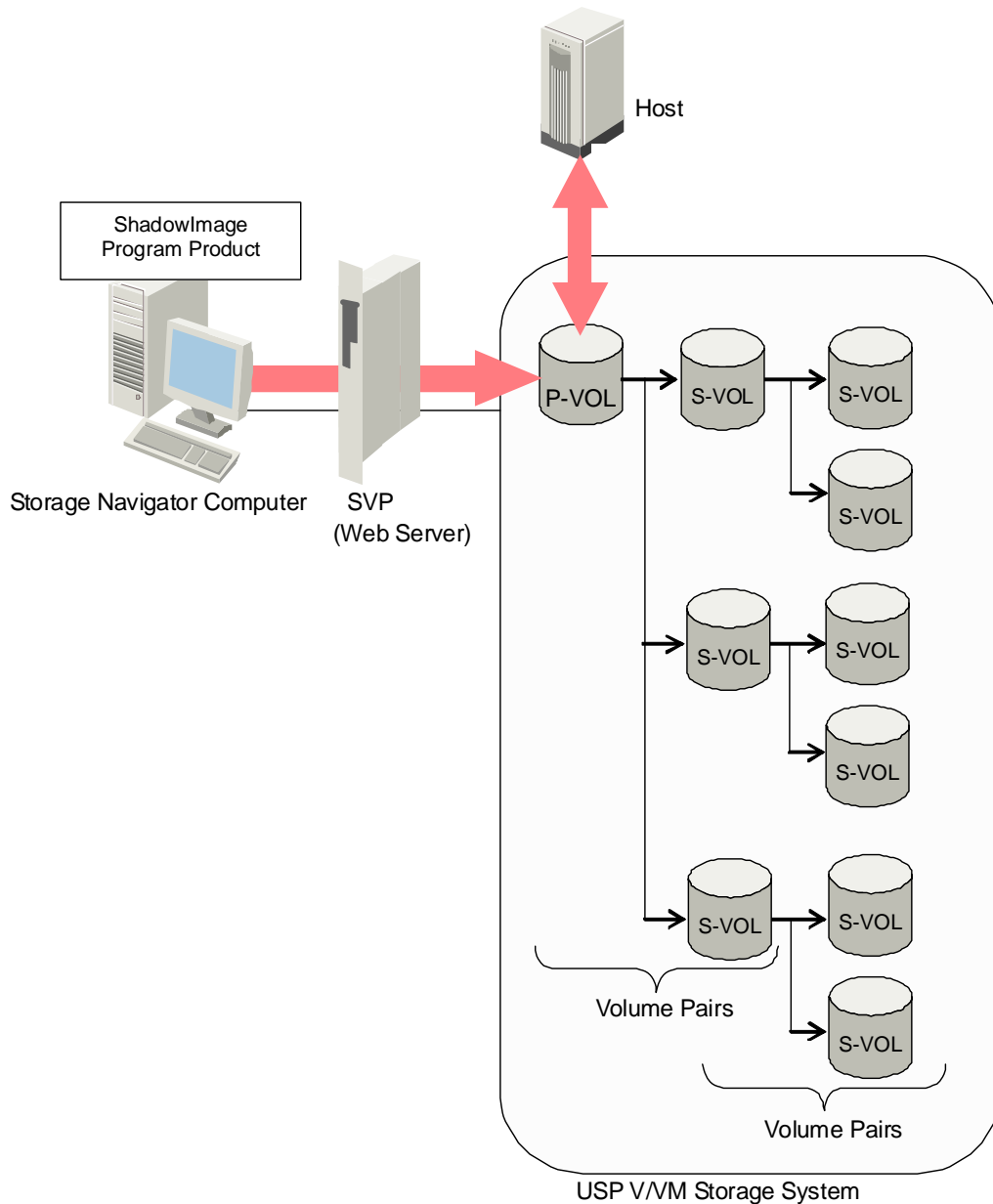


Figure 2-1 ShadowImage Components

You operate ShadowImage from the Storage Navigator computer, and copy volumes in the USP V/VM storage system. A volume that has original data is called a P-VOL, and a volume to which the data is copied is called an S-VOL. A pair of the P-VOL and the S-VOL made by ShadowImage is called a “ShadowImage pair”.

You may operate ShadowImage directly from the host if you use CCI. For details, see [Command Control Interface](#).

Volume Pairs and Consistency Groups

ShadowImage performs internal copy operations for logical volume pairs established by the user. Therefore, ShadowImage needs at least two volumes, one for the copy source (P-VOL) and the other for the copy target (S-VOL). Each ShadowImage pair consists of one P-VOL and up to three S-VOLs that are located in the same USP V/VM storage system.

The ShadowImage P-VOLs are the primary volumes that contain the original data. The ShadowImage S-VOLs are the secondary volumes that contain the backup data. Each S-VOL must be paired with only one P-VOL. During ShadowImage operations, the P-VOLs remain available to all hosts for read and write I/O online operations (except during reverse copy and quick restore operations). When the pair status is PAIR and if the P-VOL is updated, the differential data between P-VOL and S-VOL will be copied to the S-VOL regularly. However, since ShadowImage S-VOLs are updated asynchronously, the P-VOL and S-VOL of the pair in PAIR status may not be identical. Remember that the S-VOLs become available for host access only after the pair has been split.

Using CCI, you can define multiple ShadowImage pairs as one consistency group. If you have defined a consistency group, you can split all ShadowImage pairs in the group by using the At-Time Split function. For details about the At-Time Split function, see [Split Pair Operation](#).

ShadowImage Software

You can operate ShadowImage by using the Storage Navigator computer. Storage Navigator is attached to the USP V/VM storage systems through the TCP/IP local-area network (LAN). The Storage Navigator communicates and exchanges data directly with the service processor (SVP) of the attached storage systems. You become able to acquire the information of the structure or status of the storage system, or issue commands to the storage system.

License

You need to purchase the ShadowImage license and make sure that there is enough licensed capacity according to the capacity of pairs you are going to create.

P-VOLs, S-VOLs, and reserved volumes require ShadowImage licenses for volume capacity and management. Before purchasing a volume capacity license, determine how much volume capacity you will need. The total volume capacity you need to use cannot exceed the maximum licensed volume capacity you have purchased.

Command Control Interface

If you want to operate ShadowImage without using the Storage Navigator PC, you can use CCI. By using CCI, you can issue the commands directly from the host and operate ShadowImage.

ShadowImage Operations

This section describes the main operations of ShadowImage.

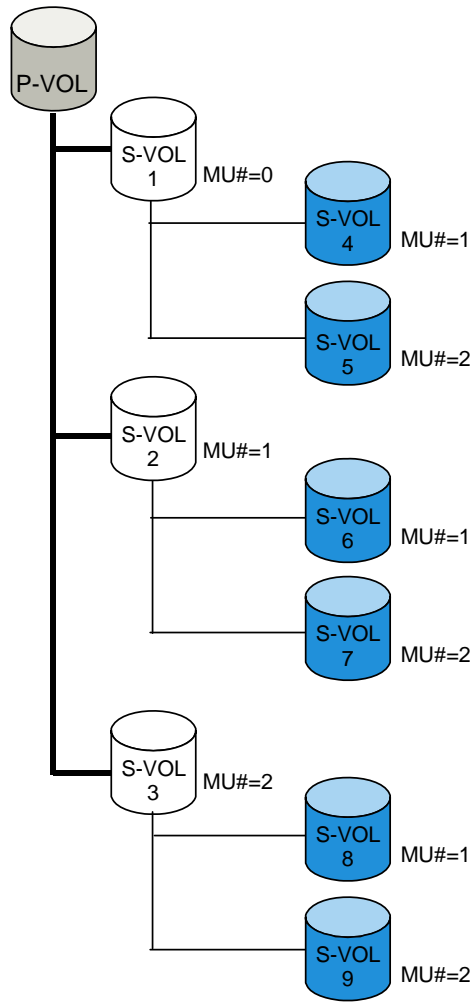
Set Reserve Attribute Operation

The ShadowImage set reserve attribute operation reserves a volume so that it can be used as a ShadowImage S-VOL. Reserved volumes can only be used as ShadowImage S-VOLs. The USP V/VM storage system rejects all write operations to reserved volumes, except when the pair is in PSUS or PSUS (SP) status. You can reserve up to 16,384 volumes in one USP V/VM storage system.

Create Pair Operation

To create a ShadowImage pair, the volume, which will be the P-VOL, must be in the SMPL status. You may set reserve attribute on the S-VOL before creating a pair. You can also create a pair with an unreserved SMPL volume. For details about how to create ShadowImage pairs, see *Creating Pairs and Performing Pair Creation and Pair Splitting*.

You can specify up to three S-VOLs for one ShadowImage P-VOL and create three pairs. In addition, the ShadowImage cascade function allows you to create up to two second layer of volume pairs underneath each first layer of ShadowImage pair. Pairs created in the first and second layer are called cascaded pairs. Figure 2-2 illustrates cascaded ShadowImage pairs.



Legend

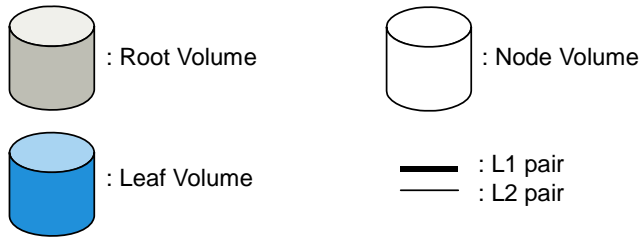


Figure 2-2 Cascade Pairs

The first cascade layer (L1) is the original ShadowImage pair. In case of cascaded pairs, the P-VOL of the L1 pair is called root volume, and the S-VOL is called node volume. The P-VOL of the second cascade layer (L2) is the node volume of L1 pair, and the S-VOL of the L2 pair is called leaf volume. As shown in Figure 2-2, this layering scheme allows you to create up to nine copies (S-VOLs) of one ShadowImage P-VOL. In Figure 2-2, "MU#" means the MU number, which identifies each MU. For example, MU# = 1 under the S-VOL1 means that the MU number of the P-VOL, which makes pair with the S-VOL1, is one (1).

Combination of L1 and L2 pairs with the TrueCopy volumes is allowed; however, node volumes and leaf volumes are both considered *secondary volumes* (S-VOLs) by TrueCopy.

When you create a new volume pair, an initial copy starts and all the data in the P-VOL is copied to the S-VOL. Figure 2-3 shows the change of the status of a pair from the start to end of the initial copy operation.

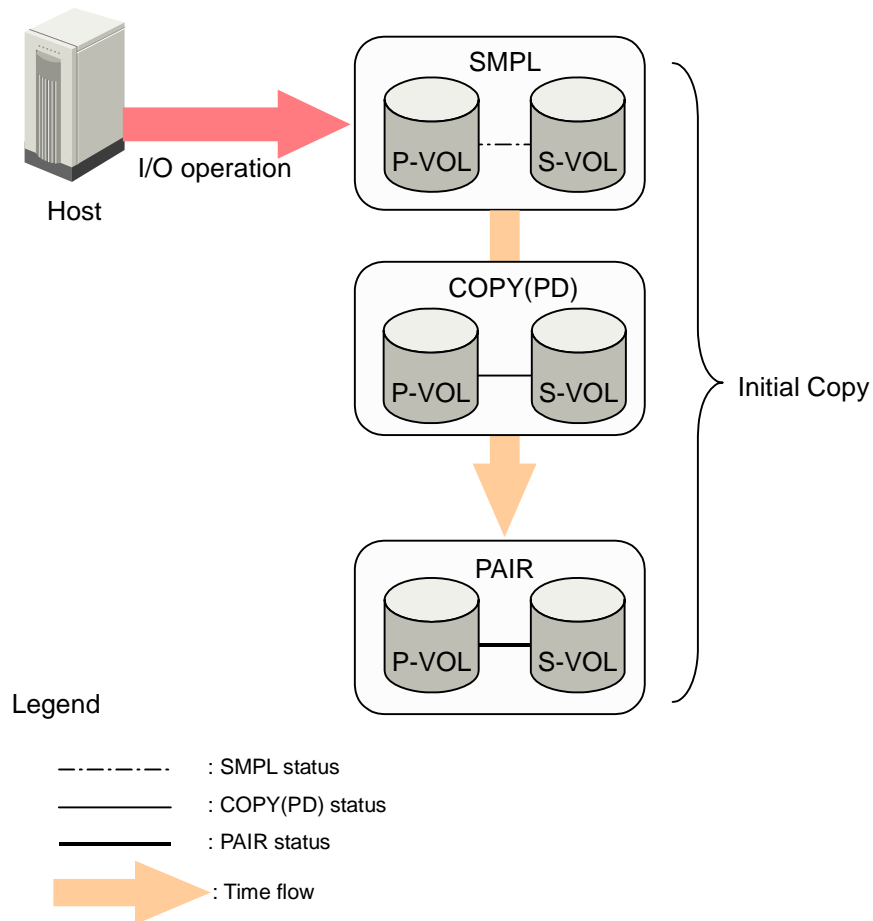


Figure 2-3 Change of Pair Status When You Create a Pair

Before the initial copy operation, the status of a pair is SMPL. The status of the pair is COPY(PD) (PD = pending) while the initial copy operation is in progress. The status changes to PAIR when the initial copy is complete.

Since a P-VOL remains available to all hosts for read and write I/Os during the initial copy operation, the P-VOL might be updated during the operation. Therefore, when the status of the pair changes to PAIR after the initial copy operation is complete, the update copy operations start and the differential data of the P-VOL is copied to the S-VOL. As write I/Os are performed on a duplex P-VOL, the USP V/VM stores the differential bitmap, and then performs update copy operations periodically based on the amount of differential data present on the P-VOL as well as the elapsed time between update copy operations. Figure 2-4 illustrates an update copy operation in a ShadowImage pair with only one S-VOL.

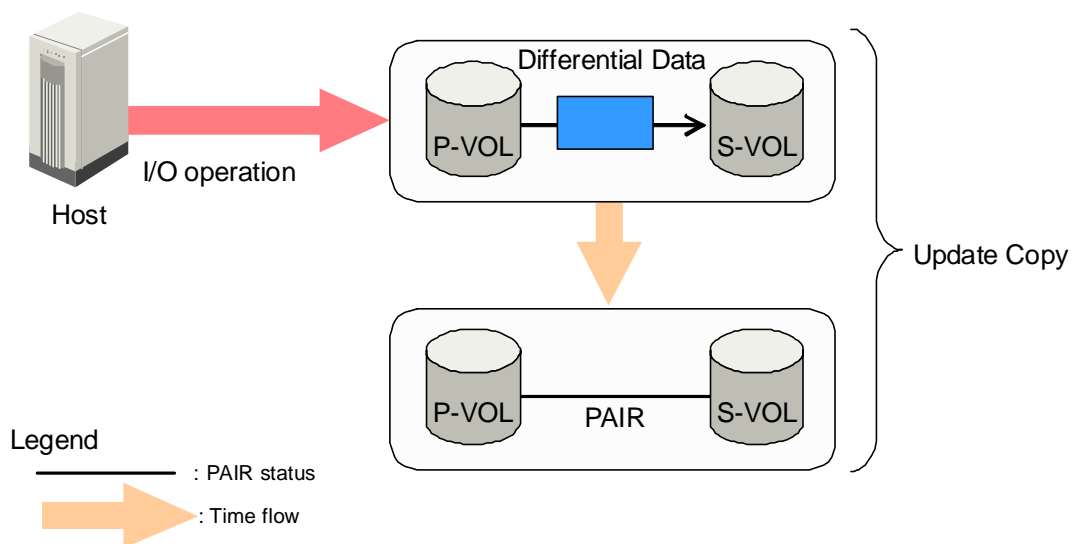


Figure 2-4 Update Copy Operation



Caution: If the copy operation is completed without any host I/O, the data in the P-VOL and the data in the S-VOL may not be the same. Whether the P-VOL and the S-VOL have the same data depends on the condition of the storage system. To make the P-VOL data and the S-VOL data equal, split the pair and make the pair status PSUS.

- Update copy operations are not performed for pairs with the following status: COPY(PD), COPY(SP), PSUS(SP), PSUS, COPY(RS), COPY(RS-R), and PSUE.
- Update copy operations do not occur every time a host issues a write I/O operation to the P-VOL of a ShadowImage pair. ShadowImage update copy operations are performed asynchronously according to the differential bitmap, which is stored in shared memory.

- If shared memory is lost (e.g., offline micro exchange, volatile power supply on), the differential bitmap is also lost. In this case, the USP V/VM treats the entire volume as differential data. For pairs with COPY(SP) or PSUS(SP) status, the USP V/VM changes the status to PSUE due to the loss of the differential bitmap. If shared memory has been lost, extra time is required for ShadowImage operations, because the USP V/VM needs to copy the entire volume.

Split Pair Operation

The ShadowImage split capability provides point-in-time backup of your data and also facilitates real data testing by making the ShadowImage copies (S-VOLs) available for host access.

The ShadowImage pairsplit operation copies whole P-VOL data or differential data at that time to the S-VOL to make the S-VOL identical to the P-VOL. If there are many host I/Os for the P-VOL, it may take time to synchronize the P-VOL and the S-VOL. When the pairsplit operation is complete, the pair status changes to PSUS. The pairsplit operations cannot be performed on the pair whose status is PSUE, COPY(RS), or COPY(RS-R).

While the pair is split, the USP V/VM establishes a differential bitmap for the split P-VOL **and** S-VOL and records all updates to **both** volumes. The P-VOL remains fully accessible during the pairsplit operation. Whether you can access the S-VOL depends on what split type is specified. There are two kinds of split types: Quick Split and Steady Split. In addition to the split types, there is At-Time Split that allows you to split all the pairs in the consistency group. You can perform Quick Split and Steady Split in the Pairsplit dialog box. However, you need CCI to perform At-Time Split.

- Pairsplit by Quick Split:

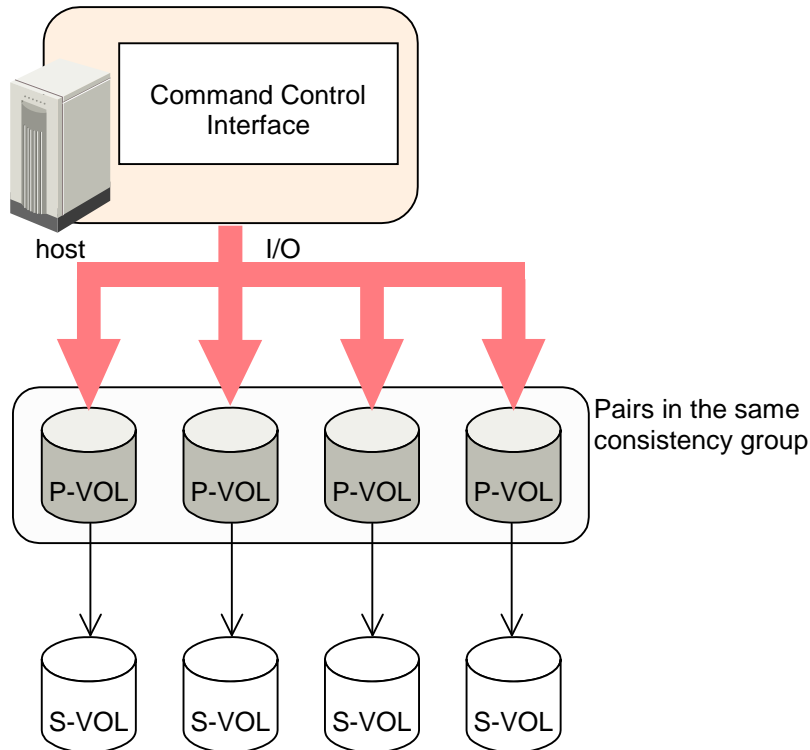
When you specify Quick Split, the pair status changes to PSUS(SP). The S-VOL is available immediately for read and write I/Os (even though it is still reserved). The entire P-VOL data or differential data will be copied to the S-VOL in the background. Pairsplit by Steady Split:

When you specify Steady Split, the pair status changes to COPY(SP), and the whole P-VOL data or differential data at that time will be copied to the S-VOL. When the Steady Split operation is complete, you have full read/write access to the split S-VOL (even though it is still reserved). If you want to quickly complete the copy operation to access the S-VOL, make the P-VOL offline before the operation.

- Pairsplit by At-Time Split

Pairsplit operation by At-Time Split can be performed by using CCI.

When the ShadowImage At-Time Split function is enabled, data in all P-VOLs in the same consistency group is created in the corresponding S-VOLs when the storage system receives the pairsplit request from the host server. Figure 2-5 shows an overview of the ShadowImage At-Time Split function.



Legend

→ : At-Time Split function

Figure 2-5 Overview of At-Time Split Function

Consistency groups are defined by CCI's configuration definition file, which should be created by users. The ShadowImage software on the Storage Navigator computer displays consistency group information, however, you cannot perform the At-Time Split operation by using Storage Navigator. Use CCI from the host in order to perform the At-Time Split operation. For further information on CCI, see the *Command Control Interface (CCI) User and Reference Guide*.

- Triggers for the change of pair status to PSUS

The performance in the state of PSUS(SP) or COPY(SP) is different depending on the value of system option mode 459 (ON or OFF, OFF by default) and whether the S-VOL or the volume in a pool that is associated with the S-VOL is an external or internal volume.

Table 2-1 Performance in PSUS(SP) or COPY(SP) vs. SOM 459 and S-VOL type

System option mode 459	S-VOL*	PSUS(SP) or COPY(SP)
OFF	Internal volume	The pair status changes to PSUS after all the differential data is copied to the cache in the storage system.
	External volume	
ON	Internal volume	The pair status changes to PSUS after all the differential data is copied to the cache in the storage system and the destage in the external storage system has completed.
	External volume	
*If the S-VOL is a Dynamic Provisioning volume, it is the volume associated with the S-VOL in the pool volumes.		

Suspend Pair Operation

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

The USP V/VM storage system will automatically suspend a ShadowImage pair when it cannot keep the pair mirrored for any reason. When the USP V/VM suspends a pair, sense information is generated to notify the host. The USP V/VM will automatically suspend a pair under the following conditions:

- When the USP V/VM detects an error condition related to an update copy operation.
- When the differential bitmap in shared memory is lost (e.g., due to offline microprogram exchange). This applies to COPY(SP) and PSUS(SP) pairs only. For PAIR, PSUS, COPY(RS), or COPY(RS-R) pairs, the pair is not suspended but the entire P-VOL (S-VOL for reverse or quick restore pairresync) is marked as difference data.

Resynchronize Pair Operations

To change the status of the pairs from PSUS to PAIR or from PSUE to PAIR, you must resynchronize the pairs. ShadowImage allows you to perform four different types of pairresync operations: forward pairresync (Normal Copy and Quick Resync) and backward pairresync (Reverse Copy and Quick Copy). Forward pairresync means copying P-VOL data to the S-VOL, and backward pairresync means copying S-VOL data to the P-VOL.

- Normal Copy (forward pairresync in normal speed)

The normal pairresync operation (see Figure 2-6) first edits the differential bitmap of P-VOL and S-VOL, and then resynchronizes the S-VOL with the P-VOL based on the information of the edited differential bitmap. The copy direction for a normal pairresync operation is P-VOL to S-VOL. Pair status changes to PAIR when the copying process of differential data completes. The pair status during a normal pairresync operation is COPY(RS), and the P-VOL remains accessible to all hosts for both read and write operations during a normal pairresync.

- Quick Resync (forward pairresync in fast speed)

The quick pairresync operation (see Figure 2-6) first edits the differential bitmap of P-VOL and S-VOL, and changes the pair status PAIR when the editing process completes. The differential data based on the information of the edited differential bitmap will be copied when update copy operations are performed for the pair in PAIR status. The pairresync operation by Quick Resync is faster than Normal Copy because Quick Resync changes pairs status to PAIR before actually copying differential data to the S-VOL.

The pair status during a quick pairresync operation is COPY(RS). The P-VOL remains accessible to all hosts for both read and write operations. The S-VOL becomes inaccessible to all hosts during a quick pairresync operation.

Figure 2-6 illustrates how the data changes during the forward pairresync operations.

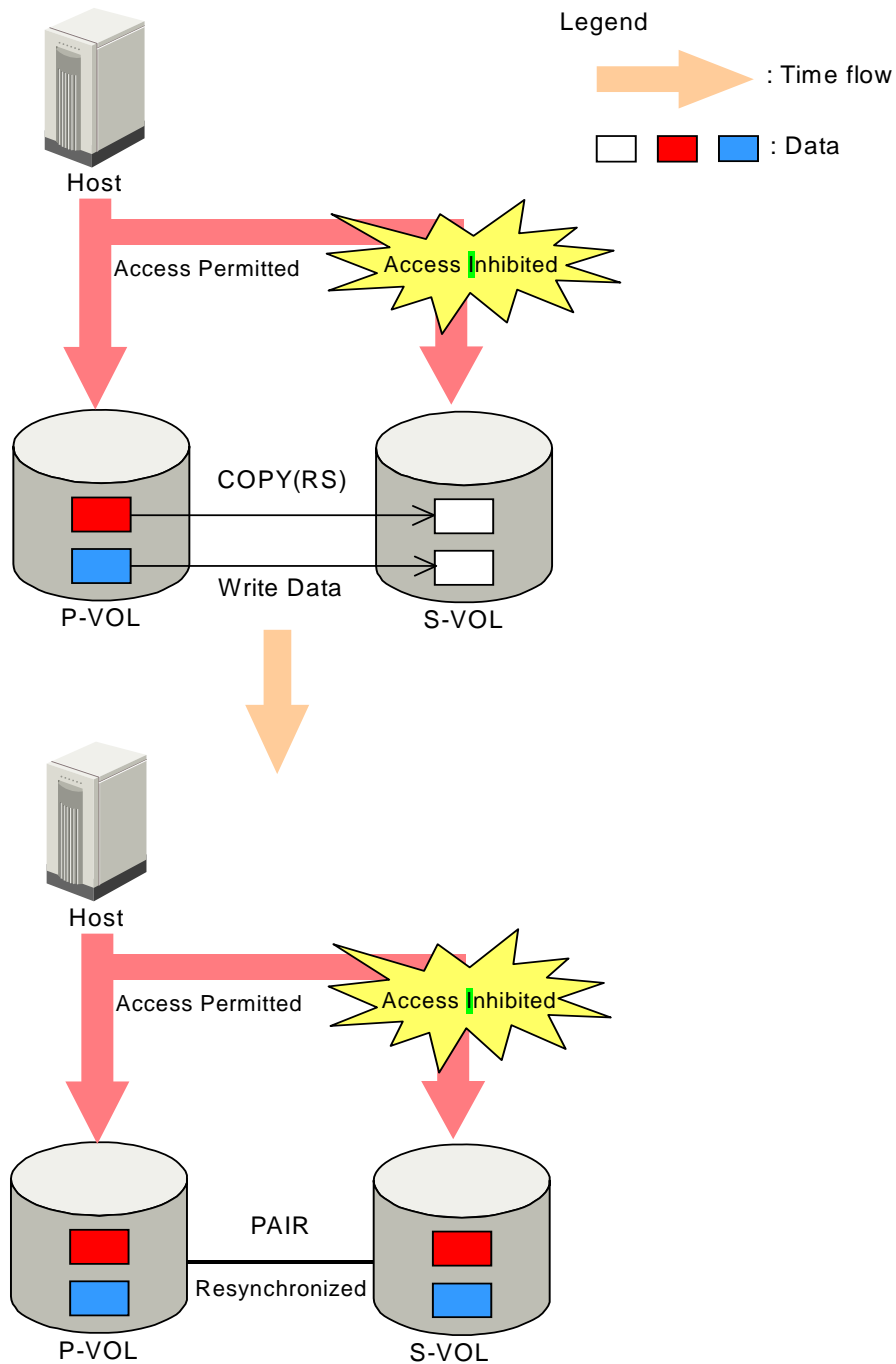


Figure 2-6 Forward Pairresync Operations



Caution: If the copy operation is completed without any host I/O, the data in the P-VOL and the data in the S-VOL may not be the same. Whether the P-VOL and the S-VOL have the same data depends on the condition of the storage system. To make the P-VOL data and the S-VOL data equal, split the pair and make the pair status PSUS.

- Reverse Copy (backward pairresync in normal speed)

The reverse pairresync operation (see Figure 2-7) synchronizes the P-VOL with the S-VOL. The copy direction for a reverse pairresync operation is S-VOL to P-VOL. The pair status during a reverse copy operation is COPY(RS-R). The P-VOL and the S-VOL become inaccessible to all hosts for write operations during a reverse pairresync operation. As soon as the reverse pairresync is complete, the P-VOL becomes accessible.

The P-VOL remains read-enabled during the reverse pairresync operation only to enable the volume to be recognized by the host. The data on the P-VOL is not guaranteed until the reverse pairresync operation is complete, and the status changes to PAIR.

- Quick Restore (backward pairresync in fast speed)

The quick restore operation (see Figure 2-7) speeds up reverse copy by changing the volume map in the storage system to swap the contents of the P-VOL and S-VOL without copying the S-VOL data to the P-VOL. The P-VOL (used to be the S-VOL) and S-VOL (used to be the P-VOL) are resynchronized when update copy operations are performed for pairs in the PAIR status.

The pair status during a quick restore operation is COPY (RS-R) until the volume map change is complete. The P-VOL and S-VOL become inaccessible to all hosts for write operations during a quick restore operation.

- After quick restore operation is executed, the Storage Navigator window may display old configuration information on components such as logical volumes (LDEVs). The window may display configurations before the quick restore operation is performed. To update configuration information on the Storage Navigator window, wait until the quick restore operation completes. Click **File** and then **Refresh** on the menu bar of the window.
- If the differential data between P-VOL and S-VOL is small, the reverse copy operation may be completed faster than the quick restore operation.
- If you create a pair by using an encrypted volume and a non-encrypted volume and then execute Quick Restore, the P-VOL encryption status and the S-VOL encryption status will be reversed. For example, if you perform Quick Restore on an encrypted P-VOL and a non-encrypted S-VOL, P-VOL will be a non-encrypted volume, and S-VOL will be an encrypted volume.

Figure 2-7 illustrates how the data changes during the backward pairresync operations.

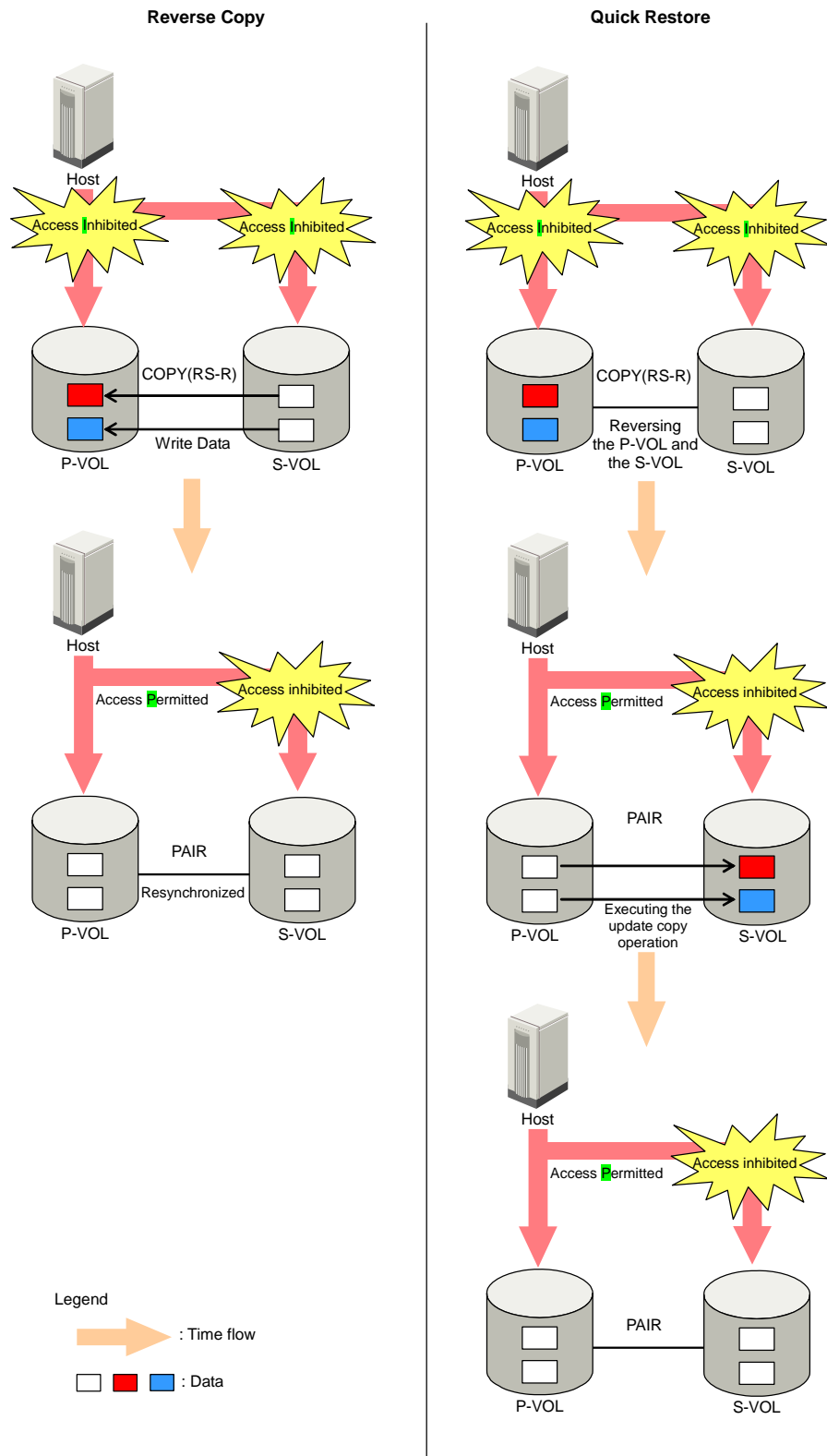


Figure 2-7 Backward Pairresync Operations

- The P-VOL remains read-enabled during the quick restore operation only to enable the volume to be recognized by the host. The data on the P-VOL is not guaranteed until the quick restore operation is complete and the status changes to PAIR.
- The P-VOL remains read-enabled during the quick restore operation only to enable the volume to be recognized by the host. The data on the P-VOL is not guaranteed until the quick restore operation is complete and the status changes to PAIR.
- When reverse or quick restore pairresync is in progress, you cannot perform paircreate, pairsplit, or pairresync for any other pair that shares the same P-VOL (pairsplit-S and pairsplit-E are allowed).

Pairresync operation time depends on the pair status, PSUS or PSUE. The relation between the pair status and the time required for pairresync operations are as follows:

- Pairresync for PSUS pair

When a normal/quick pairresync operation is performed on a split pair (status = PSUS), the USP V/VM copies all differential tracks from the P-VOL to the S-VOL. When a reverse or quick restore pairresync operation is performed on a split pair, the USP V/VM copies all differential tracks from the S-VOL to the P-VOL. This ensures that the P-VOL and S-VOL are properly resynchronized in the desired direction, and also greatly reduces the time needed to resynchronize the pair.

