Hitachi Virtual Storage Platform 5000 Series

Hitachi Virtual Storage Platform E Series

SVOS RF 9.8.3

Thin Image User Guide

The Hitachi Thin Image snapshot software enables you to rapidly create point-in-time copies of mission-critical information within the storage system or virtualized storage pool without impacting host service or performance levels. Please read this document carefully to understand how to use this product, and maintain a copy for reference purposes.

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Preface

The Hitachi Thin Image snapshot software enables you to rapidly create point-in-time copies of mission-critical information within the storage system or virtualized storage pool without impacting host service or performance levels. Please read this document carefully to understand how to use this product, and maintain a copy for reference purposes.

Intended audience

This document is intended for system administrators, Hitachi Vantara representatives, and authorized service providers who install, configure, and operate the storage system.

Readers of this document should be familiar with the following:

- Data processing and RAID storage systems and their basic functions.
- The *Hardware Guide* for your storage system model.
- The Device Manager - Storage Navigator software and the *System Administrator Guide* for your storage system model.

Product version

This document revision applies to the following versions:

- VSP 5000 series: 90-08-61 or later
- VSP E series: 93-06-61 or later
- SVOS RF 9.8.3 or later

Release notes

Read the release notes before installing and using this product. They may contain requirements or restrictions that are not fully described in this document or updates or corrections to this document. Release notes are available on the Hitachi Vantara Support Website: https://knowledge.hitachivantara.com/Documents.

Changes in this revision

- Added support for host connection and data I/O using FC-NVMe protocol.

- Added information about HOST I/O priority mode that prioritizes host I/O over copy processing for SI pairs.

Document conventions

This document uses the following typographic conventions:

Convention	Description
Bold	- Indicates text in a window, including window titles, menus, menu options, buttons, fields, and labels. Example: Click **OK**. - Indicates emphasized words in list items.
Italic	- Indicates a document title or emphasized words in text. - Indicates a variable, which is a placeholder for actual text provided by the user or for output by the system. Example: `pairdisplay -g `*`group`* (For exceptions to this convention for variables, see the entry for angle brackets.)
`Monospace`	Indicates text that is displayed on screen or entered by the user. Example: `pairdisplay -g oradb`
< > angle brackets	Indicates variables in the following scenarios: - Variables are not clearly separated from the surrounding text or from other variables. Example: `Status-<`*`report-name`*`><`*`file-version`*`>.csv` - Variables in headings.
[ ] 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:

Convention	Description
	[a | b] indicates that you can choose a, b, or nothing.
	{ a | b } indicates that you must choose either a or b.

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

Icon	Label	Description
	Note	Calls attention to additional information.
	Tip	Provides helpful information, guidelines, or suggestions for performing tasks more effectively.
	Important	Highlights information that is essential to the completion of a task.
	Caution	Warns the user of adverse conditions and/or consequences (for example, disruptive operations, data loss, or a system crash).
	CAUTION	Warns the user of a hazardous situation that, if not avoided, could result in major or minor injury.
	WARNING	Warns the user of a hazardous situation which, if not avoided, could result in death or serious injury.

Conventions for storage capacity values

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

Physical capacity unit	Value
1 kilobyte (KB)	1,000 (10^3) bytes
1 megabyte (MB)	1,000 KB or $1,000^2$ bytes
1 gigabyte (GB)	1,000 MB or $1,000^3$ bytes
1 terabyte (TB)	1,000 GB or $1,000^4$ bytes
1 petabyte (PB)	1,000 TB or $1,000^5$ bytes
1 exabyte (EB)	1,000 PB or $1,000^6$ bytes

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

Logical capacity unit	Value
1 block	512 bytes
1 cylinder	Mainframe: 870 KB Open-systems: ▪ OPEN-V: 960 KB ▪ Others: 720 KB
1 KB	1,024 (2^{10}) bytes
1 MB	1,024 KB or $1,024^2$ bytes
1 GB	1,024 MB or $1,024^3$ bytes
1 TB	1,024 GB or $1,024^4$ bytes
1 PB	1,024 TB or $1,024^5$ bytes
1 EB	1,024 PB or $1,024^6$ bytes

Accessing product documentation

Product user documentation is available on the Hitachi Vantara Support Website: https://knowledge.hitachivantara.com/Documents. Check this site for the most current documentation, including important updates that may have been made after the release of the product.

Getting help

The Hitachi Vantara Support Website is the destination for technical support of products and solutions sold by Hitachi Vantara. To contact technical support, log on to the Hitachi Vantara Support Website for contact information: https://support.hitachivantara.com/en_us/contact-us.html.

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Comments

Please send comments to doc.comments@hitachivantara.com. Include the document title and number, including the revision level (for example, -07), and refer to specific sections and paragraphs whenever possible. All comments become the property of Hitachi Vantara LLC.

Thank you!

Chapter 1: Overview of Thin Image

With Hitachi Thin Image (HTI), you can perform cost-effective replication by storing the differential data between primary volumes (P-VOLs) and secondary volumes (S-VOLs) of virtual volumes (V-VOLs). You can also copy data of an entire volume, instead of copying just the differential data, to a volume. By copying the entire volume, you can expect a higher performance than by just storing the differential data.

About Thin Image

Hitachi Thin Image stores snapshots in a Hitachi Virtual Storage Platform family (VSP family) storage system. If the data of the storage system fails, you can restore it using the stored snapshot of the data. Pairs created by using Thin Image are called Thin Image pairs in this document.

To store snapshot data, you create a pair with a logical volume functioning as the P-VOL, and a virtual volume as the S-VOL. A pair created to store snapshot data is referred to as a snapshot pair. A snapshot pair displays showing the snapshot attribute.

When you create a Thin Image pair, the status changes to "PAIR" and snapshot data is stored. You can use Thin Image to store a maximum of 1,024 snapshots of data (including the number of clones when you clone a volume).

Updating the P-VOL first copies the differential data as snapshot data in pool volumes (pool-VOL), and then updates the data. Snapshot data is a copy of differential data in Thin Image P-VOLs. If your storage system experiences a data storage failure, you can restore the data using the snapshot data in the pool.

Splitting a Thin Image pair saves a snapshot and stops the copying of replaced data in the pool.

The following figure provides a basic illustration of storing snapshot data.
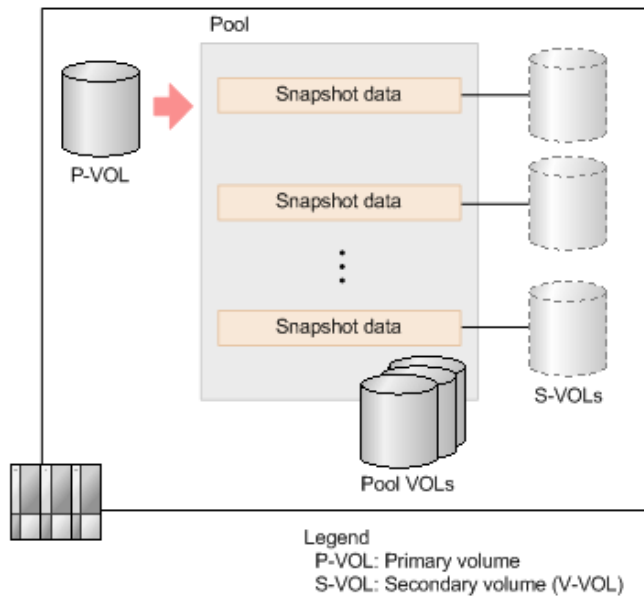
You can use snapshot data in open-system volumes.

Workflow for storing Thin Image snapshot data

Snapshot data is data in the pool, which is replaced data. Use this workflow to store snapshot data in the pool.

1. Create a Thin Image pair. You can create a pair with the snapshot attribute (snapshot pairs). The pair is in "PAIR" status.
2. The host updates the primary volume.
3. Split the snapshot pairs. The snapshot data of the primary volume is stored (Snapshot data A in the figure below).
4. The host updates the primary volume again.
5. Split the snapshot pairs. The updated data in the primary volume is stored as snapshot data (Snapshot data B in the following figure). In the event of data corruption, you can recover using this snapshot data.

The following figure illustrates how data in the pool is replaced.

Legend
P-VOL: Primary volume
S-VOL: Secondary volume (V-VOL)
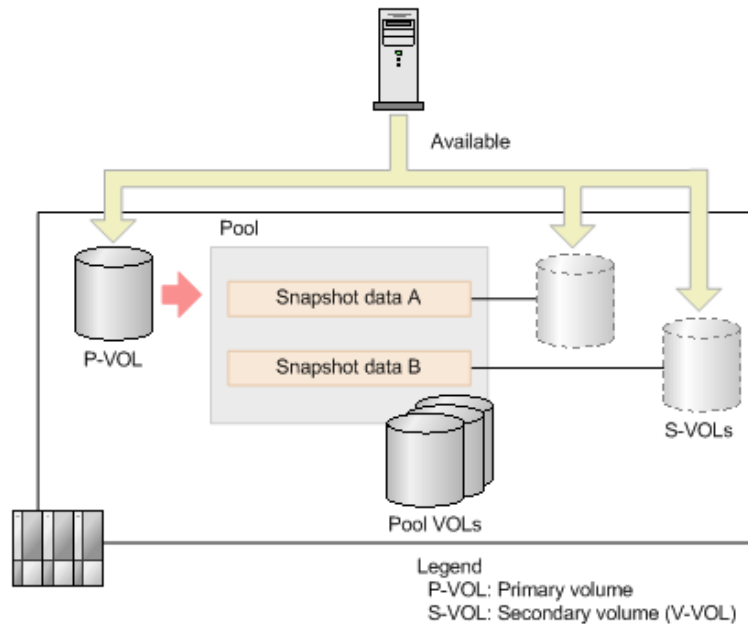
> 📄 **Note:** Because Snapshot data A and Snapshot data B are handled as a Thin Image S-VOL of a snapshot pair, the host can reference the P-VOL, Snapshot data A, and Snapshot data B.

Components of Thin Image

Hitachi Thin Image operations involve several components, including pairs, groups, and software applications. Thin Image requires Dynamic Provisioning, which is used to access data for open-system servers such as UNIX and PC servers in a pool volume through a virtual volume.

Thin Image components:

- Hitachi Thin Image pairs (clone and snapshot pairs).

- Volume related components (P-VOL, S-VOL, and pools)

- Snapshot tree related components (root volume, node volumes, and leaf volumes)

Groups:

- Consistency groups

- Snapshot groups

Software applications for Virtual Storage Platform 5000 series:

- Hitachi Thin Image

- Dynamic Provisioning (HDP)

- Command Control Interface (CCI)

    You can run CCI commands to perform Thin Image tasks (see). When using CCI, run commands directly from the host instead of using a management client.

Chapter 1: Overview of Thin Image

Thin Image pairs

This table describes Thin Image pairs.

Type	Volume that can be used as P-VOL	Volume that can be used as S-VOL	Cascade capability	Description
Pairs with the snapshot attribute	Logical volume (LDEV)	Thin Image V-VOL (V-VOL of which provisioning type is Snapshot in HDvM - SN, or V-VOL created by the `raidcom add ldev -pool snap` command in CCI)	No	Pairs used to store snapshot data. The logical volume of the P-VOL contains DP-VOLs (V-VOL of which provisioning type is Dynamic Provisioning in HDvM - SN, or V-VOL created by the `raidcom add ldev -pool` command in CCI).

Type	Volume that can be used as P-VOL	Volume that can be used as S-VOL	Cascade capability	Description
		DP-VOL	Yes	Pairs used to store snapshot data. To create a cascaded pair with the snapshot attribute, use a DP-VOL as the S-VOL. To use a DP-VOL as the S-VOL, make sure to specify a cascaded pair (with the cascade attribute enabled) regardless of whether it is in a cascaded configuration. The logical volume of the P-VOL contains DP-VOLs (V-VOL of which provisioning type is Dynamic Provisioning in HDvM - SN, or V-VOL created by the `raidcom add ldev -pool` command in CCI).

Type	Volume that can be used as P-VOL	Volume that can be used as S-VOL	Cascade capability	Description
Pairs with the clone attribute	Logical volume (LDEV)	DP-VOL	Yes	Pairs to be cloned. The logical volume of the P-VOL contains DP-VOLs (V-VOL of which provisioning type is Dynamic Provisioning in HDvM - SN, or V-VOL created by the `raidcom add ldev -pool` command in CCI).

Volume components

To create Thin Image pairs, the following volumes are required.

Volume type	Volumes that can be used	Description
Primary	Logical volume (LDEV)	Logical volume of a P-VOL contains DP-VOLs (V-VOLs of which provisioning type is Dynamic Provisioning in HDvM - SN, or V-VOL created by `raidcom add ldev -pool` in CCI).
Secondary	Thin Image V-VOL (V-VOL of which provisioning type is Snapshot in HDvM - SN, or V-VOL created by `raidcom add ldev -pool snap` in CCI)	Use this volume to create snapshot pairs. Cannot be used for cascaded or cloned pairs. This volume is required to create a pair with the S-VOL specified.
	DP-VOL	Use this volume to create cascaded or cloned pairs.

Volume type	Volumes that can be used	Description
		This volume is required to create a pair with the S-VOL specified. Cloned pairs must be created with the S-VOL specified. When a DP-VOL is used as an S-VOL, you must specify a cascaded or cloned pair.
Pool	Logical volume (LDEV)	Volumes that configure a pool which stores snapshot data. Differential data of a P-VOL is stored in a pool volume as snapshot data.

Snapshot tree components

A snapshot tree contains the following volumes.

Volume type	Volumes that can be used	Description
Root	Logical volume (LDEV)	Volume (L1 pair of the P-VOL) in the top layer of a snapshot tree. The logical volume of the P-VOL contains DP-VOLs (V-VOL of which provisioning type is Dynamic Provisioning in HDvM - SN, or V-VOL created by `raidcom add ldev -pool` in CCI).
Node	DP-VOL	Volumes located between the root volume and leaf volumes. S-VOL of the root volume (or another node volume), and the P-VOL of a leaf volume (or another node volume).

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Volume type	Volumes that can be used	Description
Leaf	DP-VOL	Volumes in the bottom layer of a snapshot tree. S-VOL of the root volume or a node volume, which is not a P-VOL of any pair.

Maximum number of Thin Image pairs

The following list specifies the maximum number of pairs that can be created on each storage system model:

- VSP 5000 series: 1,048,575

- VSP E series: 1,048,575

Consistency and snapshot groups

Consistency groups and snapshot groups are groups of pairs for which you can simultaneously perform pair tasks on all pairs within the group.

A consistency group can include Thin Image (HTI), ShadowImage (SI), and ShadowImage for Mainframe (SIz) pairs. Use consistency groups to split the Thin Image pairs that are defined in the group. Splitting the pairs using the group assures data consistency at the time the storage system receives the request.

A snapshot group is a group of only Thin Image pairs. Use consistency or snapshot groups to perform Thin Image tasks on all of the pairs within the group. You define Thin Image pairs to a snapshot group when you create the pairs.

The following table shows the differences between consistency groups and snapshot groups.

Item	Consistency group	Snapshot group
Pair limit per group	8,192	8,192
Limit	2,048	2,048
Data consistency	Guaranteed	Not guaranteed
Software application from which you can define pairs	HTI, SI, and SIz	HTI

Snapshot Clones

When distributing data in a storage system, you can use clones to improve efficiency.

The following figure illustrates cloning.

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Legend
P-VOL: Primary volume
S-VOL: Secondary volume (V-VOL)
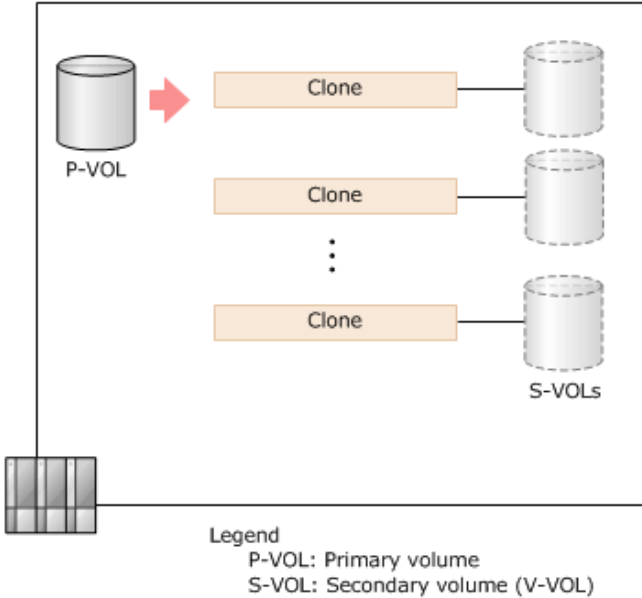
When cloning pairs, use a logical volume as the P-VOL and a DP-VOL as the S-VOL. First layer (L1) S-VOLs can be paired with secondary layer (L2) S-VOLs. A maximum of 3 layers (up to L3) can be created, and a maximum of 1,024 clones (including the number of snapshots if you store them) can be created for a P-VOL.

If you split pairs that have the clone attribute, the data of the entire P-VOL is copied to the S-VOL asynchronously to create a clone of the primary volume. When the copy completes, pairs are deleted and the S-VOL is unpaired (becomes a DP-VOL). This volume can be used as a volume in the same status as the P-VOL. This operation is referred to as cloning pairs.

Cloning pairs includes operations after the P-VOL is copied to the S-VOL, until volumes are unpaired. Volumes created by cloning are not included.