- Pairresync for PSUE pair

When a normal/quick pairresync operation is performed on a suspended pair (status = PSUE), the USP V/VM copies all data on the P-VOL to the S-VOL, since all P-VOL tracks were regarded as difference data when the pair was suspended. The normal pairresync operation for suspended pairs is equivalent to and takes as long as the ShadowImage initial copy operation. If you perform the quick pairresync operation on the suspended pairs, the update copy operation will be performed, and all the data will be copied to the S-VOL. In this case, the update copy operation will take more time than the initial copy operation.

Delete Pair Operation

The ShadowImage pairsplit-S operation (delete pair) stops the ShadowImage copy operations to the S-VOL of the pair and changes the pair status of both volumes to SMPL. A ShadowImage pair can be deleted by the user at any time except during the quick pairsplit operation (i.e., any status except SMPL and PSUS(SP)). After you delete a ShadowImage pair, the S-VOL is still not available for write operations until the reserve attribute is reset.

When a delete pair operation is performed on a pair in PSUS status, the reserve attribute of the S-VOL is reset automatically.

The S-VOL of a duplex pair (PAIR status) may not be identical to its P-VOL, because of the asynchronous ShadowImage update copy operations. See *Deleting Pairs* for instructions on synchronizing the volumes before deleting the pair.



Cautions:

- If you delete a pair, the volume status changes from SMPL(PD) to SMPL. You can check the volume status in the Pair Operation window. Although you can check the volume status by using the pairdisplay command of CCI, this command does not enable you to distinguish between SMPL and SMPL(PD). To distinguish between SMPL and SMPL(PD), perform the inqraid command. Check whether or not the volume is used by ShadowImage. If the volume is used by ShadowImage, the volume status is SMPL(PD). If the volume is not used by ShadowImage, the volume status is SMPL.
 - After you delete a ShadowImage pair, to execute a command to perform tasks such as pair operation or event waiting, wait 10 seconds until the volume status changes from SMPL(PD) to SMPL. If you do not wait 10 seconds, the command might end abnormally.
-

Pair Status

Figure 2-8 illustrates the ShadowImage pair status transitions and the relationship between the pair status and the ShadowImage operations.

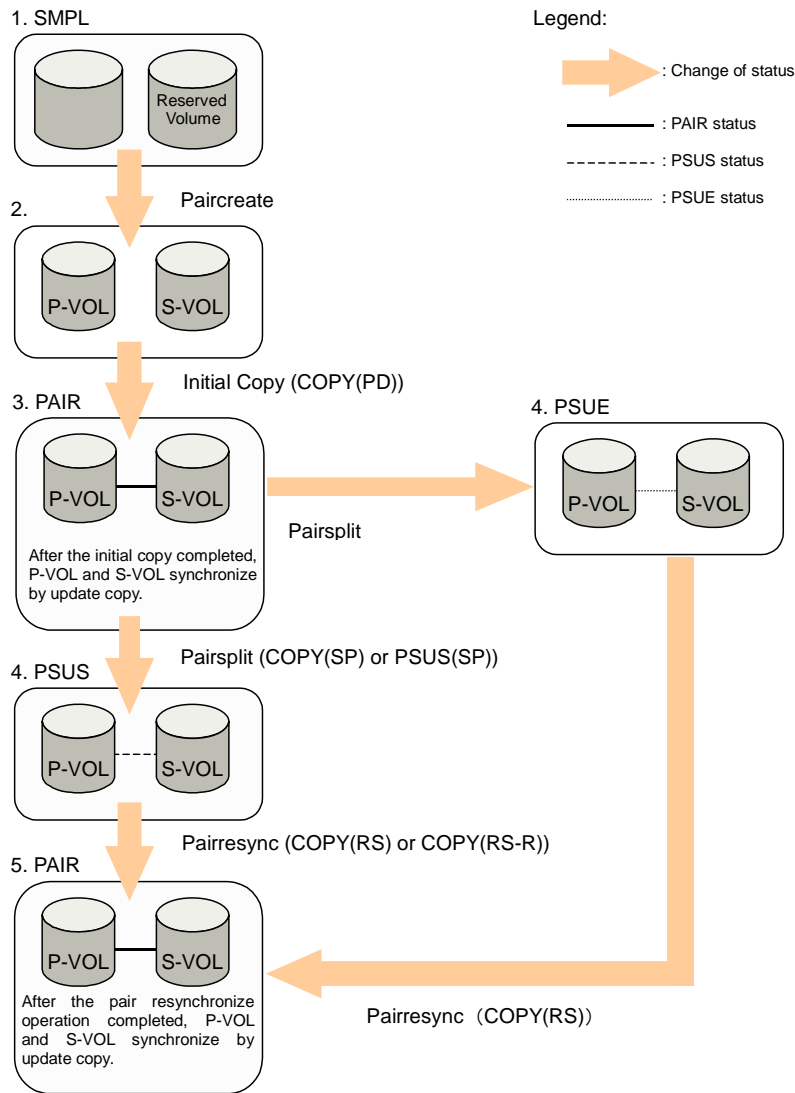


Figure 2-8 ShadowImage Pair Status Transitions

1. If a volume is not assigned to a ShadowImage pair, the volume's status is SMPL.
2. Select the SMPL volumes for P-VOL and S-VOL to create a ShadowImage pair. When you create a ShadowImage pair, the initial copy operation starts. During the initial copy operation, the status of the P-VOL and S-VOL changes to COPY(PD).

3. When the initial copy operation is complete, the pair status becomes PAIR. When the initial copy is completed, the differential data between the P-VOL and the S-VOL will be copied by the update copy.
4. There are two kinds of pair status (PSUS and PSUE) when the pair is not synchronized.
 - When you split a pair (pairsplit), the pair status changes to PSUS. During the pairsplit process, the pair status becomes COPY(SP). If you specify Quick Split pairsplit, the pair status becomes PSUS(SP) during the process. When the pairsplit operation is complete, the pair status changes to PSUS to enable you to access the split S-VOL. The update copy operation is not performed on the pairs which status is PSUS.
 - If the USP V/VM cannot maintain PAIR status for any reason, or if you suspend the pair (pairsplit-E), the pair status changes to PSUE.
5. When you start a pairresync operation, the pair status changes to COPY(RS) or COPY(RS-R). When the pairresync operation is complete, the pair status changes to PAIR.
 - When you specify Reverse Copy or Quick Restore mode for a pairresync operation, the pair status changes to COPY(RS-R).
 - When you delete a pair (pairsplit-S), the status of the volumes, which were used by the pair, changes to SMPL. You cannot delete the pair which status is PSUS(SP).

Table 2-2 lists and describes the ShadowImage pair status conditions.

Table 2-2 ShadowImage Pair Status

Pair Status	Description	S-VOL Access
SMPL	The volume is not assigned to a ShadowImage pair. The USP V/VM accepts read and write I/Os for all SMPL volumes that are not reserved.	N/A (there is no S-VOL yet).
COPY(PD)	The paircreate operation has been accepted normally. The initial copy will be performed.* The USP V/VM continues to accept read and write operations for the P-VOL, but stops accepting write operations for the S-VOL. No update copy operations are performed.	Read only.
PAIR	The initial copy operation is complete, and the USP V/VM starts performing asynchronous update copy operations from the P-VOL to the S-VOL as needed. The P-VOL and S-VOL of a duplex pair (PAIR status) may not be identical.	Read only.
COPY(SP)	The pairsplit operation in the steady split mode has been accepted normally. The split operation triggers a copy operation.* All P-VOL updates prior to the pairsplit command are being copied to the S-VOL. When these updates are complete, the split S-VOL is identical to the state of the P-VOL when the split started.	Read only.
PSUS(SP)	The pairsplit operation in the quick split mode has been accepted normally. The split operation triggers a copy operation.* Only the P-VOL differential data is being copied to the S-VOL in background. The PSUS(SP) pairs cannot be deleted.	Read and write. The S-VOL can be mounted.

Pair Status	Description	S-VOL Access
PSUS	The USP V/VM stops performing update copy operations for PSUS (split) pairs, and starts accepting write I/Os for PSUS S-VOLs. The USP V/VM keeps track of all updates to the split P-VOL and S-VOL, so that the pair can be resynchronized quickly.	Read and write. The S-VOL can be mounted.
COPY(RS)	The pairresync operation has been accepted normally. The pairresync operation triggers a copy operation.* The USP V/VM does not accept write I/Os for COPY(RS) S-VOLs. When a split pair is resynchronized in normal mode, the USP V/VM copies only the P-VOL differential data to the S-VOL. When a PSUE (suspended) pair is resynchronized, the USP V/VM 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 been accepted normally. The reverse pairresync operation triggers a copy operation.* The USP V/VM does not accept write I/Os for COPY(RS-R) S-VOLs. When a split pair is resynchronized in reverse or quick restore mode, the USP V/VM copies only the 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 USP V/VM continues accepting read and write I/Os for a PSUE (suspended) P-VOL, but does not perform update copy operations to a PSUE S-VOL. The USP V/VM marks the entire P-VOL track map as difference data so that the entire P-VOL is copied to the S-VOL when the PSUE pair is resumed. Use the pairresync command to resume a PSUE pair.	Read only.
* It may take time until the copy starts, because the starting time of the copy depends on the numbers of pairs and the system environment.		

ShadowImage Options

You can use the options in Table 2-3 for ShadowImage operations.

Table 2-3 Types of ShadowImage Options

Option Type	Features	Requirement
Swap&Freeze	Swap&Freeze option suppresses the update copy. For details, see Swap&Freeze Option.	You must change the storage system setting to allow the quick restore operation.
Host I/O Performance	Host I/O Performance option suppresses the copy operations by ShadowImage. For details, see Host I/O Performance Option.	-
Copy Threshold	Copy Threshold option temporarily stops the copy operation of ShadowImage. For details, see Copy Threshold Option.	-

Available option types depend on the USP V/VM storage system settings.

Swap&Freeze Option

The Swap&Freeze option allows the S-VOLs of a ShadowImage pair to remain unchanged after the quick restore operation. If the quick restore operation is performed on a ShadowImage pair with the Swap&Freeze option, update copy operations are suppressed and not performed for pairs in the PAIR status after the quick restore operation. If the quick restore operation is performed without the Swap&Freeze option, the P-VOL and S-VOL are resynchronized when update copy operations are performed for pairs in the PAIR status.

Make sure that the Swap&Freeze option remains in effect until the pair status changes to PAIR after the quick restore operation.

Figure 2-9 shows the state of the S-VOL after the quick restore operation with or without the Swap&Freeze option.

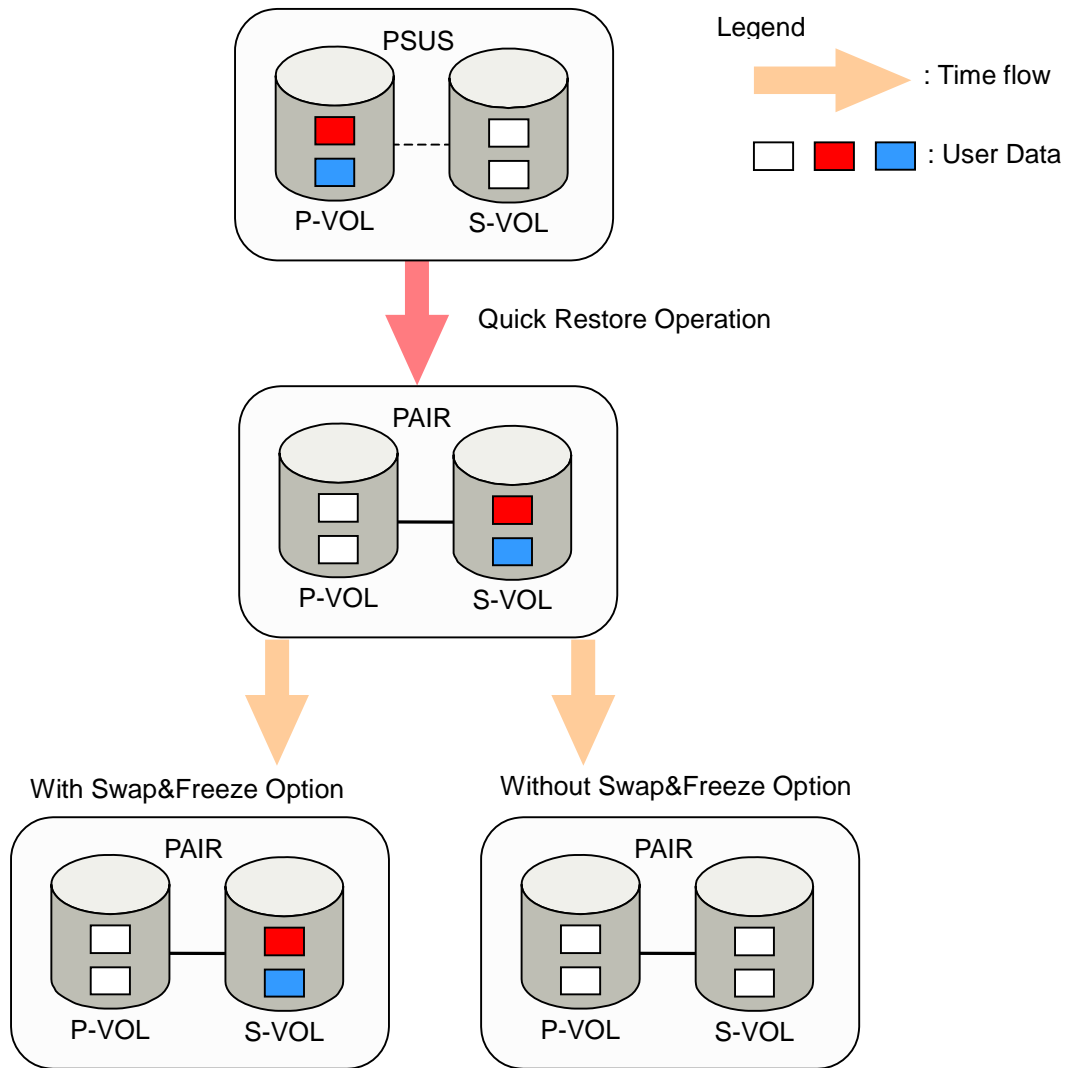


Figure 2-9 Quick Restore Operation With or Without Swap&Freeze Option

The Quick Restore pairresync operation on a pair which status is PSUS exchanges the data in the P-VOL and the S-VOL of the pair. If you use Swap&Freeze option when performing the Quick Restore pairresync operation, the update copy operation will not take place after the Quick Restore pairresync operation is complete. Therefore, the data of the P-VOL and the S-VOL is kept exchanged. If you do not use Swap&Freeze option when performing the Quick Restore pairresync operation, the update copy operation will take place after the Quick Restore pairresync operation is complete, and the data in the P-VOL overwrites the S-VOL.

Host I/O Performance Option

The Host I/O Performance option improves host I/O responses over ShadowImage copying processing time. When the Host I/O Performance option is used, the storage system suppresses the execution of ShadowImage copying processing, and consequently the host I/O responses improve.

When ShadowImage copying processing is suppressed by the Host I/O Performance option, the time taken for copying increases. Also, if ShadowImage for z/OS pairs exist, the host I/O responses might not be faster. In this case, set the Host I/O Performance option for ShadowImage for z/OS as well.

Copy Threshold Option

If the load of the storage system increases, the host server I/O performance (response) may be degraded. If ShadowImage performs copy operations when the load of the storage system is heavy, it is more likely that host server I/O performance (response) may be degraded. The Copy Threshold option temporarily stops the ShadowImage copy operations when the load of the storage system is heavy. If you set this option, you can minimize the degradation of host I/O performance by temporarily stopping ShadowImage copy operations when the load of the storage system is heavy.

ShadowImage has another option called the Host I/O Performance option, which maintains host I/O performance (response). The Host I/O Performance option suppresses the ShadowImage copy operation regardless of the status of the storage system. However, the Copy Threshold option is effective only when the load of the storage system is heavy. When the Copy Threshold option is in effect, all the ShadowImage copy operations stop.

For information about the setting of the Host I/O Performance option, see Host I/O Performance Option. For information about the setting of the Copy Threshold option, please call the Support Center.

Copy operations that are stopped by the Copy Threshold option will resume when the load of the storage system become light. If this option is valid, the ShadowImage copy operation and the copy operations of the following program products will stop when the load of the storage system is heavy.

- ShadowImage for z/OS
- Compatible Mirroring for IBM® FlashCopy® Version 1
- Compatible Mirroring for IBM® FlashCopy® Version 2
- Copy-on-Write Snapshot
- Volume Migration

Interoperability with Other Products and Functions

ShadowImage supports concurrent operations with the following data management functions:

- [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](#)
- [VERITAS® NetBackup DataCenter™](#)

Open Volume Management

Virtual LUN volumes can be assigned to ShadowImage pairs, provided that the S-VOL has the same capacity as the P-VOL. If you need to perform Open Volume Management operations on an existing ShadowImage P-VOL or S-VOL, you must delete the pair first to return the volume to SMPL status.

LUSE volumes can be assigned to ShadowImage pairs, provided that the P-VOL and S-VOL have the same LU type and the same number of LDEVs (same size). If you need to perform LUSE operations on an existing ShadowImage P-VOL or S-VOL, you must delete the pair first to return the volume to SMPL status.

Cache Residency Manager

Volumes that have Cache Residency Manager settings can be assigned to ShadowImage pairs, and Cache Residency Manager operations can be performed on ShadowImage P-VOLs and S-VOLs.



Caution: See Performance Considerations for important information about performing quick restore operations on volumes that have Cache Residency Manager settings.

LUN Manager

LUN Security 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 assigned to secure ports, WWN groups, and/or LUN groups for LUN Security. However, you cannot specify volumes that are selected as invalid S-VOLs for ShadowImage S-VOLs.

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

Data Retention Utility

ShadowImage can create pairs using volumes to which access attribute is set by Data Retention Utility. However, you cannot create a ShadowImage pair specifying the volume with "S-VOL Disable" attribute as an S-VOL.

Table 3-1 describes whether you can or cannot specify the volume with access attribute as a P-VOL or S-VOL of a ShadowImage pair.

Table 3-1 Access Attribute and Availability as a Volume of ShadowImage Pair

Access Attribute	Availability as a Volume of ShadowImage Pair	
	P-VOL	S-VOL
Read/Write	OK	OK
Read Only (Volume)	OK	OK
Protect	OK	OK
S-VOL Disable	OK	NO

Table 3-2 describes whether you can or cannot perform the ShadowImage operations to the volume with "S-VOL Disable" attribute.

Table 3-2 Availability of ShadowImage Operations to the Volume with S-VOL Disable Attribute

ShadowImage Operations	Availability of ShadowImage Operations	
	P-VOL	S-VOL
Paircreate	OK	NO
Pairsplit	OK	NO
Paircreate and Pairsplit *	OK	NO
Forward Pairresync	OK	NO
Backward Pairresync	NO	NO
Suspend	OK	NO
Delete	OK	OK

* "Paircreate and Pairsplit" means that you simultaneously create and split ShadowImage pairs (see Performing Pair Creation and Pair Splitting).

Volume Migration

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

- Root volumes that are paired with two or less node volumes.
- Node volumes that are paired with one leaf volumes.
- Node volumes that are not paired with any leaf volumes.
- Reserved volumes.

If you want to:

- Assign the ShadowImage volumes to migration volumes, or
- Reserve the ShadowImage volumes as the migration volumes, or
- Assign the ShadowImage volumes that do not meet the abovementioned conditions,

You must delete the ShadowImage volumes or unreserve ShadowImage volumes before using the volumes by Volume Migration.

If you assign ShadowImage volumes that do not meet the condition to the migration volumes, or if you assign ShadowImage volumes to other Volume Migration volumes other than migration volumes, the command will be rejected. Also, if you split the ShadowImage pair that is assigned to the Volume Migration migration volumes, migration of those volumes will be canceled.

You cannot use migration volumes, destination volumes, and reserved volumes of Volume Migration for ShadowImage pair operations (the command will be rejected). If you want to use Volume Migration volumes for ShadowImage pair operations, you must release the volumes by using Volume Migration.

Universal Volume Manager

ShadowImage operations can also be performed in conjunction with Hitachi Universal Volume Manager operations to create pairs with the external volumes. For information about the external volumes, see the *Universal Volume Manager User's Guide*.

TrueCopy

TrueCopy volumes can be assigned to ShadowImage pairs and vice versa.

ShadowImage and TrueCopy can function together in the same USP V/VM storage system to provide both internal and remote backup for your important data.



Caution: When performing the Quick Restore pairresync operation on the ShadowImage pair that shares the volume with TrueCopy Asynchronous, ShadowImage P-VOL and S-VOL must be allocated to the same CLPR. Specify the Reverse Copy mode instead of the Quick Restore mode when resynchronizing the ShadowImage pair whose P-VOL and S-VOL are allocated to the different CLPR.

- ShadowImage is recommended for intra-storage system copy operations. If ShadowImage is not installed, TrueCopy (synchronous only) can be used to copy within the same USP V/VM storage system. This TrueCopy configuration requires at least one external ESCON[®] cable loop (minimum of two is recommended).
- Combination of ShadowImage L1 and L2 pairs with TrueCopy volumes is allowed. Node volumes and leaf volumes are both considered *secondary volumes* (S-VOLs) by TrueCopy.

The configuration shown in Figure 3-1 is an example of a volume that is functioning as both a TrueCopy P-VOL and a ShadowImage P-VOL. This configuration allows you to:

- On-site backup copies of TrueCopy P-VOLs, and/or
- Remote backup copies of ShadowImage P-VOLs

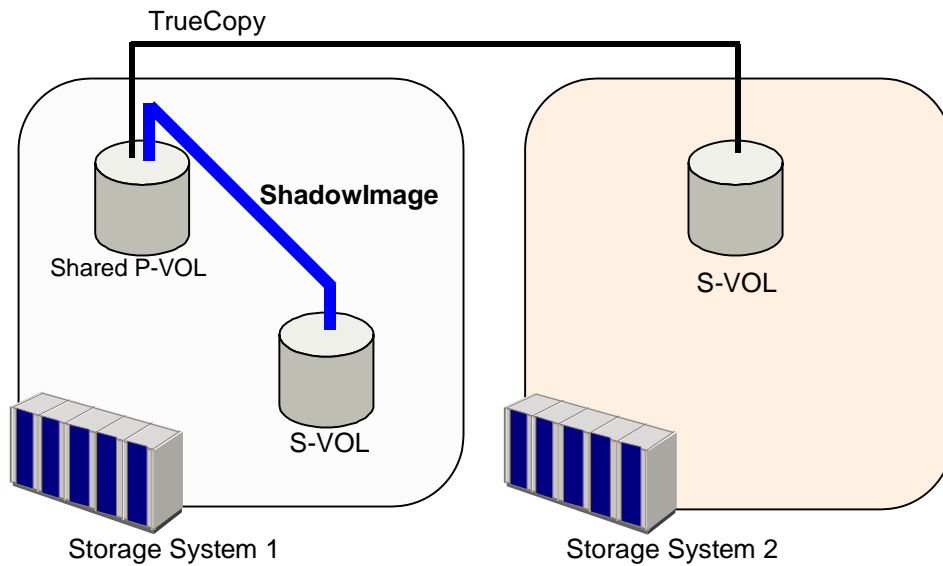


Figure 3-1 Shared Volume of ShadowImage and TrueCopy: P-VOL

Figure 3-2 illustrates a volume that is functioning as both a TrueCopy S-VOL and a ShadowImage P-VOL, which allows you to use ShadowImage to provide remote copies of TrueCopy S-VOLs.

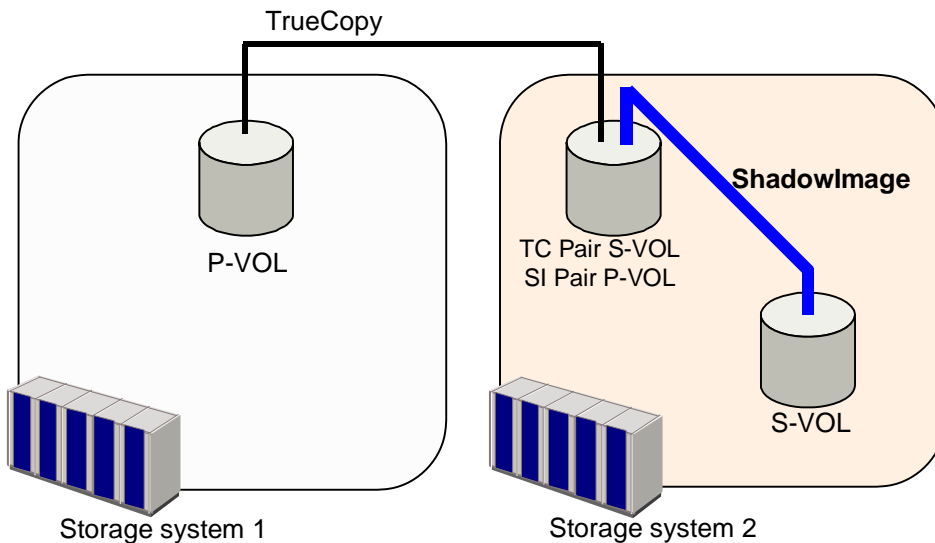


Figure 3-2 Shared Volume of ShadowImage and TrueCopy: P-VOL/S-VOL



Caution: When you share a ShadowImage P-VOL with a TrueCopy S-VOL as shown in Figure 3-2, the write operation to the TrueCopy P-VOL takes time. Especially, when the ShadowImage pair is in the PSUS(SP) status, the write operation to the TrueCopy P-VOL may take extra time according to the time for copying process of the ShadowImage pair.

In addition, in the case of TrueCopy Asynchronous, the TrueCopy pair may be suspended by failure because of the shortage of the capacity of its side file.

When you split ShadowImage pairs, if a volume is shared with TrueCopy asynchronous and ShadowImage, consider the following points (see Figure 3-2).

- Split the ShadowImage pair after you have changed the status of TrueCopy asynchronous pair to **PSUS** or **PSUE**.
- If you split ShadowImage pairs for each consistency group, split the pairs after you change the status of all TrueCopy asynchronous pairs in the specified consistency group to **PSUS** or **PSUE**, and also made the consistency time (C/T) of the consistency group equal to the C/T of each TrueCopy asynchronous pair.

You can also prevent the ShadowImage split operation, which is under the condition that does not meet the above points. For details, please call the Support Center.

The configuration shown in Figure 3-3 illustrates a volume that is functioning as both a TrueCopy P-VOL and a ShadowImage P-VOL, while the S-VOL of the same TrueCopy pair is also functioning as the P-VOL of another ShadowImage pair. This configuration allows you to:

- On-site backup copies of TrueCopy P-VOLs and S-VOLs, and/or
- Remote backup of ShadowImage P-VOLs.

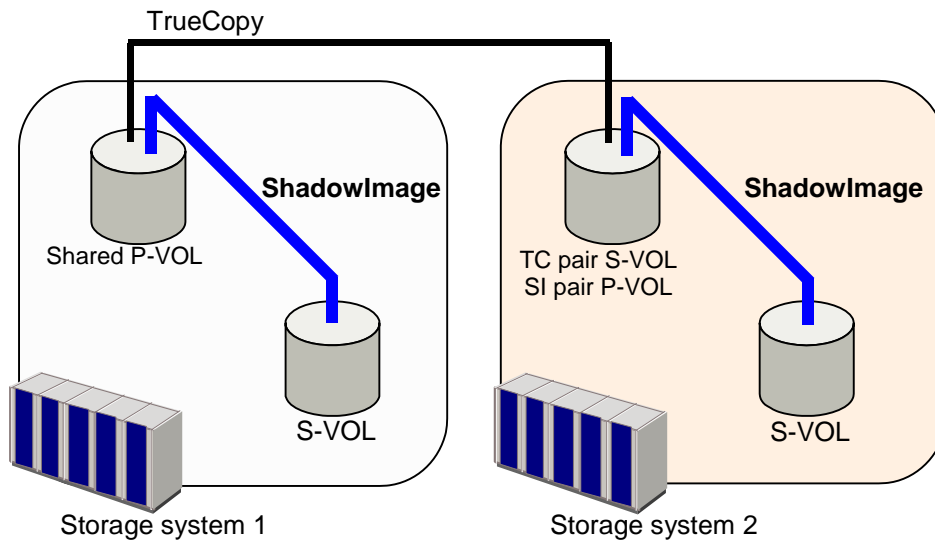


Figure 3-3 Shared Volumes of ShadowImage and TrueCopy: P-VOL/P-VOL and P-VOL/S-VOL

Figure 3-4 illustrates a volume functioning as both a ShadowImage S-VOL and a TrueCopy P-VOL, which allows you to use TrueCopy to provide asynchronous remote copy.

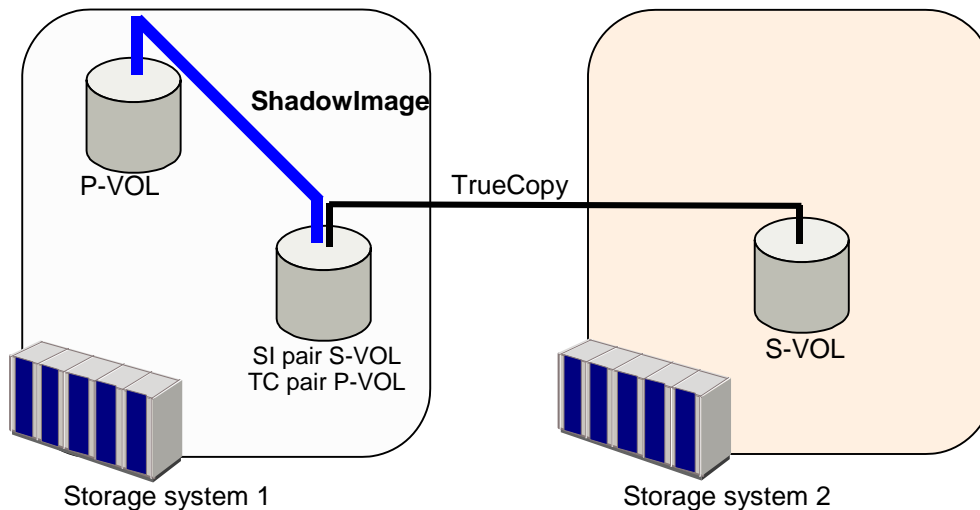


Figure 3-4 Shared Volume of ShadowImage and TrueCopy: S-VOL/P-VOL

- This configuration does not allow ShadowImage and TrueCopy to copy at the same time. Create the ShadowImage pair first, and then split the pair before creating the TrueCopy pair. You must suspend the TrueCopy pair to resynchronize the ShadowImage pair. The TrueCopy pair status cannot be changed when the ShadowImage pair is in the PSUS(SP) status.

- Usually TrueCopy and Universal Replicator can share the volumes with ShadowImage. However, in some cases, you cannot create ShadowImage pairs using the volume shared with TrueCopy and Universal Replicator. Figure 3-9 and Figure 3-10 show that you cannot create ShadowImage pairs using the volume shared with TrueCopy and Universal Replicator.
- If a volume is shared with a ShadowImage pair and a TrueCopy pair, you can perform Quick Restore on the ShadowImage pair when the TrueCopy pair is suspended. You cannot perform Quick Restore on the ShadowImage pair when the TrueCopy pair is not suspended. Table 3-3 describes whether you can perform Quick Restore when a volume is shared with a ShadowImage pair and a TrueCopy pair.

Table 3-3 Quick Restore Operation When Volume is Shared with ShadowImage Pair and TrueCopy Pair

Shared Volume		Quick Restore Operation on ShadowImage Pair
ShadowImage	TrueCopy	
P-VOL	P-VOL	OK
	S-VOL	OK
S-VOL	P-VOL	OK

Universal Replicator

Universal Replicator volumes can be assigned to ShadowImage pairs and vice versa.

ShadowImage and Universal Replicator can function together in the same USP V/VM storage system to provide both internal and remote backup for your important data.

- A primary volume (P-VOL) of Universal Replicator means a primary data volume of Universal Replicator. A secondary volume (S-VOL) of Universal Replicator means a secondary data volume of Universal Replicator.
- A combination of ShadowImage L1 and L2 pairs with Universal Replicator volumes is allowed. Node volumes and leaf volumes are both considered *secondary volumes* (S-VOLs) by Universal Replicator.

Figure 3-5 illustrates a volume that is functioning as both a Universal Replicator P-VOL and a ShadowImage P-VOL, which allows you to:

- On-site backup copies of Universal Replicator P-VOLs, and/or
- Remote backup copies of ShadowImage P-VOLs

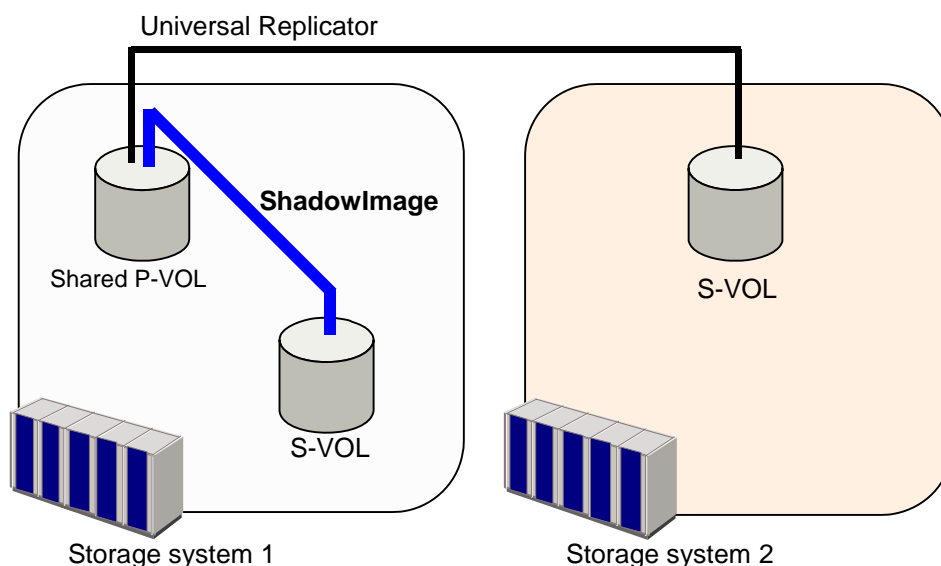


Figure 3-5 Shared Volume of ShadowImage and Universal Replicator: P-VOL/P-VOL

Figure 3-6 illustrates a volume that is functioning as both a Universal Replicator S-VOL and a ShadowImage P-VOL, which allows you to use ShadowImage to provide remote copies of Universal Replicator S-VOLs.

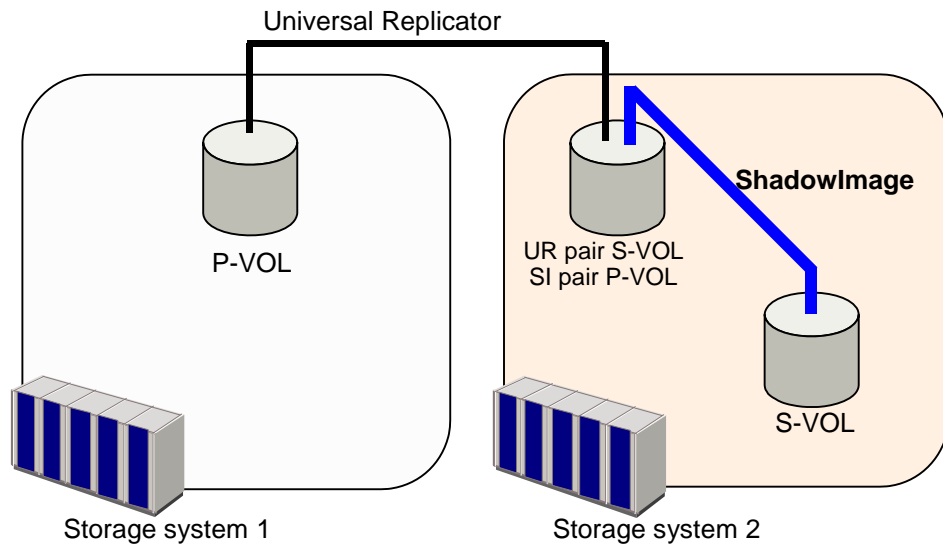


Figure 3-6 Shared Volume of ShadowImage and Universal Replicator: P-VOL/S-VOL



Caution:

- When you share a ShadowImage P-VOL with a Universal Replicator S-VOL as shown in Figure 3-6, the write operation to the Universal Replicator P-VOL takes time. Especially, when the ShadowImage pair is in the PSUS(SP) status, the write operation to the Universal Replicator P-VOL may take extra time according to the time for the copying process of the ShadowImage pair.
- If the journal volume size is small, the Universal Replicator pair may be suspended by failure because of the shortage of the capacity of its journal volume.
- Any request to split all ShadowImage pairs in one consistency group will be accepted only when the corresponding Universal Replicator pairs are in **PAIR**, **PSUS**, or **PSUE** status. If any of the Universal Replicator pairs is in another status, the status of the ShadowImage pairs in the consistency group will be unchanged.

The configuration shown in Figure 3-7 is an example of a volume which is functioning as both a Universal Replicator P-VOL and a ShadowImage P-VOL, while the S-VOL of the same Universal Replicator pair is also functioning as the P-VOL of another ShadowImage pair. This configuration allows you to:

- On-site backup copies of Universal Replicator P-VOLs and S-VOLs, and/or
- Remote backup of ShadowImage P-VOLs.

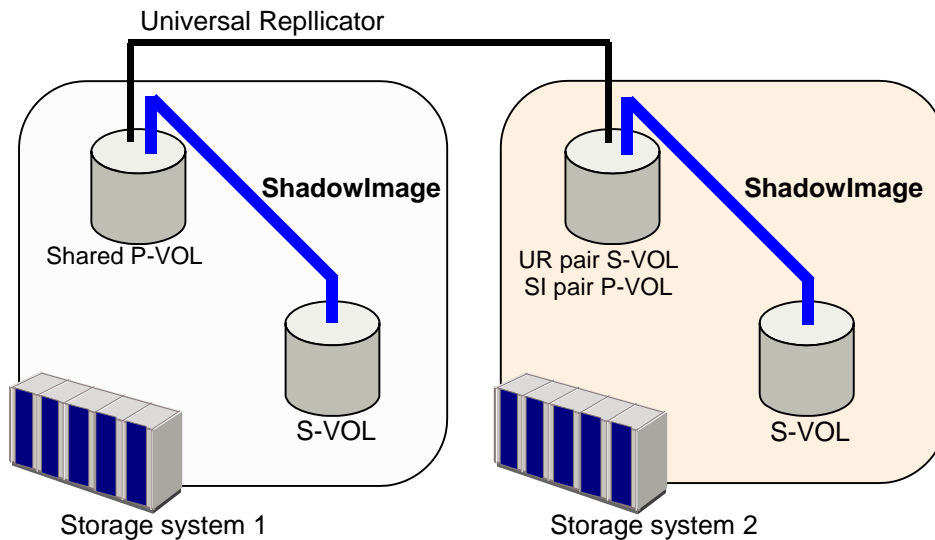


Figure 3-7 Shared Volumes of ShadowImage and Universal Replicator: P-VOL/P-VOL and P-VOL/S-VOL

Figure 3-8 illustrates a volume that is functioning as both a ShadowImage S-VOL and a Universal Replicator P-VOL, which allows you to use Universal Replicator to provide remote copies of ShadowImage S-VOLs.

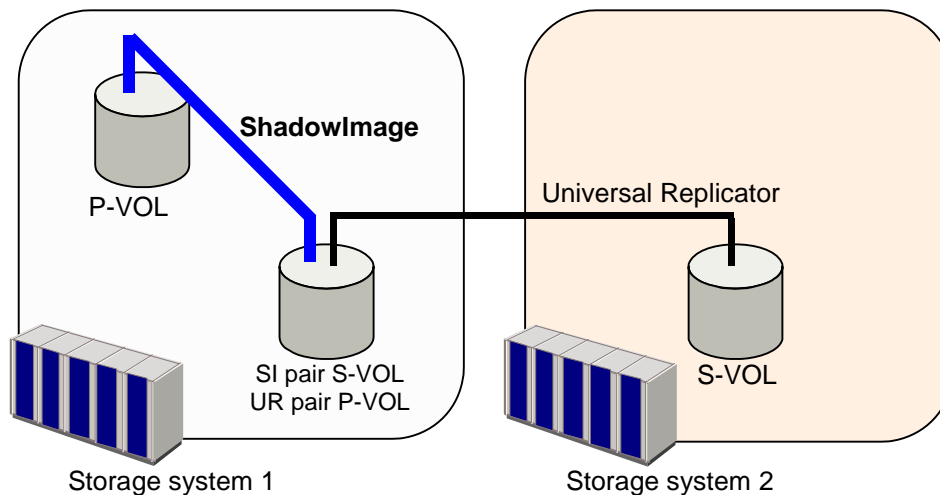


Figure 3-8 Shared Volume of ShadowImage and Universal Replicator: S-VOL/P-VOL

- In the configuration shown in Figure 3-8, you cannot perform the ShadowImage and Universal Replicator copy operations at the same time. In Figure 3-8, first you need to create and split the ShadowImage pair, then create the Universal Replicator pair. If you want to resynchronize the ShadowImage pair, suspend the Universal Replicator pair beforehand. Note that you cannot change the Universal Replicator pair status while the ShadowImage pair is in PSUS(SP) status.

- If a volume is shared with a ShadowImage pair and a Universal Replicator pair, you can perform Quick Restore on the ShadowImage pair when the Universal Replicator pair is suspended. You cannot perform Quick Restore on the ShadowImage pair when the Universal Replicator pair is not suspended. Table 3-4 describes whether you can perform Quick Restore when a volume is shared with a ShadowImage pair and a Universal Replicator pair.

Table 3-4 Quick Restore Operation When Volume is Shared with ShadowImage Pair and Universal Replicator Pair

Shared Volume		Quick Restore Operation on ShadowImage Pair
ShadowImage	Universal Replicator	
P-VOL	P-VOL	OK
	S-VOL	OK
S-VOL	P-VOL	OK

TrueCopy and Universal Replicator

Figure 3-9 and Figure 3-10 show examples of using ShadowImage, TrueCopy, and Universal Replicator at the same time.

Though each TrueCopy and Universal Replicator can share the volumes with ShadowImage, you may not create ShadowImage in some sharing pattern.

Figure 3-9 illustrates a volume functioning as both a Universal Replicator S-VOL and a TrueCopy P-VOL.

A primary volume (P-VOL) of Universal Replicator means a primary data volume of Universal Replicator. A secondary volume (S-VOL) of Universal Replicator means a secondary data volume of Universal Replicator.

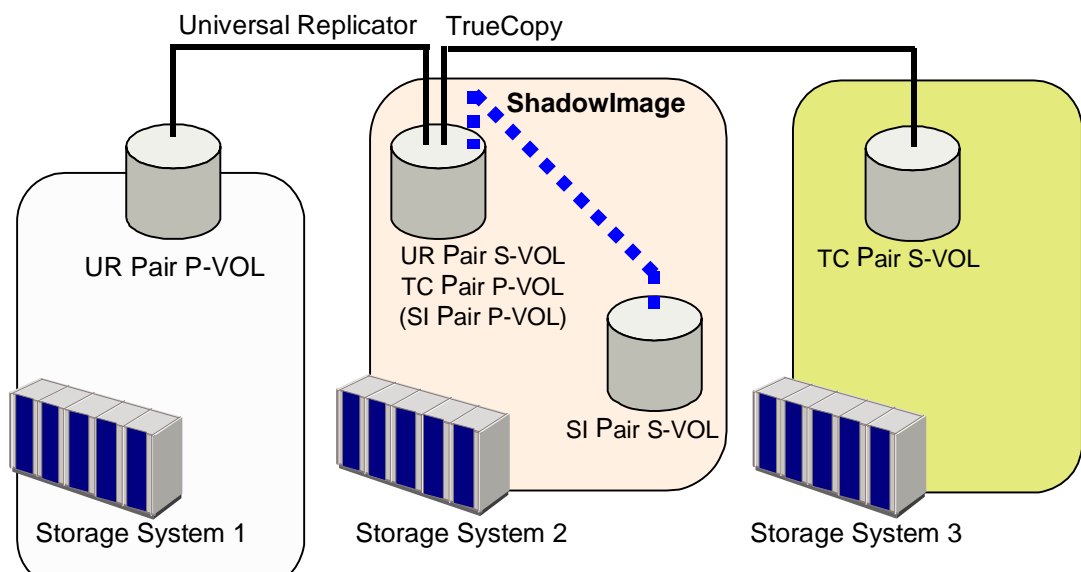


Figure 3-9 ShadowImage, Universal Replicator, and TrueCopy: Combination that is Allowed (Example 1)

Figure 3-10 illustrates a volume functioning as both a TrueCopy S-VOL and a Universal Replicator P-VOL.

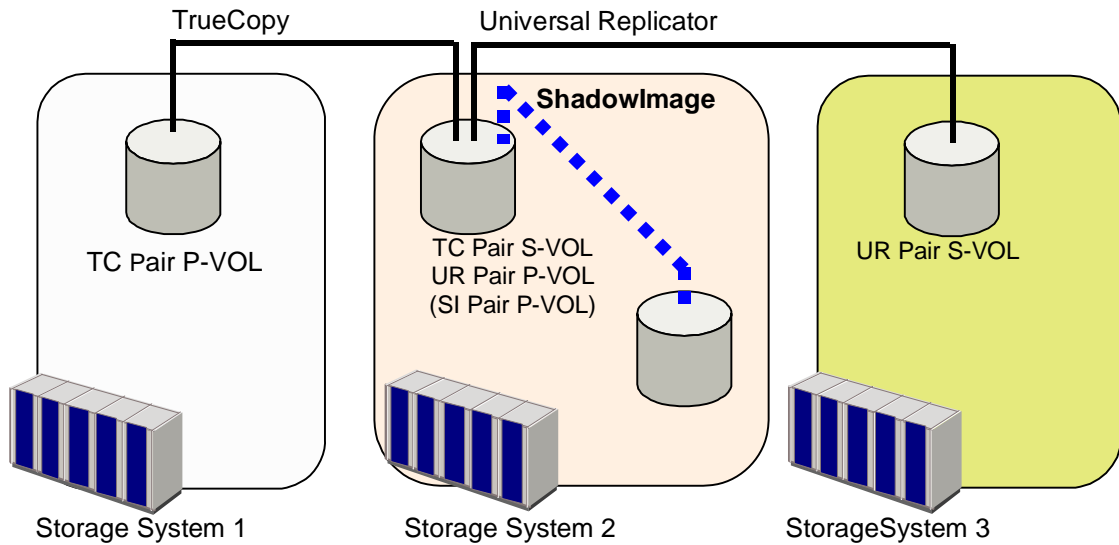


Figure 3-10 ShadowImage, TrueCopy, and Universal Replicator: Combination that is Allowed (Example 2)

If the combination of Figure 3-9 or Figure 3-10 is used, you cannot perform Quick Restore on ShadowImage pairs.

Figure 3-11 shows a 3DC multi-target configuration where the following pairs are used:

- Universal Replicator pair
- Universal Replicator pair for delta resync operation
- ShadowImage pairs
- TrueCopy pair

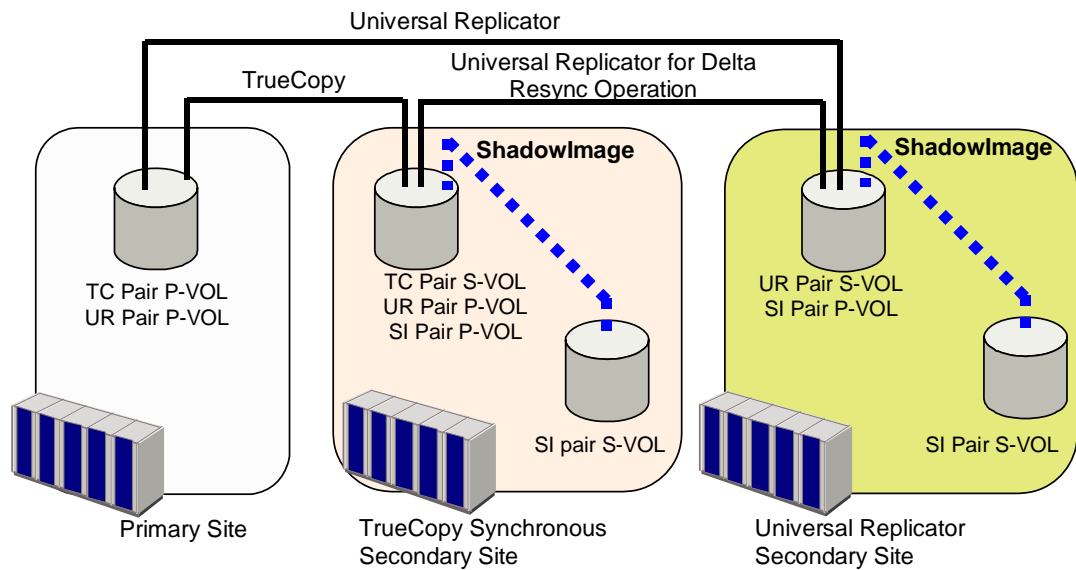


Figure 3-11 Combination of ShadowImage Pairs, a TrueCopy pair, and a Universal Replicator pair in 3DC Multi-target Configuration

Table 3-5 describes the availability of the ShadowImage operation in the TrueCopy Synchronous secondary site.

Table 3-5 Availability of ShadowImage Operation in the TrueCopy Synchronous Secondary Site

TC Pair Status	Status of UR Pair for Delta Resync Operation	ShadowImage Operation							
		Pair create	Pair split	Pairsplit-E	Pairsplit-S	Pairresync			
						Normal Copy	Quick Resync	Reverse Copy	Quick Restore
PAIR	HOLD	OK	OK	OK	OK	OK	OK	NO	NO
COPY		OK	OK	OK	OK	OK	OK	NO	NO
PSUS		OK	OK	OK	OK	OK	OK	OK	NO
SSWS		OK	OK	OK	OK	OK	OK	OK	NO
PAIR	HLDE	OK	OK	OK	OK	OK	OK	NO	NO
COPY		OK	OK	OK	OK	OK	OK	NO	NO
PSUS		OK	OK	OK	OK	OK	OK	OK	NO
SSWS		OK	OK	OK	OK	OK	OK	OK	NO

Table 3-6 describes the availability of the ShadowImage operation in the Universal Replicator secondary site.

Table 3-6 Availability of ShadowImage Operation in the Universal Replicator Secondary Site

UR Pair Status	Status of UR Pair for Delta Resync Operation	ShadowImage Operation							
		Pair create	Pair split	Pairsplit-E	Pairsplit-S	Pairresync			
						Normal Copy	Quick Resync	Reverse Copy	Quick Restore
PAIR	HOLD	OK	OK	OK	OK	OK	OK	NO	NO
COPY		OK	OK	OK	OK	OK	OK	NO	NO
PSUS		OK	OK	OK	OK	OK	OK	OK	NO
SSWS		OK	OK	OK	OK	OK	OK	OK	NO

Universal Replicator 3DC Multi-target, 3DC Cascade, and Delta Resync Configurations

Universal Replicator 3DC Multi-target Configuration

The following figure shows a configuration example of a case where ShadowImage and Universal Replicator 3DC multi-target configuration are used in combination.

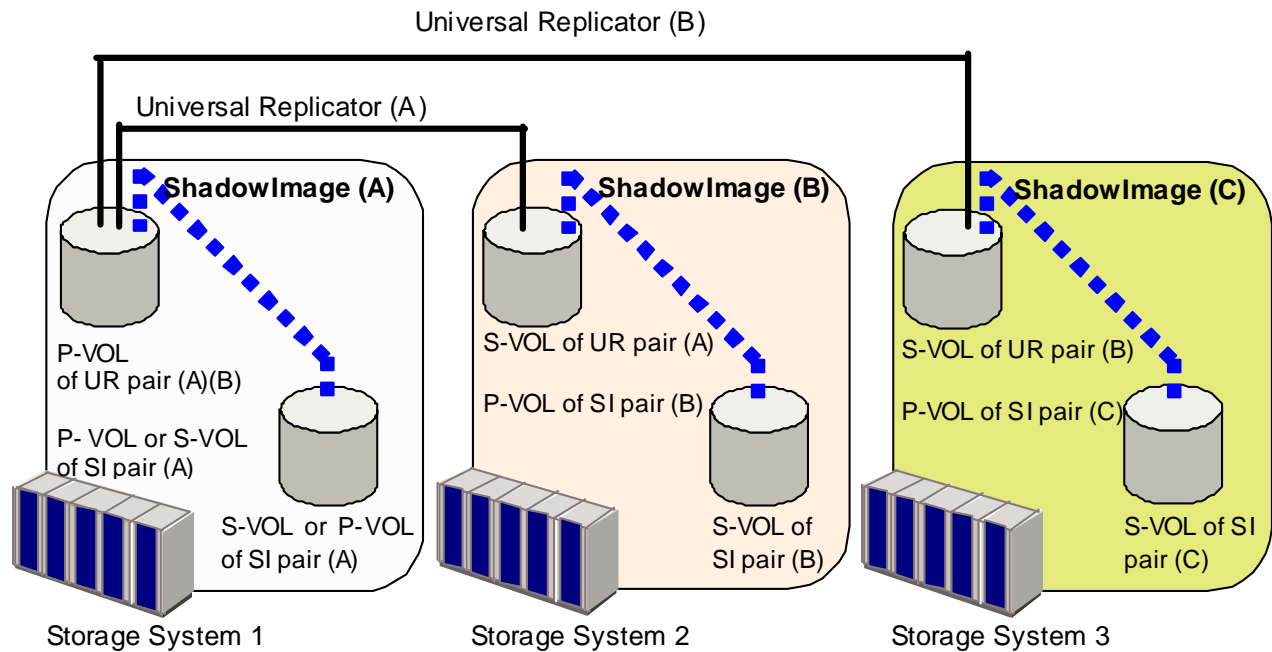


Figure 3-12 ShadowImage and Universal Replicator 3DC Multi-target Configuration

The availability of the ShadowImage operations for each pair status of a Universal Replicator pair in the storage system 1 is shown in the following.

Table 3-7 Availability of ShadowImage (A) Operation in Case Where P-VOL of ShadowImage Pair Is Used in Combination with Universal Replicator Pairs (A), (B)

UR(A) Pair Status	UR(B) Pair Status	ShadowImage Operation							
		Pair create	Pair split	Pairsplit- E	Pairsplit- S	Pairresync			
						Normal Copy	Quick Resync	Reverse Copy	Quick Restore

UR(A) Pair Status	UR(B) Pair Status	ShadowImage Operation							
		Pair create	Pair split	Pairsplit- E	Pairsplit- S	Pairresync			
						Normal Copy	Quick Resync	Reverse Copy	Quick Restore
PAIR	PAIR	OK	OK	OK	OK	OK	OK	NO	NO
COPY		OK	OK	OK	OK	OK	OK	NO	NO
PSUS *		OK	OK	OK	OK	OK	OK	NO	NO
PAIR	COPY	OK	OK	OK	OK	OK	OK	NO	NO
COPY		-	-	-	-	-	-	-	-
PSUS *		OK	OK	OK	OK	OK	OK	NO	NO
PAIR	PSUS *	OK	OK	OK	OK	OK	OK	NO	NO
COPY		OK	OK	OK	OK	OK	OK	NO	NO
PSUS *		OK	OK	OK	OK	OK	OK	OK	NO

*: Includes SSWS

Table 3-8 Availability of ShadowImage (A) Operation in Case Where S-VOL of ShadowImage Pair Is Used in Combination with Universal Replicator Pairs (A), (B)

UR(A) Pair Status	UR(B) Pair Status	ShadowImage Operation							
		Pair create	Pair split	Pairsplit- E	Pairsplit- S	Pairresync			
						Normal Copy	Quick Resync	Reverse Copy	Quick Restore
PAIR	PAIR	NO	NO	OK	OK	NO	NO	NO	NO
COPY		NO	NO	OK	OK	NO	NO	NO	NO
PSUS *		NO	NO	OK	OK	NO	NO	NO	NO
PAIR	COPY	NO	NO	OK	OK	NO	NO	NO	NO
COPY		-	-	-	-	-	-	-	-
PSUS *		NO	NO	OK	OK	NO	NO	NO	NO
PAIR	PSUS *	NO	NO	OK	OK	NO	NO	NO	NO
COPY		NO	NO	OK	OK	NO	NO	NO	NO
PSUS *		NO	OK	OK	OK	OK	OK	OK	NO

*: Includes SSWS

The availability of the ShadowImage operations for each pair status of a Universal Replicator pair in the storage system 2 is shown in the following.

Table 3-9 Availability of ShadowImage (B) Operation in Case Where P-VOL of ShadowImage Pair Is Used in Combination with Universal Replicator Pair (A)

UR(A)	ShadowImage Operation
-------	-----------------------

	Pair create	Pair split	Pairsplit-E	Pairsplit-S	Pairresync			
					Normal Copy	Quick Resync	Reverse Copy	Quick Restore
PAIR	OK	OK	OK	OK	OK	OK	NO	NO
COPY	OK	OK	OK	OK	OK	OK	NO	NO
PSUS *	OK	OK	OK	OK	OK	OK	OK	OK

*: Includes SSWS

The availability of the ShadowImage operations for each pair status of a Universal Replicator pair in the storage system 3 is shown in the following.

Table 3-10 Availability of ShadowImage (C) Operation in Case Where P-VOL of ShadowImage Pair is Used in Combination with Universal Replicator Pair (B)

UR(B) Pair Status	ShadowImage Operation							
	Pair create	Pair split	Pairsplit-E	Pairsplit-S	Pairresync			
					Normal Copy	Quick Resync	Reverse Copy	Quick Restore
PAIR	OK	OK	OK	OK	OK	OK	NO	NO
COPY	OK	OK	OK	OK	OK	OK	NO	NO
PSUS *	OK	OK	OK	OK	OK	OK	OK	OK

*: Includes SSWS

Universal Replicator 3DC Multi-target, and Delta Resync Configurations

A configuration example of a case where ShadowImage and Universal Replicator 3DC multi-target, and delta resync configurations are used in combination is shown.

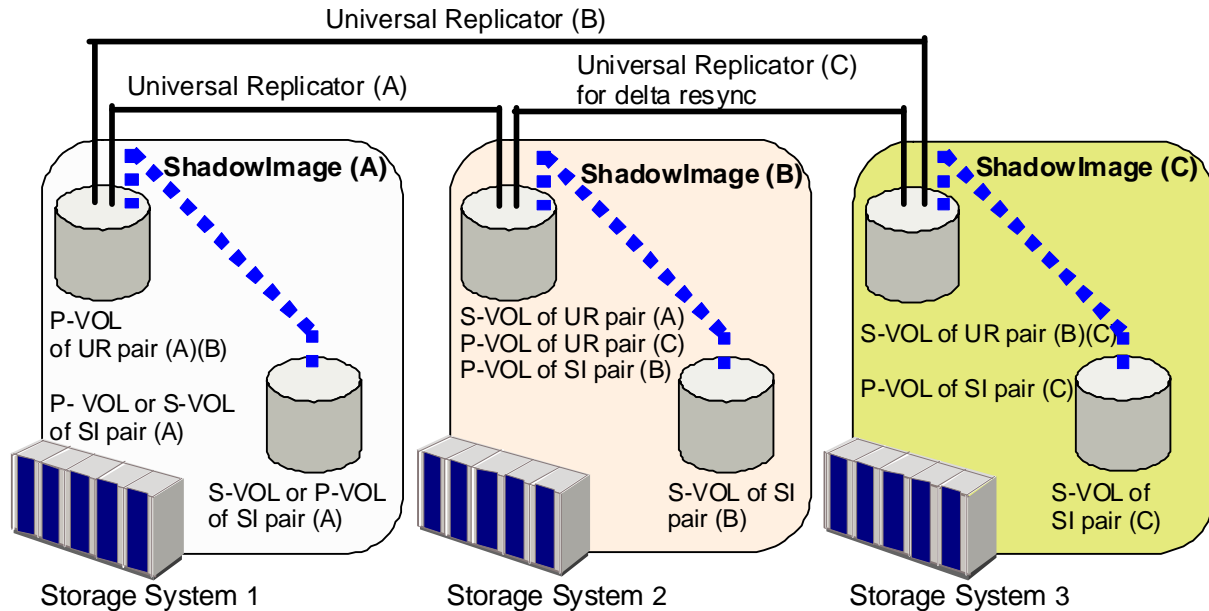


Figure 3-13 ShadowImage and Universal Replicator 3DC Multi-target and Delta Resync Configurations

The availability of the ShadowImage operations for each pair status of a Universal Replicator pair in the storage system 1 is shown in the following.

Table 3-11 Availability of ShadowImage (A) Operation in Case Where P-VOL of ShadowImage Pair Is Used in Combination with Universal Replicator Pairs (A), (B)

UR(A) Pair Status	UR(B) Pair Status	ShadowImage Operation							
		Pair create	Pair split	Pairsplit- E	Pairsplit- S	Pairresync			
						Normal Copy	Quick Resync	Reverse Copy	Quick Restore
PAIR	PAIR	OK	OK	OK	OK	OK	OK	NO	NO
COPY		OK	OK	OK	OK	OK	OK	NO	NO
PSUS *		OK	OK	OK	OK	OK	OK	NO	NO
PAIR	COPY	OK	OK	OK	OK	OK	OK	NO	NO
COPY		-	-	-	-	-	-	-	-
PSUS *		OK	OK	OK	OK	OK	OK	NO	NO
PAIR	PSUS *	OK	OK	OK	OK	OK	OK	NO	NO
COPY		OK	OK	OK	OK	OK	OK	NO	NO
PSUS *		OK	OK	OK	OK	OK	OK	OK	NO

*: Includes SSWS

Table 3-12 Availability of ShadowImage (A) Operation in Case Where S-VOL of ShadowImage Pair Is Used in Combination with Universal Replicator Pairs (A), (B)

UR(A) Pair Status	UR(B) Pair Status	ShadowImage Operation							
		Pair create	Pair split	Pairsplit- E	Pairsplit- S	Pairresync			
						Normal Copy	Quick Resync	Reverse Copy	Quick Restore
PAIR	PAIR	NO	NO	OK	OK	NO	NO	NO	NO
COPY		NO	NO	OK	OK	NO	NO	NO	NO
PSUS *		NO	NO	OK	OK	NO	NO	NO	NO
PAIR	COPY	NO	NO	OK	OK	NO	NO	NO	NO
COPY		-	-	-	-	-	-	-	-
PSUS *		NO	NO	OK	OK	NO	NO	NO	NO
PAIR	PSUS *	NO	NO	OK	OK	NO	NO	NO	NO
COPY		NO	NO	OK	OK	NO	NO	NO	NO
PSUS *		NO	OK	OK	OK	OK	OK	OK	NO

*: Includes SSWS

The availability of the ShadowImage operations for each pair status of a Universal Replicator pair in the storage system 2 is shown in the following.

Table 3-13 Availability of ShadowImage (B) Operation in Case Where P-VOL of ShadowImage Pair Is Used in Combination with Universal Replicator Pairs (A), (C)

UR(A) Pair Status	Status of UR(C) Pair for Delta Resync Operation	ShadowImage Operation							
		Pair create	Pair split	Pairsplit- E	Pairsplit- S	Pairresync			
						Normal Copy	Quick Resync	Reverse Copy	Quick Restore
PAIR	HOLD/ HLDE	OK	OK	OK	OK	OK	OK	NO	NO
COPY		OK	OK	OK	OK	OK	OK	NO	NO
PSUS *		OK	OK	OK	OK	OK	OK	NO	NO

*: Includes SSWS

The availability of the ShadowImage operations for each pair status of a Universal Replicator pair in the storage system 3 is shown in the following.

Table 3-14 Availability of ShadowImage (C) Operation in Case Where P-VOL of ShadowImage Pair Is Used in Combination with Universal Replicator Pairs (B), (C)

UR(B) Pair Status	Status of UR(C) Pair for Delta Resync Operation	ShadowImage Operation							
		Pair create	Pair split	Pairsplit- E	Pairsplit- S	Pairresync			
						Normal Copy	Quick Resync	Reverse Copy	Quick Restore
PAIR	HOLD/ HLDE	OK	OK	OK	OK	OK	OK	NO	NO
COPY		OK	OK	OK	OK	OK	OK	NO	NO
PSUS *		OK	OK	OK	OK	OK	OK	NO	NO

*: Includes SSWS

Universal Replicator 3DC Cascade Configuration

A configuration example of a case where ShadowImage and Universal Replicator 3DC cascade configuration are used in combination is shown.

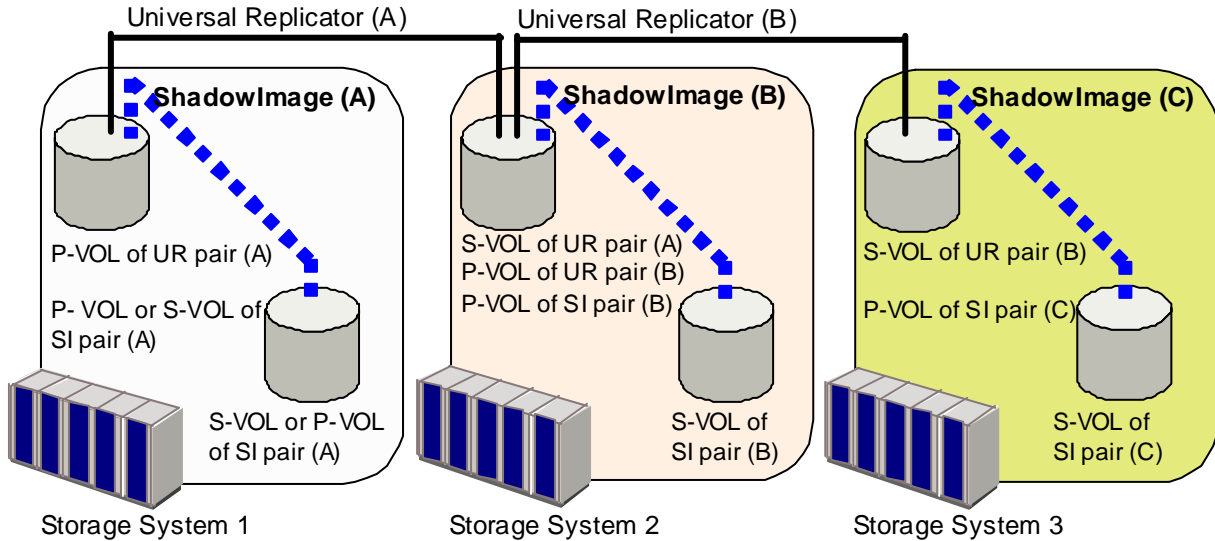


Figure 3-14 ShadowImage and Universal Replicator Cascade Configuration

The availability of the ShadowImage operations for each pair status of a Universal Replicator pair in the storage system 1 is shown in the following.

Table 3-15 Availability of ShadowImage (A) Operation in Case Where P-VOL of ShadowImage Pair Is Shared with Universal Replicator Pair (A)

UR(A) Pair Status	ShadowImage Operation							
	Pair create	Pair split	Pairsplit- E	Pairsplit- S	Pairresync			
					Normal Copy	Quick Resync	Reverse Copy	Quick Restore
PAIR	OK	OK	OK	OK	OK	OK	NO	NO
COPY	OK	OK	OK	OK	OK	OK	NO	NO
PSUS *	OK	OK	OK	OK	OK	OK	OK	OK

*: Includes SSWS

Table 3-16 Availability of ShadowImage (A) Operation in Case Where S-VOL of ShadowImage Pair Is Shared with Universal Replicator Pair (A)

UR(A) Pair Status	ShadowImage Operation							
	Pair create	Pair split	Pairsplit- E	Pairsplit- S	Pairresync			
					Normal Copy	Quick Resync	Reverse Copy	Quick Restore
PAIR	NO	NO	OK	OK	NO	NO	NO	NO
COPY	NO	NO	OK	OK	NO	NO	NO	NO
PSUS *	NO	OK	OK	OK	OK	OK	OK	OK

*: Includes SSWS

The availability of the ShadowImage operations for each pair status of a Universal Replicator pair in the storage system 2 is shown in the following.

Table 3-17 Availability of ShadowImage (B) Operation in Case Where P-VOL of ShadowImage Pair Is Shared with Universal Replicator Pairs (A), (B)

UR(A) Pair Status	UR(B) Pair Status	ShadowImage Operation							
		Pair create	Pair split	Pairsplit- E	Pairsplit- S	Pairresync			
						Normal Copy	Quick Resync	Reverse Copy	Quick Restore
PAIR	PAIR	OK	OK	OK	OK	OK	OK	NO	NO
COPY		OK	OK	OK	OK	OK	OK	NO	NO
PSUS *		OK	OK	OK	OK	OK	OK	NO	NO
PAIR	COPY	OK	OK	OK	OK	OK	OK	NO	NO
COPY		-	-	-	-	-	-	-	-
PSUS *		OK	OK	OK	OK	OK	OK	NO	NO
PAIR	PSUS *	OK	OK	OK	OK	OK	OK	NO	NO
COPY		OK	OK	OK	OK	OK	OK	NO	NO
PSUS *		OK	OK	OK	OK	OK	OK	OK	NO

*: Includes SSWS

The availability of the ShadowImage operations for each pair status of a Universal Replicator pair in the storage system 3 is shown in the following.