Snapshot trees and cascaded pairs

Snapshot trees are Thin Image pair configurations where snapshot data is stored.

The volume in the top layer of the snapshot tree is the root volume. Volumes in the bottom layer are leaf volumes.
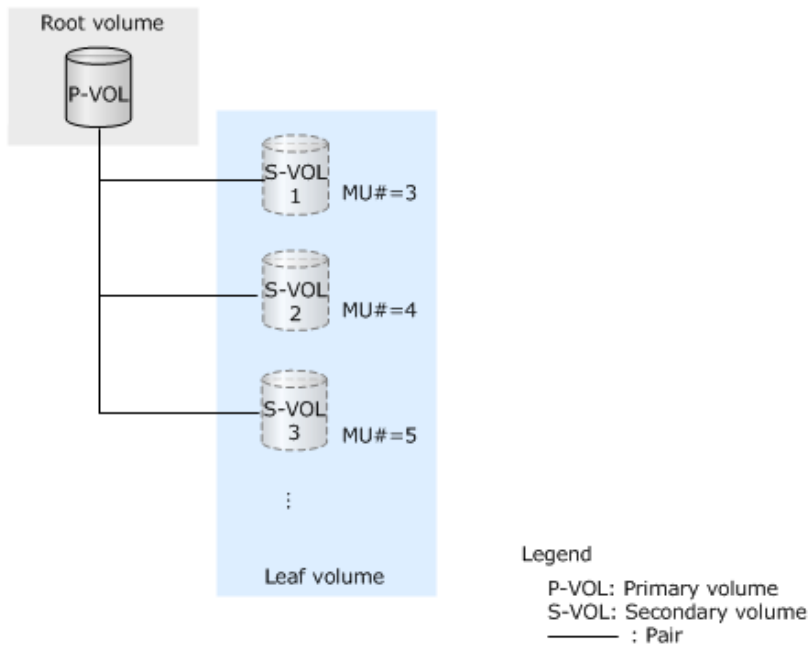
Creating cascaded pairs

Thin Image S-VOLs can be paired with secondary layer S-VOLs. First layer (L1) S-VOLs can also be paired with secondary layer (L2) S-VOLs. A maximum of 64 layers can be created, and a maximum of 1,024 S-VOLs can be used for a P-VOL. In this case, the snapshot tree is cascaded.

L2 to L64 pairs are called cascaded pairs. The following figure illustrates the configuration of cascaded snapshot trees.

Root volume

P-VOL

S-VOL
1

MU#=3

S-VOL
4   MU#=3

S-VOL
5   MU#=4

S-VOL
2

MU#=4

S-VOL
6   MU#=3

S-VOL
7   MU#=4

S-VOL
3

MU#=5

S-VOL
8   MU#=3

S-VOL
9   MU#=4

Node volume   Leaf volume

Legend

P-VOL: Primary volume
S-VOL: Secondary volume
———— : L1 pair
———— : L2 pair
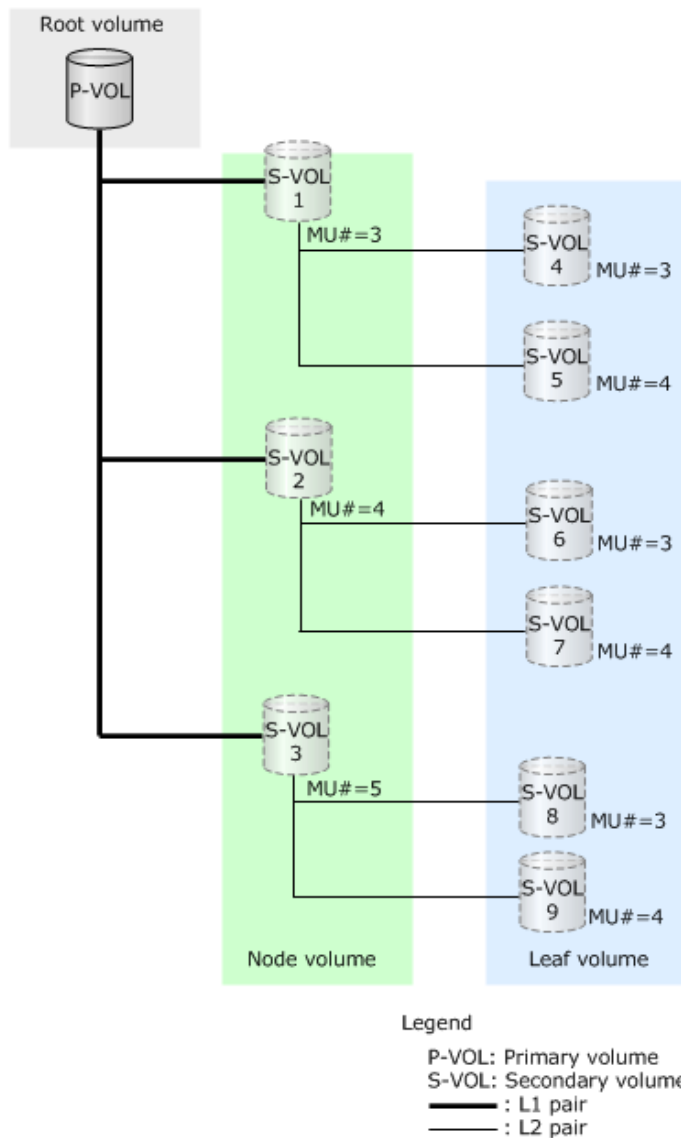
- The volume in the top layer of the snapshot tree (P-VOL of the L1 pair) is the root volume.

- Volumes between the root and leaf volumes are node volumes.

- Volumes in the bottom layer of the snapshot tree are leaf volumes.

To create a Thin Image pair that can be used in a cascaded snapshot tree, open the Create TI Pairs window and select Enable for Cascade in HDvM - SN or use the `raidcom add snapshot -snap_mode cascade` command in CCI. For details, see Creating Thin Image pairs using Device Manager - Storage Navigator (on page 127) or Adding Thin Image pairs to snapshot or consistency groups using CCI (on page 132).

When the S-VOL of a Thin Image pair you created for a P-VOL for the first time is a DP-VOL, you can create cascaded pairs. If a Thin Image pair whose secondary volume is a Thin Image V-VOL (which has the Snapshot provisioning type) is created, remove the pair first, and then create another Thin Image pair whose secondary volume is a DP-VOL.

A snapshot tree can be configured by combining snapshot and cloned pairs. As shown in the following figure, you can also cascade pairs that are being cloned, but you can only clone up to three pairs concurrently. The following figure shows an example of when pairs that are being cloned are also cascaded.

In this document, a cascade configuration represents a cascaded snapshot tree using Thin Image. A configuration where a P-VOL of a Thin Image pair shares volumes with S-VOLs of other replication software applications is not referred to as a cascade configuration.
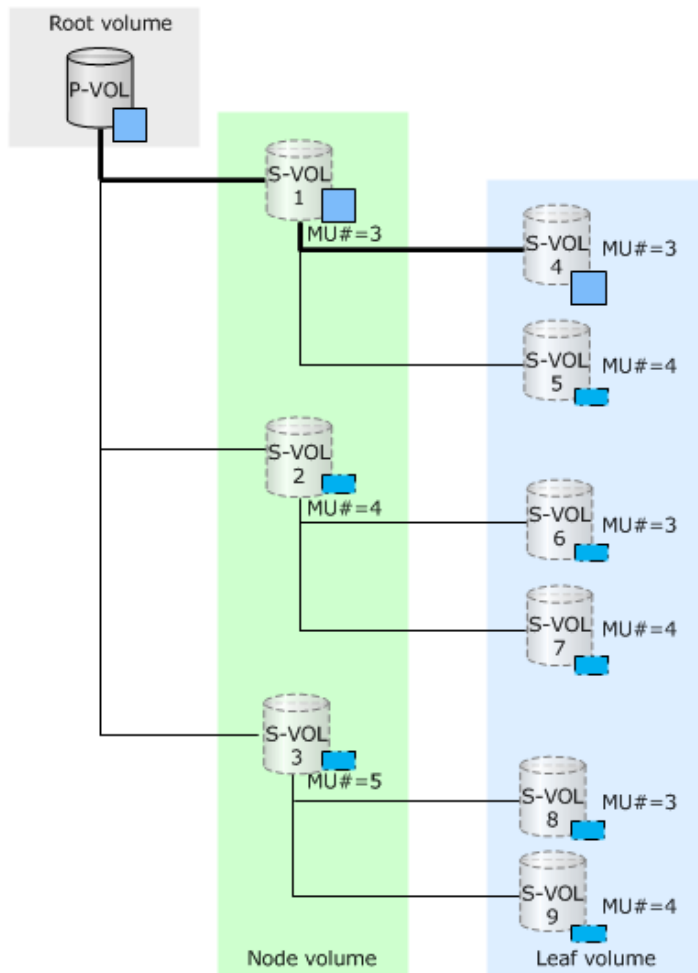
You can use the S-VOL of a cascaded and cloned pair as a new L1 pair of the P-VOL. In this case, the volume is the root volume, and a node or leaf volume.

Volume differences between Thin Image and ShadowImage

A Thin Image S-VOL (snapshot) contains data stored in the P-VOL and the pool. A ShadowImage S-VOL is created by copying all P-VOL data.

The following table summarizes the volume and other differences between Thin Image and ShadowImage.

Item	Thin Image	ShadowImage
Initial copy operation	Not required. Volumes can be copied faster.	Required.
Number of S-VOLs per P-VOL	Up to 1,024	Up to 9
Capacity efficiency	High. Only differential data is copied from the P-VOL.	Low. The entire P-VOL is copied.
Operation of copied volumes	Always used with the P-VOL.	Can be used separately from the P-VOL.
P-VOL physical failures	S-VOL data cannot be guaranteed.	P-VOL data can be restored using the S-VOL.
S-VOL or pool physical failures	If a physical failure occurs in a pool*, data in all S-VOLs that use the pool cannot be guaranteed.	If a physical failure occurs in an S-VOL, data in the S-VOL cannot be guaranteed.
*When a pool is full (the depletion threshold is exceeded in a pool for which the capacity for Thin Image pairs is limited), data in all S-VOLs using the pool cannot be guaranteed.		

The following figures explain the relation of data when a failure occurs in the P-VOL.

Thin Image

Legend
P-VOL: Primary volume
S-VOL: Secondary volume
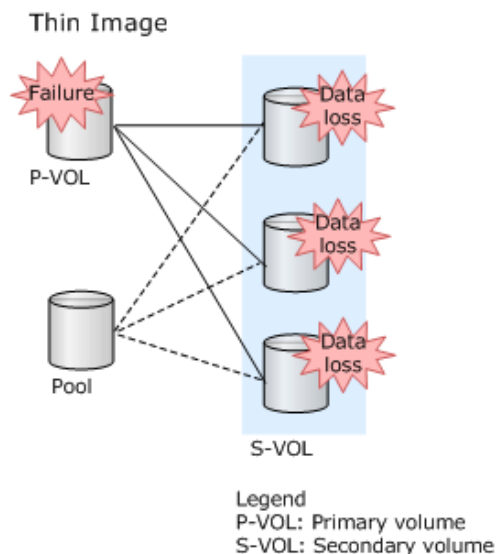
Thin Image S-VOLs reference data in the P-VOL. Therefore, if a failure occurs in the P-VOL, data in all S-VOLs under the P-VOL is lost.

ShadowImage

Legend
P-VOL: Primary volume
S-VOL: Secondary volume
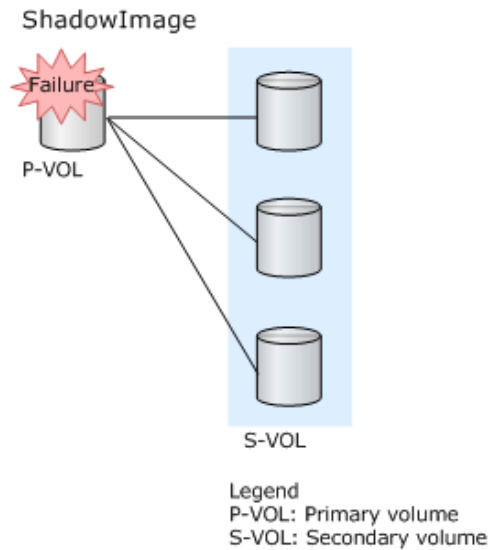
ShadowImage S-VOLs retain all P-VOL data. Therefore, if a failure occurs in the P-VOL, data in the S-VOLs is not lost.

The following figure explains the relation of data when a failure occurs in a pool.

Thin Image

Legend
P-VOL: Primary volume
S-VOL: Secondary volume
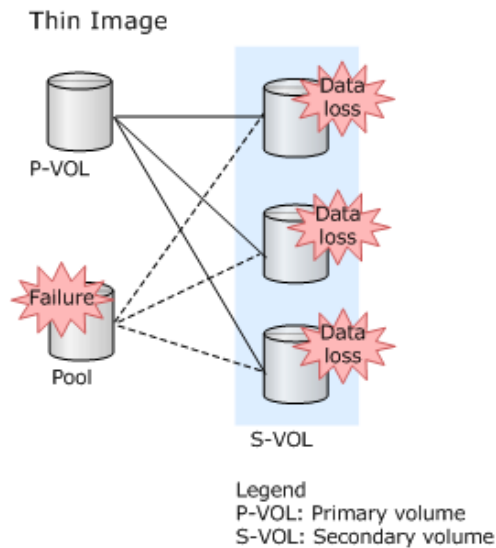
Thin Image S-VOLs reference data in the pool. If the pool cannot be used because a failure occurs in the pool or the pool becomes full, data in all S-VOLs that use the pool is lost. In addition, if a pool failure occurs or the pool becomes full during restoration, data in the P-VOL which is being restored cannot be used.

The following figure explains the relation of data when a failure occurs in an S-VOL.

Legend
P-VOL: Primary volume
S-VOL: Secondary volume
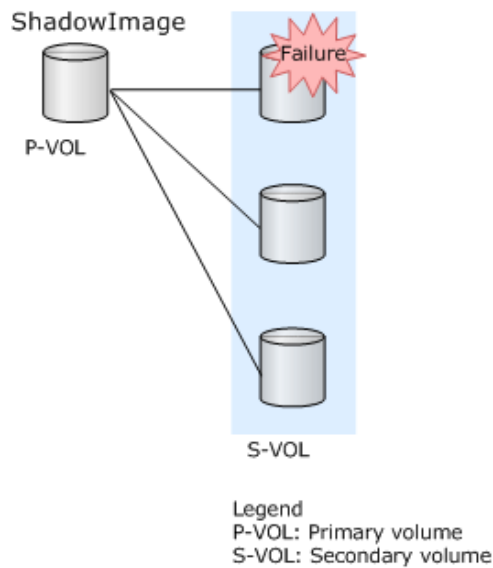
For ShadowImage, each S-VOL independently retains data. Therefore, only data in the failed S-VOL is affected. In addition, if a failure occurs in an S-VOL during restoration, data in the P-VOL which is being restored cannot be used.

Software applications for Thin Image

A Thin Image installation typically includes the Thin Image software, Dynamic Provisioning software, and CCI.

Thin Image

Use the Thin Image software on the Device Manager - Storage Navigator (HDvM - SN) computer that is connected to the service processor (SVP) by means of the TCP/IP local area network (LAN).

If a logical volume assigned as a namespace on the NVM subsystem with the NVMe-oF connection is specified as a P-VOL or an S-VOL of a Thin Image pair, CCI must be used. The pair operations cannot be performed from HDvM - SN.

Dynamic Provisioning

Use the HDP software on the HDvM - SN computer. A user license is required to use HDP.

Since Thin Image uses a portion of the HDP licensed capacity for its pool capacity, reserve enough HDP licensed capacity to run both HDP and Thin Image and to accommodate the Thin Image pairs or pools that you will create.

Thin Image and HDP pool-VOLs are also referred to as used volumes. The licensed capacity must exceed the total capacity of used volumes.

CCI

When you use CCI to define multiple Thin Image pairs in a consistency group, you can only specify one consistency group for a group defined by the configuration definition file for CCI.

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> 📄 **Note:** The configuration definition file for CCI is a group that is not a consistency group.

If you create a new pair and define the pairs in a consistency group for a group you defined using the configuration definition file for CCI, and the pair is already defined in a consistency group, the pair is defined in the same consistency group even if you try to create a new pair and assign it to a different consistency group.

How Thin Image works

This topic explains how Thin Image works.

How Thin Image uses pools and pool volumes

Thin Image stores snapshot data in DP pools (Pool Type: Dynamic Provisioning in HDvM - SN, or pools created by the `raidcom add dp_pool` command and displayed by the `raidcom get pool -key`option in CCI) or Thin Image pools (Pool Type: Thin Image in HDvM - SN, or pools created by the `raidcom add snap_pool` command and displayed by the `raidcom get pool -key` option in CCI). Unless they are defined otherwise, both DP pools and Thin Image pools are referred to as "pools". A pool consists of multiple pool volumes (pool-VOLs) which are, as a group, the container for the snapshot data.

You must create pools to use Thin Image. You can create pools and add and delete pool-VOLs from them using Thin Image.

The following figure illustrates the relationship between a Thin Image pair and a pool.