Table 3-18 Availability of ShadowImage (C) Operation in Case Where P-VOL of ShadowImage Pair Is Shared with Universal Replicator Pair (B)

UR(B) Pair Status	ShadowImage Operation							
	Pair create	Pair split	Pairsplit- E	Pairsplit- S	Pairresync			
					Normal Copy	Quick Resync	Reverse Copy	Quick Restore
PAIR	OK	OK	OK	OK	OK	OK	NO	NO
COPY	OK	OK	OK	OK	OK	OK	NO	NO
PSUS *	OK	OK	OK	OK	OK	OK	OK	OK

*: Includes SSWS

ShadowImage and Universal Replicator 3DC Cascade, and Delta Resync Configurations

A configuration example of a case where ShadowImage and Universal Replicator 3DC cascade, and delta resync configurations are used in combination is shown.

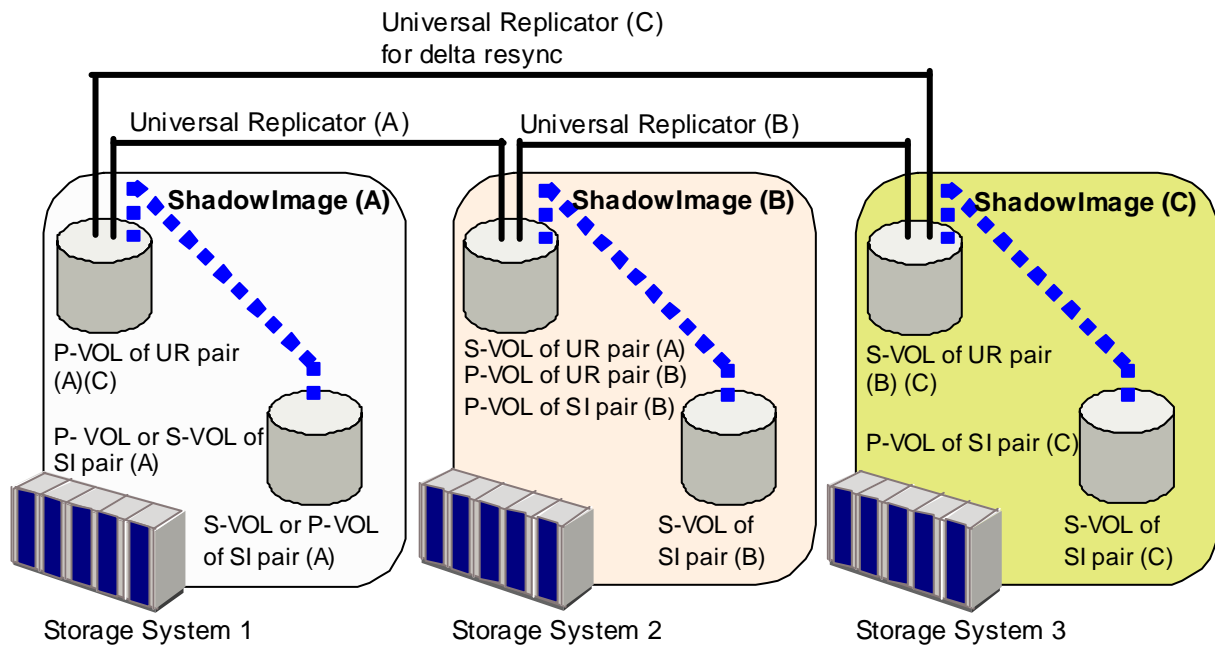


Figure 3-15 ShadowImage and Universal Replicator 3DC Cascade and Delta Resync Configurations

The availability of the ShadowImage operations for each pair status of a Universal Replicator pair in the storage system 1 is shown in the following.

Table 3-19 Availability of ShadowImage (A) Operation in Case Where P-VOL of ShadowImage Pair Is Shared with Universal Replicator Pair (A), (C)

UR(A) Pair Status	Status of UR(C) Pair for Delta Resync Operation	ShadowImage Operation							
		Paircreate	Pairsplit	Pairsplit-E	Pairsplit-S	Pairresync			
						Normal Copy	Quick Resync	Reverse Copy	Quick Restore
PAIR	HOLD/ HLDE	OK	OK	OK	OK	OK	OK	NO	NO
COPY		OK	OK	OK	OK	OK	OK	NO	NO
PSUS *		OK	OK	OK	OK	OK	OK	NO	NO

*: Includes SSWS

Table 3-20 Availability of ShadowImage (A) Operation in Case Where S-VOL of ShadowImage Pair Is Shared with Universal Replicator Pairs (A), (C)

UR(A) Pair Status	Status of UR(C) Pair for Delta Resync Operation	ShadowImage Operation							
		Pair create	Pair split	Pairsplit-E	Pairsplit-S	Pairresync			
						Normal Copy	Quick Resync	Reverse Copy	Quick Restore
PAIR	HOLD/ HLDE	NO	NO	OK	OK	NO	NO	NO	NO
COPY		NO	NO	OK	OK	NO	NO	NO	NO
PSUS *		NO	NO	OK	OK	NO	NO	NO	NO

*: Includes SSWS

The availability of the ShadowImage operations for each pair status of a Universal Replicator pair in the storage system 2 is shown in the following.

Table 3-21 Availability of ShadowImage (B) Operation in Case Where P-VOL of ShadowImage Pair Is Shared with Universal Replicator Pairs (A), (B)

UR(A) Pair Status	UR(B) Pair Status	ShadowImage Operation							
		Paircreate	Pairsplit	Pairsplit-E	Pairsplit-S	Pairresync			
						Normal Copy	Quick Resync	Reverse Copy	Quick Restore
PAIR	PAIR	OK	OK	OK	OK	OK	OK	NO	NO
COPY		OK	OK	OK	OK	OK	OK	NO	NO
PSUS *		OK	OK	OK	OK	OK	OK	NO	NO
PAIR	COPY	OK	OK	OK	OK	OK	OK	NO	NO
COPY		-	-	-	-	-	-	-	-
PSUS *		OK	OK	OK	OK	OK	OK	NO	NO
PAIR	PSUS *	OK	OK	OK	OK	OK	OK	NO	NO
COPY		OK	OK	OK	OK	OK	OK	NO	NO
PSUS *		OK	OK	OK	OK	OK	OK	OK	NO

*: Includes SSWS

The availability of the ShadowImage operations for each pair status of a Universal Replicator pair in the storage system 3 is shown in the following.

Table 3-22 Availability of ShadowImage (C) Operation in Case Where P-VOL of ShadowImage Pair Is Shared with Universal Replicator Pairs (B), (C)

UR(B) Pair Status	Status of UR(C) Pair for Delta Resync Operation	ShadowImage Operation							
		Pair create	Pair split	Pairsplit-E	Pairsplit-S	Pairresync			
						Normal Copy	Quick Resync	Reverse Copy	Quick Restore
PAIR	HOLD/ HLDE	OK	OK	OK	OK	OK	OK	NO	NO
COPY		OK	OK	OK	OK	OK	OK	NO	NO
PSUS *		OK	OK	OK	OK	OK	OK	NO	NO

*: Includes SSWS

Dynamic Provisioning

Table 3-8 describes the available sharing pattern of the ShadowImage and Dynamic Provisioning volumes.

Table 3-8 Combination of the Volumes when you Specify Dynamic Provisioning Volume as a P-VOL or an S-VOL

P-VOL	S-VOL	Combination
Dynamic Provisioning volume	Dynamic Provisioning volume	OK
Dynamic Provisioning volume	Normal volume	OK*1
Normal volume	Dynamic Provisioning volume	OK*1*2
*1 You cannot perform quick restore operation on the pair of this volume combination.		
*2 Since this combination consumes the same amount of the pool capacity as the normal volume (i.e., P-VOL) capacity, this combination is not recommended.		

If you specify a Dynamic Provisioning V-VOL (DP-VOL) as a ShadowImage P-VOL, S-VOL, or a reserved volume, you cannot perform the ShadowImage pair operation while the DP-VOL capacity is being increased. Table 3-9 describes the relation between the increase of the DP-VOL capacity and ShadowImage pair operations.

Table 3-9 Relation between Increase of DP-VOL Capacity and ShadowImage Pair Operations

ShadowImage P-VOL		ShadowImage S-VOL		ShadowImage Pair Operations		
Volumes	Increase of Capacity	Volumes	Increase of Capacity	Pair Create	Pair split, Suspend Pair, or Delete Pair	Resynchronize Pair
DP-VOL	The capacity is increasing.	DP-VOL	The capacity is increasing.	NG*1	NG*2	NG*2
			The capacity has already been increased or never been increased.	NG*1	NG*2	NG*2
		Normal volume	None	NG*1	NG*2	NG*2
	The capacity has already been increased or never been increased.	DP-VOL	The capacity is increasing.	NG*1	NG*2	NG*2
			The capacity has already been increased, or never been increased.	OK	OK	OK
		Normal volume	None	OK	OK	OK, but the Quick Restore operation cannot be performed.

ShadowImage P-VOL		ShadowImage S-VOL		ShadowImage Pair Operations		
Volumes	Increase of Capacity	Volumes	Increase of Capacity	Pair Create	Pair split, Suspend Pair, or Delete Pair	Resynchronize Pair
Normal volume	None	DP-VOL	The capacity is increasing.	NG*1	NG*2	NG*2
			The capacity has already been increased or never been increased.	OK	OK	OK, but the Quick Restore operation cannot be performed.
		Normal volume	None	OK	OK	OK

Notes:

*1 Confirm that the capacity has already been increased and that the ShadowImage P-VOL has the same capacity as the ShadowImage S-VOL, then perform ShadowImage pair operations.

*2 ShadowImage pairs cannot be created while the DP-VOL capacity is increasing. The capacity of the volumes in ShadowImage pair cannot be increased. Therefore, the volumes whose capacities are increasing are not in a ShadowImage pair.

Table 3-10 Relation between Increase of DP-VOL Capacity and Reserve Volume Operations

Target Volumes		ShadowImage Reserve Volume Operations	
Volumes	Increase of Capacity	Set Reserve Attribute	Release Reserve Attribute
DP-VOL	The capacity is increasing.	NG*1	NG*2
	The capacity has already been increased, or never been increased.	OK	OK
Normal volume*3	None	OK	OK

Notes:

*1 Confirm that the capacity has already been increased, then specify the reserve attribute again.

*2 Reserve attribute cannot be specified while the DP-VOL capacity is increasing. You cannot increase the capacity of the volumes to which the reserve attribute is set. Therefore, reserve attribute is not set to the volume whose capacity is increasing.

*3 Normal volume indicates an internal volume or an external volume that is not specified as a Dynamic Provisioning volume. Note that an external volume means an internal volume which is mapped to an external volume by Universal Volume Manager.

For information about the licensed capacity that you need to know if you specify a Dynamic Provisioning volume as a ShadowImage P-VOL or S-VOL, see License Requirements.

VERITAS® NetBackup DataCenter™

The VERITAS NetBackup DataCenter may be integrated with ShadowImage for performing centralized and automated “split mirror”, “zero-downtime” backups. This integration provides automated control of server-free data movement and allows a point-in-time volume copy to be split and backed up directly from disk to tape, and then resynchronized with a primary volume.

For further information on the ShadowImage and VERITAS NetBackup DataCenter, please contact your Hitachi Data Systems account team.

Preparing for ShadowImage Operations

This chapter describes requirements for using ShadowImage, installation procedure of ShadowImage, and calculation of the number of pairs that ShadowImage can create. Please read this chapter before you start the ShadowImage operation.

- [System Requirements](#)
- [Assessing Requirements](#)
- [Requirements for Maintaining ShadowImage](#)
- [Installing ShadowImage](#)
- [Starting ShadowImage](#)

System Requirements

ShadowImage operations involve the USP V/VM storage system containing the primary and secondary volumes and the licensed ShadowImage program product enabled on the Storage Navigator. The system requirements for ShadowImage are as follows.

Volume Requirements

The requirements for the volumes to be used as ShadowImage pairs are as follows:

- RAID level

The RAID level combinations of the P-VOL and the S-VOL of a ShadowImage pair must be one of the following.

Table 4-1 Supported Combinations of RAID Levels

P-VOL	S-VOL		
	RAID1	RAID5	RAID6
RAID1	OK	OK	OK
RAID5	OK	OK	OK
RAID6	OK	OK	OK

- Types of volumes

Besides normal volumes, you can use external volumes, custom-sized volumes, and LUSE volumes. When using external volumes, custom-sized volumes, or LUSE volumes, please note the following points:

- External volumes

The license of Universal Volume Manager is required.

- Custom-sized volumes

The license of VLL is required. To create a ShadowImage pair with custom-sized volumes, P-VOL must be paired with S-VOLs of the same capacity and the same emulation type.

- LUSE volumes

The license of LUSE is required. To create a ShadowImage pair with LUSE volumes, ensure that P-VOL is paired with S-VOL of the same size and the same structure. For example, if the P-VOL is a LUSE volume where volumes of 1 GB, 2 GB, and 3 GB are combined in this order, you must ensure that the S-VOL is a LUSE volume where volumes of 1 GB, 2 GB, and 3 GB are combined in the same order.

- Emulation type

Only volumes of the following emulation types can be used: OPEN-3, OPEN-8, OPEN-9, OPEN-E, OPEN-K, OPEN-L, OPEN-V, or NFOP-K.

- Logical DKC (LDKC), CU, LDEV number
You can use volumes whose LDKC:CU:LDEV (a combination of an LDKC number, a CU number, and an LDEV number) is within the range of 00:00:00 to 00:FE:FF, or 01:00:00 to 01:FE:FF.
- MU number
In case of L1 pair, you can use 0, 1, or 2 as an MU number. In case of L2 pair, you can use 1 or 2 as an MU number.
- Number of S-VOLs per one P-VOL
You can assign up to three S-VOLs to one P-VOL when creating an L1 pair. When creating an L2 pair, you can assign up to two S-VOLs to one P-VOL. However, you cannot assign two or more P-VOLs to one S-VOL.
- Maximum number of pairs
Up to 16,384 ShadowImage pairs can be created (when P-VOLs and S-VOLs are in a one-to-one relationship). If the LUSE volumes are included in ShadowImage pairs, the maximum number of pairs decreases.

If the above requirements are fulfilled, the following volumes cannot be used for creating ShadowImage pairs.

- Journal volumes of Universal Replicator
- Virtual volumes (except Dynamic Provisioning volumes)
- Pool volumes

For details about combining volume of Copy-on-Write Snapshot pair and volume of ShadowImage pair, see the *Copy-on-Write Snapshot User's Guide*.

ShadowImage Software Requirements

To use ShadowImage, all USP V/VM hardware, microcode, and software required for ShadowImage operations must be installed and enabled. You also need to purchase the license key of ShadowImage and install it in the storage system. For detailed information about the license key and software installation, see the *Storage Navigator User's Guide*.

Note that you must operate the Storage Navigator in modify mode to perform ShadowImage operations. Users in view mode can only view ShadowImage information, but they cannot create new pairs or change the pair status. For information about how to set up and use the Storage Navigator computer, see the *Storage Navigator User's Guide*.

System Option Modes

To provide greater flexibility, the USP V/VM storage system has additional operational parameters called *system option modes* (SOMs) that allow you to tailor the USP V/VM to your unique operating requirements. The SOMs are set on the service processor (SVP) by your Hitachi Data Systems representative.

Table 4-2 lists and describes the SOMs that apply to ShadowImage:

- **SOM:** SOM number
- **Category:** Functions to which the SOM applies
- **Description:**
 - Function that the SOM provides
 - Default setting (ON or OFF)

For a complete list of all SOMs for the USP V/VM, see the *User and Reference Guide*. Work with your Hitachi Data Systems team to make sure the appropriate SOMs are set on your storage system.



Note: The SOM information may have changed since this document was published. Contact your Hitachi Data Systems team for the latest SOM information.

Table 4-2 SOMs for ShadowImage

SOM	Category	Description
87	ShadowImage	Determines whether Normal Copy or Quick Resync, if not specified, is used when the CCI pairresync command is executed. ON: Quick Resync is performed. OFF (default): Normal Copy is performed.
459	ShadowImage ShadowImage for z/OS	PAIR → PSUS(SP) → PSUS: This SOM function is running at copy pending from P-VOL to S-VOL, such as PSUS(SP) → PSUS. This SOM works under the following conditions: <ul style="list-style-type: none"> ▪ The ShadowImage S-VOL is an external volume ▪ SI: COPY(SP) → PSUS SIz: SP-Pend → Split ▪ SI: PSUS(SP) → PSUS SIz: V-Split → Split ON: Waits for cache memory to completely destage the delta data to the S-VOL external volume before changing pair status to PSUS/Split. OFF (default): The status changes to PSUS/Split as soon as all the delta data is copied to S-VOL cache. The status does not wait for cache to destage to the S-VOL external volume.

SOM	Category	Description
460	TrueCopy TrueCopy for z/OS ShadowImage ShadowImage for z/OS Universal Replicator Universal Replicator for z/OS Volume Migration FlashCopy V1, v2 Copy-on-Write Snapshot Dynamic Provisioning	<p>Backup and recovery of control information of certain products from the SVP when the storage system is powered OFF for more than 72 hours.</p> <p>When power is turned off, the control information (in shared memory) of certain products is backed up on the SVP. After that, when volatile power ON is performed, the control information is restored into shared memory from the SVP.</p> <p>MCU/RCU: This SOM applies to both the MCU and the RCU.</p> <p>ON: Set this SOM to ON when using TC, TCz, SI, SIz, VM, FCv1, FCv2, UR, URz, COW Snapshot, or DP.</p> <p>OFF (default): Disabled</p> <p>Notes:</p> <ol style="list-style-type: none"> 1. When this SOM is ON, the completion time of power OFF for shared memory backup, or the completion time of volatile power ON after shared memory recovery, is up to 30 minutes. 2. When using power monitoring devices (such as PCI), the monitoring time for power OFF/ON must be set to the maximum of 30 minutes. 3. When the storage system is powered off automatically in a power outage while destage mode is ON, shared memory is not backed up on the SVP even when this SOM is ON. 4. For Dynamic Provisioning: The DP management information is stored in a dedicated area in the pool in case data is lost from shared memory. However, restoring the data from the dedicated area in the pool may take more time than restoring the data from the SVP. Therefore, setting this SOM to ON is recommended to enable data backup and recovery functions from the SVP.
467	ShadowImage ShadowImage for z/OS FlashCopy Copy-on-Write Snapshot Volume Migration Universal Volume Manager	<p>Controls the copy threshold to slow down copy processing to provide overload protection so that host I/O performance is not affected.</p> <p>Copy processing slows down when the percentage of "dirty" data is 60% or higher, and it stops when the percentage is 75% or higher. This happens when using these replication products: ShadowImage, ShadowImage for z/OS, FlashCopy, Copy-on-Write SnapShot, Volume Migration, Universal Volume Manager.</p> <p>This SOM is provided to prevent the percentage from exceeding 60% so that host performance is not affected.</p> <p>ON (default): Enables copy overload prevention. Copy processing stops when the percentage of "dirty" data reaches 60% or higher. When the percentage falls below 60%, copy processing restarts.</p> <p>OFF: Normal operation. Copy processing slows down if the dirty percentage is 60% or larger, and it stops if the dirty percentage is 75% or larger.</p> <p>Caution: This SOM must always be set to ON when using an external volume as the secondary volume of any of the above-mentioned replication products.</p> <p>Notes:</p> <ul style="list-style-type: none"> ▪ It takes longer to finish the copy processing because it stops for prioritizing the host I/O performance. ▪ This SOM supports background copy only. This SOM does not support the processing to copy the pre-update data to the S-VOL, which occurs when overwriting data to un-copied slots of P-VOL in Split processing or reading or writing data to un-copied slots of S-VOL.

SOM	Category	Description
491	ShadowImage ShadowImage for z/OS FlashCopy V1	<p>Improves the performance of copy processing.</p> <p>ON: The option (Reserve 05) of SI/SIz is available. When this SOM is ON, copy operations (SI, SIz, FCv1) are increased from 64 processes to 128 processes for improved performance.</p> <p>OFF (default): The option (Reserve 05) of SI/SIz is not available. Copy operations (SI, SIz, FCv1) are performed with 64 processes.</p> <p>Notes:</p> <ol style="list-style-type: none"> 1. This SOM requires at least three BED features. If there are less than three BED features, this SOM is not effective. 2. Enable this SOM when the performance of ShadowImage, ShadowImage for z/OS, or is considered to be important. 3. Do not enable this SOM when host I/O performance is important. 4. When this SOM is ON, set SOM 467 to OFF. If SOM 467 is ON, the performance may not improve.
697	TrueCopy Async TrueCopy for z/OS Async ShadowImage ShadowImage for z/OS	<p>Controls whether to prevent the SI split command execution when the coordinated TCA pair status is suspend and its consistency state is not guaranteed.</p> <p>MCU/RCU: This SOM applies to both the MCU and the RCU.</p> <p>ON: SI split is not executed when the coordinated TCA pair status is suspend and its consistency state is not guaranteed.</p> <p>OFF (default): SI split is executed regardless of the pair status or consistency state of the coordinated TCA.</p> <p>Note: This SOM should be applied only to prevent SI split when the following conditions 1 and 2, or 1 and 3 are met.</p> <ol style="list-style-type: none"> 5. The TCA S-VOL and SI P-VOL coexist (for mainframe or open). 6. The TCA pair that is coordinated with SI is not in suspend. 7. The TCA that is coordinated with SI is in suspend, and its consistency state is not current.
704	ShadowImage ShadowImage for z/OS Volume Migration Copy-on-Write Snapshot FlashCopy Resync copy	<p>Controls whether copy processing is registered into a new queue or an existing queue.</p> <p>To reduce the chance of MIH, use this SOM to lower the priority of copy processing so that host I/O has a higher priority. This SOM creates new work queues where these jobs can be assigned with a lower priority.</p> <p>ON: Copy processing requested is registered into a new queue so that the processing is scheduled with a lower priority than host I/O.</p> <p>OFF (default): Copy processing requested is not registered into a new queue. The existing queue is used.</p> <p>Note: If the PDEV is highly loaded, the priority of read/write copy processing may become lower. As a consequence the copy speed may be slower.</p>
714	TrueCopy Async TrueCopy for z/OS Async ShadowImage ShadowImage for z/OS Volume Migration	<p>Accepts or rejects a Quick Restore or Volume Migration request.</p> <p>MCU/RCU: This SOM applies to both the MCU and the RCU.</p> <p>ON: When TCA is coordinated with SI or VM, a request for Quick Restore or Volume Migration is accepted regardless of the CLPR number of the Quick Restore P-VOL and S-VOL or the Volume Migration source and target volumes.</p> <p>OFF (default): When TCA is coordinated with SI or VM, a request for Quick Restore or Volume Migration is rejected if the CLPR number is not the same as the CLPR number of the Quick Restore P-VOL and S-VOL or the Volume Migration source and target volumes.</p> <p>Note: Apply this SOM when canceling the prevention of the request (1) or (2) below.</p> <ol style="list-style-type: none"> (1) A Quick Restore operation is requested when the P-VOL and S-VOL of SI that is coordinated with TCA have a different CLPR number. (2) A Volume Migration request when the source and target volumes have a different CLPR number from the migration source volume also used as a TCA volume.

SOM	Category	Description
727	ShadowImage ShadowImage for z/OS FlashCopy V1, V2 Volume Migration Copy-on-Write Snapshot Dynamic Provisioning	<p>Controls whether control information for local copy products that resides in shared memory is saved and recovered to a system disk when power to the storage system is turned OFF.</p> <p>ON: The control information in shared memory is automatically saved to a system disk for use after power off. A system disk is required to use this setting.</p> <p>If shared memory is volatilized and recovery of the control information from the SVP fails when power is restored following power off, recovery of the control information from the system disk to shared memory is implemented.</p> <p>OFF (default): Automatic save and recovery of control information using a system disk is not available.</p> <p>Notes:</p> <ol style="list-style-type: none"> 1. Set this SOM to ON when the following local copy products are used and you want to save and recover control information for these products: SI, SIz, FCv1, FCv2, Volume Migration, COW Snapshot, or Dynamic Provisioning. 2. Set this SOM to ON after preparing a normal system disk that has more than 7.744 MB available capacity (9,082 cylinders for 3390 format). If Define Configuration & Install is performed at the SVP, set this SOM to ON after formatting the system disk. 3. Review the timeout settings on connected systems when this SOM is ON, because power ON/OFF can take up to 15 minutes longer than when this SOM is OFF. 4. You can also set this SOM to ON or OFF using Virtual LVI/LUN (Additional Configuration Back Up setting on the System Disk Options dialog box).
733	ShadowImage ShadowImage for z/OS Volume Migration	<p>Allows or suspends Volume Migration or Quick Restore operation during LDEV-related maintenance. This is for functional improvement to avoid maintenance failure.</p> <p>ON: Suspends operation of Volume Migration or Quick Restore during LDEV-related maintenance.</p> <p>OFF (default): Allows operation of Volume Migration or Quick Restore during LDEV-related maintenance.</p> <p>Notes:</p> <ol style="list-style-type: none"> 1. Use this SOM to suspend operation of Volume Migration or Quick Restore during LDEV-related maintenance. 2. When this SOM is ON, the time to complete Volume Migration or Quick Restore copy increases. If virtual volume capacity expansion operation conflicts with Volume Migration or Quick Restore operation, the virtual volume capacity expansion operation may fail. 3. Setting this SOM to ON is recommended, because operations from Storage Navigator may be disabled when a problem occurs. 4. If this SOM is not set to ON, maintenance ends in failure if Volume Migration or Quick Restore is active while LDEV-related maintenance is being performed.

License Requirements

ShadowImage license capacity will be required for ShadowImage P-VOLs, S-VOLs, and reserved volumes. In addition, P-VOLs and pool volumes that are used by Copy-on-Write Snapshot will require the ShadowImage license capacity. You need to make sure that the ShadowImage license capacity will be larger than the total capacity of these volumes when you decide the ShadowImage license capacity.

When a volume is used for multiple purposes, only the capacity of this volume is added to the total volume capacity. There is no need to multiply the capacity of this volume by the number of purposes it is used for. For example, if you specify a volume as an S-VOL, and use it as a reserved volume by setting its reserve attribute, only the capacity of the volume itself is added to the total volume capacity and there is no need for it to be doubled.



Caution: If you specify a Dynamic Provisioning volume as a P-VOL or an S-VOL, the capacity of the pool used by the Dynamic Provisioning volume will require the ShadowImage license capacity. Information of the license capacity of Dynamic Provisioning volumes is not updated in real time. Therefore, certain write request may cause the data excess. Prepare the license capacity corresponding to the pool capacity when you are going to use the Dynamic Provisioning volumes.

If the amount of data exceeds the license capacity, you can use the volumes for additional 30 days. Once 30 days have passed, you cannot perform ShadowImage operations except deleting pairs.

The following case examples should help you calculate the total capacity of ShadowImage volumes that will be used. The capacity of each volume is assumed to be 1. The colored volume or volumes represent the volumes that are used.

Figure 4-1 illustrates one reserved volume and one unreserved volume.



Figure 4-1 Total Capacity of ShadowImage Volumes (Example 1)

In Figure 4-1, the total capacity of ShadowImage volume in use will be 1.

Figure 4-2 illustrates one ShadowImage pair.

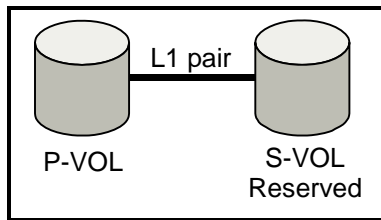


Figure 4-2 Total Capacity of ShadowImage Volumes (Example 2)

In Figure 4-2, the total capacity of ShadowImage volumes in use will be 2.

Figure 4-3 illustrates ShadowImage pairs (L1 pairs and L2 pairs).

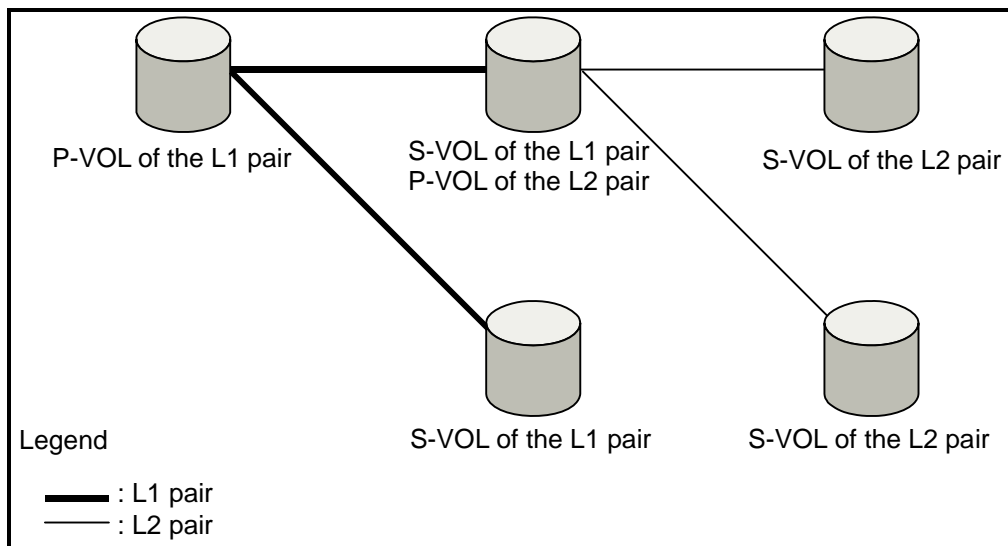


Figure 4-3 Total Capacity of ShadowImage Volumes (Example 3)

In Figure 4-3, the total capacity of ShadowImage volumes in use will be 5.

Requirements for Command Control Interface

To use CCI for ShadowImage operations, you need to have one volume for CCI's command device. For details about how to set the command device, see the *Command Control Interface (CCI) User and Reference Guide*.

Assessing Requirements

This section describes the assessments about ShadowImage operations, such as how many pairs you are going to create or how to decide the settings like copy pace and paths.

Calculating Maximum Number of Pairs

When you create ShadowImage pairs, resources called differential tables and pair tables will be required. The number of available differential tables and pair tables in one storage system depends on whether the additional shared memory is installed or not. There are several patterns of additional shared memory for differential tables and pair tables, and you can choose any pattern you like. Table 4-3 describes the pattern of additional shared memory.

Table 4-3 Additional Shared Memory for Differential Tables

Additional Shared Memory for ShadowImage	Number of Differential Tables	Number of Pair Tables	Number of Volumes in Storage system
No additional shared memory for ShadowImage	0	0	1,024
Additional shared memory for ShadowImage is installed	26,176	8,192	16,384
Extension 1	57,600	8,192	16,384
Extension 2	104,768	16,384	65,536
Extension 3 *	146,688	16,384	131,072
Extension 4 *	209,600	16,384	131,072

*: This can be used only in USP V.

- To install additional shared memory for differential tables, please call the Support Center.
- If you install additional shared memory for differential tables and pair tables, the maximum number of pairs is half of the total number of volumes in the storage system (see Table 4-3). For example, if additional shared memory for ShadowImage is installed (second line in Table 4-3), and when P-VOLs and S-VOLs are in a one-to-one relationship, you can create up to 8,192 pairs. However, in the case of Extension 2 to Extension 4, the maximum number of pairs is 16,384 regardless of the total number of volumes in the storage system.

To calculate the maximum number of ShadowImage pairs, you need to calculate how many differential tables and pair tables are required to create ShadowImage pairs, and then compare the result with the number of differential tables and pair tables in the entire storage system. In addition to ShadowImage, the following program products will also use differential tables and pair tables.

- Program products using differential tables
 - ShadowImage for z/OS
 - Compatible FlashCopy Version 1
 - Compatible FlashCopy Version 2
 - Volume Migration
 - Copy-on-Write Snapshot
- Program products using pair tables
 - ShadowImage for z/OS
 - Compatible FlashCopy Version 1
 - Volume Migration (migration plans instead of pairs)

Differential and pair tables for ShadowImage and the other program products noted above come from a common pool. When ShadowImage and these program products are used in the same storage system, the number of differential and pair tables available for the ShadowImage is reduced by the number of tables being used by the other products.

For information about how to calculate the number of differential tables and pair tables that are required for ShadowImage for z/OS, see the *ShadowImage for z/OS User's Guide*. For Compatible FlashCopy Version 1 and Compatible FlashCopy Version 2, see the *Compatible Mirroring for IBM FlashCopy User's Guide*. For information about how to calculate the number of differential tables and pair tables that are required for Volume Migration, contact the Hitachi Data Systems Support Center. See [Calling the Hitachi Data Systems Support Center](#). See the *Copy-on-Write Snapshot User's Guide* to calculate the number of differential tables and pair tables that are required for Copy-on-Write Snapshot.

Assuming that only ShadowImage uses differential tables and pair tables, this section describes how to calculate the number of differential tables and pair tables required for one ShadowImage pair, and the conditions you need to consider when calculating the number of ShadowImage pairs that can be created.

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 *Command Control Interface User and Reference Guide*.

Calculation of the Number of Differential Tables and Pair Tables Required for One Pair

When you create a ShadowImage pair, the number of required differential tables and pair tables will change according to the emulation type of the volumes. To calculate the number of differential tables and pair tables required for a pair according to the emulation type, use the expression in Table 4-4.

Table 4-4 Total Number of the Differential Tables Per Pair

Emulation Type	Expression
OPEN-3, OPEN-8, OPEN-9, OPEN-E, OPEN-L	<p>Total number of the differential tables per pair = $((X) \div 48 + (Y) \times 15) \div (Z)$</p> <p>(X): The capacity of the volume. (KB)* (Y): The number of the control cylinders. (See Table 4-5) (Z): 20,448 (The number of the slots that can be managed by a differential table)</p> <p>Note that you should round up the number to the nearest whole number. For example, if the emulation type of a volume is OPEN-3, and when provided that the number of the cylinders of the divided volume is 2,403,360 KB (X) in the expression above), the calculation of the total number of the differential tables is as follows.</p> <p>$(2,403,360 \div 48 + 8 \times 15) \div 20,448 = 2.4545\dots$</p> <p>When you round up 2.4545 to the nearest whole number, it becomes 3. Therefore, the total number of the differential tables for one pair is 3 when emulation type is OPEN-3.</p> <p>You may use 36 differential tables per one pair table. The total number of the pair tables is 1 when emulation type is OPEN-3.</p>
OPEN-V	<p>Total number of the differential tables per pair = $((X) \div 256) \div (Z)$</p> <p>(X): The capacity of the volume. (KB) (Z): 20,448 (The number of the slots that can be managed by a differential table)</p> <p>Note that you should round up the number to the nearest whole number. For example, if the emulation type of a volume is OPEN-V, and when provided that the number of the cylinders of the divided volume is 3,019,898,880 KB (X) in the expression above), the calculation of the total number of the differential tables is as follows.</p> <p>$(3,019,898,880 \div 256) \div 20,448 = 576.9014\dots$</p> <p>When you round up 576.9014 to the nearest whole number, it becomes 577. Therefore, the total number of the differential tables for one pair is 577 when emulation type is OPEN-V.</p> <p>You may use 36 differential tables per one pair table. The total number of the pair tables is 17 when emulation type is OPEN-V. The emulation type of case when multiple pair tables are used in the open system is only OPEN-V.</p>

If the volume is divided by VLL function, you need to apply the capacity of the volume after the division. You cannot perform VLL operations on an OPEN-L volume. Therefore, if the emulation type is OPEN-L, the value substitute for (X) is the default capacity of the volume.

Table 4-5 lists the number of the control cylinders according to the emulation types.

Table 4-5 Number of Control Cylinders According to Emulation Type

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

Conditions for the Number of ShadowImage Pairs that can be Created (when No LUSE Volume Exists)

The number of ShadowImage pairs that can be created will change according to whether LUSE volumes are used or not. This section describes how to calculate the number of ShadowImage pairs that can be created, when no LUSE volume is used (e.g., 1 LU consists of one volume).

When you do not use LUSE volume, you can use the following equation to determine whether you will be able to create the desired number of ShadowImage pairs or not.

You need to meet the equation below:
 $\Sigma \{(\alpha) \times (\text{the number of ShadowImage pairs})\} \leq (\beta)$
 and $\Sigma \{(\gamma) \times (\text{the number of ShadowImage pairs})\} \leq (\delta)$

- (α) : The required number of differential tables per pair.
 (α) changes according to the emulation type. For information about how to calculate (α) , see Table 4-4.
- (β) : The number of differential tables available in the storage system.
 (β) will differ according to the installed additional shared memory. For details, see Table 4-3.
- (γ) : The required number of pair tables per pair.
 (γ) changes according to the value of (α) . For information about how to calculate (γ) , see Table 4-4.
- (δ) : The number of pair tables available in the storage system.
 (δ) differs according to the installed additional shared memory. For details, see Table 4-3.

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 condition in 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 to the above-mentioned in equation:

$$3 \times 10 + 577 \times 20 = 11,570 \leq 26,167$$

and also

$$1 \times 10 + 17 \times 20 = 350 \leq 8,192$$

Therefore, you can see that 10 pairs of OPEN-3 volumes and 20 pairs of OPEN-V volumes can be created.

Conditions for the Number of ShadowImage Pairs that can be Created (when LUSE Volume Exists)

The number of ShadowImage pairs that can be created will change according to whether LUSE volumes are used or not. This section describes how to calculate the number of ShadowImage pairs that can be created, when LUSE volumes are used.

When you use LUSE volume, you can use the following equation to know whether you will be able to create the desired number of ShadowImage pairs or not.

You need to meet the inequation below.

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

and also

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

- (α) : The required number of differential tables for each volume that forms LUSE volume.

When you use LUSE volumes to create a ShadowImage pair, every volume that forms the LUSE volume will use the differential tables as a pair. For example, if you create a ShadowImage pair by using LUSE volumes, which are created by combining two OPEN-V volumes, you need differential tables for two OPEN-V pairs.

(α) changes according to the emulation type. For information about how to calculate (α) , see Table 4-4.

- (β) : The number of differential tables available in the storage system.
 (β) differs according to the installed additional shared memory for differential tables. For details, see Table 4-3.
- (γ) : The required number of pair tables for each volume that forms LUSE volume.
 (γ) changes according to the value of (α) . For information about how to calculate (γ) , see Table 4-4.

- (δ) : The number of pair tables available in the storage system.
 (δ) differs according to the installed additional shared memory. For details, see Table 4-3.

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 will be 3, and the number of pair tables required for a pair will be 1.

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

$$(3 \times 3) \times 10 = 90 \leq 26,176$$

and also

$$(1 \times 3) \times 10 = 30 \leq 8,192$$

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

Performance Considerations

- When you operate ShadowImage:

ShadowImage operations affect the I/O performance of the storage system because of the copy operations to the S-VOLs. You should consider the relative importance of the storage system's I/O performance and the ShadowImage operations when you decide the number or structures of pairs and their copy pace.

For example, assigning three S-VOLs to each P-VOL takes more resources than assigning only one or two. The more S-VOLs you assign on a P-VOL, the risk of I/O performance of the storage system increases.

If you assign one S-VOL on a P-VOL, the pace of the initial copy operations may affect the I/O performance of the storage system. Using a slower copy pace minimizes the impact of ShadowImage operations on I/O performance, while a faster copy pace produces copies more quickly but may affect I/O performance.

- Load sharing of parity groups:

ShadowImage P-VOLs or S-VOLs should not be concentrated in the same parity group. To disperse workloads of the parity groups, each parity group should have both P-VOLs and S-VOLs evenly distributed. ShadowImage pairs for which ShadowImage operations are performed simultaneously should be in different parity groups. If ShadowImage pairs are concentrated in only a few parity groups, the host I/O performance may be degraded.

To minimize effect on the host I/O performance, take the following actions:

- Specify **Slower** for the copy pace when you create, split, or resynchronize the ShadowImage pairs.
- If the ShadowImage pairs that you want to perform copy operation are in the same parity group, reduce the number of pairs at one copy operation. For example, if you want to split multiple ShadowImage pairs in the same parity group, wait until one pair is completely split before splitting another pair.

If the USP V/VM storage system is overloaded, you must increase cache, back-end directors (BEDs), and/or parity groups. Hitachi Data Systems recommends that ShadowImage S-VOLs be assigned in newly installed parity groups. If you continue ShadowImage operations with an overloaded storage system, host I/O performance may be degraded.

- Structure for the case using multiple program products simultaneously:

If you are using more than one USP V/VM data management program products (e.g., ShadowImage, TrueCopy, Open Volume Management, Cache Residency Manager) at the same time in the same storage system, please contact the Hitachi Support Center to ensure that your storage system is optimized for your configuration of concurrent operations (e.g., sufficient cache).

Each USP V/VM program product can affect the performance of the storage system and/or the operation of other program products. For example, ShadowImage and TrueCopy operations both involve initial copy operations and update copy operations to the secondary/remote volumes in addition to the host I/O workload.

- Structure for AIX host servers:

When you use ShadowImage on the AIX host servers, Hitachi Data Systems strongly recommends that you use two AIX host servers to locate P-VOLs in one host server, and the paired S-VOLs in the other. If you use only one AIX host server, consider the following:

- When the paircreate or pairresync operation is performed, ShadowImage copying takes place between the P-VOL and S-VOL. Consequently the P-VOL and S-VOL have the same PVID.
- If the host server reboots while the P-VOL and S-VOL have the same PVID, the host server might misidentify the P-VOL and S-VOL (i.e., identify the S-VOL as the P-VOL) after rebooting.
- You can use the **recreatevg** command to change the PVID of the P-VOL and S-VOL. However, until the **recreatevg** command is executed, the PVID remains the same, and the host server might misidentify the volumes.

- When you resynchronize a pair by Quick Restore:

During a quick restore operation, the **RAID levels, HDD types, and Cache Residency Manager settings** of the P-VOL and S-VOL are exchanged. For example, if the P-VOL has a RAID-1 level and the S-VOL has a RAID-5 level, the quick restore operation changes the RAID level of the P-VOL to RAID-5 and of the S-VOL to RAID-1. This also applies to RAID-6 volumes. To avoid any performance impact due to the quick restore operation, perform the following:

 - Make sure that the P-VOL and S-VOL have the same RAID level and HDD type before performing the quick restore operation. If you want to restore the original RAID levels after quick restore, stop host I/Os to the pair, split the pair, perform the quick restore operation for that pair again, and then restart the host I/Os to the pair.
 - Because the Cache Residency Manager settings are exchanged during a quick restore operation, you must perform one of the following operations:
 - Set the same Cache Residency Manager settings (locations) for the P-VOL and S-VOL before performing the quick restore operation.
 - Release the Cache Residency Manager settings of the P-VOL and S-VOL before the quick restore operation, and then reset the Cache Residency Manager settings of the P-VOL and S-VOL after the pair changes to PAIR status as a result of the quick restore operation.

If you do not perform one of the operations listed above, the cache residence location change may cause I/O performance to diminish.

For details about Cache Residency Manager settings, see the *Cache Residency Manager User's Guide*.

Identifying the Source and Target Volumes

For each volume, set the LU path, whether the volume will be a P-VOL or an S-VOL, and the other volume(s) in its pair (see Table 4-6). For details about how to set the LU path, see the *LUN Manager User's Guide*.

Table 4-6 ShadowImage Configuration Information

CU#	Port	GID: LUN	L1 P-VOL?	Associated L1 S-VOL(s)	L1 S-VOL?	Assoc. L1 P-VOL	L2 P-VOL?	Associated L2 S- VOL(s)	L2 S-VOL?	Assoc. L2 P-VOL
0	1A	0:00	Yes	1B-0:00, 2A-0:00, 2B-0:00	No	--	No	--	No	--
0	1A	0:01	Yes	1B-0:01, 2A-0:01, 2B-0:01	No	--	No	--	No	--
etc.										
0	1B	0:00	No	--	Yes	1A-0:00	Yes	3A-0:00,	No	--

								3A-0:01		
0	1B	0:01	No	--	Yes	1A-0:01	Yes	3B-0:00, 3B-0:01	No	--
etc.										
0	2A	0:00	No	--	Yes	1A-0:00	Yes	4A-0:00, 3B-0:01	No	--
0	2A	0:01	No	--	Yes	1A-0:01	Yes	4B-0:00, 3B-0:01	No	--
etc.										
0	3A	0:00	No	--	No	--	No	--	Yes	1B-0:00
0	3A	0:01	No	--	No	--	No	--	Yes	1B-0:00

The volumes that will be P-VOLs will remain fully accessible to all hosts throughout normal ShadowImage operations, however, the volumes that will be S-VOLs will need to be unmounted before being reserved for ShadowImage operations.

Requirements for Maintaining ShadowImage

This section describes the ShadowImage maintenance requirements. Note that in some cases, you need to re-create ShadowImage pairs after the storage system maintenance or micro program updates. Also note that if the ShadowImage operations are not complete because of failures, the copying process will be automatically suspended.

Cautions on Maintaining the Devices

- Maintenance of PDEV

The maintenance of a PDEV, which is not used by ShadowImage, does not affect the ShadowImage operations and the status of ShadowImage pairs. Even if a PDEV contains LDEVs used by ShadowImage, you can maintain that PDEV independently of the ShadowImage operations or ShadowImage pair status. However, if a PDEV failure occurs, even though the ShadowImage pair status is kept the same as before the failure, there will be degradation of copy pace.

If a failure occurs that requires the USP V/VM to utilize dynamic sparing or automatic correction copy, the status of the paired volumes associated with the failed PDEV will not be affected.

- Maintenance of LDEV

- If an LDEV failure occurs, the USP V/VM suspends the pair.
- If the status of a ShadowImage pair is either COPY(PD), PAIR, PSUS, PSUS(SP), COPY(SP), COPY(RS), or COPY(RS-R), the maintenance for the LDEVs that are used by that pair will be restricted. In addition, the maintenance for LDEVs, which set the **Reserve** attribute by ShadowImage, will be restricted too. If you want to maintain these LDEVs, suspend or delete the ShadowImage pair, or reset (unreserve) the **Reserve** attribute.

Cautions on Maintaining the Cache

If USP V/VM cache maintenance is performed during a period of high I/O usage, one or more ShadowImage pairs may suspend. Reduce the I/O load before cache maintenance.

Cautions on Switching Off the Power Supply

If you have to switch off the power supply of the USP V/VM storage system during ShadowImage operations, make sure to:

- Complete the copying operation for the ShadowImage pair in the *COPY(SP)* or *PSUS(SP)* status to change the pair status from *COPY(SP)* or *PSUS(SP)* to *PSUS*, and then switch off the power supply.

If the shared memory is volatilized when you switch on the power supply again, the pair in the *COPY(SP)* or *PSUS(SP)* status changes to *PSUE*.

- Complete the processing of At-Time Split function, and then switch off the power supply.

If the status of only a part of the pairs in the same consistency group is changed, the processing of At-Time Split function may not resume when you switch on the power supply. The status of some pairs may remain unchanged.

- Establish a timetable for any ShadowImage copying operations that may take longer because of the power-supply off (PSOFF).

If the shared memory is volatilized when you switch on the power supply again, the following conditions occur.

- If the ShadowImage pair was in the *COPY(PD)* or *COPY(SP)* status, data that was already copied before the power-supply off (PSOFF) again becomes the target data to be copied after the power-supply on (PSON). If there is no host I/O, the data consistency rate does not reach 100% when the ShadowImage pair status changes to *PAIR*. When the ShadowImage pair status changes to *PAIR*, the target data is copied to the secondary volume.
- If the ShadowImage pair was in the *PAIR* status, data that was already copied before the power-supply off (PSOFF) again becomes the target data to be copied after the power-supply on (PSON). In this case, the data consistency rate is 0%, and the target data is copied to the S-VOL.
- If the ShadowImage pair was in the *PSUS* status, the entire volume becomes the differential data. In this case, the data consistency rate is 0%, and the entire volume is copied to the secondary volume when you perform the pairresync operation.

Installing ShadowImage

To operate ShadowImage on the Storage Navigator computer, you need to install ShadowImage by using the license key.

To install ShadowImage:

1. Log on to the SVP and start up the Java application of the Storage Navigator.

For information about how to log on to the SVP, see the *Storage Navigator User's Guide*.

2. Install ShadowImage on the Storage Navigator computer.

You need to install ShadowImage in every storage system on which you want to use ShadowImage. For information about how to install ShadowImage, see the *Storage Navigator User's Guide*.

Starting ShadowImage

After you have enabled the feature for the Storage Navigator and prepared for ShadowImage operations, you are ready to start up the ShadowImage.

To start ShadowImage and display the window you need:

1. Display the Storage Navigator main window.

For information about how to display the Storage Navigator main window, see the *Storage Navigator User's Guide*.

2. Click **Go** and then **ShadowImage** on the menu bar of the Storage Navigator main window.

The names of the windows that you need for ShadowImage operations display in the submenu.

3. Click the name of the window you want to display.

ShadowImage starts up, and the window whose name you clicked in the submenu displays.

For details about the displayed windows, see the next chapter.

When you use Storage Navigator on UNIX workstations or in other non-Windows environments, certain additional operating conventions must be followed. For details, see the *Storage Navigator User's Guide*.

Using the ShadowImage GUI

This chapter describes the use of the ShadowImage graphical user interface. Please read this chapter before you start the ShadowImage operation.

- [Pair Operation Window](#)
- [History Window](#)
- [Option Window](#)

Pair Operation Window

The Pair Operation window (see Figure 5-1) displays the ShadowImage volume and pair information for the selected port of the connected USP V/VM storage system and allows you to perform all ShadowImage operations.

A P-VOL or S-VOL LDEV number that ends with a pound or gate symbol (#) indicates that the LDEV is an external volume (e.g., 00:00:01 #). An LDEV number that ends with a letter "X" indicates that the LDEV is a virtual volume used by Dynamic Provisioning (e.g., 00:00:01 X). For details regarding the external volumes, see the *Universal Volume Manager User's Guide*. For information about Dynamic Provisioning, see the *Dynamic Provisioning User's Guide*.

The Pair Operation window displays both ShadowImage and Copy-on-Write Snapshot pairs information. However, this section only explains the items related to the ShadowImage pairs. For details about the items related to the Copy-on-Write Snapshot pairs, see the *Copy-on-Write Snapshot User's Guide*.

No volume displays when you select **Subsystem** on the top of the Tree.

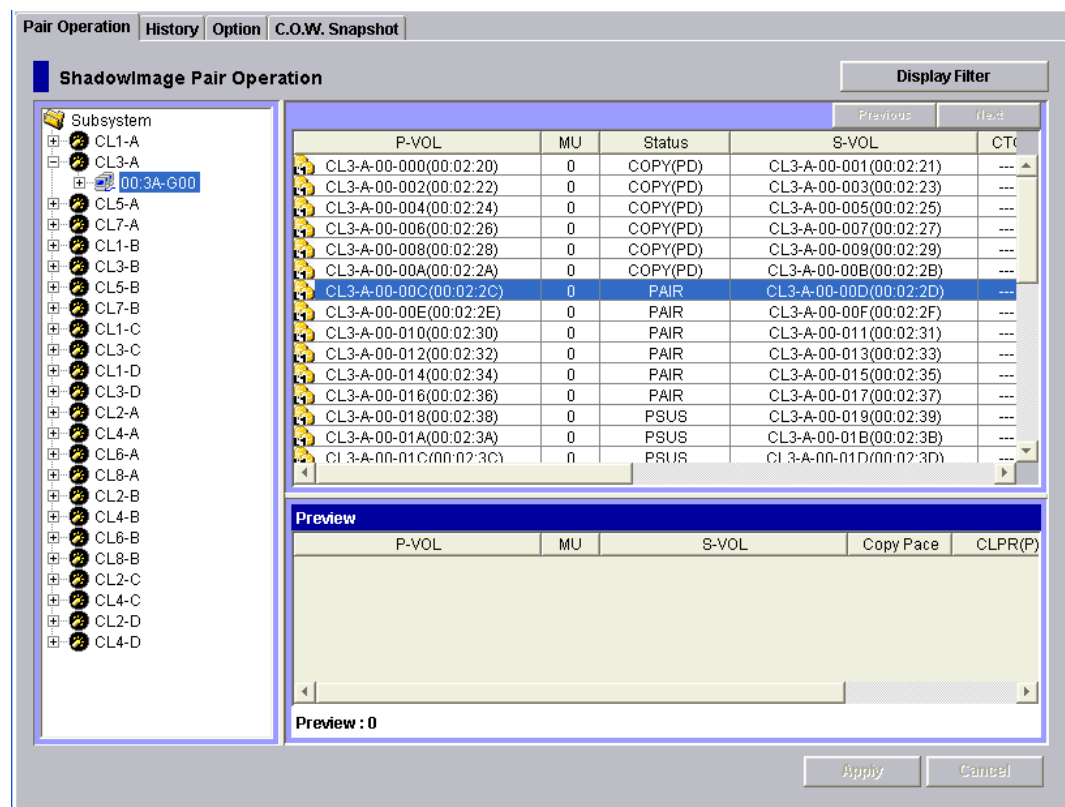












Figure 5-1 Pair Operation Window

Item	Description
Tree	<p>Allows you to select the desired port, 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 a host group.</p> <p>No volume displays when you select Subsystem on the top of the Tree.</p>
volume list	<p>Displays all available volumes and is on the upper right of the Pair Operation window. For details, See Volume List.</p>
Icons	<p>The following icons indicate the status of a volume or pair on the Pair Operation window:</p> <ul style="list-style-type: none"> ▪ : L1 pair ▪ : L2 pair ▪ : S-VOL (Node volume: Secondary, Leaf volume: Leaf) ▪ : Reserved volume when displayed in the Volume List. Preview item when displayed in the Preview List. ▪ : Indicates that an error occurred during an operation. (This error icon is displayed in the Preview List.) ▪ : Port (displayed in the Tree) ▪ : Host group (displayed in the Tree) ▪ : SMPL volume ▪ : Root (displayed in the Tree)
Display Filter button	<p>Displays the Display Filter dialog box (see Figure 6-1) where you can filter the volumes displayed in the Volume List</p>
Previous button	<p>Allows you to return to the previous page of the Volume List. This button is selectable only when the number of volumes defined in the storage system exceeds 1,024 volumes, which is the maximum number of volumes that can be displayed on one page. The button is grayed out if the total number of volumes defined in the storage system is less than 1,024 volumes.</p>
Next button	<p>Allows you to turn to the next page of the Volume List. This button is selectable only when the number of volumes defined in the storage system exceeds 1,024 volumes, which is the maximum number of volumes that can be displayed on one page. The button is grayed out if the total number of volumes defined in the storage system is less than 1,024 volumes.</p>
Preview List	<p>Displays the content of the operations (volume/pair information) that have been set or specified in the Pair Operation window, but are still not applied to the storage system. Located under the Volume List. For details, see Preview List.</p>
Apply button	<p>Applies the ShadowImage operations displayed in the Preview List to the storage system. If the specified operations complete successfully, the Preview List will be cleared.</p> <p>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 <i>Storage Navigator Messages</i>.</p>
Cancel button	<p>Cancels all the operations set in the Preview List.</p>

Volume List

The Volume List (see Figure 5-2) displays volume/pair information based on the filter options you select in the Tree (along the left side of the window). You can sort the volumes by any of the items displayed as the column header of the Volume List. You can also filter the volumes by reserve attribute, by pair condition, and by pair status using the Display Filter dialog box. For information about how to use this dialog box, see *Configuring the Volume List*.

The number of volumes that can be displayed in the Volume List is limited to 1,024 volumes. If the number of volumes defined in the storage system exceeds this limit, use the **Previous** and **Next** buttons on the upper right of the Volume List to turn the pages of the Volume List and see the entire list.

The Volume List lists all the installed volumes (LUs) on the selected port and displays information for each volume.

P-VOL	MU	Status	S-VOL	CTC
CL1-A-00-000(00:00:00)	0	COPY(PD)	CL3-A-00-100(00:08:00)	---
CL1-A-00-001(00:00:01)	0	COPY(PD)	CL3-A-00-101(00:08:01)	---
CL1-A-00-002(00:00:02)	0	COPY(PD)	CL3-A-00-102(00:08:02)	---
CL1-A-00-003(00:00:03)	0	COPY(PD)	CL3-A-00-103(00:08:03)	---
CL1-A-00-004(00:00:04)	0	COPY(PD)	CL3-A-00-104(00:08:04)	---
CL1-A-00-005(00:00:05)	0	COPY(PD)	CL3-A-00-105(00:08:05)	---
CL1-A-00-006(00:00:06)	0	COPY(PD)	CL3-A-00-106(00:08:06)	---
CL1-A-00-007(00:00:07)	0	COPY(PD)	CL3-A-00-107(00:08:07)	---
CL1-A-00-008(00:00:08)	0	COPY(PD)	CL3-A-00-108(00:08:08)	---
CL1-A-00-009(00:00:09)	0	COPY(PD)	CL3-A-00-109(00:08:09)	---
CL1-A-00-00A(00:00:0A)	---	SMPL	---	---
CL1-A-00-00B(00:00:0B)	---	SMPL	---	---
CL1-A-00-00C(00:00:0C)	---	SMPL	---	---
CL1-A-00-00D(00:00:0D)	---	SMPL	---	---
CL1-A-00-00E(00:00:0E)	---	SMPL	---	---

Figure 5-2 Volume List Displaying Volumes (L1 pairs)

Item	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	The information about P-VOL displays in <i>AAA-BB-CCC(XX:YY:ZZ)</i> format. <ul style="list-style-type: none"> AAA: Port ID (cluster and channel number) BB: Group number of host group CCC: LU number XX:YY:ZZ: LDKC number:CU number:LDEV number
MU	The MU number of the ShadowImage pair formed with the P-VOL. For details about what displays in this item if you select Copy-on-Write Snapshot pairs, see the <i>Copy-on-Write Snapshot User's Guide</i> .
Status	The ShadowImage pair status of the volume pair. For details about the Copy-on-Write Snapshot pair status, see the <i>Copy-on-Write Snapshot User's Guide</i> .

Item	Description
S-VOL	<p>The information about S-VOL displays in <i>AAA-BB-CCC(XX:YY:ZZ)</i> format.</p> <ul style="list-style-type: none"> ▪ AAA: Port ID (cluster and channel number) ▪ BB: Group number of host group ▪ CCC: LU number ▪ XX:YY:ZZ: LDKC number:CU number:LDEV number <p>For LUs with more than one path, only one path is listed. The path is connected to the first port within the ports configured to a path that are shown in the tree view of the Pair Operation Window.</p>
CTG	<p>The consistency group number of the S-VOL. If no consistency group is set for the S-VOL, dashes (---) display. For details about what displays in this item if you select Copy-on-Write Snapshot pairs, see the <i>Copy-on-Write Snapshot User's Guide</i>.</p>
SvolMode	<p>SvolMode: The status of the S-VOL. For details about what displays in this item if you select Copy-on-Write Snapshot pairs, see the <i>Copy-on-Write Snapshot User's Guide</i>.</p> <ul style="list-style-type: none"> ▪ S-VOL Write: When the S-VOL status is PSUS(SP) or PSUS, and the host writes to the S-VOL, W displays. ▪ Hlde Mode: When the S-VOL cannot be read in the mode, N displays. <p>The S-VOL status indicated by the SvolMode is listed in Table 5-1</p>
Copy Pace	<p>The information shown in Table 5-2 displays. The information to be displayed depends on the status of the pair. For details about what displays in this item if you select Copy-on-Write Snapshot pairs, see the <i>Copy-on-Write Snapshot User's Guide</i>.</p>
Sync.	<p>The information shown in Table 5-3 to the pair status displays. For details about what displays in this item if you select Copy-on-Write Snapshot pairs, see the <i>Copy-on-Write Snapshot User's Guide</i>.</p>
Emulation	<p>The emulation type of the volume. For details on the kinds of emulation type, see Table 4-4.</p>
Capacity (MB)	<p>The storage capacity of the volume displays in megabytes (MB).</p>
CLPR (P)	<p>The cache logical partition of the P-VOL displays.</p>
CLPR (S)	<p>The cache logical partition of the S-VOL displays.</p>

The S-VOL Status indicated by the SvolMode is listed in the following table.

Table 5-1 S-VOL Status Indicated by the SvolMode

S-VOL Write (W)	Hide Mode (N)	Letter(s)
OFF	OFF	—
OFF	ON	N
ON	OFF	W
ON	ON	W

Information to be displayed in **Copy Pace** and **Sync.** depends on the status of the pair, as shown in the following tables.

Table 5-2 Displayed Information in Copy Pace

Pair Status	Displayed Information
SMPL	- - - is displayed.
COPY(PD)	The copy pace (Slower , Medium , or Faster) for the pair being created *
PAIR	- - - is displayed.
COPY(SP)	The copy pace (Slower , Medium , or Faster) for the pair being created *
PSUS(SP)	
PSUS	- - - is displayed.
COPY(RS)	The copy pace (Slower , Medium , or Faster) for the pair being created *
COPY(RS-R)	
PSUE	- - - is displayed.
SMPL(PD)	
*: When you create ShadowImage pairs by using Command Control Interface, the copy pace is set as follows. <ul style="list-style-type: none"> ▪ 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. 	

Table 5-3 Displayed Information in Sync.

Pair Status	Displayed Information
SMPL	- - - is displayed.
COPY(PD)	The progress (%) of copying.
PAIR	Identical data (%) of P-VOL and S-VOL.
COPY(SP)	Copy completed data (%).
PSUS(SP)	

Pair Status	Displayed Information
PSUS	Identical data (%) of P-VOL and S-VOL.
COPY(RS)	
COPY(RS-R)	
PSUE	- - - is displayed.
SMPL(PD)	

You can perform ShadowImage operations for the desired volume(s) in the Volume List by using the menu commands listed in the following table.

Table 5-4 ShadowImage Menu Commands of the Pair Operation Window

Command	Feature
Detail	Opens the Detail dialog box that displays detailed information for the selected volume or pair (see Figure 6-9).
Paircreate	Opens the Paircreate dialog box, which allows you to create new ShadowImage pairs (see Figure 6-4).
Pairsplit	Opens the Pairsplit dialog box, which allows you to split ShadowImage pairs (see Figure 6-5).
Pairresync	Opens the Pairresync dialog box, which allows you to resynchronize ShadowImage pairs (see Figure 6-7).
Pairsplit-E	Opens the Pairsplit-E dialog box, which allows you to suspend ShadowImage pairs (see Figure 6-6).
Pairsplit-S	Opens the Pairsplit-S dialog box, which allows you to delete ShadowImage pairs (see Figure 6-8).
Change Reserve	Opens the Set/Reset Reserve Attribute dialog box, which allows you to set/reset the ShadowImage reserve attribute (see Figure 6-2 and Figure 6-3).
S-VOL Path	Opens the S-VOL Path dialog box (see Figure 6-10), which displays the port or host group of the S-VOL of the selected pair.
Information	Opens the Information dialog box (see Figure 6-11), which displays the number of pairs or reserved volumes.

Preview List

The **Preview List** (see Figure 5-3) is located below the Volume List, and lists the specified operations (volume/pair information), which have not been performed in the storage system.

Preview				
P-VOL	MU	S-VOL	Copy Pace	CLPR(P)
(R) CL1-B-00-019(00:04:01)	1	CL1-B-00-01A(00:04:02)	---	00:CLPRC

Preview : 1 (Pairsplit-S)

Figure 5-3 Preview List Displaying Settings (Operations)

Item	Description
P-VOL	Information about P-VOL displays in <i>AAA-BB-CCC(XX:YY:ZZ)</i> format. AAA: Port ID (cluster and channel number) BB: Group number of host group CCC: LU number XX:YY:ZZ: LDKC number:CU number:LDEV number
MU	The MU number of the ShadowImage pair created with the P-VOL. For details about what displays in this item if you select Copy-on-Write Snapshot pairs, see the <i>Copy-on-Write Snapshot User's Guide</i> .
S-VOL	The information about S-VOL displays in <i>AAA-BB-CCC(XX:YY:ZZ)</i> format. <ul style="list-style-type: none"> ▪ AAA: Port ID (cluster and channel number) ▪ BB: Group number of host group ▪ CCC: LU number XX:YY:ZZ: LDKC number:CU number:LDEV number
Copy Pace	The copying pace for all pairs being created. For details about what displays in this item if you select Copy-on-Write Snapshot pairs, see the <i>Copy-on-Write Snapshot User's Guide</i> .
CLPR (P)	The cache logical partition of the P-VOL displays.
CLPR (S)	The cache logical partition of the S-VOL displays.
Error Code	If the specified operation in the Preview List is performed by clicking the Apply button in the Pair Operation window, and the operation fails, the reason code displays.

The following information displays in the information field below the **Preview List**:

Preview: X(Y)/Z, where

X = the number of settings remaining in the **Preview List** that are still not applied to the storage system

Y = the type of pair operation

Z = command option

You can change the **Preview List** by right-click the setting in the **Preview List** and displaying the menus. The following table lists the available menu commands in the **Preview List**.

Table 5-5 ShadowImage Menu Commands of the Preview List

Command	Feature
Delete	Cancels the selected setting(s). If you perform this command, the selected setting(s) will be cleared.
Modify	Allows you to change the setting of the selected operation. This command becomes accessible only when the item you select from the Preview List is set to Paircreate , Pairsplit or Pairresync operation.
Error Detail	Displays the error message dialog box, which displays the error code and message. For the ShadowImage error codes, see the <i>Storage Navigator Messages</i> .

History Window

The History window (see Table 5-5) displays the past record of pair operations performed on the Pair Operation window. For information about how to look up the operation history, see Viewing Pair Operation History.

A P-VOL or S-VOL LDEV number that ends with a pound or gate symbol (#) indicates that the LDEV is an external volume (e.g., 00:00:01 #). An LDEV number that ends with a letter "X" indicates that the LDEV is a virtual volume used by Dynamic Provisioning (e.g., 00:00:01 X). For details about the external volumes, see the *Universal Volume Manager User's Guide*. For information about Dynamic Provisioning, see the *Dynamic Provisioning User's Guide*.

The upper area of the History window lists the operation history of ShadowImage pairs. The lower area of the window lists the operation history of Copy-on-Write Snapshot pairs. For details about the operation history of Copy-on-Write Snapshot pairs, see the *Copy-on-Write Snapshot User's Guide*. The upper area of the History window displays the items in the following table.

The screenshot shows a GUI window titled "Pair Operation" with tabs for "History", "Option", and "C.O.W. Snapshot". The "History" tab is active, displaying two sections: "ShadowImage History" and "C.O.W. Snapshot History".

ShadowImage History

Date	P-VOL	S-VOL	Code	Message
2007/01/11 19:53:25	---	---	47EB	INITIALIZE ENDED ABNORMAL
2007/01/11 19:53:14	---	---	47EA	INITIALIZE END
2007/01/11 19:53:00	---	---	47E9	INITIALIZE START

C.O.W. Snapshot History

Date	P-VOL	S-VOL	MU	Pool ID	Code	Mess
2007/07/19 09:57:25	---	---	---	---	2041	INITIALIZE END
2007/07/19 09:57:17	---	---	---	---	2040	INITIALIZE START
2007/07/18 11:44:12	00:0D:00	00:07:01	0	2	2021	SMPL
2007/07/18 11:43:00	00:0D:00	00:07:01	0	2	2031	COPY(RS-R) END
2007/07/18 11:42:39	00:0D:00	00:07:01	0	2	2030	COPY(RS-R) START
2007/07/18 11:42:15	00:0D:00	00:07:01	0	2	2011	PSUS
2007/07/18 11:41:27	00:0D:00	00:07:01	0	2	2051	COPY(RS)
2007/07/18 11:39:46	00:0D:00	00:07:01	0	2	2011	PSUS
2007/07/18 11:38:47	00:0D:00	00:07:01	0	2	2001	PAIR
2007/07/18 11:33:31	00:1A:00	00:07:00	0	2	2021	SMPL

Figure 5-4 History Window

Item	Description
Previous button	Allows you to return to the previous page of the list. This button is selectable only when the number of operation histories in the storage system exceeds 16,384, which is the maximum number of histories that can be displayed on one page. The button is grayed out if the total number of operation histories in the storage system is less than 16,384
Next button	Allows you to turn to the next page of the list. This button is selectable only when the number of operation histories in the storage system exceeds 16,384 volumes, which is the maximum number of histories that can be displayed on one page. The button is grayed out if the total number of operation histories in the storage system is less than 16,384.
Date	Displays the date and time (YYYY/MM/DD hour/min/sec) when a ShadowImage pair or volume operation has been performed.
Status	The ShadowImage pair status of the volume pair. For details about the Copy-on-Write Snapshot pair status, see the <i>Copy-on-Write Snapshot User's Guide</i> .
P-VOL	Displays the LDKC:CU:LDEV of the P-VOLs used for pair operation in the past.
S-VOL	Displays the LDKC:CU:LDEV of the S-VOLs used for pair operation in the past.
Code	Displays the ShadowImage reference codes.
Message	Displays the messages to inform the conditions of the past ShadowImage pair operations.

ShadowImage status and history reference codes and messages are listed in the following table.

Table 5-6 ShadowImage Status and History Reference Codes and Messages

Code	Message	Description
4710	PAIR START	The ShadowImage initial copy operation started.
4720	PAIR END	The ShadowImage initial copy operation ended, and the pair status changed to PAIR.
4730	PSUS START	The ShadowImage pairsplit operation started.
4740	PSUS END	The ShadowImage pairsplit operation ended, and the pair status changed to PSUS.
4750	COPY(RS) START COPY(RS-R) START	The ShadowImage pairresync operation started.
4760	COPY(RS) END COPY(RS-R) END	The ShadowImage pairresync operation ended, and the pair status changed to PAIR.
4780	SMPL	The ShadowImage pairsplit-S operation was performed, and the pair status changed to SMPL.
4790	PSUE	The ShadowImage pairsplit-E operation was performed, 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 can set the options for ShadowImage on the Option window (see Figure 5-5). For detailed information about how to set the options, see Setting Options.