Pair

Pool

P-VOL

Pool VOLs

S-VOLs

Legend

⟶ : Data flow

▮ : Data

P-VOL: Primary volume
S-VOL: Secondary volume (V-VOL)
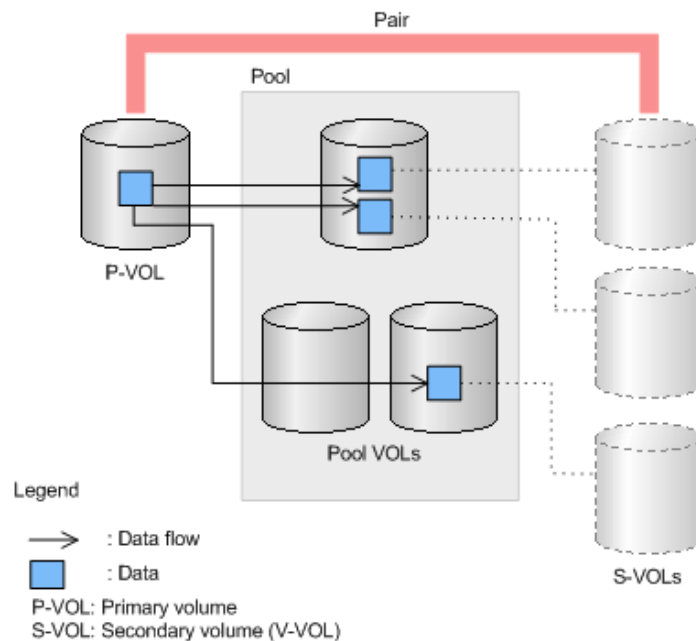
> ⚠️ **Caution:** When creating pools, calculate the pool capacity and reserve a sufficient amount of pool capacity. When you write data to Thin Image pair volumes and the amount of pool usage exceeds the pool capacity, the Thin Image pair is suspended ("PSUE" status), snapshot data is not stored, and you cannot create additional Thin Image pairs.

Usage level rebalancing among parity groups

If multiple parity groups that contain LDEVs used as pool-VOLs exist, rebalancing can improve biased usage rates in parity groups.

Rebalancing is performed as if each parity group were a single pool-VOL. After rebalancing, the usage rates of LDEVs in a parity group may not be balanced, but the usage rate in the entire pool is balanced.

The usage level among parity groups is automatically rebalanced when expanding or shrinking pool capacity operations are in progress.

If you expand the pool capacity, Dynamic Provisioning moves data to the added space on a per-page basis. When the data is moved, the usage rate among parity groups of the pool-VOLs is rebalanced.

Host I/O performance may decrease when data is moved. If you do not want to have the usage level of parity groups automatically balanced, call customer support.

You can see the rebalancing progress of the usage level among parity groups in the **View Pool Management Status** window in HDvM - SN. In CCI, you can use the `raidcom get pool -key` command to see if the usage levels among parity groups are rebalanced. Dynamic Provisioning automatically stops balancing the usage levels among parity groups if the cache memory is not redundant or the pool usage rate reaches up to the threshold.

How Thin Image uses V-VOLs

V-VOLs are virtual volumes that do not have any physical storage space.

Thin Image uses Thin Image V-VOLs (V-VOLs of provisioning type Snapshot in HDvM - SN, or V-VOLs created by the `raidcom add ldev -pool snap` command in CCI) or DP-VOL as V-VOLs. Thin Image V-VOLs and DP-VOLs are referred to as virtual volumes (V-VOLs) in this document. Use DP-VOLs to create cascaded or cloned pairs. Use Thin Image V-VOLs to create snapshot pairs. Note that you can use DP-VOLs to cascade snapshot pairs.

Thin Image uses V-VOLs to access snapshot data from hosts or clone pairs, so if you create clone pairs or use snapshot pairs (a pair with the snapshot attribute) to access snapshot data from hosts, then V-VOLs are required to create Thin Image pairs or assign an S-VOL to snapshot data. If the storage system or snapshot pair does not need to access snapshot data from hosts, V-VOLs are not necessary.

You can release the V-VOLs that are being used as Thin Image S-VOLs from assignment of snapshot data. Released V-VOLs can be assigned to other snapshot data. However, you cannot release allocation of V-VOLs used as node volumes to snapshot data or allocate the V-VOL to different snapshot data. Also, you cannot release allocation of V-VOLs which are being used for the S-VOL of a clone pair to snapshot data, or allocate it to different snapshot data.

If you release a V-VOL being used as a Thin Image S-VOL from assignment to snapshot data, and then assign the V-VOL to different snapshot data, this V-VOL becomes the S-VOL of another pair. Therefore, each time you assign a V-VOL to snapshot data, execute the command which allows the host server to recognize the device.

You cannot release definitions of V-VOLs if the V-VOLs are being used as Thin Image secondary volumes; you must first release the Thin Image pairs that are using the V-VOLs.

How Thin Image pairs are created

Create Thin Image pairs in the **Create TI Pairs** window in HDvM - SN, or by using the `raidcom add snapshot` command in CCI.

When creating a Thin Image pair, you need to specify the pool to be used for the pair. If multiple Thin Image pairs share the same primary volume, the pairs must also share the same pool. For example, if you specify three secondary volumes for one primary volume, you must specify the same pool for the three Thin Image pairs.

If you release a Thin Image pair, the volume status becomes SMPL. Immediately after a volume becomes SMPL, you cannot use the volume to create a Thin Image pair. If you want to create Thin Image pairs using SMPL volumes, you should wait for a while before creating the pairs. The wait time required depends on your system environment.

You can check the status of volumes in the **Local Replication** window and the **View Pair Properties** window in HDvM - SN, or by using the `raidcom get snapshot` command in CCI.

Using snapshot pairs (not cascaded)

The following figure shows how snapshot pairs are used when they are not cascaded.

Data in the P-VOL is backed up one time every day. The P-VOL can be restored using the S-VOL if a logical failure occurs during data update or if there is a virus in the P-VOL.
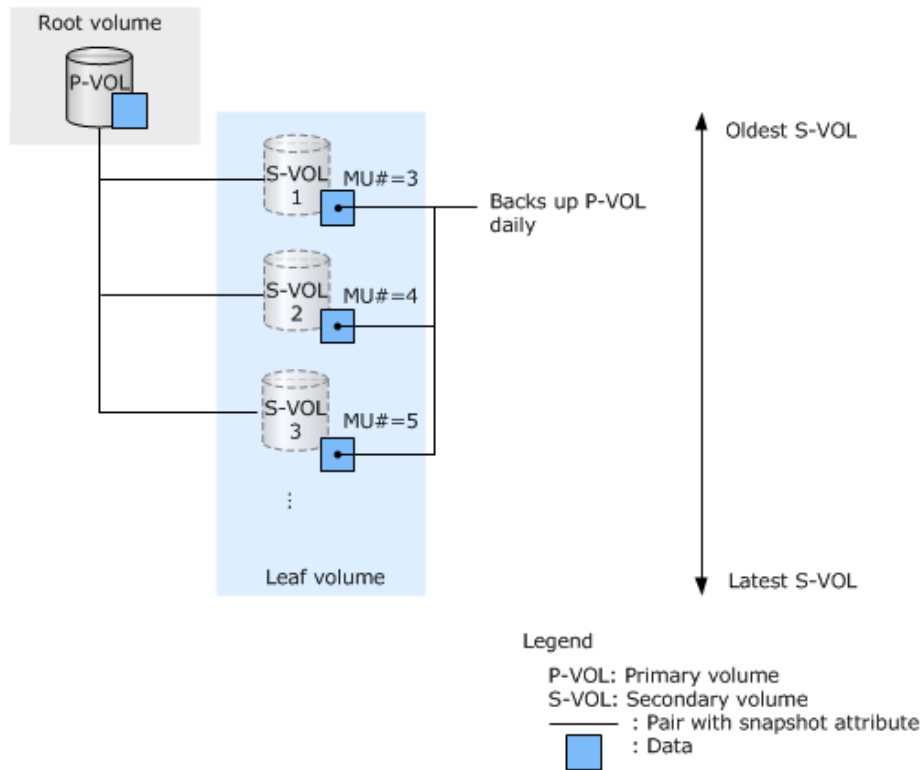
Using cascaded pairs

Distributing data in the P-VOL to multiple users

Create the same number of leaf volumes as the number of users to whom you want to distribute data. This allows you to distribute data in the P-VOL without increasing loads to the P-VOL.
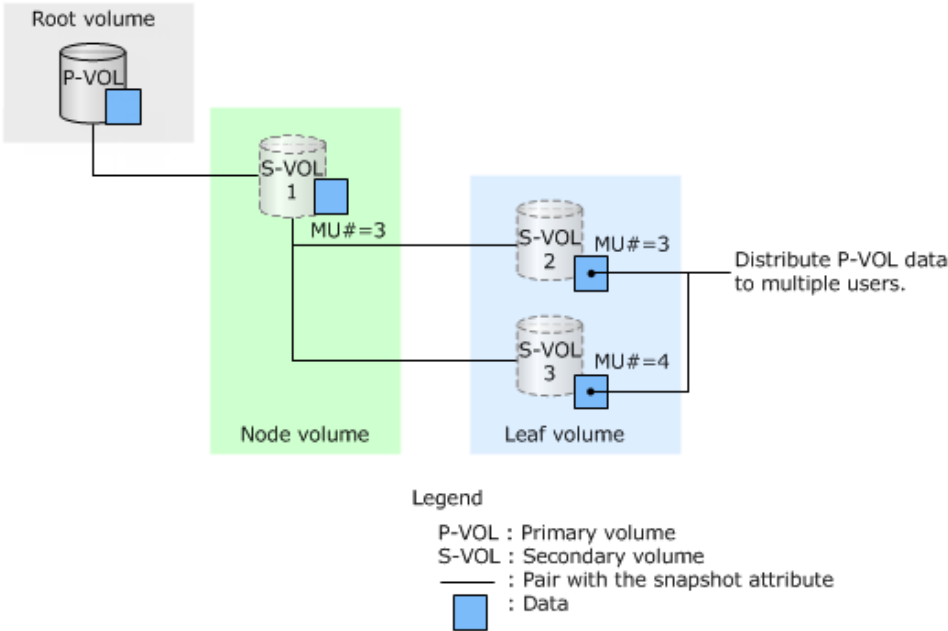
Distributing updated data in the P-VOL to specified users
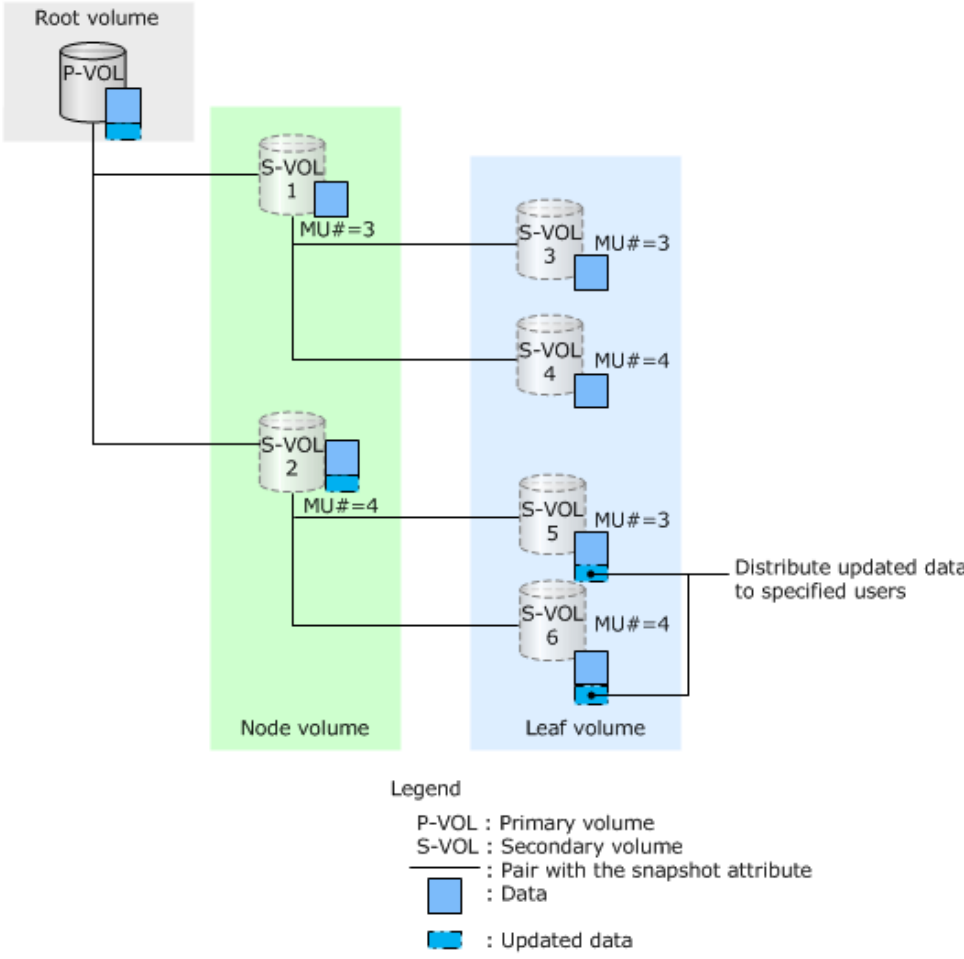
When you update the P-VOL and want to give it only to the specified users (S-VOLs 5 and 6 in the figure), do the following:

1. Create cascaded pairs, and distribute data in the P-VOL. Assign users to whom you want to distribute the updated data, and users to whom you do not want to distribute the updated data to separate node volumes.

2. Delete the pairs in the node volume where you assigned users you do not want to distribute the updated data to (S-VOL 1 in the figure).

3. Update the P-VOL.

Creating a new distributor with cloned pairs
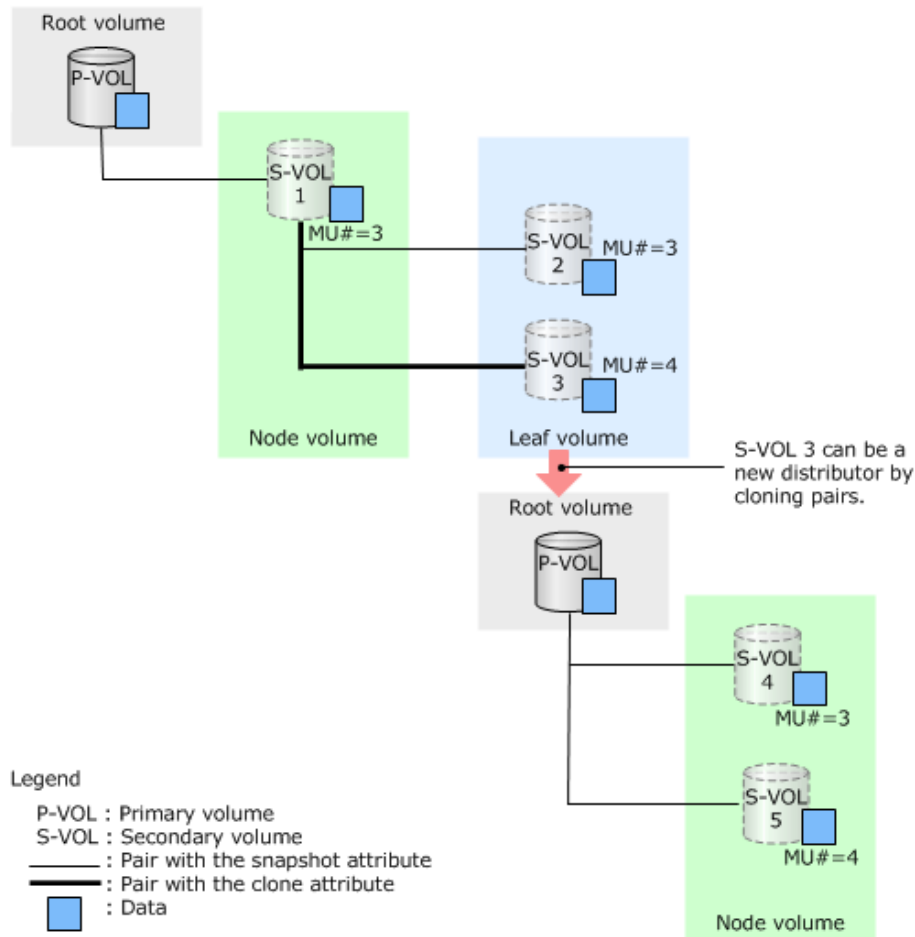
1. Create cascaded pairs and distribute data in the P-VOL. Assign the clone attribute to the volume to be a new distributor (S-VOL 3 in the figure).

2. Clone pairs.

By cloning pairs, S-VOL 3 and S-VOL 1 become unpaired volumes (DP-VOLs) in the same status, and S-VOL 3 can be a new distributor. As a result, the overhead of the Thin Image pairs can be reduced.

Workflow for creating groups and storing snapshot data using CCI

You can use CCI raidcom commands to create a consistency or snapshot group and to split pairs to store the snapshot data for the group.

With Thin Image, ShadowImage, and ShadowImage for Mainframe, you can create up to 2,048 consistency groups in Virtual Storage Platform 5000 series.

The following figure illustrates how snapshot data is stored for a consistency or snapshot group using CCI raidcom commands.
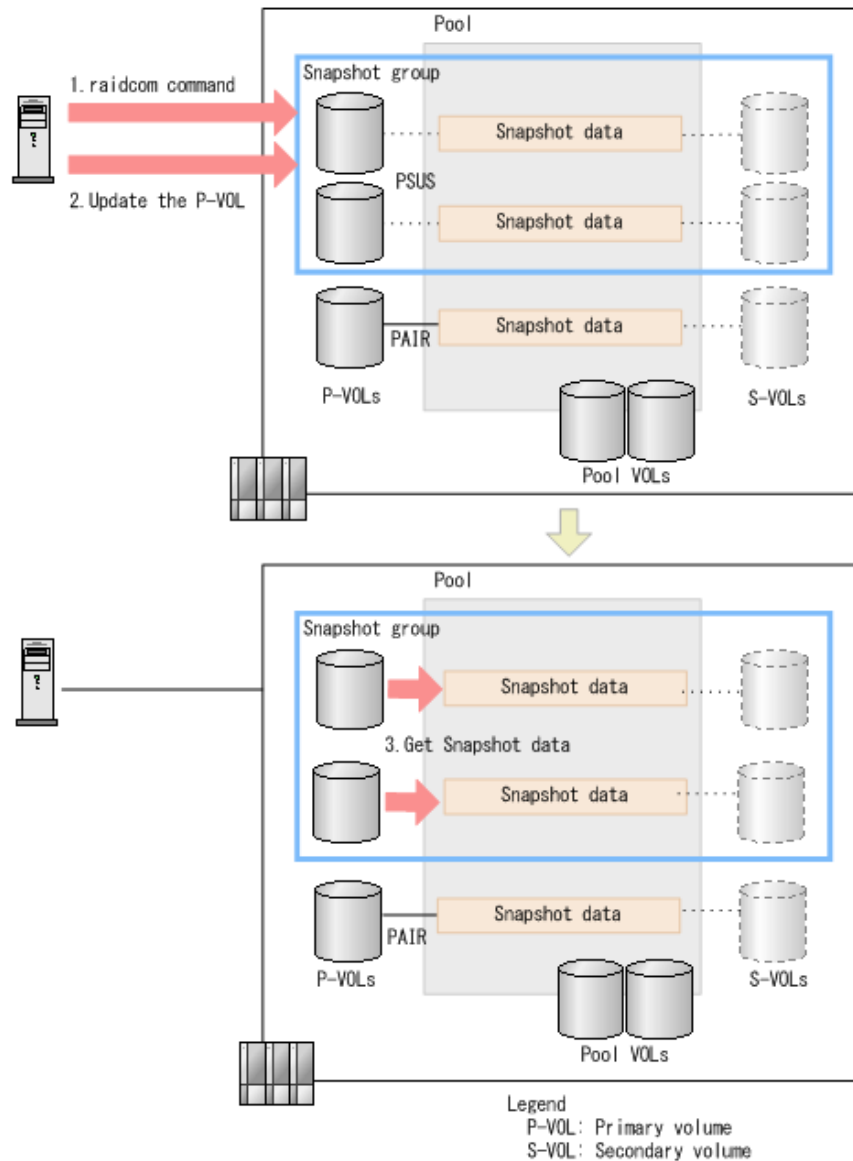
Use the following workflow to create a snapshot group and store volume snapshot data in the group:

1. Split the pair and store snapshot data for a group. To do this using CCI, run the following raidcom command:

    raidcom modify snapshot -snapshot_data create

2. The host issues a write request to each P-VOL in the group.

Snapshot data for the volumes are stored.

A CCI command is used to store snapshot data for a consistency group or a snapshot group. Device Manager - Storage Navigator can only be used to reference consistency groups and snapshot groups.

Methods of storing snapshot data

The Copy-After-Write (CAW) method is the default method of storing snapshot data. However, if the write pending rate (percentage of data waiting to be written in cache memory) is 60% or higher when writing in cascaded pairs random access mode, or 30% or higher when writing in sequential access mode, the Copy-On-Write (COW) method is used.

In the CAW method, writing the P-VOL snapshot data changes the status to "write completion". In the COW method, storing the P-VOL snapshot data changes the status to "write completion". The CAW method wait time is shorter than that of the COW method.

Workflow for the CAW method

The following workflow describes the CAW method and how Virtual Storage Platform 5000 series stores snapshot data:

1. The host writes data to a P-VOL.
2. The storage system returns the write completion status to the host.
3. The storage system stores snapshot data for the P-VOL in the background.

The following figure illustrates the CAW method.
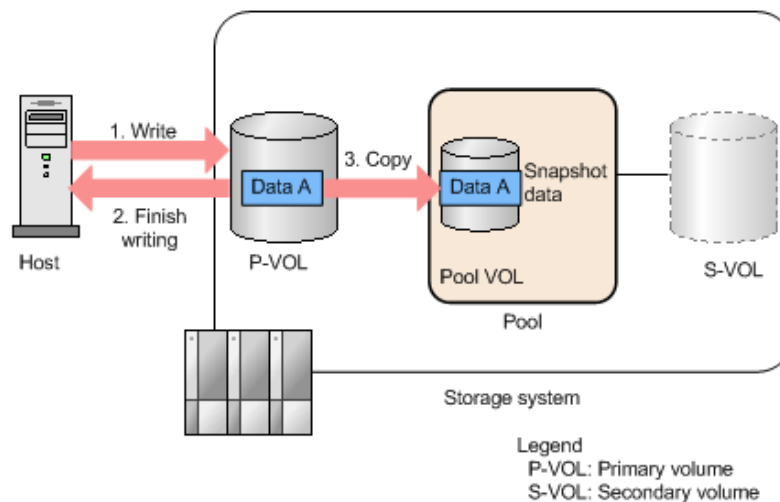
Workflow for the COW method

The following workflow describes the COW method and how Virtual Storage Platform 5000 series stores snapshot data:

1. The host writes data to a P-VOL.
2. The storage system stores snapshot data for the P-VOL.
3. The storage system returns the write completion status to the host.

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The following figure illustrates the COW method.
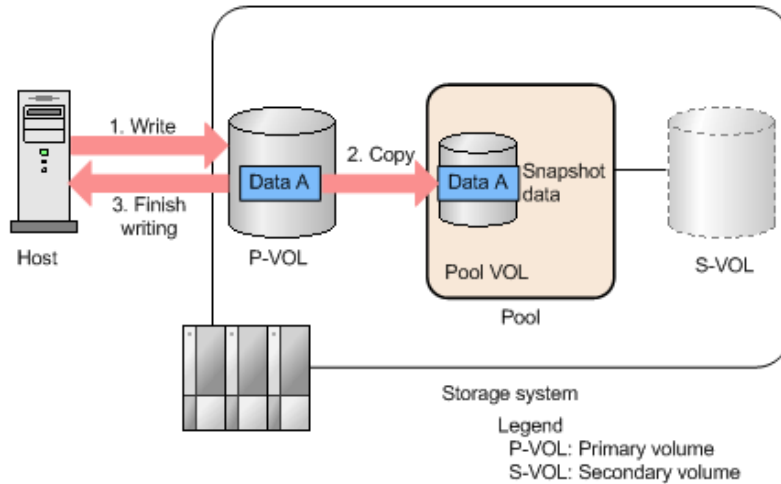
Thin Image pair restoration

You can use Thin Image to overwrite snapshot data in pools to P-VOLs so that the P-VOL content is returned to the condition it was when you stored snapshot data.

Overwriting snapshot data to P-VOLs is also referred to as restoring Thin Image pairs.

If data is written to a secondary volume, this particular data (not snapshot data) is overwritten to the primary volume when the Thin Image pair is restored.

If a problem occurs in P-VOL data due to a failure, restoring the pair restores the P-VOL data saved when the snapshot data was stored. However, if the pair status is PSUE, the pair cannot be restored.

The time for restoring a Thin Image pair depends on the following, even if the pair synchronization rate is 100%:

- The amount of pool capacity a pair is using.

- The number of pairs being operated concurrently.

The pair synchronization rate shows the rate that S-VOL data matches that of the next generation of the S-VOL. If the S-VOL is the latest one, the synchronization rate is computed by comparing the S-VOL with the P-VOL.

For the Thin Image pair where the cascade attribute is enabled, the information displayed in Synchronization Rate (%) of the View Pair Synchronization Rate window varies depending on the pair status.

How Thin Image pair status changes

The Thin Image pair status changes as you create, split, or perform other pair tasks.

The following figure illustrates status changes to Thin Image and snapshot pairs.
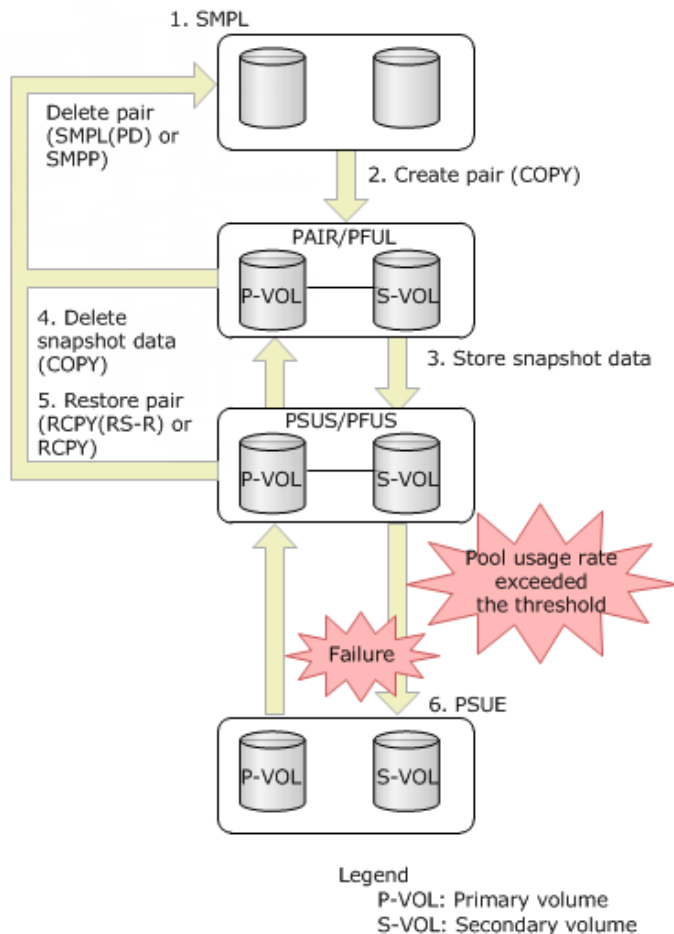
The following workflow describes the Thin Image pair status changes:

1. You choose two volumes that are in SMPL status and are not in use as a Thin Image pair.

2. You create a pair.

   If the primary volume has not previously been paired with any secondary volume, the pair status changes to "COPY" at first, and then to "PAIR" after the pair creation finishes.

   - Creation of a Thin Image pair may be time consuming if you create a pair immediately after deleting the last snapshot data for the primary volume.

   - If the pool threshold is exceeded when the Thin Image pair is in "PAIR" status, the pair status changes to "PFUL."

   - Thin Image pairs cannot be created when the pool threshold (warning threshold when snapshot data is stored in a DP pool) is exceeded.

3. Snapshot data is stored when you split a pair in "PAIR" status.

   After snapshot data is stored, the pair status is "PSUS." If the pool Warning threshold is exceeded when the Thin Image pair is in "PSUS" status, the pair status changes to "PFUS."

4. If you only want to delete snapshot data but do not want to release the Thin Image pair, you delete the snapshot data for the pair in "PSUS" or "PFUS" status.

5. If you restore a Thin Image pair in "PSUS" status, snapshot data is overwritten to the primary volume.

   The pair status is "COPY(RS-R) or RCPY" when the restore process is in progress. The pair status is "PAIR" after the restore process finishes.

6. The pool can only contain data of predetermined capacity.

   If the total capacity of snapshot data in the pool exceeds the pool capacity, the status of the Thin Image pair becomes "PSUE." In addition, the pair status changes to "PSUE" if a failure occurs during the restore process or if the pool usage rate reaches 100 percent. Even if the restore process is not in progress, the pair status may change to "PSUE" when a failure occurs. When snapshot data is stored in the DP pool, the timing of changing to PSUE is determined by the setting in "Suspend TI pairs when the deletion threshold is exceeded" in HDvM - SN, or by the setting specified by using the `raidcom modify pool -suspend_tipair <yes|no>` command in CCI. For details, see the *Provisioning Guide* for your storage system.

Thin Image host access and pair status

The status of Thin Image (HTI) pairs depends on whether the hosts can read from or write to the Thin Image pair P-VOL or S-VOLs.

The following table explains the host access and pair status for snapshot pairs.

	P-VOL		S-VOL	
HTI pair status	**Read**	**Write**	**Read**	**Write**
SMPL	Yes	Yes	No	No
SMPL(PD) or SMPP	Yes	Yes	No	No
COPY	Yes	Yes	No	No
PAIR/PFUL	Yes	Yes	No	No
PSUS/PFUS	Yes	Yes	Yes[1]	Yes
COPY(RS-R) or RCPY	Yes[2]	Yes	No	No
PSUE	Yes	Yes	No	No
1: When the cascade attribute is disabled for the pair, access to the S-VOL might not be available if the usage rate of the pool to which the P-VOL belongs is 100%.				
2: The data of the S-VOL can be read when pairs are restored.				
Legend				
Yes: Hosts can access the volume				

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HTI pair status	P-VOL		S-VOL	
	Read	**Write**	**Read**	**Write**
No: Hosts cannot access the volume				

> ⚠ **Caution:** If a host uses a software application to monitor Thin Image pair volumes other than Thin Image, the S-VOL status determines if the software application ends abnormally. For example, if the S-VOLs are in a status other than "PSUS" and "PFUS," the host can reject access.
>
> If a host connects to at least two ports, an abnormality can occur with ports that are not connected to S-VOLs rejecting access from hosts. To resolve these issues, close the software application that monitors volumes.

Workflow for Thin Image pair status changes

The following figure illustrates status changes to Thin Image cloned pairs.

Legend
P-VOL: Primary volume
S-VOL: Secondary volume
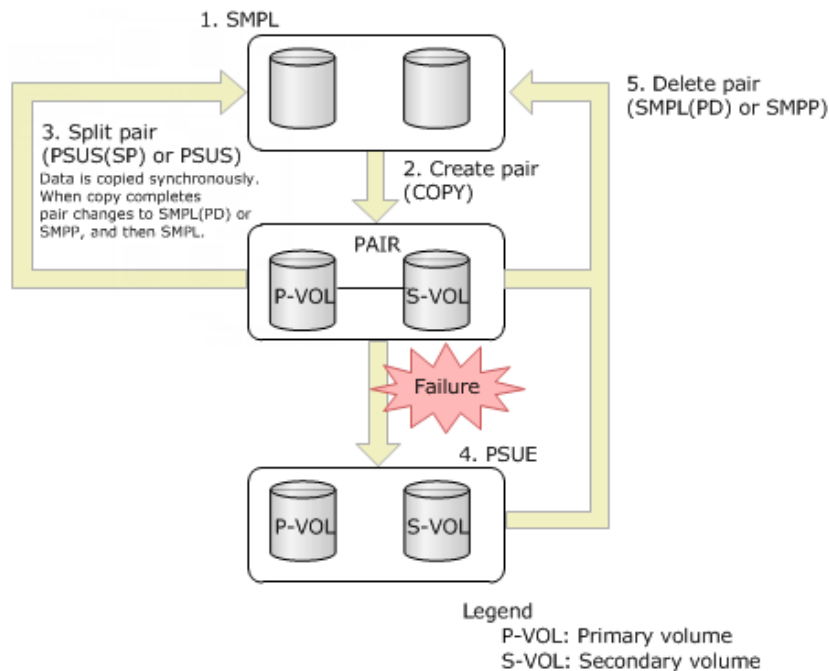
The following workflow describes Thin Image pair status changes:

1. You choose two volumes that are in the SMPL status and are not in use as a Thin Image pair.

2. You create a pair. If the P-VOL has not previously been paired with any S-VOL, the pair status changes to COPY at first, and then to PAIR after the pair creation finishes.

3. You split a pair. When you split a pair in the PAIR status, the pair status changes to PSUS(SP) or PSUP, and copying data is started asynchronously. When the copy operation completes, the pair status changes to SMPL(PD) or SMPP. When the pair

deletion completes, the pair status changes to SMPL. The S-VOL becomes unpaired (a DP-VOL) and can be used as a volume in the same status as the P-VOL.

> 📄 **Note:** If you delete a pair when the pair status is PSUS(SP) or PSUP, copying data stops at the time when the pair deletion is accepted, and the status changes to SMPL. If this happens, data in the S-VOL is not guaranteed.

4. The DP pool can only contain data of predetermined capacity. If the total capacity of data in the pool exceeds the pool capacity, the status of the Thin Image pair changes to PSUE. In addition, the pair status also changes to PSUE if a failure occurs during the process or if the pool usage rate reaches 100 percent. When snapshot data is stored in the DP pool, the timing of changing to PSUE is determined by the setting in "Suspend TI pairs when the deletion threshold is exceeded" in HDvM - SN, or by the setting specified by using the `raidcom modify pool -suspend_tipair <yes|no>` command in CCI. For details, see the *Provisioning Guide* for your storage system.

5. You delete a pair. When a pair is deleted, the pair status changes to SMPL(PD) or SMPP. After that, it changes to SMPL when pair deletion completes.

Whether the host can read or write data from and to a Thin Image pair P-VOL or S-VOL is determined by the pair status. The following table describes whether the host can access volumes, and their cloned pair status.

Pair status	Primary volume		Secondary volume	
	Read	Write	Read	Write
SMPL	Y	Y	Y	Y
COPY	Y	Y	N	N
PAIR	Y	Y	N	N
PSUS(SP) or PSUP	Y	Y	Y	Y
SMPL(PD) or SMPP	Y	Y	Y	Y
PSUE	Y	Y	N	N

Copy threshold option and host server I/O performance for Thin Image (SOM 467)

You can enable the copy threshold option (SOM 467) to help minimize the decline of host server I/O performance by lowering the workload on the storage system.