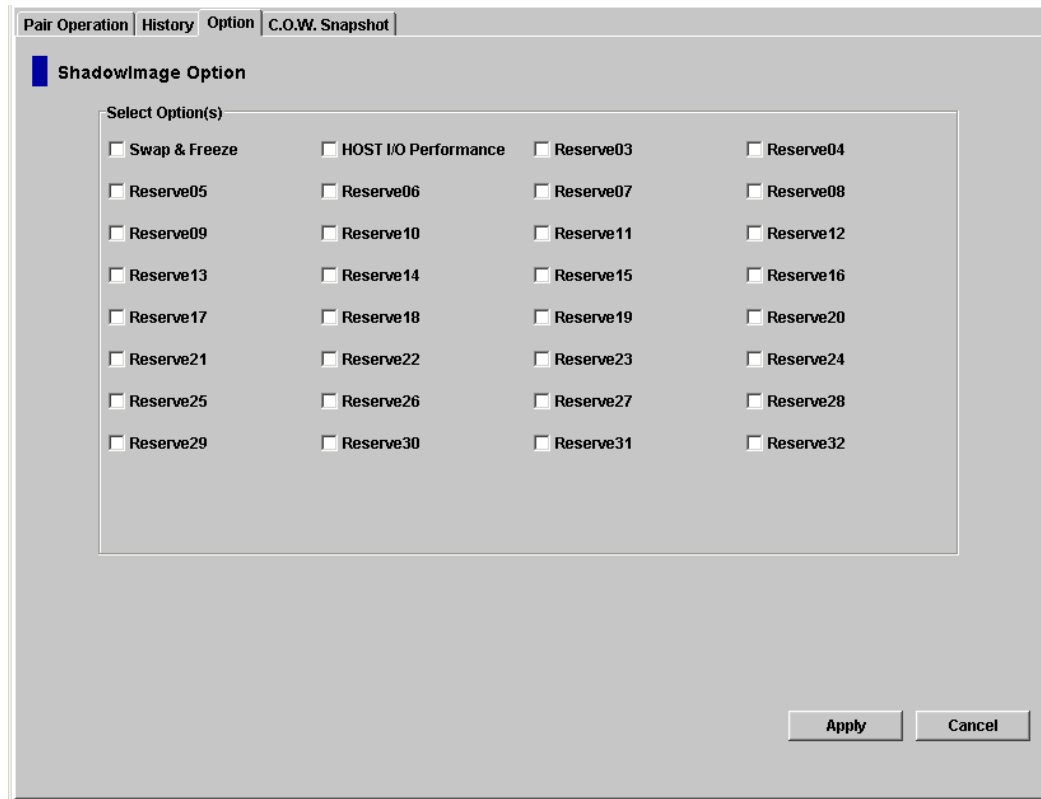


Figure 5-5 Option Window

Item	Description
Select Option(s) box	When you check the check box of the option name, that option will be enabled. If you unselect the check box, that option will be disabled. The only options that are available in this box are Swap & Freeze and HOST I/O Performance . If you selected the check boxes of other option names, they will not be enabled.
Apply button	Applies the ShadowImage options checked in the Select Option(s) box to the storage system.
Cancel button	Cancels all the options set in the Select Option(s) box.

Performing ShadowImage Operations

This chapter provides instructions for performing ShadowImage operations using the ShadowImage software on Storage Navigator.

- [Configuring the Volume List](#)
- [Changing or Deleting the Settings in Preview List](#)
- [Setting or Resetting the Reserve Attribute](#)
- [Setting Options](#)
- [Creating Pairs](#)
- [Splitting Pairs](#)
- [Suspending Pairs](#)
- [Resynchronizing Pairs](#)
- [Deleting Pairs](#)
- [Viewing Detailed Volume and Pair Information](#)
- [Viewing S-VOL Path Information](#)
- [Viewing the Number of Pairs and License Information](#)
- [Viewing Pair Operation History](#)

When you want to check the result or progress of the operations, or when you want to display the latest information on the windows, click **File** and then **Refresh** on the menu bar of the Storage Navigator main window.

Configuring the Volume List

The Display Filter dialog box allows you to "filter" the volumes displayed in the Volume List by reserve attribute, pair condition, and pair status.

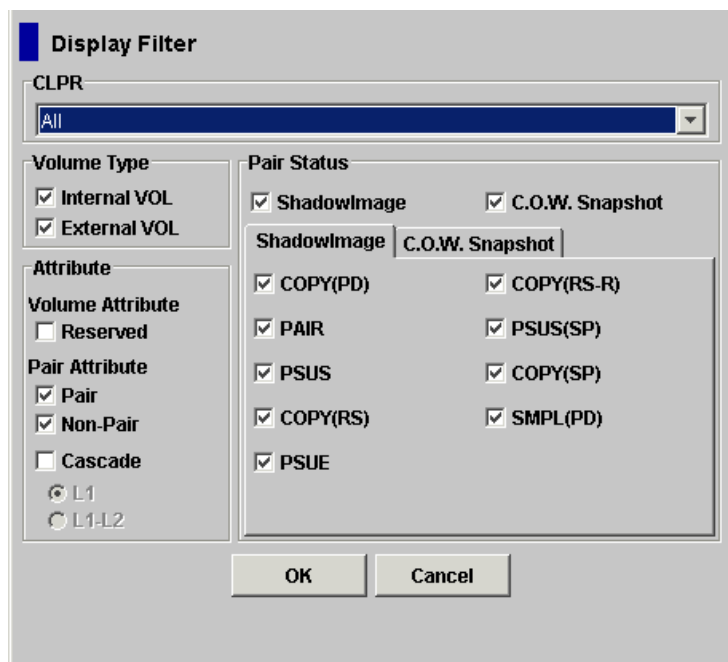


Figure 6-1 Display Filter Dialog Box (ShadowImage Tab Selected)

The Display Filter dialog box (**ShadowImage** tab selected) has the following features:

- **CLPR** drop-down list: Allows you to display the specified cache logical partition (CLPR).
- The **Volume Type** box:
 - The **Internal VOL** check box allows you to display the internal volumes.
 - The **External VOL** check box allows you to display the external volumes.

Both check boxes are selected by default. You need to select either one of these two check boxes, otherwise all the settings in the Display Filter dialog box become invalid.

- **Attribute** box:
 - The **Reserved** check box allows you to display reserved or unreserved volumes. If you select the **Reserved** check box, reserved volumes and volumes specified as the S-VOL display in the **Volume List**. If you clear the **Reserved** check box, only the unreserved volumes display.

If you select the **Reserved** check box, you cannot select any other check boxes.

Volumes specified as the S-VOL of a ShadowImage pair are automatically reserved by the storage system.

- **Pair** check box: Allows you to display paired volumes.
- **Non-Pair** check box: Allows you to display non-paired volumes.
- **Cascade** check box: Allows you to filter the pairs in the **Volume List** by cascade level. You can select either of the following radio buttons:

L1: Displays L1 pairs only.

L1-L2: Displays both L1 and L2 pairs in hierarchical structure.

If you select **Cascade**, you cannot select **Reserve**. If you select **L1-L2**, you cannot select any other check boxes.

- The **Pair Status** box has following check boxes.
 - **ShadowImage**: Displays or Hlde the ShadowImage pairs.
 - **C.O.W. Snapshot**: Displays or Hlde the Copy-on-Write Snapshot pairs.

If the check box is not selected, all the check boxes in each tab will be grayed out.

- **ShadowImage** tab

Check boxes of the pair status are available only when you select the **Pair** check box in the **Attribute** box. If you select the check boxes, you can display the pairs in those statuses. You also need to select **ShadowImage** check box in the **Pair Status** tab to use these check boxes.

- **C.O.W. Snapshot** tab

This tab is for Copy-on-Write Snapshot pairs. For details, see the *Copy-on-Write Snapshot User's Guide*.

- The **OK** button applies the settings, and closes the Display Filter dialog box.
- The **Cancel** button resets the settings, and closes the Display Filter dialog box.

To configure the Volume List:

1. Click **Display Filter** in the Pair Operation window.
The Display Filter dialog box displays.
2. Select the CLPR where the volumes you want to display in the Volume List belong, and then select the check boxes of volume type, attribute, and pair status.
3. Click **OK**.

The Display Filter dialog box closes and only the volumes that meet the conditions you set in the dialog box will display in the Volume List.

The filter settings are only effective within the current ShadowImage operations. If you switch to another program product, or click a button on the toolbar on the Storage Navigator main window, the settings will be reset.

Changing or Deleting the Settings in Preview List

The **Preview** list temporarily retains multiple operations of the same type. The setting in the **Preview** list will be reflected in the storage system when you click **Apply**. If the specified operations complete successfully, the **Preview** list will be cleared. 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.

The setting of the **Preview** list can be changed or deleted only before clicking **Apply**. The following procedures describe how to change and delete the **Preview** list setting.

Changing the Settings in Preview List

To change the settings of the **Preview** list:

1. Verify that the **Preview** list shows settings made in the Paircreate dialog box, Pairsplit dialog box, or Pairresync dialog box.
2. Select and right-click the setting you want to change.
A menu displays.
3. Select the **Modify** command from the menu.
The dialog box that enables you to change the selected setting displays.
4. Change the setting and click **OK**.
The dialog box closes and the setting change is reflected in the **Preview** list.

Deleting the Settings in Preview List

To delete all of the settings in the **Preview** list, click the **Cancel** button.

To delete only some of the settings in the **Preview** list:

1. Select and right-click the setting that you want to delete.
A menu will be displayed.
2. Select the **Delete** command from the menu.
Only the selected setting is deleted from the **Preview** list.

Setting or Resetting the Reserve Attribute

You set reserve attribute to the volumes when you want to make sure that you can use those volumes for ShadowImage S-VOLs. This section describes how to set and reset the reserve attribute.

Setting the Reserve Attribute

The Set Reserve Attribute dialog box (see Figure 6-2) enables you to set the reserve attribute for the SMPL volume(s) selected on the Pair Operation window, and reserve the volumes as ShadowImage S-VOLs.

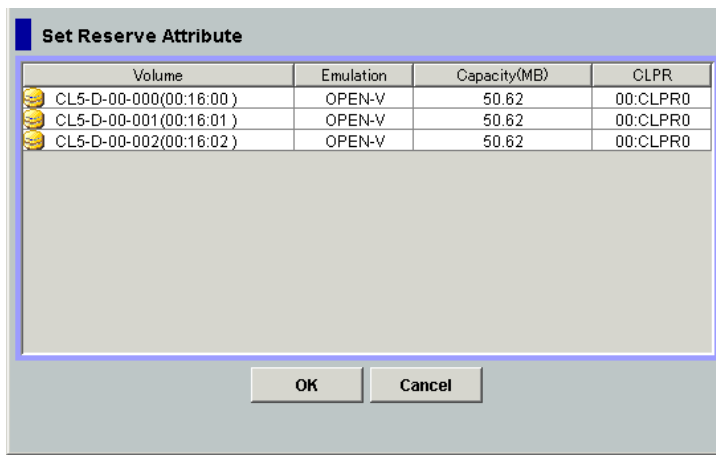


Figure 6-2 Set Reserve Attribute Dialog Box

The Set Reserve Attribute dialog box displays the unreserved SMPL volume(s) that you selected on the Pair Operation window.

- **Volume:** Information of the volume displays in *AAA-BB-CCC(XX:YY:ZZ)* format.
 - AAA: Port ID (cluster and channel number)
 - BB: Group number of host group
 - CCC: LU number
 - XX:YY:ZZ: LDKC number:CU number:LDEV number

An LDEV number that ends with a pound or gate symbol (#) indicates that the LDEV is an external volume (e.g., 00:00:01#). An LDEV number that ends with a letter "X" indicates that the LDEV is a virtual volume used by Dynamic Provisioning (e.g., 00:00:01X). For details about the external volumes, see the *Universal Volume Manager User's Guide*. For information about Dynamic Provisioning, see the *Dynamic Provisioning User's Guide*.

- **Emulation:** The emulation type of the volume.
- **Capacity (MB):** The storage capacity of the volume displayed in megabytes (MB).

- **CLPR**: The cache logical partition of the volume displays.
- The **OK** button allows you to “reserve” an SMPL volume as the ShadowImage S-VOL by setting its reserve attribute.

The setting(s) display in the **Preview List** on the Pair Operation window. To apply the setting(s) to the storage system, click **Apply** on the Pair Operation window.

- The **Cancel** button closes the Set Reserve Attribute dialog box without setting the reserve attribute.

To reserve one or more volumes for use as ShadowImage S-VOLs (by setting the reserve attribute):

1. Unmount the volume(s) that you want to reserve.
The storage system will reject all write I/Os to reserved volumes (except when in the PSUS status).
2. Go to the Pair Operation window, and select the desired port or host group in the Tree.
3. Select and right-click the desired SMPL volume(s).
The menu displays.
You can display only the SMPL volumes in the Volume List by using the Display Filter dialog box.
4. Select the **Change Reserve** command in the menu.
The Set Reserve Attribute dialog box opens.
Select only unreserved and unpaired volumes to use the **Change Reserve** command.
5. On the Set Reserve Attribute dialog box, assure that the right volume(s) display, and then click **OK**.
The setting will be reflected in the **Preview List** on the Pair Operation window.
6. Click **Apply** on the Pair Operation window.
The settings are reflected in the storage system.

You can check whether the attribute setting is updated or not on the Display Filter dialog box.

Resetting the Reserve Attribute

The Reset Reserve Attribute dialog box (see Figure 6-3) enables you to reset the reserve attribute for (i.e., unreserve) the volume(s) selected on the Pair Operation window.

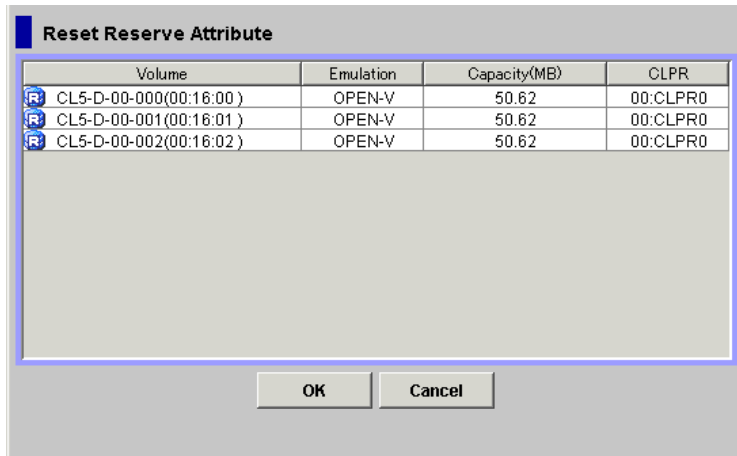


Figure 6-3 Reset Reserve Attribute Dialog Box (Un-reserve)

The Reset Reserve Attribute dialog box displays the reserved volume(s) that you selected on the Pair Operation window.

- **Volume:** Information of the volume displays in *AAA-BB-CCC(XX:YY:ZZ)* format.
 - AAA: Port ID (cluster and channel number)
 - BB: Group number of host group
 - CCC: LU number
 - XX:YY:ZZ: LDKC number:CU number:LDEV number

An LDEV number that ends with a pound or gate symbol (#) indicates that the LDEV is an external volume (e.g., 00:00:01#). An LDEV number that ends with a letter "X" indicates that the LDEV is a virtual volume used by Dynamic Provisioning (e.g., 00:00:01X). For details about the external volumes, see the *Universal Volume Manager User's Guide*. For information about Dynamic Provisioning, see the *Dynamic Provisioning User's Guide*.

- **Emulation:** The emulation type of the volume.
- **Capacity (MB):** The storage capacity of the volume displayed in megabytes (MB).
- **CLPR:** The cache logical partition of the volume displays.
- The **OK** button resets the reserve attribute of the ShadowImage S-VOL(s) and sets the status of the volume(s) back to SMPL.

The setting(s) display in the **Preview List** on the Pair Operation window. To apply the setting(s) to the storage system, you must click **Apply** on the Pair Operation window.

- The **Cancel** button closes the Set Reserve Attribute dialog box without resetting the reserve attribute.

To unreserve one or more volumes (by resetting the reserve attribute):

1. Make sure that the volumes you want to un-reserve are no longer assigned to ShadowImage pairs as S-VOLs.

If the reserved volume is assigned to a ShadowImage pair, you need to delete the pair before you unreserve the volume. See *Deleting Pairs* for instructions on deleting ShadowImage pairs.

2. Go to the Pair Operation window, and select the desired port or host group in the Tree
3. Select and right-click the desired SMPL volume(s). The menu displays.
You can display only the SMPL volumes in the Volume List by using the Display Filter dialog box.
4. Select the **Change Reserve** command in the menu.

The Reset Reserve Attribute dialog box opens.

Select only reserved and unpaired volumes to use the **Change Reserve** command.

5. On the Reset Reserve Attribute dialog box, assure that the right volume(s) are displayed and then click **OK**.

The setting will be reflected in the **Preview List** on the Pair Operation window.

6. Click **Apply** on the Pair Operation window.

The settings are reflected in the storage system.

You can check whether the attribute setting is updated or not on the Display Filter dialog box.

Setting Options

The Option window (see Option Window) allows you to specify the options to expand ShadowImage operations.

To set options:

1. Display the Option window.

If you are already displaying the other window shown by a tab, click the **Option** tab. For information about how to display the Option window directly by starting up Storage Navigator, See Starting ShadowImage.

2. Select the check box of the option you want to set.
 - For detailed information about options, see ShadowImage Options.
 - If you do not want to set any option, clear all check boxes in the **Select Option(s)** box.
3. Click **Apply**.

You can now perform a ShadowImage operation with the specified option.

Creating Pairs



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

The Paircreate dialog box (see Figure 6-4) allows you to select the S-VOL(s) for each P-VOL, set the copy pace for all pairs being created, and start the paircreate operation(s). For information about how to create normal pairs or cascaded L1 pairs, see Creating L1 Pairs. For information about how to create cascaded L2 pairs, see Creating L2 Pairs.

If you want to create new ShadowImage pairs and then split them immediately to access the S-VOLs as soon as possible, use the Pairsplit dialog box instead of the Paircreate dialog box to create and split new pairs at the same time (see Splitting Pairs for instructions).

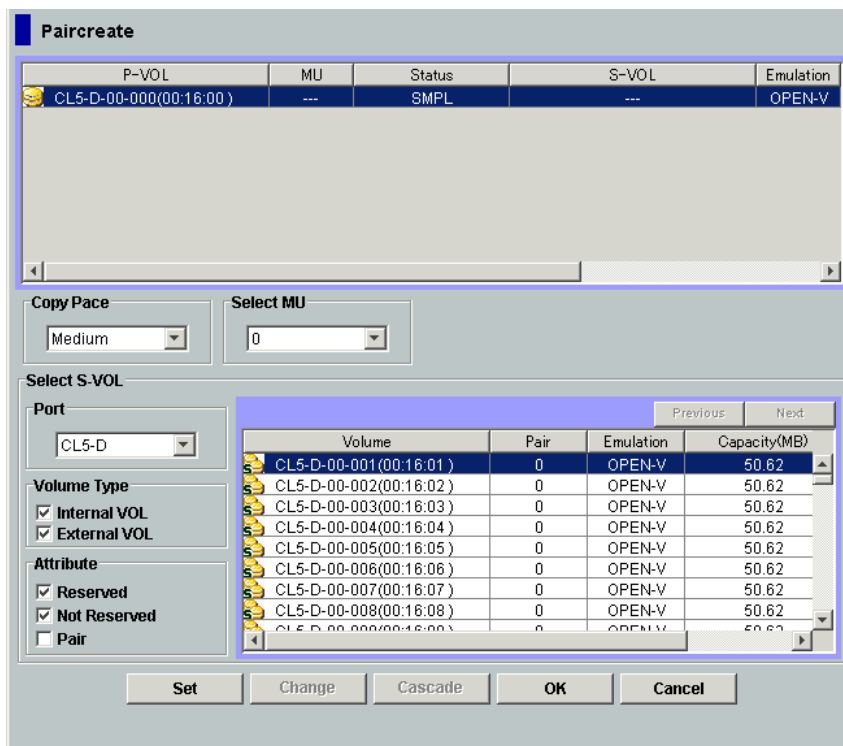


Figure 6-4 Paircreate Dialog Box

The Paircreate dialog box consists of the following components.

- Paircreate Volume List

The Volume List located on the upper side of the Paircreate dialog box displays the following information pertaining to the P-VOL and S-VOL used for creating a pair:

- **P-VOL**: Information about P-VOL displays in *AAA-BB-CCC(XX:YY:ZZ)* format.
 - AAA: Port ID (cluster and channel number)
 - BB: Group number of host group
 - CCC: LU number
 - XX:YY:ZZ: LDKC number:CU number:LDEV number

An LDEV number that ends with a pound or gate symbol (#) indicates that the LDEV is an external volume (e.g., 00:00:01#). An LDEV number that ends with a letter "X" indicates that the LDEV is a virtual volume used by Dynamic Provisioning (e.g., 00:00:01X). For details about the external volumes, see the *Universal Volume Manager User's Guide*. For information about Dynamic Provisioning, see the *Dynamic Provisioning User's Guide*.

- **MU**: The MU number of the P-VOL.
- **Status**: The status of the P-VOL.
- **S-VOL**: Information about S-VOL displays in *AAA-BB-CCC(XX:YY:ZZ)* format.
 - AAA: Port ID (cluster and channel number)
 - BB: Group number of host group
 - CCC: LU number
 - XX:YY:ZZ: LDKC number:CU number:LDEV number

An LDEV number that ends with a pound or gate symbol (#) indicates that the LDEV is an external volume (e.g., 00:00:01#). An LDEV number that ends with a letter "X" indicates that the LDEV is a virtual volume used by Dynamic Provisioning (e.g., 00:00:01X). For details regarding the external volumes, see the *Universal Volume Manager User's Guide*. For information about Dynamic Provisioning, see the *Dynamic Provisioning User's Guide*.

- **Emulation**: The emulation type of the P-VOL and S-VOL.
- **Capacity (MB)**: The volume capacity displayed in megabytes (MB).
- **CLPR(P)**: The cache logical partition of the P-VOL.
- **CLPR(S)**: The cache logical partition of the S-VOL.
- The **Copy Pace** drop-down list allows you to select the copy pace (from **Slower**, **Medium**, or **Faster**) for all pairs being created. By clicking the **Set** button, the same copy pace will be applied to all the new pairs being created.
 - When the **Preview List** already holds Paircreate settings, and you specify a different copy pace for new pairs in the Paircreate dialog box, the copy pace for the existing Paircreate settings displayed in the **Preview List** will be also changed. The latest copy pace specified in the Paircreate dialog box is in effect before the settings are reflected to the storage system.

- If you specify **Slower**, the pace of initial copying will be slow, but you can minimize the impact of ShadowImage operations on storage system I/O performance. If you specify **Faster**, the initial copy operation completes as quickly as possible, but it will cause a large impact on the I/O operation.
- The **Select MU** drop-down list allows you to select the MU number for each pair being created from: **0**, **1**, and **2** for L1 pairs, and **1** and **2** for L2 pairs.
 - When a P-VOL makes pair with more than one S-VOLs, the storage system assumes that there are same numbers of virtual P-VOLs. For example, when a P-VOL makes pair with three S-VOLs, there is only one real P-VOL, however, the storage system assumes that there are three virtual P-VOLs. Virtual P-VOL is called MU (Mirror Unit).
 - You can select a MU number for a cascade pair. You cannot select the same MU number for different cascade pairs of the same P-VOL (root or node volume).
 - If you specify the MU number that is already used for Copy-on-Write Snapshot pair, or if you specify MU number 0 for L2 pair, an error occurs.
- The **Select S-VOL** box allows you to filter the S-VOLs displayed in the **S-VOL List** located on the right.
 - The **Port** drop-down list allows you to select the available S-VOLs by port
 - The **Volume Type** box:
 - The **Internal VOL** check box allows you to select the available S-VOLs that are internal volumes.
 - The **External VOL** check box allows you to select the available S-VOLs that are external volumes.
 - You need the Universal Volume Manager features to select the external volumes.
 - The **Attribute** box allows you to select the available S-VOLs that are reserved when the **Reserved** check box is selected, or those that are unreserved when the **Not Reserved** check box is selected. The **Attribute** box also allows you to select the pairs that can be set as L2 pairs when the **Pair** check box is selected.
 - The number of secondary volumes that can be displayed in the **S-VOL List** at a time is limited to 1,024 volumes. In case the number of volumes defined in the storage system exceeds this limit, use the **Previous** and **Next** buttons on the upper right of the **S-VOL List** to turn the pages of the **S-VOL List** and see the entire list.

- The **Previous** button allows you to return to the previous page of the **S-VOL List**. This button is selectable only when the number of volumes defined in the storage system exceeds 1,024 volumes, which is the maximum number of volumes that can be displayed on one page. The button is grayed out if the total number of volumes defined in the storage system is less than 1,024 volumes.
- The **Next** button allows you to turn to the next page of the **S-VOL List**. This button is selectable only when the number of volumes defined in the storage system exceeds 1,024 volumes, which is the maximum number of volumes that can be displayed on one page. The button is grayed out if the total number of volumes defined in the storage system is less than 1,024 volumes.
- The S-VOL List displays the following information related to S-VOLs:
 - **Volume:** Information about the volume displays in *AAA-BB-CCC(XX:YY:ZZ)* format.
 - AAA: Port ID (cluster and channel number)
 - BB: Group number of host group
 - CCC: LU number
 - XX:YY:ZZ: LDKC number:CU number:LDEV number

An LDEV number that ends with a pound or gate symbol (#) indicates that the LDEV is an external volume (e.g., 00:00:01#). An LDEV number that ends with a letter "X" indicates that the LDEV is a virtual volume used by Dynamic Provisioning (e.g., 00:00:01X). For details regarding the external volumes, see the *Universal Volume Manager User's Guide*. For information about Dynamic Provisioning, see the *Dynamic Provisioning User's Guide*.

- **Pair:** The number of pairs.
- **Emulation:** The emulation type of the S-VOL.
- **Capacity(MB):** The capacity of the S-VOL displayed in megabytes (MB).
- **CLPR:** The cache logical partition (CLPR) of the S-VOL.
- The **Set** button adds the selected S-VOL and P-VOL to the Paircreate Volume List as an L1 pair.
- The **Change** button replaces the existing S-VOL of the selected L1 pair (meaning the S-VOL of the pair after completing the operation selected in the Paircreate Volume List) with the selected S-VOL.
- The **Cascade** button adds the selected S-VOL and the P-VOL (node volume) to the Paircreate Volume List as a L2 pair. To use the **Cascade** button, you must select one of the listed L1 pairs.
- The **OK** button adds the operation (setting) to create a new pair using the P-VOL and S-VOL you selected in the Paircreate dialog box to the **Preview List** on the Pair Operation window.

To apply the new pair operation setting displayed in the **Preview List** to the storage system, you must click **Apply** on the Pair Operation window.

- The **Cancel** button cancels the operations set in the Paircreate dialog box and closes the dialog box.

Creating L1 Pairs

To create new ShadowImage (L1) pair(s):

1. Make sure that the desired S-VOL(s) is/are un-mounted.
2. 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.
3. Select the desired P-VOL(s) for the new pair(s), right-click the selected P-VOL(s) to display the menu, and then select the **Paircreate** command to open the Paircreate dialog box.

Do not select any reserved volumes for P-VOLs.

4. On the Paircreate dialog box, select from the **Copy Pace** drop-down list, the initial copy pace for all pairs being created.
5. Verify that the Paircreate dialog box displays the desired P-VOL(s).

If you want to remove any volumes from the list, select the volume(s), right-click the mouse to display the menu, and then select the **Delete** command.

6. Select the S-VOL(s) for each P-VOL as follows:
 - a. Select the desired P-VOL on the Paircreate Volume List.
 - b. Select the MU number (**0**, **1**, or **2**) for the L1 pair being created from the **Select MU** drop-down list.
 - c. Select the desired port from the **Port** drop-down list in the **Select S-VOL** box. Then select the **Reserved** check box to display the reserved volumes, and then select from the reserved volumes displayed in the **S-VOL List**, the one that you want to use as the S-VOL of the new ShadowImage pair.

You can also select an unreserved volume as the S-VOL. When you create the pair, the storage system changes the reserve attribute to "Reserved" automatically.

- d. Click **Set** to create (add) the S-VOL to the selected P-VOL. The S-VOL displays next to the selected P-VOL.
- e. If you want to add a second and/or third S-VOL to the same P-VOL, repeat steps b through d to add each S-VOL to the selected P-VOL. Each pair to be created displays separately in the Paircreate Volume List.

You cannot select the same MU number for different pairs.

7. Repeat step 6 until all desired pairs display.

Use the **Change** button to replace an S-VOL. Use the **Set** button to add an S-VOL. To remove pairs from the Paircreate Volume List, select the **Delete** command from the menu that appears by right-clicking the pair that you want to remove.

8. When the Paircreate dialog box displays the desired new pair(s), click **OK** to reflect all pairs (settings) in the Paircreate Volume List to the **Preview List** on the Pair Operation window.
9. On the Pair Operation window, click **Apply** to apply the operation(s) set in the Paircreate dialog box to the storage system.

When the initial copy operation to create the L1 pair(s) starts, the Pair Operation window shows the new pair(s) with COPY(PD) status and the progress (%) of the initial copy operation(s).

Table 6-1 describes the relationship between the L1 pair status and the availability of ShadowImage pair operations on the L1 pairs. (CMD RJT = command rejected.)

Table 6-1 Relationship between L1 Pair Status and L1 Pair Operations

L1 Pair Status	L1 Pair Operations				
	Paircreate	Pairsplit	Pairresync	Pairsplit-E	Pairsplit-S
COPY(PD)	NO (CMD RJT) *	OK	NO (CMD RJT)	OK	OK
PAIR	NO (CMD RJT) *	OK	NO (CMD RJT)	OK	OK
COPY(SP)	NO (CMD RJT) *	NO (CMD RJT) *	NO (CMD RJT)	OK	OK
PSUS(SP)	NO (CMD RJT) *	NO (CMD RJT) *	OK	OK	NO (CMD RJT)
PSUS	NO (CMD RJT) *	NO (CMD RJT) *	OK	OK	OK
COPY(RS)	NO (CMD RJT) *	NO (CMD RJT) *	NO (CMD RJT)	OK	OK
COPY(RS-R)	NO (CMD RJT) *	NO (CMD RJT) *	NO (CMD RJT)	OK	OK
PSUE	NO (CMD RJT) *	NO (CMD RJT) *	OK	NO (CMD RJT)	OK
Note* : The operation to the P-VOL is available.					

Creating L2 Pairs

To create one or more new L2 cascade pairs:



WARNING: The L2 paircreate operation overwrites all existing data on the L2 S-VOLs. The user is responsible for backing up the data on the S-VOLs before creating ShadowImage pairs.

1. Make sure that the L2 S-VOLs are un-mounted.
2. Go to the Pair Operation window, and select the desired L1 pair(s) to which you want to add the L2 pair(s), right-click the selected L1 pair(s) to display the menu, and then select the **Paircreate** command to open the Paircreate dialog box.
3. On the Paircreate dialog box, select the desired L1 pair from the Paircreate Volume List.
4. Select the MU number (**1** or **2**) from the **Select MU** drop-down list.
5. Select the desired S-VOL for the new L2 pair.
6. Click **Cascade** to add the desired L2 pair to the Paircreate Volume List.
7. Repeat steps 2 through 5 until all the desired L2 pairs are displayed.
Use the **Change** button to replace an S-VOL. Use the **Set** button to add an S-VOL. To remove pairs from the Paircreate Volume List, select the **Delete** command from the menu that appears by right-clicking the pair that you want to remove.
8. When the Paircreate dialog box displays all desired new pairs, click **OK** to reflect all pairs (settings) in the Paircreate Volume List to the **Preview** List on the Pair Operation window.
9. On the Pair Operation window, click **Apply** to apply the paircreate operation(s) set in the Paircreate dialog box to the storage system.
When the initial copy operation(s) to create the L2 pair(s) starts, the Pair Operation window shows the new pairs with COPY(PD) status and the progress (%) of the initial copy operation(s).

To split an L2 pair, you must first split the L1 pair (L1 status = PSUS). The reverse and quick restore pairresync operations cannot be used for L2 pairs. Table 6-2 describes the relationship between the L1 pair status and the availability of ShadowImage pair operations on the associated L2 pairs. (CMD RJT = command rejected.)

Table 6-2 Relationship between L1 Pair Status and L2 Pair Operations

L1 Pair Status	L2 Pair Operations				
	Paircreate	Pairsplit	Pairresync *1	Pairsplit-E	Pairsplit-S
COPY(PD)	OK	NO (CMD RJT)	OK	OK	OK
PAIR	OK	NO (CMD RJT)	OK	OK	OK

L1 Pair Status	L2 Pair Operations				
COPY(SP)	OK	NO (CMD RJT)	OK	OK	OK
PSUS(SP)	NO (CMD RJT)	NO (CMD RJT)	OK	OK	OK
PSUS	OK	OK *2	OK	OK	OK
COPY(RS)	OK	NO (CMD RJT)	OK	OK	OK
COPY(RS-R)	OK	NO (CMD RJT)	OK	OK	OK
PSUE	OK	NO (CMD RJT)	OK	OK	OK
<p>Note *1: You can only resynchronize L2 pairs in Normal Copy or Quick Resync mode. Note that you cannot perform backward resynchronization (i.e., Reverse Copy or Quick Restore).</p> <p>Note *2: In order to split L2 pairs, you need to change the status of the L1 pair to PSUS at first.</p>					

Table 6-3 describes the relationship between the L2 pair status and the availability of pair operations on the associated L1 pairs. (CMD RJT = command rejected.) If you delete an L1 pair that contains an L2 pair, the L2 pair becomes the L1 pair.

Table 6-3 Relationship between L2 Pair Status and L1 Pair Operations

L2 Pair Status	L1 Pair Operations				
	Paircreate	Pairsplit	Pairresync	Pairsplit-E	Pairsplit-S
COPY(PD)	OK*1*2	OK	OK	OK	OK
PAIR	OK*1*2	OK	OK	OK	OK
COPY(SP)	NO (CMD RJT) *2	NO (CMD RJT) *2	NO (CMD RJT)	OK	OK
PSUS(SP)	NO (CMD RJT) *2	NO (CMD RJT) *2	NO (CMD RJT)	OK	OK
PSUS	OK*1*2	OK	OK	OK	OK
COPY(RS)	OK*1*2	OK	OK	OK	OK
COPY(RS-R)	NO (CMD RJT) *2	NO (CMD RJT)	—	—	—
PSUE	OK*1*2	OK	OK	OK	OK
<p>*1 MU# of L2 pair must be 1 or 2.</p> <p>*2 Not displayed by the Storage Navigator.</p>					

The read/write operation to each volume (root, node or leaf volume) from the host is enabled or disabled depending on the status of L1/L2 pairs. Table 6-4 indicates the relationship between read/write operation from the host to the node volume and the status of L1/L2 pairs.

Table 6-4 Read/Write to Node Volume According to Status of L1/L2 Pairs

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							
COPY(RS)	Read Only	Read Only	Read Only	Read Only	Read Only	Read Only	Read Only
COPY(RS-R)							
PSUE							

Table 6-5 describes the relationship between read/write operation from the host to the leaf volume and the L2 pair status.