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I/O performance of the host server might be lowered as the workload on the storage system increases. If you perform Thin Image restore operations when the workload on the storage system is high, I/O performance of the host server is more likely to be lowered because replication processes for the primary volumes are triggered. The copy threshold option (SOM 467) can be used to temporarily stop the replication processes triggered by the restore operations when the workload on the storage system is high. The copy threshold option (SOM 467) can contribute to minimizing the decline in I/O performance of the host server.

The copy threshold option (SOM 467) is applicable only when the workload on the storage system is excessively heavy. If the copy threshold option (SOM 467) is applied, all the replication processes triggered by restore operations are stopped.

Replication processes stopped by the copy threshold option (SOM 467) will be restarted as the workload on the storage system is lowered. Enabling the copy threshold option (SOM 467) stops replication processes for Thin Image and the following products when the storage system is overloaded.

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

For more information about enabling the copy threshold option (SOM 467), call customer support.

For more information about Compatible FlashCopy® V2, see the *Hitachi Compatible FlashCopy/FlashCopy SE User Guide*.

Copy threshold option for capacity saving

The copy threshold option for capacity saving enables you to choose whether to slow down copy processing performed in the background when the workload on the storage system is high. By using the copy threshold option for capacity saving, you can prevent the decline in the host server I/O performances (responses) for virtual volumes with capacity saving enabled.

When this option is set to ON, it can be used to slow down copy processing performed in the background when the write pending rate of the MP unit in the CLPR to which the target volume belongs is 35% or higher. Slowing down copy processing performed in the background prevents the write pending rate of the target storage system from increasing.

When this option is set to OFF, the copy threshold option (SOM 467) is in effect.

You can use one of two SOMs to enable the copy threshold option for capacity saving, depending on whether you want to enable the function to all of the CLPRs on the storage system or enable the function to individual CLPRs on the storage system.

SOM 1254

Use this mode to enable the copy threshold option for capacity saving to all CLPRs on the storage system.

SOM 1260

Use this mode to enable the copy threshold option for capacity saving to an individual CLPR on the storage system.

For more information about the copy threshold option and the workflow, see the copy threshold option topic in the Provisioning Guide and SOM 1254 or SOM 1260 in the System Administrator Guide.

The copy threshold option for capacity saving is available with the following DKCMAIN versions:

VSP 5000 series

- 90-07-03-xx/xx or later, but earlier than 90-08-00-xx/xx

- 90-08-02-xx/xx or later

VSP E series

- 93-04-04-xx/xx or later, but earlier than 93-05-00-xx/xx

- 93-05-04-xx/xx or later

Sharing Thin Image volumes with other software applications

You can create Thin Image (HTI) pairs using pair volumes for other replication software applications, such as ShadowImage and TrueCopy. You can also create Thin Image pairs using volumes to which you define attributes using Data Retention Utility or CCI even when you use HDvM - SN.

You can share Thin Image volumes with the following software application volumes:

- Data Retention Utility (VSP 5000 series)

- Volume Migration V2

- ShadowImage (SI)

- TrueCopy (TC)

- Universal Replicator (UR)

- Global-active device (GAD)

The following table shows when you can share Thin Image pair volumes with other software application volumes. If a volume that you share with a Thin Image volume is shown in the table, the pair status determines whether you can perform tasks. If the S-VOL is not assigned to snapshot data, you cannot share Thin Image volumes with other software applications, because the S-VOL does not exist.

> 📄 **Note:** For node or leaf volumes, see the Used as an HTI S-VOL column instead of the Used as an HTI P-VOL column.

Software application volume type	Used as an HTI P-VOL	Used as an HTI S-VOL
SI P-VOL	Yes[3]	No
SI S-VOL	Yes	No
TC P-VOL	Yes	No
TC S-VOL	Yes	No
UR P-VOL	Yes	No
UR S-VOL	Yes	No
UR journal volume	No	No
GAD P-VOL	Yes	No
GAD S-VOL	Yes	No
GAD volume with reservation attribute	No	No
GAD volume for quorum disk	No	No
Volume Migration source volume	No	No
Volume Migration target volume	No	No
Read Only volume[1, 4, 6]	Yes	Yes
Protect volume[1, 4, 6]	Yes	Yes
S-VOL Disable volume[4, 6]	Yes	No
Zero Read Capacity volume[2, 5, 6]	Yes	Yes
Invisible volume[2, 5, 6]	Yes	Yes
DP-VOL	Yes	Yes[7]
V-VOL with capacity saving enabled	Yes	Yes[8]
Deduplication system data volume	No	No

1. If you use HDvM - SN to share the volume with other software applications, the pair status determines whether you can share the volume.
2. To share the volume with other software applications, you must use CCI.
3. You cannot use Quick Restore.
4. Use the Data Retention Utility (VSP 5000 series) to set this attribute.
5. CCI is required to set this attribute. For setting the attribute, use the `raidvchkset -vg` command.
6. Use the Data Retention Utility (VSP 5000 series) or use the `raidvchkdsp -v gfalg` command to confirm whether this attribute is set to volume.

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Software application volume type	Used as an HTI P-VOL	Used as an HTI S-VOL
7. Can be shared if the pair is cascaded or has the clone attribute.		
8. Can be set on an S-VOL of a cascaded pair or a clone attribute pair. Note that only the clone attribute enables capacity saving.		

Sharing Thin Image volumes that have Data Retention Utility access attributes

You can create Thin Image (HTI) pairs using volumes on which you set Data Retention Utility access attributes. In addition, you can set any access attribute for virtual volumes of HTI.

Depending on access attributes of the P-VOL, S-VOL, or pool volume, you cannot perform some pair tasks and pool tasks with Thin Image. The Thin Image pair tasks you can perform are different depending on whether you assign Data Retention Utility access attributes using CCI or HDvM - SN. The tables below explain whether you can perform Thin Image pair tasks and pool tasks on volumes that have access attributes assigned by Data Retention Utility. If you release assignment of snapshot data after assigning access attributes to a Thin Image S-VOL, the Thin Image tasks you can perform are the same as those that can be performed when the Read/Write attribute is assigned to the S-VOL.

Also, you can assign access attributes to Thin Image P-VOL and S-VOLs. The tables below also explain Thin Image pair tasks and pool tasks after access attributes are assigned.

Access attributes and supported Thin Image pair tasks

The following table lists the relationship between P-VOL and S-VOL access attributes and Thin Image pair tasks when using HDvM - SN to assign Data Retention Utility access attributes.

Volume access attributes specified for the HTI pair		HTI pair task		
P-VOL	**S-VOL**	**Create, split, suspend, Resync pair (Normal Copy)**	**Resync (Reverse Copy)[1]**	**Delete**
Read/Write	Read/Write	Yes		
	Read Only, Protect, S-VOL Disable	No		
Read Only, Protect, S-VOL Disable	Read/Write	Yes	No	Yes
	Read Only, Protect, S-VOL Disable	No		

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Volume access attributes specified for the HTI pair		HTI pair task		
P-VOL	**S-VOL**	**Create, split, suspend, Resync pair (Normal Copy)**	**Resync (Reverse Copy)[1]**	**Delete**
1. Reverse Copy does not copy S-VOL access attributes to P-VOLs (see Pair resynchronization methods (on page 140)).				

The following table lists the relationship between P-VOL and S-VOL access attributes and Thin Image pair tasks when using CCI to assign Data Retention Utility access attributes.

Volume access attributes specified for the HTI pair		HTI pair task		
P-VOL	**S-VOL**	**Create, split, suspend, Resync pair (Normal Copy)**	**Resync (Reverse Copy)[1]**	**Delete**
Read/Write, Read Only, Protect	Read/Write, Read Only, Protect	Yes		
	S-VOL Disable	No		
S-VOL Disable	Read/Write, Read Only, Protect	Yes	No	Yes
	S-VOL Disable	No		
1. Reverse Copy does not copy S-VOL access attributes to P-VOLs (see Pair resynchronization methods (on page 140)).				

Access attributes and supported Thin Image pool tasks

The following table lists the relationship between P-VOL and S-VOL access attributes specified by Thin Image and Thin Image pool tasks when using CCI or HDvM - SN to assign Data Retention Utility access attributes.

Volume access attributes specified by HTI	Pool-VOL setting
Read/Write	Yes
Read Only	No

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Volume access attributes specified by HTI	Pool-VOL setting
Protect	No
S-VOL Disable	No

📄 **Note:** Performing a Thin Image task does not change the volume access attributes.

Required Thin Image pair status when using Data Retention Utility to assign access attributes to some volumes

The following table shows the Thin Image pair status that is required to use Data Retention Utility to assign access attributes to some Thin Image P-VOLs and S-VOLs when also using HDvM - SN to assign Data Retention Utility access attributes.

HTI volume		Access attribute to be assigned	
Pair status	Volume	Read/Write	Read Only Protect S-VOL Disable
COPY	P-VOL	Yes	Yes
	S-VOL	Yes	No
PAIR, PFUL	P-VOL	Yes	Yes
	S-VOL	Yes	Yes
PSUS, PFUS	P-VOL	Yes	Yes
	S-VOL	Yes	Yes
SMPL(PD)	P-VOL	Yes	Yes
	S-VOL	Yes	No
RCPY	P-VOL	Yes	No
	S-VOL	Yes	No
PSUE	P-VOL	Yes	Yes
	S-VOL	Yes	No

The following table shows the Thin Image pair status that is required to use Data Retention Utility to assign access attributes to some Thin Image P-VOLs and S-VOLs when also using CCI to assign Data Retention Utility access attributes.

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HTI volume		Access attribute to be assigned	
Pair status	**Volume**	**Read/Write** **Read Only** **Protect**	**S-VOL Disable**
COPY	P-VOL	Yes	Yes
	S-VOL	Yes	No
PAIR, PFUL	P-VOL	Yes	Yes
	S-VOL	Yes	Yes
PSUS, PFUS	P-VOL	Yes	Yes
	S-VOL	Yes	Yes
SMPL(PD)	P-VOL	Yes	Yes
	S-VOL	Yes	No
RCPY	P-VOL	Yes	No
	S-VOL	Yes	No
PSUE	P-VOL	Yes	Yes
	S-VOL	Yes	No

Sharing Thin Image volumes with Hitachi Volume Migration

You cannot do the following:

- Perform Thin Image tasks on volumes reserved for Volume Migration without regard to the migration plan status.

- Use Thin Image pair volumes or pool-VOLs as volumes reserved for Volume Migration V2.

For more information about the migration plan status and Volume Migration tasks, see the *Hitachi Volume Migration User Guide*.

Sharing Thin Image volumes with ShadowImage

You can share Thin Image (HTI) P-VOLs with ShadowImage (SI) P-VOL and S-VOLs.

Available Thin Image tasks

The following table lists the Thin Image tasks you can perform when sharing a Thin Image P-VOL with a ShadowImage P-VOL.

HTI task	SI pair status							
	COPY(PD)/ COPY	PAIR	COPY(SP)/ COPY	PSUS(SP)/ PSUS	PSUS	COPY(RS)/ COPY	COPY(RS-R)/ RCPY	PSUE
Create pair	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Store snapshot data	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Restore pair	No	No	No	No	Yes	No	No	Yes
Delete snapshot data	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Release pair	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Legend:								

The following table lists the Thin Image tasks you can perform when sharing a Thin Image P-VOL with a ShadowImage S-VOL.

HTI task	SI pair status							
	COPY(PD)/ COPY	PAIR	COPY(SP)/ COPY	PSUS(SP)/ PSUS	PSUS	COPY(RS)/ COPY	COPY(RS-R)/ RCPY	PSUE
Create pair	No	No	No	No	Yes	No	No	No
Store snapshot data	N/A	No	No	No	Yes	No	No	No
Store snapshot data for a consistency group	N/A	No	No	No	Yes[*]	No	No	No
Restore pair	N/A	No	No	No	Yes	No	No	No
Delete snapshot data	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Release pair	N/A	Yes	Yes	Yes	Yes	Yes	Yes	Yes

* The SI pair status must be "PSUS" during the period between when you create the HTI pair to store snapshot data and when HTI starts to store snapshot data for a consistency group, and when all of the pairs in the consistency group are split ("PSUS" status). If the SI pair status changes to a status other than "PSUS" while HTI is storing snapshot data for the consistency group, the snapshot data consistency cannot be guaranteed.

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Available ShadowImage tasks

The following table lists the ShadowImage tasks you can perform when sharing a Thin Image P-VOL with a ShadowImage P-VOL.

SI task	HTI pair status					
	COPY	**PAIR, PFUL**	**PSUS, PFUS**	**SMPL(P D)**	**RCPY**	**PSUE**
Create pair	Yes	Yes	Yes	Yes	No	Yes
Create and split pair	Yes	Yes	Yes	Yes	No	Yes
Split pair	Yes	Yes	Yes	Yes	No	Yes
Normal Copy	Yes	Yes	Yes	Yes	No	Yes
Reverse Copy	Yes	Yes	Yes	Yes	No	Yes
Quick Restore	No	No	No	No	No	No
Suspend replication	Yes	Yes	Yes	Yes	Yes	Yes
Delete pair	Yes	Yes	Yes	Yes	Yes	Yes

The following table lists the ShadowImage tasks you can perform when sharing a Thin Image P-VOL with a ShadowImage S-VOL.

SI task	HTI pair status					
	COPY	**PAIR, PFUL**	**PSUS, PFUS**	**SMPL(P D)**	**RCPY**	**PSUE**
Create pair	No	No	No	No	No	No
Create and split pair	No	No	No	No	No	No
Split pair	Yes	Yes	Yes	Yes	No	Yes
Normal Copy	Yes	Yes	Yes	Yes	No	Yes
Reverse Copy	Yes	Yes	Yes	Yes	No	Yes
Quick Restore	No	No	No	No	No	No
Suspend replication	Yes	Yes	Yes	Yes	No	Yes
Delete pair	Yes	Yes	Yes	Yes	Yes	Yes

You can perform ShadowImage pair tasks after you store snapshot data, but the consistency of the stored snapshot data is not guaranteed.

Thin Image S-VOLs use the data in the P-VOL. You cannot Quick Restore in ShadowImage.

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For more information about ShadowImage tasks and pair statuses, see the *Hitachi ShadowImage® User Guide*.

> ⚠️ **Caution:** Thin Image uses MU numbers 0 to 1,023, and they are assigned in the order of 3 to 1,023, followed by 0 to 2. ShadowImage uses MU numbers 0 to 2. Thin Image cannot use the MU numbers 0 to 2 if you want to share Thin Image volumes with ShadowImage.
>
> To share Thin Image volumes with ShadowImage if Thin Image is using the MU numbers 0 to 2:
>
> 1. Delete the Thin Image pair of the MU number 0 to 2.
> 2. Create the ShadowImage pairs and Thin Image pairs.

Sharing Thin Image volumes with TrueCopy and Universal Replicator

You can share Thin Image (HTI) P-VOLs with TrueCopy (TC) and Universal Replicator (UR) pair volumes.

The following tables list the relationship between pair tasks and status.

The following table lists the Thin Image tasks you can perform when the P-VOL is shared with a TrueCopy or Universal Replicator P-VOL.

HTI task	TC/UR status					
	COPY	**PAIR**	**PSUS**	**PSUE**	**Suspending**	**Deleting**
Create pair	Yes	Yes	Yes	Yes	Yes	Yes
Store snapshot data	Yes	Yes	Yes	Yes	Yes	Yes
Restore pair	No	No	Yes	Yes	No	No
Delete snapshot data	Yes	Yes	Yes	Yes	Yes	Yes
Delete pair	Yes	Yes	Yes	Yes	Yes	Yes

The following table lists the Thin Image tasks you can perform when the P-VOL is shared with a TrueCopy or Universal Replicator S-VOL.

HTI task	TC/UR status						
	COPY	**PAIR**	**PSUS**	**PSUE**	**SSWS**	**Suspending**	**Deleting**
Create pair	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Store snapshot data	No	Yes	Yes	Yes	Yes	Yes	Yes
Restore pair*	No	No	No	No	No	No	No

HTI task	TC/UR status						
	COPY	**PAIR**	**PSUS**	**PSU E**	**SSWS**	**Suspendin g**	**Deleting**
Delete snapshot data	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Delete pair	Yes	Yes	Yes	Yes	Yes	Yes	Yes
*When restoring an HTI pair and you are using the P-VOL as a TC or UR S-VOL, switch tasks to the remote storage system using the `horctakeover` command.							

The following table lists the TrueCopy/Universal Replicator tasks you can perform when the Thin Image P-VOL is shared with a TrueCopy or Universal Replicator P-VOL.

TC/UR task	HTI status				
	COP Y	**PAIR, PFUL**	**PSUS, PFUS**	**RCPY**	**PSUE**
Create pair	Yes	Yes	Yes	No	Yes
Split pair	Yes	Yes	Yes	N/A	Yes
Resynchronize pair	Yes	Yes	Yes	No	Yes
Delete pair	Yes	Yes	Yes	Yes	Yes
Switch to remote storage	Yes	Yes	Yes	No	Yes

The following table lists the TrueCopy/Universal Replicator tasks you can perform when the Thin Image P-VOL is shared with a TrueCopy or Universal Replicator S-VOL.

TC/UR task	HTI status				
	COPY	**PAIR, PFUL**	**PSUS, PFUS**	**RCPY**	**PSUE**
Create pair	No	No	No	No	No
Split pair	Yes	Yes	Yes	N/A	Yes
Resynchronize pair	Yes	Yes	Yes	N/A	Yes
Delete pair	Yes	Yes	Yes	N/A	Yes
Switch to remote storage	Yes	Yes	Yes	N/A	Yes
*Use a TC/UR S-VOL as an HTI P-VOL.					

Chapter 1: Overview of Thin Image

Volume backup with Thin Image, TrueCopy, and Universal Replicator in a 3DC multitarget configuration workflow

You can use Thin Image to back up TrueCopy and Universal Replicator volumes on the remote sites in a 3DC multitarget configuration.

The following figure shows how to back up the volumes.
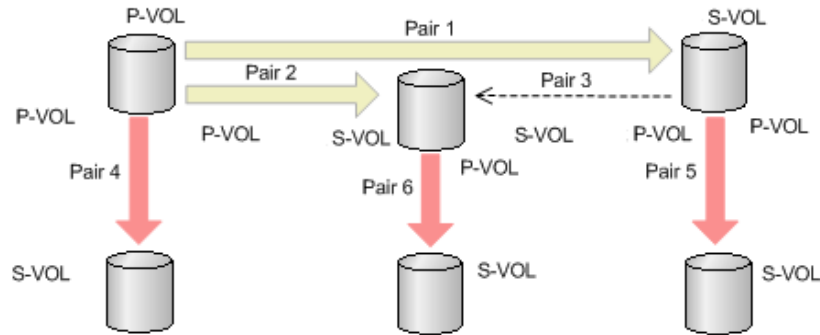
- Pair 1 is a TrueCopy pair.

- Pair 2 is a Universal Replicator pair.

- Pair 3 is a Universal Replicator pair for delta resync.

- Pairs 4, 5, and 6 are Thin Image pairs.

You must create 3DC multitarget and delta resync pairs (pairs 1, 2, and 3) before creating pairs 5 and 6, but pair 4 can be created at any time.

Volume backup with Thin Image and Universal Replicator in a 3DC multitarget configuration workflow

(Virtual Storage Platform 5000 series) You can use Thin Image to back up Universal Replicator volumes on the remote sites in a 3DC multitarget configuration.

The following figure shows how to back up the volumes.
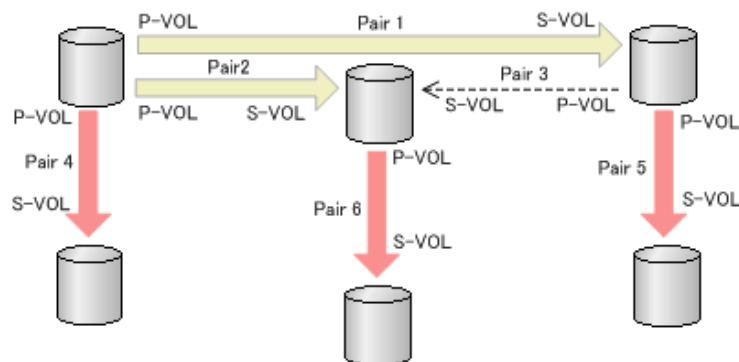
- Pairs 1 and 2 are Universal Replicator pairs.

- Pair 3 is a Universal Replicator pair for delta resync.

- Pairs 4, 5, and 6 are Thin Image pairs.

You must create pairs 1 and 2 before creating pairs 5 and 6, but pair 4 can be created at any time.

Volume backup with Thin Image and Universal Replicator in a 3DC cascade configuration workflow

(Virtual Storage Platform 5000 series) You can use Thin Image to back up Universal Replicator volumes on the remote sites in a 3DC cascade configuration.

The following figure shows how to back up the volumes.
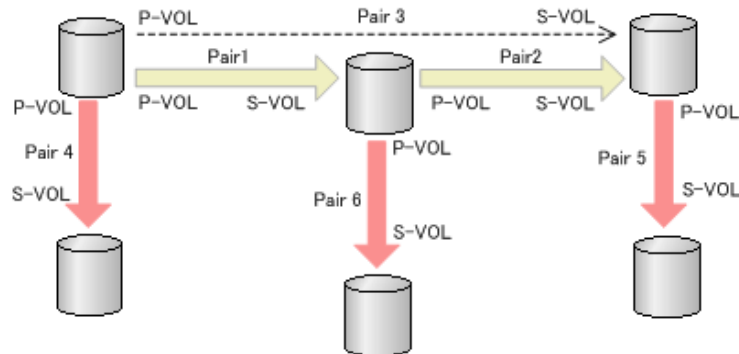
- Pairs 1 and 2 are Universal Replicator pairs.

- Pair 3 is a Universal Replicator pair for delta resync.

- Pairs 4, 5, and 6 are Thin Image pairs.

You must create pairs 1 and 2 before creating pairs 5 and 6, but pair 4 can be created at any time.

Sharing Thin Image volumes with global-active device

You can use a Thin Image (HTI) P-VOL as a global-active device (GAD) P-VOL or S-VOL.

The following tables list the relationship between Thin Image tasks and GAD pair status.

📄 **Note:** If you share GAD volumes with Thin Image volumes, stop I/O to a volume before storing snapshot data. Snapshot consistency cannot be guaranteed if you store snapshot data without stopping I/O to the volume.

For more information about GAD, see the *Global-Active Device User Guide*.

The following table lists the Thin Image tasks you can perform when the P-VOL is shared with a GAD P-VOL.

GAD status	I/O mode	HTI task				
		Create pair	Store snapshot data	Restore pair	Delete snapshot data	Delete pair
COPY	Mirror (RL)	Yes	Yes	No	Yes	Yes
PAIR	Mirror (RL)	Yes	Yes	No	Yes	Yes
PSUS	Local	Yes	Yes	Yes	Yes	Yes
	Block	Yes	Yes	No	Yes	Yes
PSUE	Local	Yes	Yes	Yes	Yes	Yes
	Block	Yes	Yes	No	Yes	Yes

The following table lists the Thin Image tasks you can perform when the P-VOL is shared with a GAD S-VOL.

GAD status	I/O mode	HTI task				
		Create pair	Store snapshot data	Restore pair	Delete snapshot data	Delete pair
COPY	Block	No	No	No	No	Yes
PAIR	Mirror (RL)	Yes	Yes	No	Yes	Yes
SSUS	Block	Yes	Yes	No	Yes	Yes
PSUE	Block	Yes	Yes	No	Yes	Yes
SSWS	Local	Yes	Yes	No	Yes	Yes

Storage system configuration with Thin Image and GAD

Not all storage system configurations are supported when sharing a Thin Image volume with a GAD volume.

When you create a Thin Image pair using a volume from a GAD pair, the server recognizes the GAD P-VOL and S-VOL as a single volume. If you create Thin Image pairs using both the P-VOL and S-VOL of a GAD pair, the server recognizes the GAD P-VOL and S-VOL as a single volume being paired with multiple volumes by Thin Image.

Supported configurations

The following figure shows a supported storage system configuration with a Thin Image pair using a GAD P-VOL.
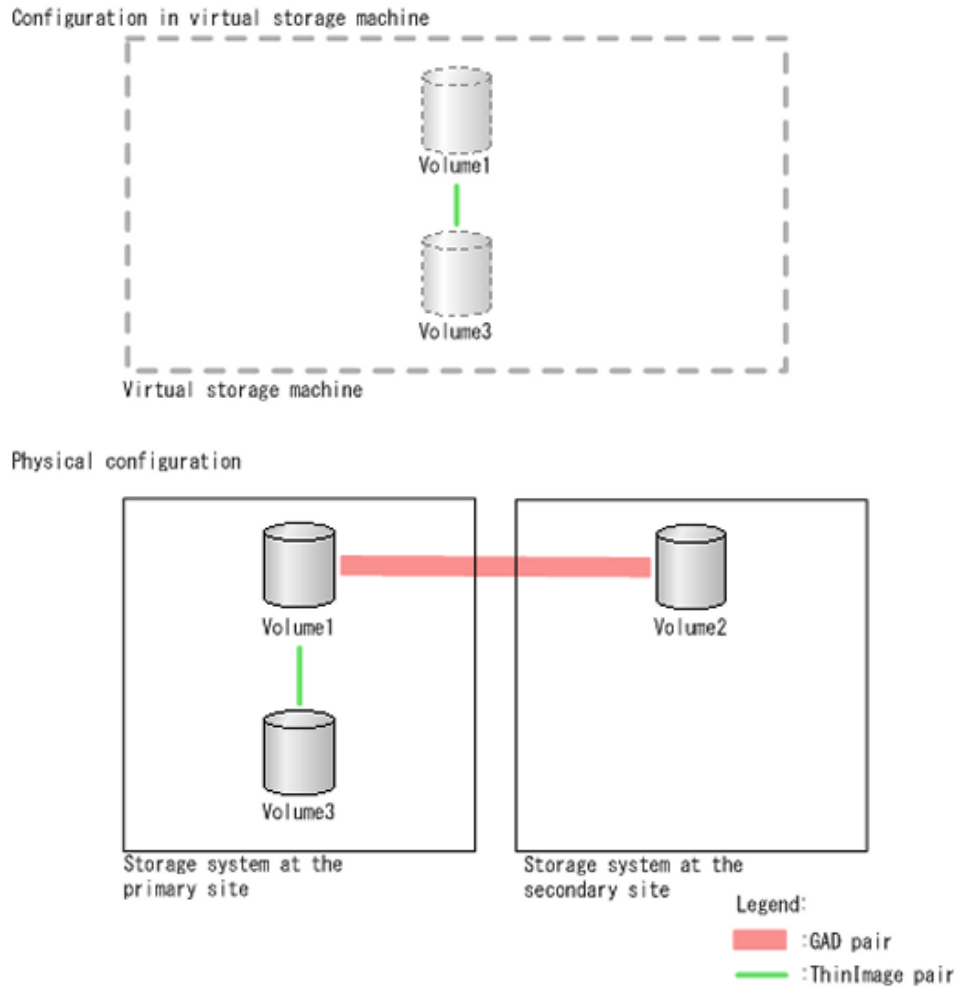
Configuration in virtual storage machine

Volume1

Volume3

Virtual storage machine

Physical configuration

Volume1

Volume3

Volume2

Storage system at the
primary site

Storage system at the
secondary site

Legend:

:GAD pair

:ThinImage pair

The following figure shows a supported storage system configuration with a Thin Image pair using a GAD S-VOL.

Configuration in virtual storage machine

Volume1

Volume3

Virtual storage machine

Physical configuration

Volume1

Volume2

Volume3

Storage system at the primary site

Storage system at the secondary site

Legend:

:GAD pair
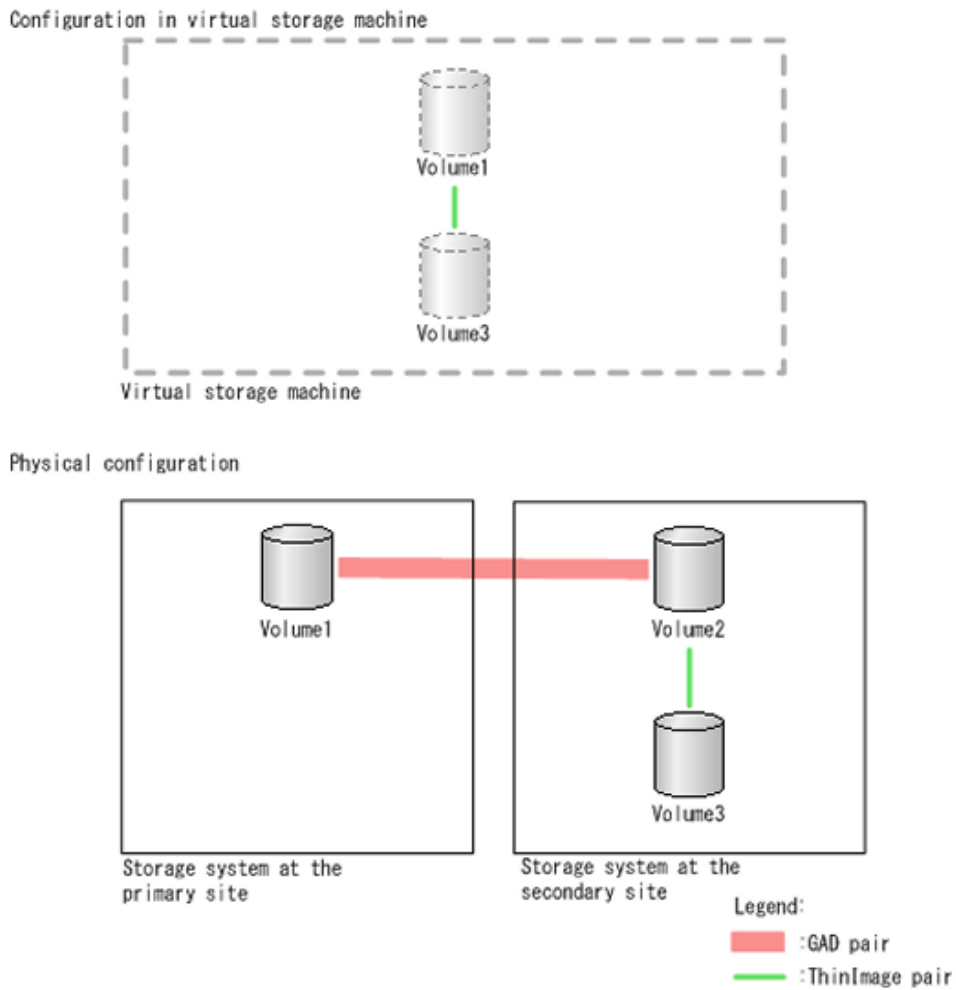
:ThinImage pair

The following figure shows a supported storage system configuration with Thin Image pairs using a GAD P-VOL and S-VOL.

Configuration in virtual storage machine
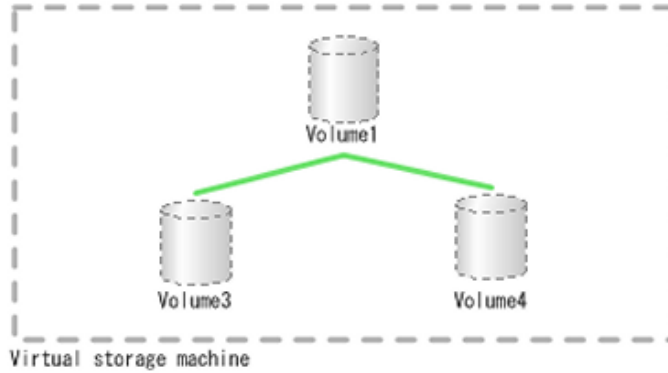
Physical configuration
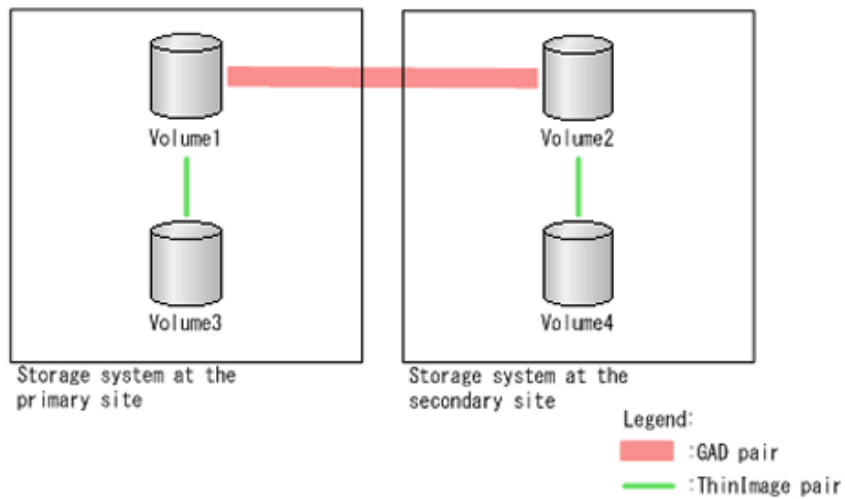
Unsupported configuration

You cannot create a GAD pair using Thin Image volumes that are already being used as a GAD P-VOL and S-VOL. The following figure shows this unsupported storage system configuration.
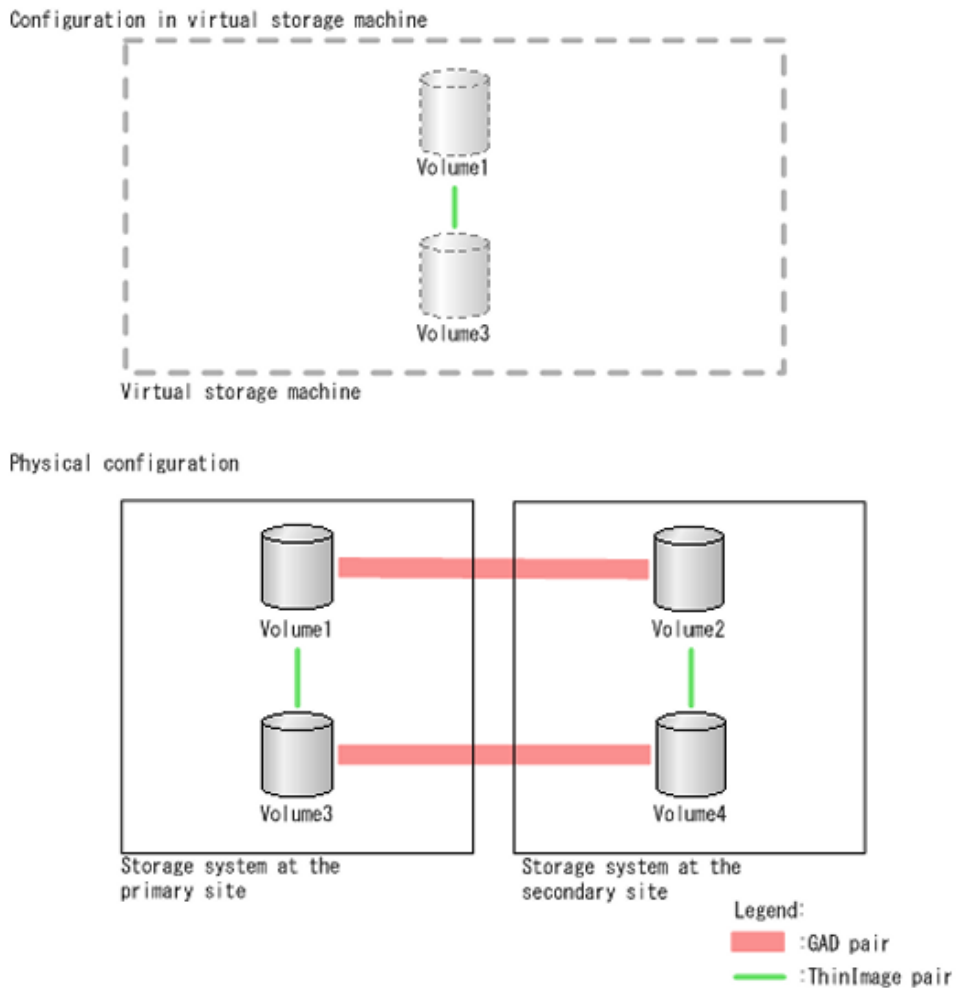
Consistency group configuration with Thin Image and GAD

Not all consistency group configurations are supported when sharing a Thin Image volume with a GAD volume.