Table 6-5 Read/Write to Leaf Volume According to 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

Splitting Pairs

The Pairsplit dialog box (see Table 6-5) allows you to split existing ShadowImage pairs. The Pairsplit dialog box can also be used to simultaneously create and split new ShadowImage pairs.

For information about how to split pairs, see Performing Only Pair Splitting. For information about how to create and split pairs, see Performing Pair Creation and Pair Splitting. In addition, you can split multiple pairs at the same specified time by using CCI. For details, see Performing At-Time Split Operation (Multiple Pair Splitting).

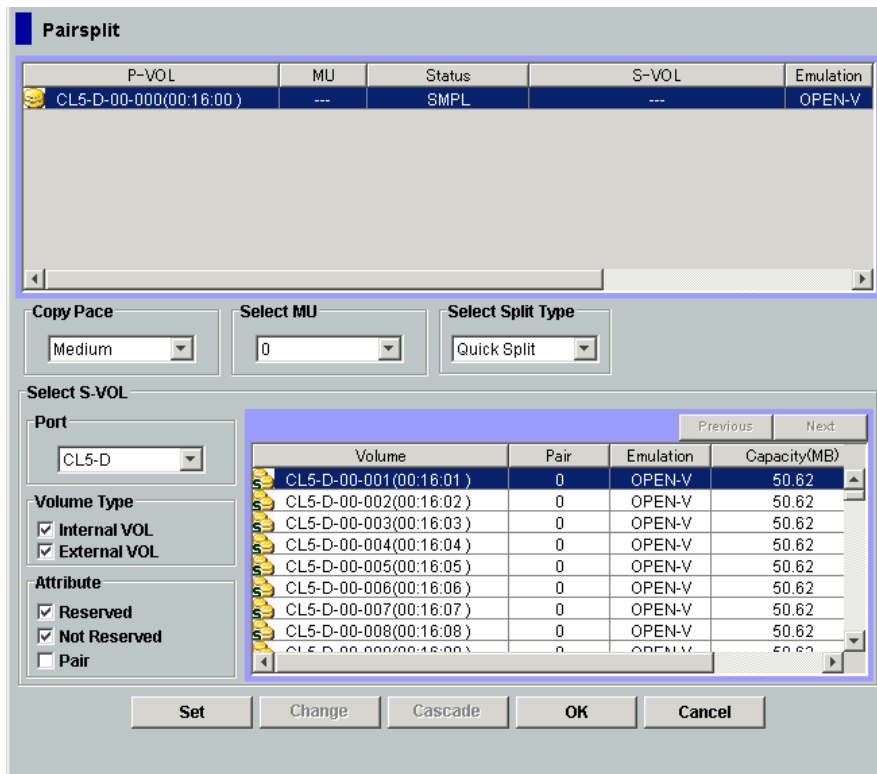


Figure 6-5 Pairsplit Dialog Box

The Pairsplit dialog box consists of the following components.

- Pairsplit Volume List

The Volume List located on the upper side of the Pairsplit dialog box displays the following information pertaining to the P-VOL and S-VOL of the pair you want to split:

- **P-VOL:** Information about P-VOL displays in *AAA-BB-CCC(XX:YY:ZZ)* format.
 - AAA: Port ID (cluster and channel number)
 - BB: Group number of host group

- CCC: LU number
- XX:YY:ZZ: LDKC number:CU number:LDEV number

An LDEV number that ends with a pound or gate symbol (#) indicates that the LDEV is an external volume (e.g., 00:00:01#). An LDEV number that ends with a letter "X" indicates that the LDEV is a virtual volume used by Dynamic Provisioning (e.g., 00:00:01X). For details regarding the external volumes, see the *Universal Volume Manager User's Guide*. For information about Dynamic Provisioning, see the *Dynamic Provisioning User's Guide*.

- **MU**: The MU number of the P-VOL.
- **Status**: The status of the P-VOL.
- **S-VOL**: Information about S-VOL displays in AAA-BB-CCC(XX:YY:ZZ) format.
 - AAA: Port ID (cluster and channel number)
 - BB: Group number of host group
 - CCC: LU number
 - XX:YY:ZZ: LDKC number:CU number:LDEV number

An LDEV number that ends with a pound or gate symbol (#) indicates that the LDEV is an external volume (e.g., 00:00:01#). An LDEV number that ends with a letter "X" indicates that the LDEV is a virtual volume used by Dynamic Provisioning (e.g., 00:00:01X). For details regarding the external volumes, see the *Universal Volume Manager User's Guide*. For information about Dynamic Provisioning, see the *Dynamic Provisioning User's Guide*.

- **Emulation**: The emulation type of the P-VOL and S-VOL.
- **Capacity(MB)**: The volume capacity displayed in megabytes (MB).
- **CLPR(P)**: The cache logical partition of the P-VOL.
- **CLPR(S)**: The cache logical partition of the S-VOL.
- The **Copy Pace** drop-down list allows you to select the copy pace (from **Slower**, **Medium**, or **Faster**) for all the pairs that you are splitting. By clicking **Set**, the same copy pace will be applied to all the newly pairs that you are splitting.
 - When the **Preview List** already holds some Pairsplit settings, and you specify a different copy pace for new pairs in the Pairsplit dialog box, the copy pace for the existing Pairsplit settings displayed in the **Preview List** will be also changed. The latest copy pace specified in the Pairsplit dialog box is in effect before the settings are reflected to the storage system.
 - If you specify **Slower**, the pace of copying will be slow, but you can minimize the impact of ShadowImage operations on storage system I/O performance. If you specify **Faster**, the copy operation completes as quickly as possible, but it will cause a large impact on the I/O operation.

- The **Select MU** drop-down list allows you to select the MU number for each pair being created from: **0**, **1**, and **2** for L1 pairs, and **1** and **2** for L2 pairs.
 - You can select a MU number for a cascade pair. You cannot select the same MU number for different cascade pairs of the same P-VOL (root or node volume).
 - If you specify the MU number that is already used for Copy-on-Write Snapshot pair, or if you specify MU number 0 for L2 pair, an error occurs.
- The **Select Split Type** drop-down list allows you to select the pairsplit type from: **Quick Split** or **Steady Split**. The following table shows read/write operations from the host servers to the volumes during the pairsplit operation.

Table 6-6 Operations from the Host Servers during the Pairsplit Operation

Operations	Volumes	Quick Split	Steady Split
Read	P-VOL	Both areas which are not copied and areas which are already copied can be read as usual.	
	S-VOL	<p>The areas which are already copied can be read as usual.</p> <p>If the host server tries to read the area which is not copied yet, firstly ShadowImage copies that area from the P-VOL, and then the host server will read the area after the copy operation completes. Therefore, the result will be the same as when the host server reads the area which is already copied.</p>	Cannot be read, though the read processing itself will finish normally.
Write	P-VOL	<p>Write operation for the area which is already copied to the S-VOL is performed normally.</p> <p>If the host server tries to write data to the area which is not copied yet, new data will be written after the old data is copied to the S-VOL. P-VOL data during the pairsplit operation will therefore be copied to the S-VOL for sure.</p>	
	S-VOL	<p>The areas which are already copied can be written as usual.</p> <p>If the host server tries to write data to the area which is not copied yet, firstly ShadowImage copies that area from the P-VOL, and then the host server will write data to the area after the copy operation completes. Therefore, the result will be the same as when the host server writes data to the area which is already copied.</p>	Cannot be written. Write processing will finish abnormally.

- The **Select S-VOL** box allows you to filter the S-VOLs displayed in the S-VOL List located on the right.
 - The **Port** drop-down list allows you to select the available S-VOLs by port.
 - The **Volume Type** box:
 - The **Internal VOL** check box allows you to select the available S-VOLs that are internal volumes.
 - The **External VOL** check box allows you to select the available S-VOLs that are external volumes.



Important: You need the Universal Volume Manager features to select the external volumes.

- The **Attribute** box allows you to select the available S-VOLs that are reserved when the **Reserved** check box is selected, or those that are unreserved when the **Not Reserved** check box is selected. The **Attribute** box also allows you to select available pairs that can be set as L2 pairs when the **Pair** check box is selected.

The number of secondary volumes that can be displayed in the S-VOL List at a time is limited to 1,024 volumes. In case the number of volumes defined in the storage system exceeds this limit, use the **Previous** and **Next** buttons on the upper right of the S-VOL List to turn the pages of the S-VOL List and see the entire list.

- The **Previous** button allows you to return to the previous page of the **S-VOL List**. This button is selectable only when the number of volumes defined in the storage system exceeds 1,024 volumes, which is the maximum number of volumes that can be displayed on one page. The button is grayed out if the total number of volumes defined in the storage system is less than 1,024 volumes.
- The **Next** button allows you to turn to the next page of the S-VOL List. This button is selectable only when the number of volumes defined in the storage system exceeds 1,024 volumes, which is the maximum number of volumes that can be displayed on one page. The button is grayed out if the total number of volumes defined in the storage system is less than 1,024 volumes.
- The S-VOL List displays the following information related to S-VOLs:
 - **Volume:** Information about the volume displays in *AAA-BB-CCC(XX:YY:ZZ)* format.
 - AAA: Port ID (cluster and channel number)
 - BB: Group number of host group
 - CCC: LU number
 - XX:YY:ZZ: LDKC number:CU number:LDEV number

An LDEV number that ends with a pound or gate symbol (#) indicates that the LDEV is an external volume (e.g., 00:00:01#). An LDEV number that ends with a letter "X" indicates that the LDEV is a virtual volume used by Dynamic Provisioning (e.g., 00:00:01X). For details regarding the external volumes, see the *Universal Volume Manager User's Guide*. For information about Dynamic Provisioning, see the *Dynamic Provisioning User's Guide*.

- **Pair:** The number of pairs.
- **Emulation:** The emulation type of the S-VOL.
- **Capacity(MB):** The capacity of the S-VOL displayed in megabytes (MB).
- **CLPR:** The cache logical partition (CLPR) of the S-VOL.

- The **Set** button adds the selected S-VOL and P-VOL to the Pairsplit Volume List as an L1 pair.
- The **Change** button replaces the existing S-VOL of the selected L1 pair (meaning the S-VOL of the pair displayed in the Pairsplit **Volume List**) with the selected S-VOL.
- The **Cascade** button adds the selected S-VOL and the P-VOL (node volume) to the Pairsplit Volume List as a L2 pair. To use the **Cascade** button, you must select one of the listed L1 pairs.
- The **OK** button adds the operation (setting) to split a pair composed of the P-VOL and S-VOL you selected in the Pairsplit dialog box to the **Preview List** on the Pair Operation window.

To apply the new setting displayed in the **Preview List** to the storage system, you must click **Apply** on the Pair Operation window.

- The **Cancel** button cancels the operations set in the Pairsplit dialog box and closes the dialog box.

Performing Only Pair Splitting

To split one or more existing ShadowImage pairs:



Caution: 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 pairsplit operations are synchronizing the S-VOLs to the P-VOLs.

1. 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.
2. Select the pair(s) you want to split, right-click the selected pair(s) to display the menu, and then select the **Pairsplit** command to open the Pairsplit dialog box.

You cannot split a suspended (PSUE) pair.

3. On the Pairsplit dialog box, select the copy pace from the **Copy Pace** drop-down list for all pairs being split.

The copy pace is set for all pairs being split. If you change the setting, the last setting will become effective.

4. Select the split type from the **Select Split Type** drop-down list for all pairs being split.

The split type is set for all pairs being split. If you change the setting, the latest setting is applied to all pairs.

5. When the Pairsplit dialog box displays the desired pair(s), click **OK** to reflect all pairs to the **Preview List** on the Pair Operation window.

Use the **Delete** command selected from the menu (that displays by right-clicking) to remove any pairs from the Pairsplit Volume List.

6. On the Pair Operation window, click **Apply** to apply the pairsplit operation(s) set in the Pairsplit dialog box to the storage system.

When the pairsplit operation(s) start, the Pair Operation window shows the new pairs with COPY(SP) or PSUS(SP) status and the progress (%) of the update copy operation(s).

Performing Pair Creation and Pair Splitting

The Pairsplit dialog box can also be used to simultaneously create and split new ShadowImage pairs.



Caution: 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 creating and splitting the pairs. This ensures that there are no updates to the P-VOLs while the pairsplit operations are synchronizing the S-VOLs to the P-VOLs.

1. 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.
2. Select the SMPL volume(s) that will be the P-VOL(s) of the new pairs to be created and split, right-click the selected P-VOL(s) to display the menu, and then select the **Pairsplit** command to open the Pairsplit dialog box.
3. On the Pairsplit dialog box, select the copy pace from the **Copy Pace** drop-down list.
4. Select **Quick Split** or **Steady Split** from the **Select Split Type** drop-down list.
5. Specify the S-VOL that you want to form an L1 pair with each P-VOL by performing the following the steps:
 - a. From the Pairsplit Volume List, select the desired P-VOL.
 - b. From the **Select MU** drop-down list, select the MU number (**0**, **1**, or **2**) for the L1 pair to be created.
 - c. From the **Port** drop-down list in the **Select S-VOL** box, select the desired S-VOL port.
 - d. Select the **Reserved** checkbox in the **Reserved** box to make the reserved volumes appear on the S-VOL List.
 - e. From the S-VOL List, select the volume you want to use as the S-VOL of the pair you are creating.

You can also select the S-VOL from unreserved volumes, because once you select an unreserved volume, the storage system automatically sets its reserve attribute and make it a reserved volume.
 - f. Click Set.

The S-VOL displays next to the selected P-VOL in the Pairsplit Volume List.

- g. If you want to add and split another S-VOL to and from the same P-VOL, repeat steps b through f. Each pair to be created and split displays separately in the Volume List.

You cannot select the same MU number for different pairs.

6. Repeat step 4 until the desired L1 pair(s) display.
Use the **Change** button to replace S-VOLs, the **Set** button to add L1 S-VOLs, and the **Delete** command in the menu to remove pairs from the Pairsplit Volume List.
7. If you also want to create and split L2 cascade pairs, add the L2 S-VOL(s) to the L1 pairs as follows:
 - a. Select the desired L1 pair from the Pairsplit Volume List.
 - b. If you are selecting an existing L1 pair, make sure that the status of the desired L1 pair is PSUS.
 - c. From the **Select MU** drop-down list, select the MU number (**1** or **2**) for the L2 pair to be created.
 - d. From the Pairsplit Volume List, select the volume that you want to assign as the S-VOL for the L2 pair.
 - e. Click **Cascade** to add the L2 S-VOL to the selected L1 pair. The new L2 pair to be created will then be displayed in the Pairsplit Volume List.
 - f. If you want to add another L2 S-VOL to the same L1 pair, repeat steps b through e. Each L2 pair to be created and split displays separately in the Pairsplit Volume List.
8. Repeat step 7 until the desired pair(s) is/are displayed.
Use the **Change** button to replace S-VOLs, the **Cascade** button to add L2 S-VOLs, and the **Delete** command selected from the menu (that displays by right-clicking) to remove pairs.
9. When the Pairsplit dialog box displays the desired L1 and L2 pair(s), click **OK** to reflect the settings in the Pairsplit dialog box to the **Preview List** on the Pair Operation window.
10. On the Pair Operation window, click **Apply** to apply the operation settings in the **Preview List** to the storage system.

The pair(s) will then be created and split according to the operations set in the Pairsplit dialog box. When the paircreate and pairsplit operation(s) start, the Pair Operation window will show that the status of the new pairs has changed to COPY(SP) or PSUS(SP) and the progress (%) of the ongoing update copy operation(s). The pair status will change to PSUS when the pairsplit operation completes.

Performing At-Time Split Operation (Multiple Pair Splitting)

By using CCI, you can immediately split the multiple ShadowImage pairs in the same consistency group. First define the consistency group in the CCI configuration definition file. ShadowImage consistency groups have the following restrictions:

Table 6-7 Specifications of Consistency Groups

Items	Descriptions
Consistency group number	A number (0–127) is assigned to each consistency group. You can specify a consistency group number when you create ShadowImage pairs. If you do not specify a number, the storage system assigns a number automatically. Use the Volume List of the Pair Operation window to view the list of the consistency group numbers ShadowImage assigned by default. You can configure up to 128 consistency groups in a storage system, including ShadowImage for z/OS consistency groups and Copy-on-Write Snapshot consistency groups.
Number of pairs	You can define up to 8,192 ShadowImage pairs in a consistency group. However, you should count LUSE volumes that contain n LDEVs as n volumes. For further information on LUSE volumes, see the <i>LUN Expansion User's Guide</i> . Note: ShadowImage pairs, ShadowImage for z/OS pairs, and Copy-on-Write Snapshot pairs cannot co-exist in the same consistency group.

Consistency groups have the following restrictions:

- You cannot define L1 and L2 cascade pairs if they share the same node volume in a consistency group. If you specify these pairs in the same consistency group, the paircreate command will be rejected.
- Do not mix pairs created with the At-Time Split option and pairs not created with the At-Time Split option in the same group as defined in the CCI configuration file. If you mix these two types of pairs, the pairsplit operation may terminate abnormally or the S-VOLs of the P-VOLs in the same consistency group may not be correctly created when the pairsplit request is received.

To enable the At-Time Split function using CCI, take the following high-level steps:

1. Edit the CCI configuration definition file so that the ShadowImage pairs you want to apply the At-time Split function to belong to the same consistency group.
2. Execute the CCI paircreate command, specifying the option for using the At-Time Split function. The ShadowImage pairs for the At-Time Split function are created.
3. Execute the pairsplit command using CCI. Data that P-VOLs has when the pairsplit command executes will be copied to S-VOLs.

If the At-Time Split option is enabled, the data in all P-VOLs (in the same consistency group) is created in the corresponding S-VOLs at the time the pairsplit request is received by the storage system.

If the At-Time Split option is disabled, the pairsplit operation does not ensure that S-VOLs will be created from P-VOLs in the same consistency group. The At-Time Split option is disabled if you perform ShadowImage pair operations from the Storage Navigator computer on the ShadowImage At-Time Split pairs created by CCI.

For detailed information, see the *Command Control Interface (CCI) User and Reference Guide*.

If the At-Time Split function using CCI fails, the following problems will ensue:

- When the pairsplit operation by CCI ends abnormally, all the ShadowImage pairs in the same consistency group will be 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, follow the next steps:

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

Troubleshooting At-Time Split function using CCI:

Use Case: Using a Universal Replicator S-VOL is used as ShadowImage P-VOL:

If the status of some pairs belonging to a consistency group cannot be changed, the Pairsplit command of CCI 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 as follows:

- 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 Table 6-1.
- 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 Table 6-2 and Table 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. See [Interoperability with Other Products and Functions](#).

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

Suspending Pairs

The Pairsplit-E dialog box (see Figure 6-6) allows you to suspend the pair(s).

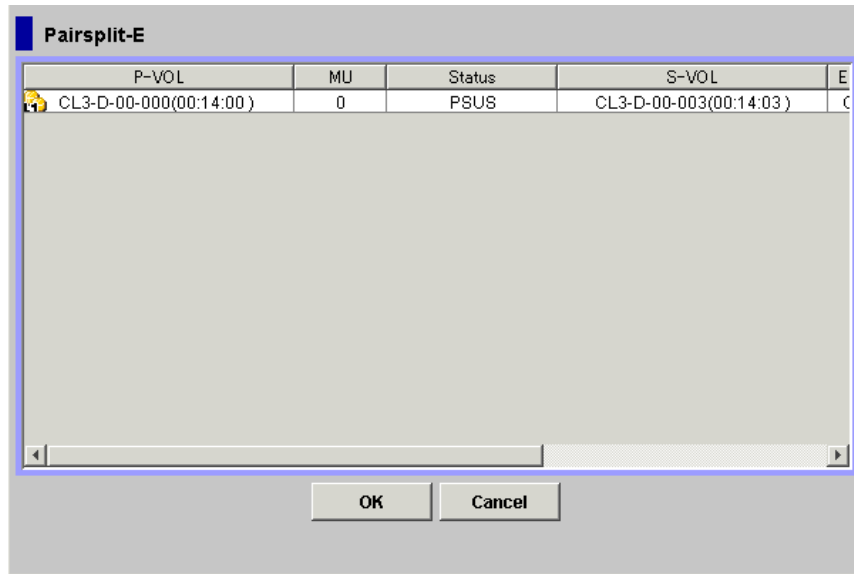


Figure 6-6 Pairsplit-E Dialog Box

The Pairsplit-E dialog box consists of the following components.

- Pairsplit-E Volume List

The Volume List located on the upper side of the Pairsplit-E dialog box displays the following information pertaining to the P-VOL and S-VOL of the pair you want to suspend:

- **P-VOL:** Information about P-VOL displays in *AAA-BB-CCC(XX:YY:ZZ)* format.
 - AAA: Port ID (cluster and channel number)
 - BB: Group number of host group
 - CCC: LU number
 - XX:YY:ZZ: LDKC number:CU number:LDEV number

An LDEV number that ends with a pound or gate symbol (#) indicates that the LDEV is an external volume (e.g., 00:00:01#). An LDEV number that ends with a letter "X" indicates that the LDEV is a virtual volume used by Dynamic Provisioning (e.g., 00:00:01X). For details regarding the external volumes, see the *Universal Volume Manager User's Guide*. For information about Dynamic Provisioning, see the *Dynamic Provisioning User's Guide*.

- **MU:** The MU number of the P-VOL.
- **Status:** The status of the P-VOL.

- **S-VOL**: Information about S-VOL displays in *AAA-BB-CCC(XX:YY:ZZ)* format.
 - AAA: Port ID (cluster and channel number)
 - BB: Group number of host group
 - CCC: LU number
 - XX:YY:ZZ: LDKC number:CU number:LDEV number

An LDEV number that ends with a pound or gate symbol (#) indicates that the LDEV is an external volume (e.g., 00:00:01#). An LDEV number that ends with a letter "X" indicates that the LDEV is a virtual volume used by Dynamic Provisioning (e.g. 00:00:01X). For details regarding the external volumes, see the *Universal Volume Manager User's Guide*. For information about Dynamic Provisioning, see the *Dynamic Provisioning User's Guide*.

- **Emulation**: The emulation type of the P-VOL and S-VOL.
- **Capacity(MB)**: The volume capacity displayed in megabytes (MB).
- **CLPR(P)**: The cache logical partition of the P-VOL.
- **CLPR(S)**: The cache logical partition of the S-VOL.
- The **OK** button adds the operation setting(s) to suspend the selected pair(s) displayed in the Pairsplit-E Volume List to the **Preview List** on the Pair Operation window.

You must click **Apply** on the Pair Operation window to apply the pairsplit-E operation displayed in the **Preview List** to the storage system.

- The **Cancel** button cancels the operations set in the Pairsplit-E dialog box and closes the dialog box.

To remove any pairs from the Pairsplit-E Volume List, select the desired pairs displayed in the **Preview List** on the Pair Operation window, right-click the mouse to select the **Delete** command from the menu that appears after right-clicking.

To suspend ShadowImage pair(s):

1. 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.
2. 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.
3. 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.

4. Repeat steps 1 and 2 to suspend additional pairs in the Pairsplit-E Volume List.

5. 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).

Resynchronizing Pairs

The Pairresync dialog box (see Figure 6-7) allows you to resynchronize the pair(s) in PSUS or PSUE status.

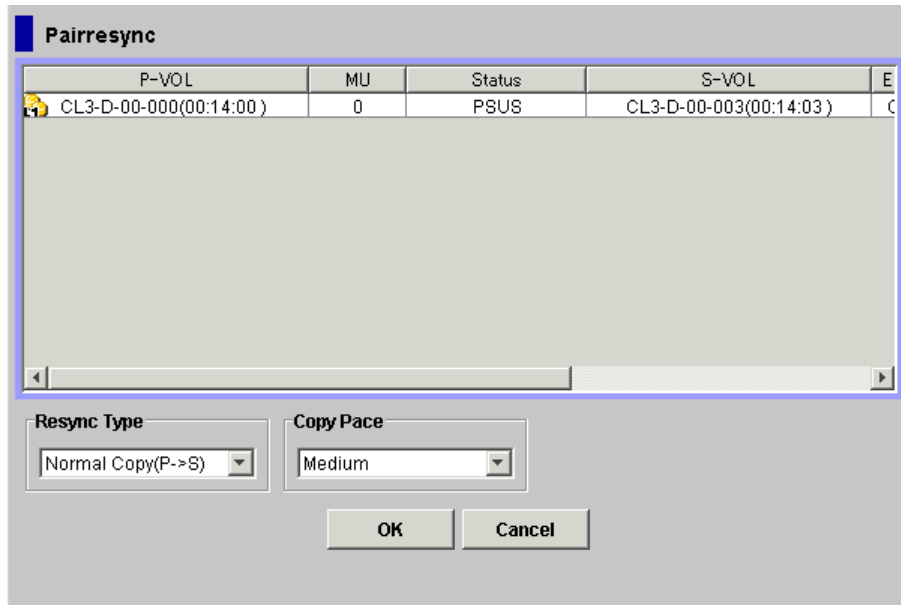


Figure 6-7 Pairresync Dialog Box

The Pairresync dialog box consists of the following components.

- Pairresync Volume List

The Volume List located on the upper side of the Pairresync dialog box displays the following information pertaining to the P-VOL and S-VOL of the pair you want to resynchronize:

- **P-VOL:** Information about P-VOL displays in *AAA-BB-CCC(XX:YY:ZZ)* format.
 - AAA: Port ID (cluster and channel number)
 - BB: Group number of host group
 - CCC: LU number
 - XX:YY:ZZ: LDKC number:CU number:LDEV number

An LDEV number that ends with a pound or gate symbol (#) indicates that the LDEV is an external volume (e.g., 00:00:01#). An LDEV number that ends with a letter "X" indicates that the LDEV is a virtual volume used by Dynamic Provisioning (e.g., 00:00:01X). For details regarding the external volumes, see the *Universal Volume Manager User's Guide*. For information about Dynamic Provisioning, see the *Dynamic Provisioning User's Guide*.

- **MU:** The MU number of the P-VOL.

- **Status:** The status of the P-VOL.
- **S-VOL:** Information about S-VOL displays in *AAA-BB-CCC(XX:YY:ZZ)* format.
 - AAA: Port ID (cluster and channel number)
 - BB: Group number of host group
 - CCC: LU number
 - XX:YY:ZZ: LDKC number:CU number:LDEV number

An LDEV number that ends with a pound or gate symbol (#) indicates that the LDEV is an external volume (e.g., 00:00:01#). An LDEV number that ends with a letter "X" indicates that the LDEV is a virtual volume used by Dynamic Provisioning (e.g., 00:00:01X). For details regarding the external volumes, see the *Universal Volume Manager User's Guide*. For information about Dynamic Provisioning, see the *Dynamic Provisioning User's Guide*.

- **Emulation:** The emulation type of the P-VOL and S-VOL.
- **Capacity(MB):** The volume capacity displayed in megabytes (MB).
- **CLPR(P):** The cache logical partition of the P-VOL.
- **CLPR(S):** The cache logical partition of the S-VOL.
- The **Resync Type** drop-down list allows you to select the pairresync type for the pairs being resynchronized (from **Normal Copy(P->S)**, **Quick Resync(P->S)**, **Reverse Copy(S->P)**, or **Quick Restore(S->P)**). Remember that you must select either **Normal Copy(P->S)** or **Quick Resync(P->S)** if the selected pair is L2 pair or its status is PSUE. Before selecting **Reverse Copy(S->P)** or **Quick Restore(S->P)**, make sure that the pair you are going to select meets the following requirements:

Table 6-8 Requirements for Reverse Copy(S->P) or Quick Restore(S->P) Pairresync Operations

Parameter	Requirement(s)
Pair status	The specified pair must be in the PSUS state. All other pairs that share the same P-VOL as the specified pair must also be in the PSUS or PSUE state.
Pair type	Whether you can execute a quick restore command to a pair that consists of VLL and normal volumes depends on the volume emulation type. For details, see Table 6-9.
Volume status	You cannot perform Quick Restore on any pair including a volume on which Quick Format is being performed.
Shared SI/TC volume.	If the ShadowImage and TrueCopy pairs share the same volume, and the TrueCopy pair is not suspended, the reverse and quick restore pairresync operations cannot be performed. <i>Note:</i> You cannot perform Quick Restore when ShadowImage and TrueCopy pairs include external volume(s).
Shared SI/UR volume.	If the ShadowImage and Universal Replicator pairs share the same volume, and the Universal Replicator pair is not suspended, the reverse and quick restore pairresync operations cannot be performed. <i>Note:</i> You cannot perform Quick Restore when ShadowImage and Universal Replicator pairs include external volume(s).

Parameter	Requirement(s)
<i>Note:</i> During the reverse or quick restore pairresync operations, a TrueCopy pair or a Universal Replicator pair cannot be created. The TrueCopy paircreate command and the Universal Replicator paircreate command will be rejected when the ShadowImage pair status is COPY(RS-R).	

Table 6-9 Executability of Quick Restore Command to Pairs that Consist of VLL Volume and Normal Volumes

P-VOL	S-VOL			
	Normal Volume (not OPEN-V)	Normal Volume (OPEN-V)	VLL Volume (not OPEN-V)	VLL Volume (OPEN-V)
Normal Volume (not OPEN-V)	Executable	-	Not executable	-
Normal Volume (OPEN-V)	-	Executable	-	Executable
VLL Volume (not OPEN-V)	Not executable	-	Executable	-
VLL Volume (OPEN-V)	-	Executable	-	Executable

- : You can not make pairs of the volumes.

- The **Copy Pace** drop-down list allows you to select the copy pace (from **Slower, Medium, or Faster**) for all the pairs that you are resynchronizing. When resynchronizing pairs, you can select the pace for the pairresync operation(s): slower, medium, or faster. The slower pace minimizes the impact of ShadowImage operations on storage system I/O performance. The faster pace resynchronizes the pair(s) as quickly as possible, but it may affect the storage system I/O performance.
- The **OK** button adds the operation setting displayed in the Pairresync Volume List for resynchronizing the specified pair(s) to the **Preview List** on the Pair Operation window.

You must click **Apply** on the Pair Operation window to start the pairresync operation for the specified pair(s).

- The **Cancel** button cancels the operations set in the Pairresync dialog box and closes the dialog box.

To resynchronize one or more ShadowImage pairs that have been split or suspended:

1. Unmount the split (PSUS) S-VOLs from the host before starting the pairresync operations.

When the pairresync operation starts, the storage system will stop accepting write I/Os to the S-VOL.

2. 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.

3. On the Pair Operation window, select the pair(s) in PSUS, PSUS(SP), or PSUE status, right-click the selected pair(s) to display the menu, and then select the **Pairresync** command to open the Pairresync dialog box.
4. On the Pairresync dialog box, select the pair(s) you want to resynchronize. To remove the pair(s) in the Pairresync Volume List, select and right-click the pair, and then select the **Delete** command in the menu.
5. Select the desired copy pace from the **Copy Pace** drop-down list.
6. Select the desired resync type for each pair from the **Resync Type** drop-down list



WARNING: Make sure to select the correct resync direction (normal/quick, or reverse/quick restore).



Cautions:

- If you do not want the P-VOL and S-VOL to be resynchronized after the quick restore operation, you must set the Swap&Freeze option before performing the quick restore operation (see Swap&Freeze Option and Setting Options).
 - If the reverse or quick restore pairresync operation is performed on one ShadowImage pair in a 1-to-n ShadowImage configuration ($n > 1$), the P-VOL and the other S-VOLs are no longer synchronized.
-
- Reverse and quick restore operations cannot be performed on pairs in the PSUE or PSUS(SP) status, or on L2 cascade pairs.
 - When a quick restore operation is in progress, the Storage Navigator window may display old configuration information on components such as logical volumes (LDEVs); the window may display configurations before the quick operation is performed. To update configuration information on the Storage Navigator window, wait until the quick restore operation completes. Click **File** and then **Refresh** on the menu bar of the window.
7. Click **OK** to reflect the settings displayed in the Pairresync dialog box to the **Preview List** on the Pair Operation window.
If you try to perform the quick restore operation to the pair you select from the Pairresync Volume List that is composed of volumes stored in multiple cache logical partitions (CLPRs), a message asking you whether you want to click **OK** and continue the operation will appear. Click **OK** if you do, or click **Cancel** if you wish to discontinue the quick restore operation.
 8. Repeat steps 6 and 7 until the **Preview List** on the Pair Operation window displays the desired pairs (settings).
 9. Make sure to verify that the S-VOL(s) is/are offline before starting the pairresync operations.

10. On the Pair Operation window, click **Apply** to resynchronize the specified pair(s).

The Pair Operation window displays the result(s) of the pairresync operation(s) (i.e., pair status changed to COPY(RS), COPY(RS-R), or PAIR) and the progress (%) of the update copy operation. The pair status will change to PAIR right away, if the update copy operation is not necessary.



Cautions:

- When reverse or quick restore resync operation ends abnormally, or Pairsplit-E (PSUE) is requested during reverse or quick restore resync operation, the pair status changes to PSUE. The P-VOL of the PSUE pair is read- and write-enabled for all hosts; however, the data on the P-VOL is not guaranteed. The S-VOL of the PSUE pair remains write-disabled (read-only); however, the data on the S-VOL is not guaranteed.
 - Even when reverse or quick restore resync operation ends abnormally, or Pairsplit-E (PSUE) is requested during reverse or quick restore resync operation, the status of other ShadowImage pairs that share the same P-VOL does not change.
-

Deleting Pairs

The Pairsplit-S dialog box (see Figure 6-8) allows you to delete the pair(s). The Pairsplit-S is an operation to stop copying data into the S-VOL of a ShadowImage pair, and set the status of the P-VOL and S-VOL back to SMPL volumes.

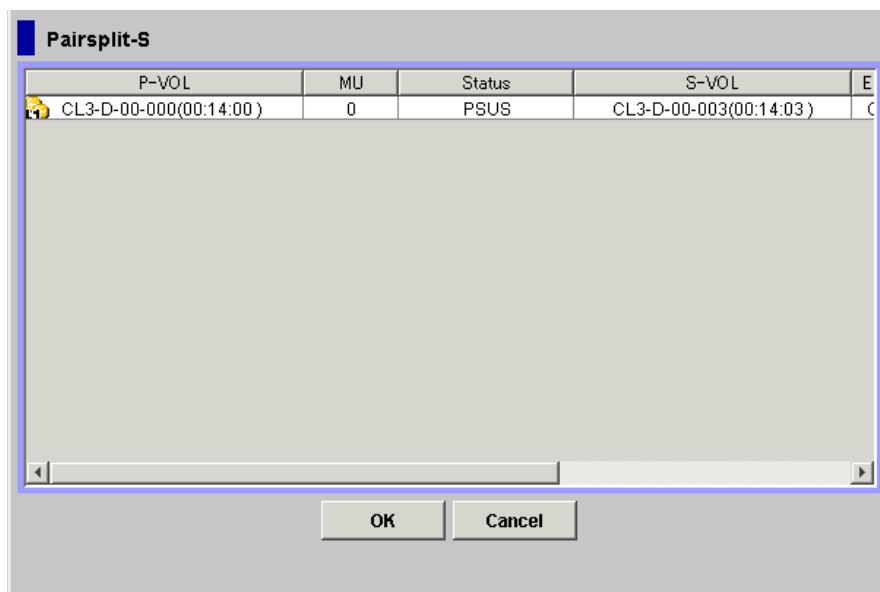


Figure 6-8 Pairsplit-S Dialog Box

The Pairsplit-S dialog box consists of the following components.

- Pairsplit-S Volume List

The Volume List located on the upper side of the Pairsplit-S dialog box displays the following information pertaining to the P-VOL and S-VOL of the pair you want to delete:

- **P-VOL:** Information about P-VOL displays in *AAA-BB-CCC(XX:YY:ZZ)* format.
 - AAA: Port ID (cluster and channel number)
 - BB: Group number of host group
 - CCC: LU number
 - XX:YY:ZZ: LDKC number:CU number:LDEV number

An LDEV number that ends with a pound or gate symbol (#) indicates that the LDEV is an external volume (e.g., 00:00:01#). An LDEV number that ends with a letter "X" indicates that the LDEV is a virtual volume used by Dynamic Provisioning (e.g., 00:00:01X). For details regarding the external volumes, see the *Universal Volume Manager User's Guide*. For information about Dynamic Provisioning, see the *Dynamic Provisioning User's Guide*.

- **MU:** The MU number of the P-VOL.
- **Status:** The status of the P-VOL.
- **S-VOL:** Information about S-VOL displays in *AAA-BB-CCC(XX:YY:ZZ)* format.
 - AAA: Port ID (cluster and channel number)
 - BB: Group number of host group
 - CCC: LU number
 - XX:YY:ZZ: LDKC number:CU number:LDEV number

An LDEV number that ends with a pound or gate symbol (#) indicates that the LDEV is an external volume (e.g., 00:00:01#). An LDEV number that ends with a letter "X" indicates that the LDEV is a virtual volume used by Dynamic Provisioning (e.g., 00:00:01X). For details regarding the external volumes, see the *Universal Volume Manager User's Guide*. For information about Dynamic Provisioning, see the *Dynamic Provisioning User's Guide*.

- **Emulation:** The emulation type of the P-VOL and S-VOL.
- **Capacity(MB):** The volume capacity displayed in megabytes (MB).
- **CLPR(P):** The cache logical partition of the P-VOL.
- **CLPR(S):** The cache logical partition of the S-VOL.
- The **OK** button adds the operation setting(s) to suspend the selected pair(s) displayed in the Pairsplit-S Volume List to the **Preview List** on the Pair Operation window.

You must click **Apply** on the Pair Operation window to apply the Pairsplit-S operation displayed in the **Preview List** to the storage system.
- The **Cancel** button cancels the operations set in the Pairsplit-S dialog box and closes the dialog box.

To delete ShadowImage pair(s), follow the procedure below:

1. If you want 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 from the host server to prevent the P-VOL from being updated during or after the Pairsplit-S operation.
 - c. After the P-VOL is offline, suspend the pair to copy all pending updates to the S-VOL. When the pair status changes to PSUS, the P-VOL and S-VOL are synchronized.
2. 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.
3. Select the pair(s) you want to delete, right-click while selecting the pair(s), and then select the **Delete** command from the menu that appears by right-clicking.

The Pairsplit-S dialog box displays.

4. On the Pairsplit-S dialog box, select the pair(s) you want to delete, and click **OK** to reflect the settings to the **Preview List** on the Pair Operation window.

To remove a pair in the Pairsplit-S Volume List, select and right-click the pair you want to delete, and then select the Delete command in the menu.

5. On the Pair Operation window, click **Apply** to delete the specified pair(s) or volume(s).

The Pairsplit-S operation settings displayed in the Pairsplit-S dialog box will be applied to the storage system, and the Pair Operation window will display the result(s) of the Pairsplit-S operation(s).

Viewing Detailed Volume and Pair Information

The Detail dialog box (see Figure 6-9) displays information such as emulation types or status of the selected volume or pair.

To display the Detail dialog box:

1. Select a volume or a ShadowImage pair from the Volume List of the Pair Operation window.
2. Right-click the selected volume or pair.
A menu displays.
3. Select the **Detail** command from the menu.

The Detail dialog box displays.

- If the P-VOL of the selected pair has two or more S-VOLs that share the same P-VOL, all S-VOLs display on the Detail dialog box.
- If you select the **Detail** command when you are selecting a Copy-on-Write Snapshot pair, the displayed Detail dialog box will be different from the one displayed when you select a ShadowImage pair. For details, see the *Copy-on-Write Snapshot User's Guide*.

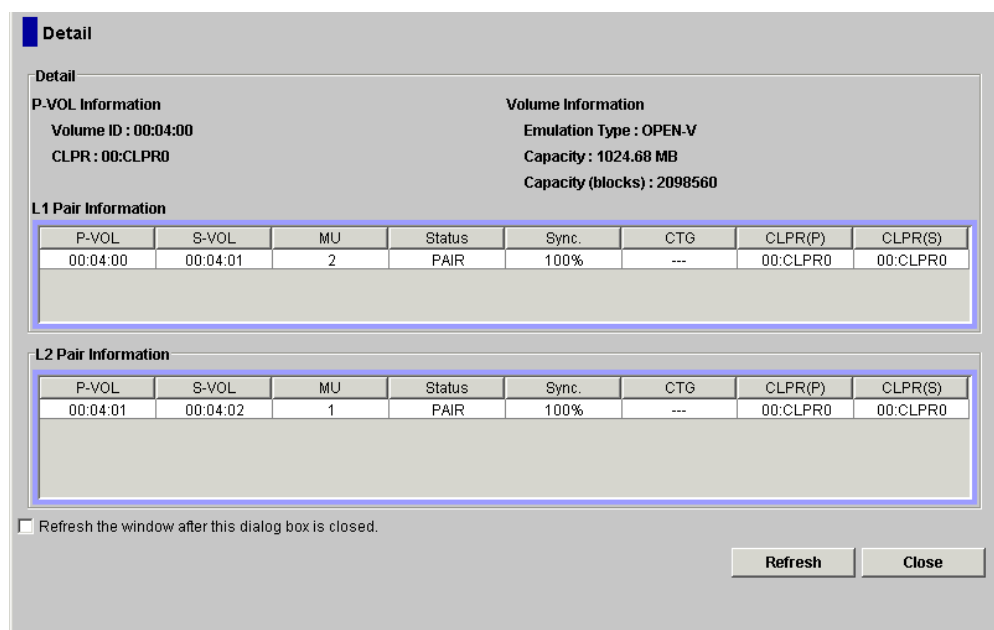


Figure 6-9 Detail Dialog Box Displaying Pair Information (L1 and L2 Pairs)

The **Detail** box in the Detail dialog box has the following features:

- **P-VOL Information** displays the following information:
 - **Volume ID:** The information of the P-VOL displays in *XX:YY:ZZ* (LDKC number:CU number:LDEV number) format.

An LDEV number that ends with a pound or gate symbol (#) indicates that the LDEV is an external volume (e.g., 00:00:01#). An LDEV number that ends with a letter "X" indicates that the LDEV is a virtual volume used by Dynamic Provisioning (e.g., 00:00:01X). For details regarding the external volumes, see the *Universal Volume Manager User's Guide*. For information about Dynamic Provisioning, see the *Dynamic Provisioning User's Guide*.

- **CLPR:** The information of the cache logical partition (CLPR) of the P-VOL displays in *AA:BB* (CLPR number:CLPR name) format.
- **Volume Information** displays the following information:
 - **Emulation Type:** The emulation type of the volume.
 - **Capacity:** The capacity of the volume in mega bytes (MB).
 - **Capacity(blocks):** The number of blocks of the volume.
- The **L1 Pair Information** box displays the following information:
 - **P-VOL:** The LUN information of the P-VOL displays in *XX:YY:ZZ* (LDKC number:CU number:LDEV number) format.
 - **S-VOL:** The LUN information of the S-VOL displays in *XX:YY:ZZ* (LDKC number:CU number:LDEV number) format.
 - **MU:** MU number.
 - **Status:** The status of the L1 pair displays. For detailed information about pair statuses, see Table 2-2.
 - **Sync.:** The rate of synchronization of the P-VOL and the S-VOL.
 - **CTG:** The consistency group number displays if the L1 pair is registered to the group. If the pair is not registered to the consistency group, --- displays.
 - **CLPR(P):** The information of the cache logical partition (CLPR) of the P-VOL displays in *AA:BB* (CLPR number:CLPR name) format.
 - **CLPR(S):** The information of the cache logical partition (CLPR) of the S-VOL displays in *AA:BB* (CLPR number:CLPR name) format.

An LDEV number that ends with a pound or gate symbol (#) indicates that the LDEV is an external volume (e.g., 00:00:01#). An LDEV number that ends with a letter "X" indicates that the LDEV is a virtual volume used by Dynamic Provisioning (e.g., 00:00:01X). For details regarding the external volumes, see the *Universal Volume Manager User's Guide*. For information about Dynamic Provisioning, see the *Dynamic Provisioning User's Guide*.

The **L2 Pair Information** box in the Detail dialog box has the following features:

- **P-VOL:** The LUN information of the P-VOL displays in *XX:YY:ZZ* (LDKC number:CU number:LDEV number) format.

An LDEV number that ends with a pound or gate symbol (#) indicates that the LDEV is an external volume (e.g., 00:00:01#). An LDEV number that ends with a letter "X" indicates that the LDEV is a virtual volume used by Dynamic Provisioning (e.g., 00:00:01X). For details regarding the external volumes, see the *Universal Volume Manager User's Guide*. For information about Dynamic Provisioning, see the *Dynamic Provisioning User's Guide*.

- **S-VOL:** The LUN information of the S-VOL displays in *XX:YY:ZZ* (LDKC number:CU number:LDEV number) format.
- **MU:** MU number.
- **Status:** The status of the L1 pair displays. For detailed information about pair statuses, see Table 2-2.
- **Sync.:** The rate of synchronization of the P-VOL and the S-VOL.
- **CTG:** The consistency group number displays if the L1 pair is registered to the group. If the pair is not registered to the consistency group, --- displays.
- **CLPR(P):** The information of the cache logical partition (CLPR) of the P-VOL displays in *AA:BB* (CLPR number:CLPR name) format.
- **CLPR(S):** The information of the cache logical partition (CLPR) of the S-VOL displays in *AA:BB* (CLPR number:CLPR name) format.
- **Refresh the window after this dialog box is closed.** check box: 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.
- The **Refresh** button updates the information on the Detail dialog box.
- The **Close** button closes the Detail dialog box.

Viewing S-VOL Path Information

The S-VOL Path dialog box displays information on the selected pair (all paths defined for the S-VOL).

To open the S-VOL Path dialog box:

1. Select one or more pair in the Volume List on the Pair Operation window.
2. Right-click the selected volumes or pairs to display the menu commands.
3. Select the **S-VOL Path** command from the menu.

The S-VOL Path dialog box displays.

You cannot select the **S-VOL Path** command when you have selected SMPL volumes.

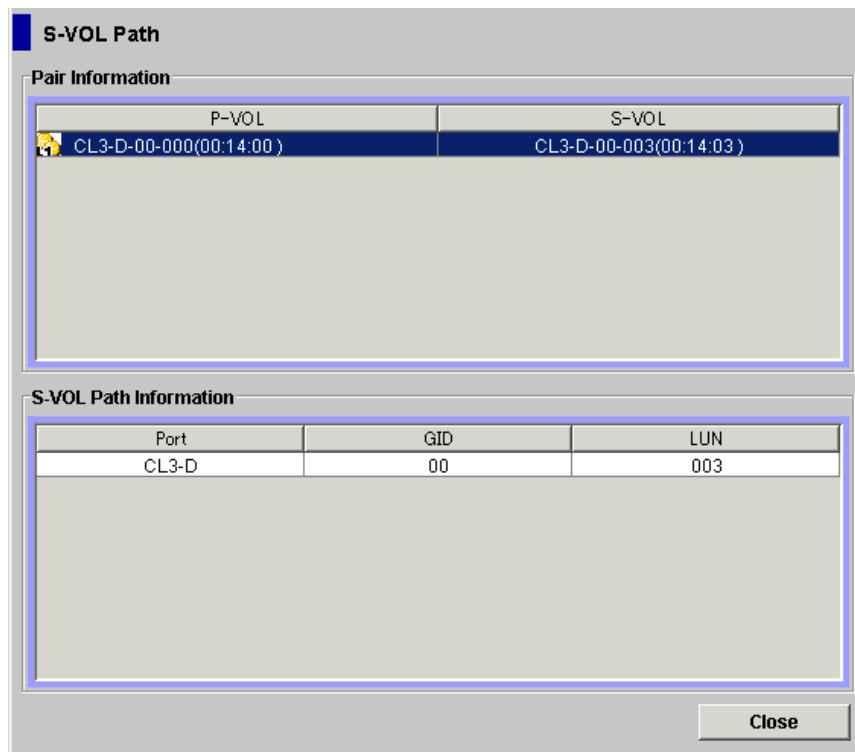


Figure 6-10 S-VOL Path Dialog Box

The S-VOL Path dialog box has the following features:

- The **Pair Information** box displays only the information of the paths that are used by the ShadowImage pairs selected in the Pair Operation window Volume List. **P-VOL** displays the path information of the P-VOLs, and **S-VOL** displays the path information of the S-VOLs in *AAA-BB-CCC(XX:YY:ZZ)* format.
 - AAA: Port ID (cluster name and channel number)
 - BB: Group number (G-ID) of host group

- CCC: LU number
- XX:YY:ZZ: LDKC number:CU number: LDEV number

An LDEV number that ends with a pound or gate symbol (#) indicates that the LDEV is an external volume (e.g., 00:00:01#). An LDEV number that ends with a letter "X" indicates that the LDEV is a virtual volume used by Dynamic Provisioning (e.g., 00:00:01X). For details regarding the external volumes, see the *Universal Volume Manager User's Guide*. For information about Dynamic Provisioning, see the *Dynamic Provisioning User's Guide*.

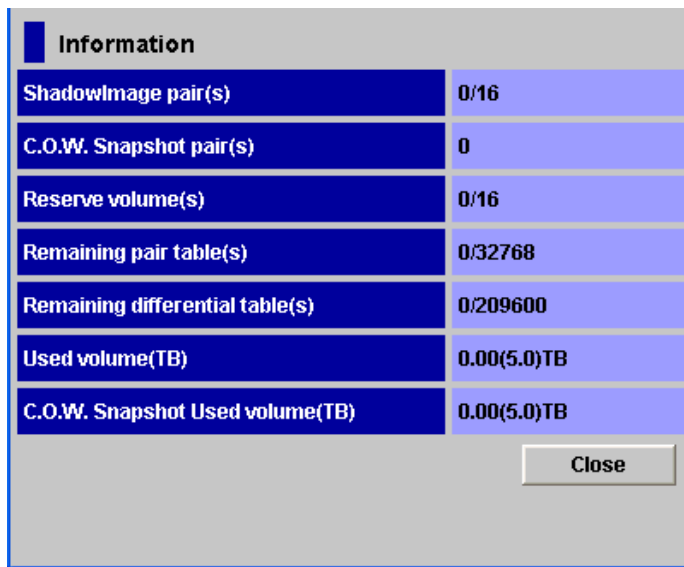
- The **S-VOL Path Information** box displays all the path information including the alternate paths regarding the S-VOLs selected in the **Pair Information** box.
 - **Port:** Port ID
 - **GID:** Group number of host group
 - **LUN:** LU number
- The **Close** button closes the S-VOL Path dialog box.

Viewing the Number of Pairs and License Information

The Information dialog box displays information such as the number of pairs in the storage system, the number of reserved volumes, and the license capacity.

To display the Information dialog box:

1. Right-click anywhere on the volume list of the Pair Operation window.
A menu displays.
2. Click the **Information** command in the menu.
The Information dialog box displays.



Information	
ShadowImage pair(s)	0/16
C.O.W. Snapshot pair(s)	0
Reserve volume(s)	0/16
Remaining pair table(s)	0/32768
Remaining differential table(s)	0/209600
Used volume(TB)	0.00(5.0)TB
C.O.W. Snapshot Used volume(TB)	0.00(5.0)TB

Close

Figure 6-11 Information Dialog Box

The following information displays in the Information dialog box:

- **ShadowImage pair(s)**

The number of ShadowImage pairs display in the format of XXXX / YYYY. XXXX indicates the number of ShadowImage pairs, and YYYY indicates the total number of ShadowImage pair tables and ShadowImage for z/OS pair tables.

- The maximum number of pairs that can be created in one storage system is 16,384, including migration plans and relationships. Therefore, if Copy-on-Write Snapshot pairs, migration plans of Volume Migration, and relationships of Compatible Mirroring for IBM FlashCopy Version 1 and Compatible Mirroring for IBM FlashCopy Version 2 are created in the same storage system, the maximum number of pairs that you can create may be less than 16,384 minus YYYY.

- When the volume size is large, ShadowImage uses multiple pair tables per one pair. Therefore, sometimes you cannot create 16,384 pairs. For information about the number of pairs and the pair tables, see Calculating Maximum Number of Pairs.
- **C.O.W. Snapshot pair(s)**
The number of Copy-on-Write Snapshot pairs displays.
- **Reserved volume(s)**
The number of reserved volumes of ShadowImage displays in the format of *XXXX / YYYY*. *XXXX* indicates the number of reserved volumes of ShadowImage, *YYYY* indicates the total number of reserved volumes of ShadowImage and ShadowImage for z/OS.

Reserved volumes include S-VOLs of ShadowImage and T-VOLs of ShadowImage for z/OS pairs.
- **Remaining pair table(s)**
The number of remaining pair tables in the storage system displays on the left side of the slash (/). The total number of pair tables in the storage system displays on the right side of the slash (/). For information about the total number of pair tables in the storage system, see Calculating Maximum Number of Pairs.
- **Remaining differential table(s)**
The number of remaining differential tables in the storage system displays on the left side of the slash (/). The total number of differential tables in the storage system displays on the right side of the slash (/). For information about the total number of differential tables in the storage system, see Calculating Maximum Number of Pairs.
- **Used volume (TB)**
License information of ShadowImage will be indicated in the format of *X(Y)*. *X* indicates license capacity used by ShadowImage, and *Y* indicates 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)**
License information of Copy-on-Write Snapshot will be indicated in the format of *X(Y)*. *X* indicates license capacity used by Copy-on-Write Snapshot, and *Y* indicates total license capacity reserved for Copy-on-Write Snapshot. **Unlimited** displays when there is no limit on license capacity for Copy-on-Write Snapshot.
- **Close button**
Closes the Information dialog box.

Viewing Pair Operation History

The History window (History Window) displays history of ShadowImage operations.

To see the history:

1. Display the History window.
 - If you are already displaying the other window shown by a tab, click the **History** tab. For information about how to display the History window directly by starting up Storage Navigator, See Starting ShadowImage.
 - 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
 - Copy-on-Write Snapshot pairs
 - ShadowImage for z/OS pairs
 - Compatible Mirroring for IBM FlashCopy Version 1 relationships
 - Compatible Mirroring for IBM FlashCopy 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** on the menu bar of the Storage Navigator main window. 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.

Troubleshooting

This chapter provides troubleshooting information for ShadowImage and instructions for calling technical support.

- [Troubleshooting](#)
- [Troubleshooting when Using Command Control Interface](#)
- [Calling the Hitachi Data Systems Support Center](#)

Troubleshooting

If you have a problem with Storage Navigator, see the *Storage Navigator User's Guide* for troubleshooting information.

Table 7-1 describes the general troubleshooting instructions for ShadowImage operations.

Table 7-1 General ShadowImage Troubleshooting

Error	Corrective Action
<p>The Storage Navigator computer hangs, or ShadowImage operations do not function properly.</p>	<p>Make sure all ShadowImage requirements and restrictions are met.</p> <p>Make sure the USP V/VM storage system is powered on and fully functional. See the <i>Hitachi Universal Storage Platform V and Hitachi Universal Storage Platform VM User and Reference Guide</i> for operational and troubleshooting information for the USP V/VM storage system.</p> <p>Check all input values and parameters to make sure that you entered the correct information on the ShadowImage windows (e.g. P-VOL and S-VOL IDs).</p>
<p>The volume pairs are not displaying correctly.</p>	<p>Make sure the correct CU image is selected.</p>
<p>A ShadowImage error message is displayed on the Storage Navigator.</p>	<p>Storage Navigator displays an error message if an error occurs during ShadowImage operations. The Error dialog box of ShadowImage displays the error code and the message (see Figure 7-1).</p>
<p>There is a problem with the Storage Navigator.</p>	<p>Save the Java log file on the Storage Navigator, and report to the Hitachi Technical Support Center.</p> <p>For Windows 2000, the Java log file is in the following location: c:\Documents and Settings\login user ID\plugin131.trace</p> <p>Exit the Web browser, close all other applications, and then restart the computer. If the problem persists, verify that the computer's operating system and LAN hardware and software are properly configured.</p>
<p>The ShadowImage pair status is incorrect (or unexpected).</p>	<p>The pair may have been suspended or deleted from the UNIX/PC server host using Hitachi Command Control Interface (CCI). If not, the USP V/VM detected an error condition during ShadowImage operations. Check the Storage Navigator error log. If necessary, call the Hitachi Data Systems Support Center for assistance.</p>
<p>There is a pinned track on a ShadowImage volume.</p>	<p>If a pinned track occurs on a ShadowImage P-VOL or S-VOL, the USP V/VM will suspend the pair. Please contact your Hitachi Data Systems representative for assistance in recovering pinned tracks.</p>
<p>Only the Exit and Refresh menus are effective when accessing the SVP from the Storage Navigator.</p>	<p>The SVP might not be ready or another user performs write processing. Wait for a while, and then select File and then Refresh from the window.</p>

The ShadowImage software displays error messages on the Storage Navigator computer when error conditions occur during ShadowImage operations. The ShadowImage Error dialog box (see Figure 7-1) displays the ShadowImage error code and message.

To display the Error dialog box, 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 the *Storage Navigator Messages* for the list of error codes and corrective actions.

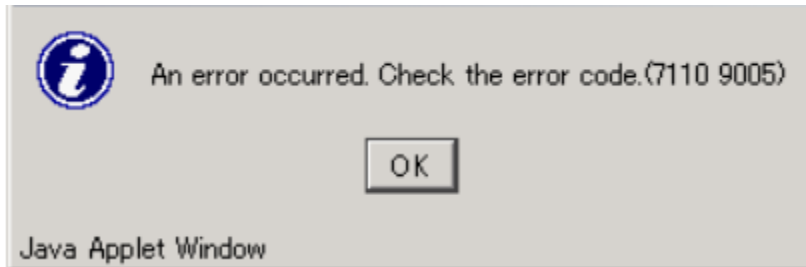


Figure 7-1 Error Dialog Box

Troubleshooting When Using Command Control Interface

When an error has occurred in ShadowImage pair operation using CCI, you might identify the cause of the error by referring to the log displayed on the CCI window or the CCI operation log file. The CCI operation log file is stored in the following directory by default.

The log file is stored in: /HORCM/log*/curlog/horcmlog_HOST/horcm.log

Where:

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

To identify the cause of the error using the log file, follow the procedure below. For more information about CCI, see the *Hitachi Command Control Interface (CCI) User and Reference Guide* (MK-90RD011).

1. Open the CCI log file, and find the error code.

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

Error codes appear on the right of the equal symbol (=). The alphanumeric characters of last four digits on the left of the comma (,) indicates SSB1 (e.g. b9a0), and the right of the comma (,) indicates SSB2 (e.g. 2089).

2. See Table 7-2 to locate the meaning of the error code.

For details about the cause of the error that is not described in Table 7-2, contact the Hitachi Data Systems Support Center (see Calling the Hitachi Data Systems Support Center).

To identify the cause of the error using the log displayed on the CCI window, follow the procedure below. For more information about CCI, please see the *Hitachi Command Control Interface (CCI) User and Reference Guide* (MK-90RD011).

1. Find the error code from the logs displayed on the CCI window.

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

Error codes appear on the right of "SSB=". The alphanumeric characters of last four digits on the left of the comma (,) indicates SSB1 (e.g. B9E1), and the alphanumeric characters of last four digits on the right of the comma (,) indicates SSB2 (e.g. B901).

2. See Table 7-2 and find the meaning of the error code.

For details about the cause of the error that is not described in Table 7-2, contact the Hitachi Data Systems Support Center (see Calling the Hitachi Data Systems Support Center).

Table 7-2 Error Code and Error Contents When Operating CCI

Error Code (SSB1)	Error Code (SSB2)	Error Contents
b9a0/b9a1/b9a2/ b9a5/b9a6/b9ae/ b9af	-	Error occurred in ShadowImage pair operation.
	200d	Because the specified Dynamic Provisioning 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.
	2036	Because the volume specified as a P-VOL was a quorum disk, the pair operation was rejected.
	2037	Because the volume specified as an S-VOL was a quorum disk, the pair operation was rejected.
	2043	The volume specified as a P-VOL was a volume using two mirrors included in the 3DC multi-target configuration, the 3DC cascade configuration or the delta resync configuration by three Universal Replicator sites, and the operation was rejected due to either of the following. <ul style="list-style-type: none"> ▪ Being used by Universal Replicator 3DC delta resync configuration. ▪ Being used by a Universal Replicator data volume.
	2044	The volume specified as an S-VOL was a volume using two mirrors included in the 3DC multi-target configuration, the 3DC cascade configuration or the delta resync configuration by three Universal Replicator sites, and the operation was rejected due to either of the following. <ul style="list-style-type: none"> ▪ Being used by Universal Replicator 3DC delta resync configuration. ▪ Being used by a Universal Replicator data volume.
	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.
	2067	5. Volumes of the specified pair were shared by the TrueCopy pair (Synchronous and Asynchronous) and the Universal Replicator pair. Therefore, the quick restore operation was rejected. 6. Volumes of the specified pair were shared by the TrueCopy pair (Synchronous and Asynchronous) and the Universal Replicator pair. The reverse copy operation was rejected because the status of the TrueCopy pair (Synchronous and Asynchronous) or the Universal Replicator pair was not PSUS.
2068	Because the specified P-VOL or S-VOL was being shredded, the pair operation was rejected.	

Error Code (SSB1)	Error Code (SSB2)	Error Contents
b9a0/b9a1/b9a2/ b9a5/b9a6/b9ae/ b9af	2072	<p>Because the volume specified as the P-VOL met one of the following conditions, the pair operation was rejected.</p> <p>7. The P-VOL was a pool volume for Copy-on-Write Snapshot.</p> <p>8. The P-VOL was the S-VOL of a Copy-on-Write Snapshot pair or a V-VOL for Copy-on-Write Snapshot.</p> <p>9. The P-VOL was the P-VOL of a Copy-on-Write Snapshot pair and one of the following conditions held true.</p> <ul style="list-style-type: none"> ▪ While the Copy-on-Write Snapshot pair was restored, the create pair operation, the Split operation, or the pairresync operation was performed on the ShadowImage pair. ▪ The ShadowImage quick restore operation was performed. ▪ The consistency group was defined for ShadowImage. ▪ The create pair operation, the Split operation, or the pairresync operation was performed on the ShadowImage pair after the MU number used by a Copy-on-Write Snapshot pair was specified.
	2073	<p>Because the volume specified as the S-VOL met one of the following conditions, the pair operation was rejected.</p> <p>10. The S-VOL was a pool volume for Copy-on-Write Snapshot.</p> <p>11. The S-VOL was the S-VOL of a Copy-on-Write Snapshot pair or a V-VOL for Copy-on-Write Snapshot.</p> <p>12. The S-VOL was the P-VOL of a Copy-on-Write Snapshot pair and one of the following conditions held true.</p> <ul style="list-style-type: none"> ▪ The Copy-on-Write Snapshot pair was being restored. ▪ The ShadowImage quick restore operation was performed. ▪ The create pair operation was performed on the ShadowImage pair.
	2078	<p>Because the specified P-VOL was a P-VOL for a Universal Replicator pair for delta resync operation, one of the following error occurred.</p> <p>13. Because the Universal Replicator pair was not in the PSUS status, the reverse copy operation was rejected.</p> <p>14. The quick restore operation was rejected.</p>
	2079	<p>Because the specified P-VOL was a P-VOL for a Universal Replicator pair for delta resync operation, the pair operation was rejected.</p>
	2086	<p>Because the initialization process was being performed, the pair operation was rejected.</p>
	2089	<p>Because the volume specified as a P-VOL was undergoing quick format, the quick restore operation was rejected.</p>
	208a	<p>Because the volume specified as an S-VOL was undergoing quick format, the quick restore operation was rejected.</p>
	208c	<p>Because the volume specified as the S-VOL was a FICON Data Migration volume, the pair operation was rejected.</p>
	2093	<p>The volume specified as a P-VOL was an S-VOL of a TrueCopy asynchronous pair. Because the status of the TrueCopy asynchronous pair was not Suspend, the Split operation was rejected.</p>

Error Code (SSB1)	Error Code (SSB2)	Error Contents
b9a0/b9a1/b9a2/ b9a5/b9a6/b9ae/ b9af	2094	The volume specified as a P-VOL was an S-VOL of a TrueCopy asynchronous pair. Because the consistency time of the consistency group is not equal to the consistency time of the TrueCopy asynchronous pair, the Split operation was rejected.
	2097	When you performed the quick restore command, the quick restore operation was rejected because of one of the following reasons: <ul style="list-style-type: none"> The P-VOL of the ShadowImage pair was a Dynamic Provisioning V-VOL, and the S-VOL of the ShadowImage pair was a normal volume. The P-VOL of the ShadowImage pair was a normal volume, and the S-VOL of the ShadowImage pair was a Dynamic Provisioning V-VOL.
	209b	Because the emulation type of only one of volumes in the ShadowImage 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 FICON Data Migration volume, the pair operation was rejected.
	20a0	The specified pairs contain the volumes of the TrueCopy asynchronous pairs. 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 the Dynamic Provisioning V-VOL whose capacity was increasing, the create pair operation was rejected.
	20a3	Because the S-VOL was the Dynamic Provisioning 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 V-VOL and its zero data area was being discarded, the pair creation was rejected.
	20ab	Because the volume specified as the S-VOL was a Dynamic Provisioning V-VOL and its zero data area was being discarded, the pair creation was rejected.
	20b0	Because the volume specified as the P-VOL was a Dynamic Provisioning V-VOL and its capacity was increasing, the pair creation was rejected.
	20b1	Because the volume specified as the S-VOL was a Dynamic Provisioning V-VOL and its capacity was increasing, the pair creation was rejected.
	22f6	Because the volume specified as the P-VOL was the S-VOL of the Compatible FlashCopy Version 2, the pair operation was rejected.
	22f7	Because the volume specified as the S-VOL was the P-VOL or the S-VOL of Compatible FlashCopy Version 2, the pair operation was rejected.

Error Code (SSB1)	Error Code (SSB2)	Error Contents
b9a0/b9a1/b9a2/ b9a5/b9a6/b9ae/ b9af	22f9	Because the volume specified as the S-VOL was the P-VOL or the S-VOL of Compatible FlashCopy Version 2, the quick restore operation or the reverse copy operation was rejected.
	2301	The pair operation was rejected because of one of the following reasons: <ul style="list-style-type: none"> ▪ Shared memory is not allocated. ▪ ShadowImage is not installed.
	2302	Because the volume specified as the P-VOL or the volume specified as the 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. <ol style="list-style-type: none"> 1. Because the specified consistency group number had already been used for L1 pair, the pair creation was rejected. 2. Because the specified consistency group number had already been used for L2 pair, the pair creation was rejected. 3. 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. 4. Because the VLL setting of the P-VOL was different from that of the S-VOL, the quick restore operation was rejected. 5. Because the specified P-VOL and S-VOL were the FlashCopy pair, the pair operation was rejected. 6. 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. 7. Because the specified P-VOL and the S-VOL was the L2 pair, the quick restore operation or the reverse copy operation was rejected. 8. The At-Time Split operation on a consistency group was rejected because some of the pairs in the consistency group were being resynchronized, being split, or already suspended. 9. 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 ShadowImage pair whose pair status was PSUS, the pair creation was rejected.

Error Code (SSB1)	Error Code (SSB2)	Error Contents
b9a0/b9a1/b9a2/ b9a5/b9a6/b9ae/ b9af	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.
	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. 1. The volume specified as the P-VOL was a reserved volume. 2. The volume specified as the P-VOL was the source volume for the Volume Migration. 3. 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	1. Because the volume specified as the P-VOL had the emulation type that could not be handled by CCI, the pair operation was rejected. 2. 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.

Error Code (SSB1)	Error Code (SSB2)	Error Contents
b9a0/b9a1/b9a2/ b9a5/b9a6/b9ae/ b9af	2337	1. Because the volume specified as the P-VOL was an intermediate volume, the pair operation for the cascade configuration was rejected. 2. 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 P-VOL of the TrueCopy pair (Synchronous and Asynchronous), the pair operation was rejected.
	233F	Because the volume specified as the S-VOL was the P-VOL of the TrueCopy pair (Synchronous and Asynchronous) 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 P-VOL of a TrueCopy synchronous or asynchronous pair. Because the status of the TrueCopy pair was invalid, the pair operation was rejected.
	2347	The volume specified as an S-VOL was an S-VOL of a TrueCopy synchronous or asynchronous pair. 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.	

Error Code (SSB1)	Error Code (SSB2)	Error Contents
b9a0/b9a1/b9a2/ b9a5/b9a6/b9ae/ b9af	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 P-VOL of a TrueCopy synchronous or asynchronous pair. 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 an S-VOL of a TrueCopy synchronous or asynchronous pair. 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 P-VOL of a TrueCopy synchronous or asynchronous pair. 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.
	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	1. Because the volume specified as the S-VOL was not mounted, the pair operation was rejected. 2. 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.	

Error Code (SSB1)	Error Code (SSB2)	Error Contents
b9a0/b9a1/b9a2/ b9a5/b9a6/b9ae/ b9af	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.
	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 the ShadowImage for z/OS, the registering of 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, the 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.

Calling the Hitachi Data Systems Support Center

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

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

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



Acronyms and Abbreviations

GB	gigabytes (see Convention for Storage Capacity Values)
G-ID	host group ID
KB	kilobytes (see Convention for Storage Capacity Values)
LAN	local-area network
LDEV	logical device
LDKC	logical disk controller
LU	logical unit
LUN	logical unit number
MB	megabytes (see Convention for Storage Capacity Values)
PB	petabytes (see Convention for Storage Capacity Values)
PC	personal computer
PDEV	physical device
P-VOL	primary volume
RAID	redundant array of independent disks
SMPL	simplex
SOM	system option mode
S-VOL	secondary volume
SVP	service processor
TB	terabyte (see Convention for Storage Capacity Values)
TC	TrueCopy
UR	Universal Replicator
USP V	Hitachi Universal Storage Platform V
USP VM	Hitachi Universal Storage Platform VM
WWN	world wide name

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