Pairs in a Thin Image consistency group must be in the same storage system. Therefore, if a GAD P-VOL and S-VOL are each used in Thin Image pairs, the Thin Image pairs cannot be registered to the same consistency group.

Supported configuration

The following figure shows a supported consistency group configuration.

Configuration in virtual storage machine
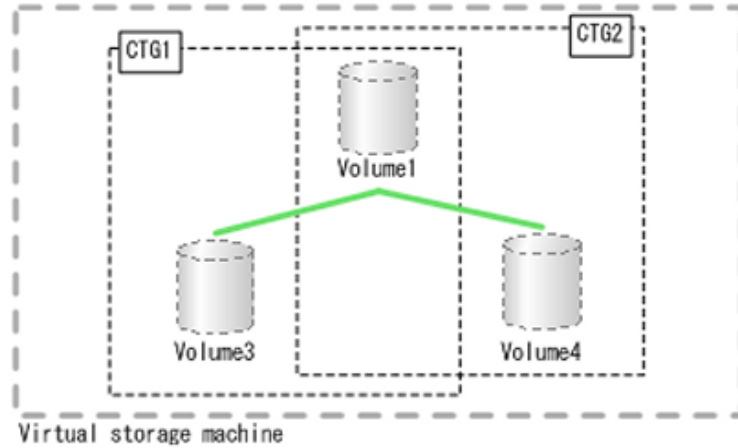
Physical configuration
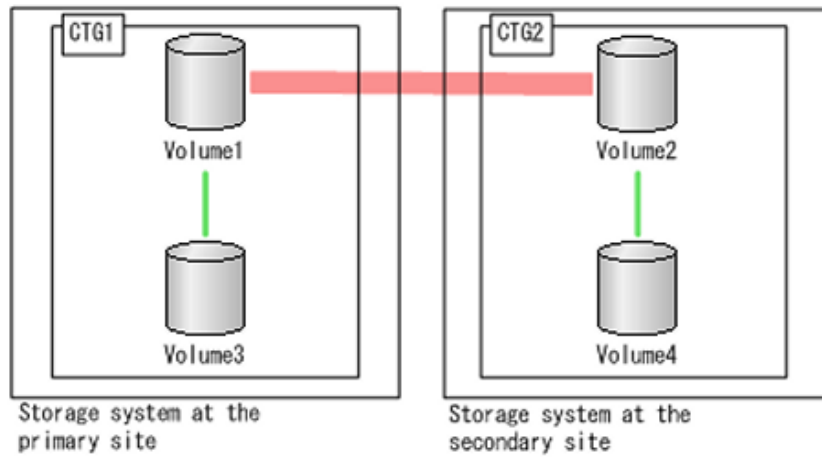
Legend:
- :GAD pair
- :ThinImage pair
- CTG :Consistency group

Unsupported configuration

The following figure shows an unsupported consistency group configuration.

Configuration in virtual storage machine
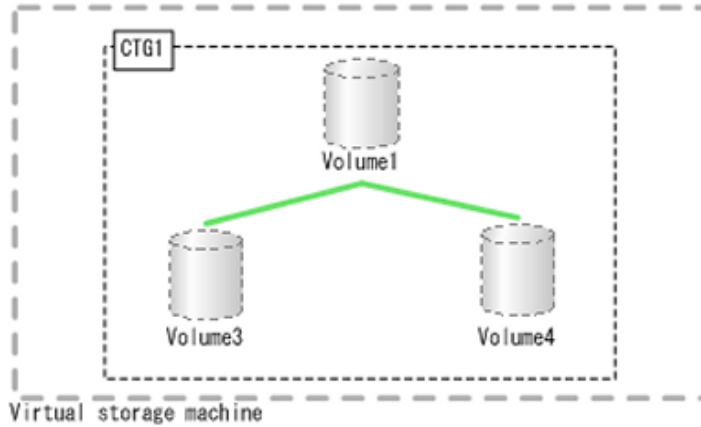
Physical configuration
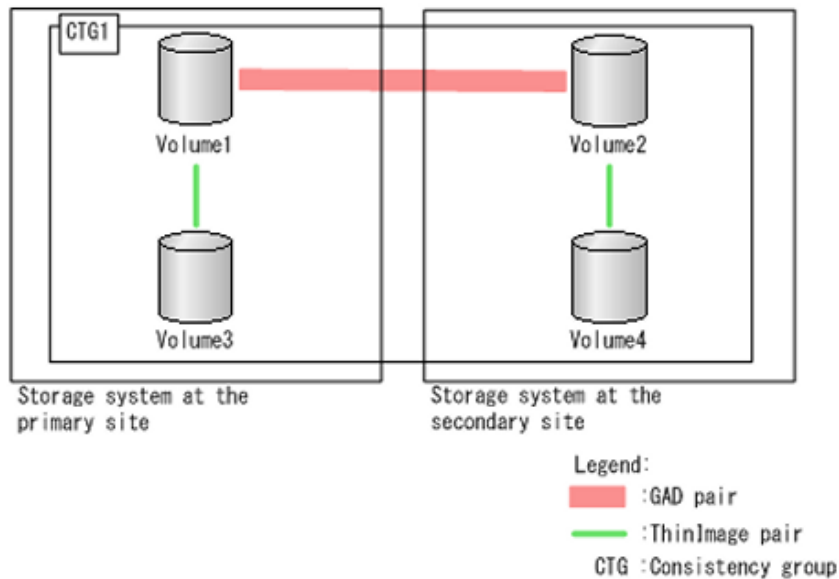
Snapshot group configuration with Thin Image and GAD

Not all snapshot group configurations are supported when sharing a Thin Image volume with a GAD volume.

Pairs in a Thin Image snapshot group must be in the same storage system. Therefore, if a GAD P-VOL and S-VOL are each used in Thin Image pairs, the Thin Image pairs cannot be registered to the same snapshot group.

Supported configuration

The following figure shows a supported snapshot group configuration.
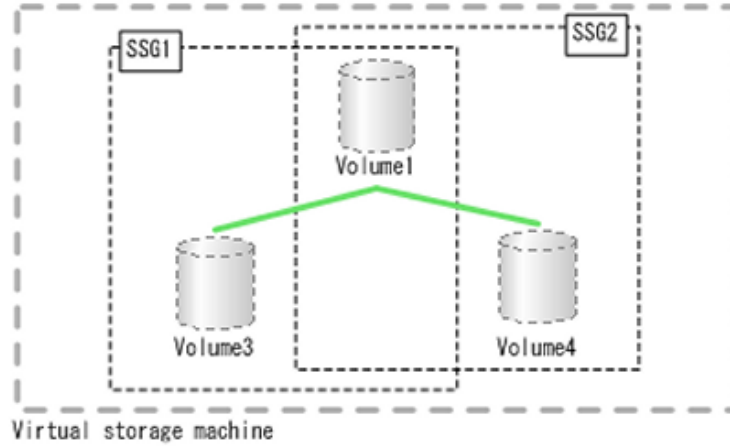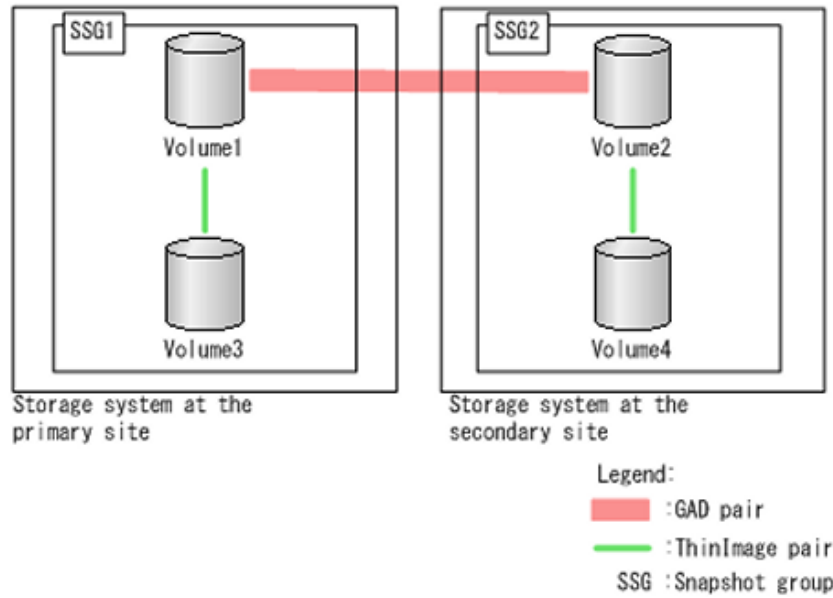
Unsupported configuration

The following figure shows an unsupported snapshot group configuration.

Configuration in virtual storage machine

SSG1

Volume1

Volume3   Volume4

Virtual storage machine

Physical configuration

SSG1

Volume1   Volume2

Volume3   Volume4

Storage system at the   Storage system at the
primary site   secondary site

Legend:

▬▬▬ :GAD pair

───── :ThinImage pair

SSG :Snapshot group
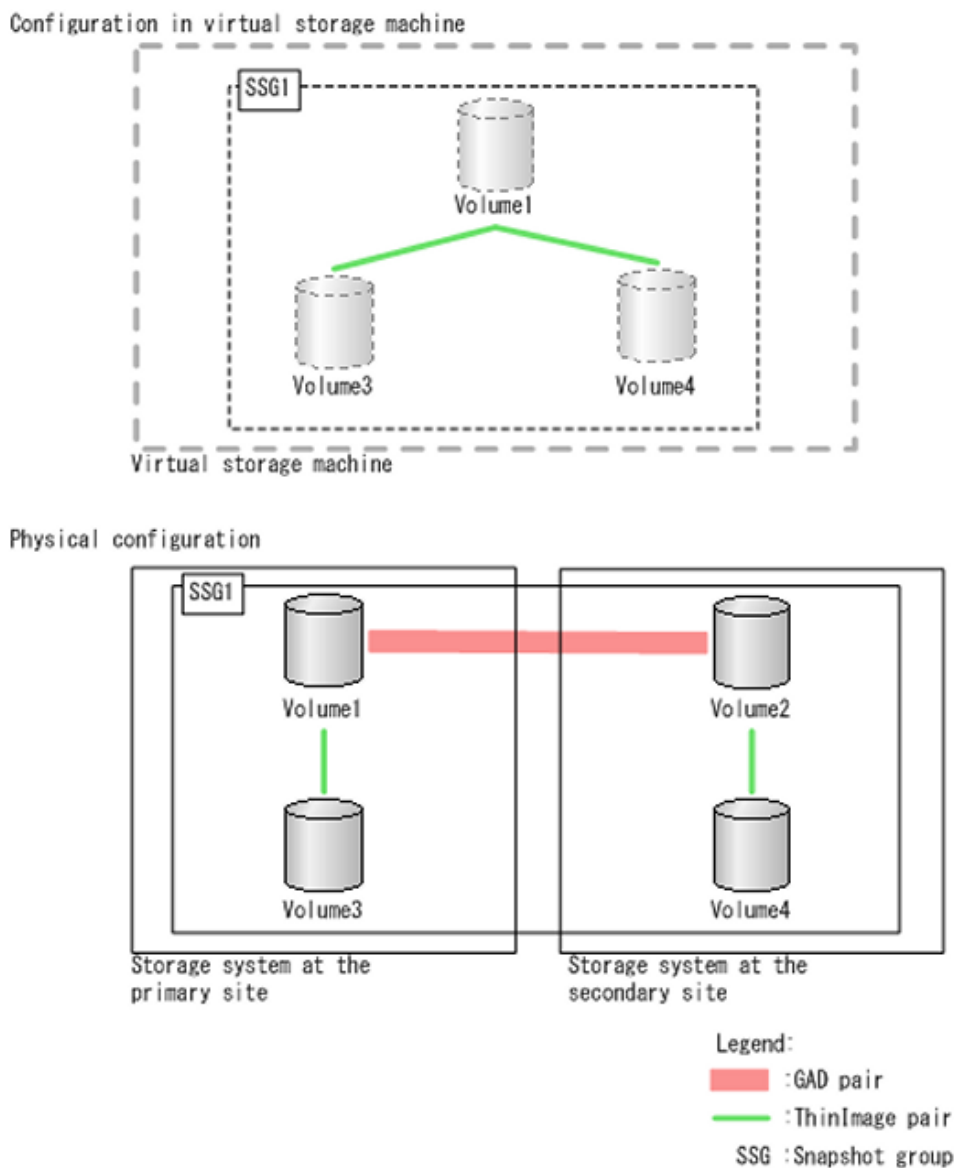
Sharing Thin Image volumes with Dynamic Provisioning and Dynamic Provisioning for Mainframe in a single storage system

If you are using Thin Image, Dynamic Provisioning, and Dynamic Provisioning for Mainframe in a single storage system, note the following when creating Thin Image pairs:

- (VSP 5000 series) Data compressed or deduplicated by the capacity saving function is copied to a volume after compression and deduplication are released. The capacity saving function is not performed immediately for copied data. Before creating or resynchronizing a Thin Image pair, verify that the available capacity in the copy destination volume is greater than the used capacity in the copy origination volume. For details, see the *Provisioning Guide for Open Systems*.

- If you create a Thin Image pair using a volume with the capacity saving function enabled, the compressed or deduplicated data is copied. Because of this, copy or I/O performance may be degraded.

- When the capacity saving function is used, management information is stored in a pool. As a result, there may be difference between a P-VOL and an S-VOL in the number of used pages or licensed capacity.

- The capacity saving function can be set on the P-VOL or S-VOL of a cascaded or clone pair, but only works on the clone pair. The deduplication system data volume cannot be used as a Thin Image P-VOL or S-VOL.

- You can create a Thin Image pair whose P-VOL or S-VOL is a Dynamic Provisioning V-VOL only if you are not currently expanding the Dynamic Provisioning V-VOL capacity.

- Performing a Thin Image paircreate operation while zero pages are being reclaimed (including reclamation by WriteSame, Unmap command, or rebalancing) results in the zero-page operation being interrupted.

- When the WriteSame or Unmap command is issued to the P-VOL or the S-VOL for a Thin Image pair, zero pages are not reclaimed by the command.

- If the Unmap command is issued to the Thin Image virtual volume, the command ends abnormally.

- Thin Image pair creation might be rejected if the Unmap command operation is in progress with system option mode 905 ON. Wait a while and then retry the operation. If the operation still fails, set system option mode 905 to OFF and try again.

- You can use a maximum size Dynamic Provisioning volume as a Thin Image P-VOL or S-VOL. For information about the maximum size for Dynamic Provisioning volumes, see the *Provisioning Guide* for your storage system.

- For details about whether zero pages can be reclaimed when you specify Thin Image P-VOLs or Thin Image S-VOLs on Device Manager - Storage Navigator or Command Control Interface, see the the *Provisioning Guide* for your storage system.

Sharing Thin Image volumes with Resource Partition Manager

You can create a Thin Image pair without regards to the resource group assignment of the P-VOL and S-VOLs. You must assign the pool you are using to the resource group where the P-VOL is assigned or to a resource group where you can create Thin Image pairs.

For more information about resource groups, see the *Provisioning Guide* for your storage system.

Chapter 1: Overview of Thin Image

Chapter 2: Thin Image system and planning requirements

Before you start working with Thin Image, review the requirements associated with licensed capacity, shared memory, volume, data pool, and for general planning and management tasks.

Thin Image system requirements

The following are requirements for completing Thin Image tasks:

- Dynamic Provisioning. The Dynamic Provisioning software is a prerequisite for Thin Image. On the License Keys window, verify that the Dynamic Provisioning license is installed.

- Thin Image. On the License Keys window, verify that the Thin Image license is installed. If it is not installed, install it. For details, see the *System Administrator Guide* for your storage system.

Thin Image licensed capacity requirements

Thin Image requires licensed capacity for the Thin Image P-VOLs and pools.

Thin Image uses a portion of the Dynamic Provisioning licensed capacity for its pool capacity. Make sure you have enough Dynamic Provisioning licensed capacity to run both HDP and Thin Image. Use the maintenance utility to ensure that the license key for the Dynamic Provisioning program product is installed.

There are some licensing differences when using separate HDP and Thin Image pools compared to using a single, mixed pool. In the following examples, the total capacity is 20 TB and an estimated 3 TB is needed for Thin Image data.

In the case of separate pools of 17 TB for the HDP pool and 3 TB for the Thin Image pool, the license capacities are as follows:

- HDP licensed capacity: 17 TB + 3 TB = 20 TB

- Thin Image license capacity: 3 TB + Total P-VOL capacity (see note)

In the case of a mixed 20 TB pool, the license capacities are as follows:

- HDP licensed capacity: 20 TB

- Thin Image license capacity: 20 TB + Total P-VOL capacity (see note)

> **Note:**
>
> - For thin provisioned volumes the occupied pool space is used for this calculation.
>
> - For compressed P-VOLs the original size is used in this calculation, not the compressed size.
>
> - Where multiple Thin Image snapshots are created from a single P-VOL, the capacity is only counted once for licensing.

The following table shows the Thin Image volumes and capacity calculated as the Thin Image usage. The total amount of these values must not exceed the Thin Image licensed capacity.

Intended volumes			
Software application	**Volume type**	**Normal volume or DP-VOL**	**Intended capacity**
HTI	P-VOL	Normal volume	The volume capacity
		DP-VOL	The pool capacity used by the volume[1]
	Pool-VOL	Normal volume	- Thin Image pool: volume capacity - DP pool: volume capacity[2]
Notes:			
1. For the volume with capacity saving enabled, HTI licensed capacity is the data capacity before saving.			
2. Not including the volumes of pools which are not in use by Thin Image pairs.			

If the available licensed capacity is exceeded, regardless of whether a normal volume or a DP-VOL is used, the following restrictions apply to the pair operations:

- The pair with the available licensed capacity exceeded cannot be created.

- Pair creation cannot be performed.

- Thirty days after the licensed capacity is exceeded, pair creation, pair split, and pair resync operations cannot be performed.

For more information about licenses, see the *System Administrator Guide* for your storage system.

Thin Image shared memory requirements

Thin Image requires dedicated shared memory (SM) for the Thin Image pair management area.

The Thin Image pair management area is an area used to store information for associating Thin Image pairs. It is automatically created when you install shared memory.

Additional shared memory is required when the total capacity of all pools exceeds 4.4 PB.

The following table shows the shared memory requirements:

Table 1 Shared memory requirements (VSP 5000 series)

Shared memory function	Maximum pool or V-VOL capacity
Base	4.4 PB
Extension1	8.05 PB
Extension2	12.5 PB
Extension3	16.6 PB

Table 2 Shared memory requirements (VSP E series)

Shared memory function	Maximum pool or V-VOL capacity			
	VSP E1090	VSP E990	VSP E790	VSP E590
Base	4.4 PB	4.4 PB	4.4 PB	4.4 PB
Extention1	8.05 PB	8.05 PB	8.05 PB	8.05 PB
Extention2	12.5 PB	12.5 PB	12.5 PB	Not applicable
Extention3	16.6 PB	16.6 PB	Not applicable	Not applicable
Extention4	16.6 PB	Not applicable	Not applicable	Not applicable

When Dynamic Provisioning, Dynamic Tiering, active flash, Thin Image, and deduplication and compression are used, the capacity of a pool or V-VOL that can be created is also expanded when you add shared memory, depending on how much shared memory added.

You can reduce or remove shared memory when pools for Dynamic Provisioning, Dynamic Tiering, active flash, and Thin Image have been deleted.

For more information about how to expand, reduce, or remove shared memory, contact customer support.

Thin Image volume requirements

Thin Image operations require the following three types of volumes:

- P-VOLs: Contain the original data

- S-VOLs: Contain the snapshot of the original data in the associated P-VOL

- Pool-VOLs: Pool volumes that make up Thin Image pools.

📄 **Note:** The term "Pool VOLs" refers to Thin Image pool volumes. For information about DP pool volumes, see the *Provisioning Guide* for your storage system.

The following table lists the requirements for Thin Image P-VOLs.

Item	Requirement or specification
Volume type	Logical volumes (LDEVs). You cannot specify the following volumes as HTI P-VOLs: - Pool-VOLs - HTI S-VOLs - Volumes belonging to a parity group with accelerated compression enabled For more information about creating pairs using other software applications, see <u>Sharing Thin Image volumes with other software applications (on page 44)</u>.
Emulation type	OPEN-V
Path definitions	Required. The LU path definitions or a namespace on the NVM subsystem with an NVM subsystem port added for NVMe must be defined. Not required for cascaded pairs and pairs with the clone attribute.
Volume capacity limit	256 TB
Maximum number of cascades	64 layers (L64). For each primary volume, 1,024 S-VOLs can be used.
Maximum number of clones	1,024 (for a P-VOL). When storing snapshot data, this number includes the number of snapshots. Maximum number of layers for cloning: 3 (L1 to L3).

Item	Requirement or specification
Mixture of pair types	A pair with the cascade attribute enabled and a pair with the cascade attribute disabled cannot share a P-VOL. A pair with the cascade attribute disabled and a pair with clone attribute cannot share a P-VOL. A pair with the cascade attribute enabled and a pair with the clone attribute can share a P-VOL.

You can create a Thin Image pair with or without an S-VOL. The following table lists the requirements for Thin Image S-VOLs.

Item	Requirement
Volume type	Thin Image V-VOL (V-VOLs of provisioning type Snapshot in HDvM - SN or V-VOL for the `raidcom add ldev -pool snap` command in CCI) or DP-VOL. You cannot specify the following volumes as HTI S-VOLs: ▪ Volumes that are already used as S-VOLs. ▪ Volumes that other software applications are using for pairs or migration plans. ▪ Deduplication system data volume.
Emulation type	OPEN-V
Path definitions	Required. The LU path definitions or a namespace on the NVM subsystem with an NVM subsystem port added for NVMe must be defined. Not required for cascaded pairs and pairs with the clone attribute.

The following table lists the requirements for Thin Image pool-VOLs.

Item	Requirement
Volume type	Logical volumes (LDEVs).

Chapter 2: Thin Image system and planning requirements

Item	Requirement
	To maintain performance levels, use the following configurations: ▪ Place normal volumes and pool-VOLs in separate parity groups (see <u>Thin Image licensed capacity requirements (on page 66)</u>). ▪ Ensure that pool-VOLs consist of LDEVs from more than one parity group. You cannot specify the following volumes as HTI pool-VOLs: ▪ LDEV whose LDEV status in HDvM - SN is other than Normal, Correction Access, or Copying. In CCI, use the `raidcom get ldev` command to check the volume type. ▪ Volumes that are already being used as HTI P-VOL or S-VOLs. ▪ Volumes that are already contained in HTI, HDP, HDT, or active flash pools. ▪ Volumes used as migration plans or pair volumes for another product. ▪ Volumes for which you have used the Data Retention Utility to set Read Only, Protect, or S-VOL Disable attributes. ▪ Command device volumes. ▪ GAD volumes with the reservation attribute. ▪ GAD volumes for quorum disks. ▪ External volumes with the Data Direct Mapping attribute. ▪ DP-VOLs with the Data Direct Mapping attribute. **Note:** The following restrictions apply to volumes used in the same data pool: ▪ Volumes must be in the same resource group. ▪ External pool-VOLs must have the same cache mode, either enabled or disabled. ▪ When using both internal and external volumes, the external volumes must have cache mode enabled.
Emulation type	OPEN-V
RAID level	All RAID levels that can be used for DP pool volumes are supported. For details, see the *Provisioning Guide* for your storage system.
Data drive type	You can use SSD, FMD, and HDD.*

Chapter 2: Thin Image system and planning requirements

Item	Requirement
	Regardless of the type of the volume (internal volume or external volume), you can use pool-VOLs with different drive types in the same pool. For best performance, use pool-VOLs with the same drive type in the same pool. For more information about the data drive type, see Pool creation and data drive type priority (on page 109). 📄 **Note:** You cannot use a volume created on an SCM drive as a pool volume.
CLPR	Registering pool-VOLs to Cache Logical Partition Numbers (CLPRs) in pools: You can register pool-VOLs assigned to different CLPRs in a pool. Changing CLPRs: You can change CLPRs in the parity group belonging to the pool-VOL. In this case, regardless of the CLPR in the pool-VOL, the CLPR ID in the parity must be the same as that of the P-VOL that you are using.
Pool limit	1,024
Volume capacity	8 GB to 4 TB
Path definition	A volume on which an unnecessary path is defined or a volume that is assigned to a namespace for NVMe cannot be specified as a pool-VOL.
*SSD contains SLC and MLC.	

Thin Image data pool requirements

The following table lists the pool types that can be used as a pool when creating Thin Image pairs.

Item	Requirement
Pool type	Thin Image pool or HDP pool can be used. However, the following pools cannot be specified: • The pool for which Hitachi Dynamic Tiering or active flash is enabled. • The pool used for Dynamic Provisioning for Mainframe. • The pool for which the Data Direct Mapping attribute is enabled.

The following table lists the requirements for Thin Image data pools.

Item	Requirement
Pool capacity	Calculate the pool capacity (see <u>Calculating and assigning pool capacity (on page 81)</u>). The maximum total capacity of pools in a storage system depends on the storage system model: • VSP 5000 series: 12.3 PB (if Extension1, Extension2, or Extension3 is added in the shared memory capacity). • VSP E990, VSP E1090: 16.6 PB • VSP E790: 12.5 PB • VSP E590: 8.05 PB The maximum pool capacity that can be used for each Thin Image P-VOL is 768 TB.
Pool-VOL limit per pool	1,024 **Note:** You cannot assign a volume that is already assigned to a pool as a pool-VOL to another pool.

Pool limit per storage system	• VSP 5000 series: 128
	
	  Pool IDs are assigned from 0 to 127.
	
	• VSP E990, VSP E1090: 128
	
	  Pool IDs are assigned from 0 to 127.

Item	Requirement
	▪ VSP E790: 64 Pool IDs are assigned from 0 to 63. ▪ VSP E590: 64 Pool IDs are assigned from 0 to 63. This can include HDP (including HDT and active flash), HDPz (including HDTz and active flash for mainframe), and HTI pool types.
Increasing capacity	Dynamically increase the pool-VOL capacity. To do this, increase the capacity for at least one parity group.
Decreasing pool capacity	Use the following workflow to decrease pool capacity: 1. Delete the pool-VOLs (see Decreasing pool capacity (on page 175)). 2. Reconfigure the pool (see Creating Thin Image data pools (on page 105)).
Deleting pools	The pool is not used by an HTI pair. For more information about deleting pools, see Deleting pools (on page 185).
Data pool warning threshold	Value: *Warning Threshold* Range: 20 - 95%, in 1% increments. Default: 80% **Note:** If you exceed the data pool warning threshold, a warning is issued through a service information message (SIM) and an SNMP trap reporting excessive pool usage. For more information: ▪ About editing the data pool warning threshold, see Editing the data pool warning threshold (on page 179). ▪ About checking alerts and checking the details of a SIM, see the *System Administrator Guide* for your storage system. ▪ About SNMP traps, see the *Hitachi Alert Notification Guide*.

Thin Image consistency group requirements

The attributes of Thin Image consistency groups, such as the pair limit and pair type, have usage requirements. Review these requirements before creating consistency groups.

Item	Requirement
Consistency group ID	Value: 0 to 2,047 With SI, SIz, and HTI, you can create up to 2,048 consistency groups in VSP 5000 series storage. Manual assignment of a consistency group ID to an HTI pair using the `paircreate` command: ▪ Specify a consistency group ID from 0 to 255. Automatic assignment of a consistency group ID to an HTI pair using the `paircreate` or `raidcom add snapshot` commands: ▪ Using the `paircreate` command, if a number is not specified, an unassigned number from 0 to 255 is automatically assigned.[1] ▪ Using the `raidcom add snapshot` command, if a number is not specified, an unassigned number from 0 to 2,047 is automatically assigned.[2] Consistency group ID is displayed in the following windows in HDvM - SN: ▪ **Consistency Groups** tab in **Local Replication** window. ▪ **Consistency Group Properties** window. ▪ In CCI, use the `raidcom get snapshot` command to view the consistency group ID.
Pair limit	8,192 pairs per consistency group.
Pair type	SI, SIz, and Thin Image pairs cannot be contained in a single consistency group. For Thin Image consistency groups, only Thin Image pairs can be defined in a group. Snapshot and cloned pairs cannot be contained in a single consistency group.

Notes:

1. Thin Image assigns a number in ascending order from 0 to 255.
2. ShadowImage uses numbers from 0 to 127. Because of this, Thin Image assigns an unassigned number from 128 to 2,047 first. If there is no unassigned number from 128 to 2,047, then Thin Image assigns an unassigned number from 0 to 127.

Consistency group restrictions:

- Thin Image pairs that share P-VOLs or are in higher and lower layers of a snapshot tree cannot be defined in the same consistency group. If they are defined in the same consistency group, the `raidcom add snapshot` command is rejected.

- Do not place pairs that are not in consistency groups, in a group defined by the CCI configuration definition file. If these pairs are in the same group, the `pairsplit` command may terminate and the snapshot data may not be the P-VOL data generated when a storage system received the `pairsplit` command.

- Only one consistency group can be specified for a group defined in the CCI configuration definition file.

- When a pair for which a consistency group is specified and is already created, if you specify another consistency group to create a pair, the pair is added to the same consistency group.

- To specify multiple consistency groups, use the CCI configuration definition file to define the same number of groups as the consistency groups you want to specify.

Thin Image snapshot group requirements

The following table outlines the requirements for working with Thin Image snapshot groups.

Item	Requirement
Name	Character limit: 32. You can change snapshot group names using CCI commands. For details about CCI commands, see Appendix A (on page 219) and the *Command Control Interface Installation and Configuration Guide*.
Group and HTI pair limit	- Snapshot groups per storage system: 2,048. - HTI pairs per snapshot group: 8,192.
Pair type	Snapshot and cloned pairs cannot be contained in a single snapshot group.

Restrictions for Snapshot groups:

- When creating a Thin Image cascaded pair with the CTG mode specified using CCI, a volume belonging to the snapshot group and the following volumes cannot be contained in the same snapshot group:

  - The P-VOL or S-VOL of a volume belonging to the snapshot group

  - A volume that uses the same P-VOL with a different MU number as the volume belonging to the snapshot group

Thin Image planning requirements

You must calculate the number of Thin Image pairs you can create.

When you create Thin Image pairs for a P-VOL for the first time, the number of pairs that you can create in a storage system depends on several variables.

- The number of Thin Image pairs that you can create based on the number of available pair tables.

- The snapshot estimated manageable capacity.

- The number of cache management devices that you must make available.

The smallest of the three calculations is the maximum number of Thin Image pairs that you can create in the storage system.

When you create Thin Image pairs again, you only need to know the number of pair tables to calculate the number of pairs that you can create. You do not need to know the snapshot estimated manageable capacity or the number of cache management devices.

If you have multiple P-VOLs, calculate the number of Thin Image pairs that you can create for each P-VOL in the storage system.

Calculating the number of Thin Image pairs based on pair tables

Pair tables contain information that is required to manage HTI pairs. Each HTI pair requires one pair table. The maximum number of pair tables is the maximum number of pairs that can be used in a storage system.

The number of HTI pairs that you can create is *maximum-number-of-pair-tables-per-storage-system - number-of-existing-pairs*.

Maximum number of pair tables:

- VSP E series: 1,048,575

- VSP 5000 series: 1,048,575

To view the number of existing HTI pairs in HDvM - SN, use the Local Replication window. In CCI, use the `raidcom get snapshot` command. For details, see .

Calculating Thin Image pairs based on the snapshot estimated manageable capacity

You can calculate the number of HTI pairs you can create based on the snapshot estimated manageable capacity.

To view the snapshot estimated manageable capacity in HDvM - SN, see Viewing local replication summary information (on page 155).

Calculate the number of HTI pairs that you can create using the following formulas, where SM refers to shared memory:

```
Number of HTI pairs that you can create =
Snapshot estimated manageable capacity / Snapshot management capacity in a P-VOL
```

```
Snapshot estimated manageable capacity in a P-VOL [GB] =
(P-VOL capacity of HTI pairs [TB] / 2.6) * 3,024 + (168 * 2 (consumed shared memory
[GB]))
```

Calculating Thin Image pairs based on cache management devices

Cache management devices are the unit for controlling the cache in association with logical volumes (LDEVs). They are required to perform HTI tasks, such as creating HTI pairs for a volume.

To view the number of cache management devices in HDvM - SN, see Viewing the number of cache management devices (on page 168).

Use the following formula to calculate the number of HTI pairs that you can create based on the number of cache management devices:

```
Number of HTI pairs that you can create =
Number of cache management devices / ceil (the P-VOL capacity of HTI pairs [TB]) /
2.6)
```

Calculating the number of cache management devices

You can calculate the number of cache management devices you must reserve to initially create a Thin Image pair for a volume.

For Virtual Storage Platform 5000 series, 8,192 cache management devices are required to create TI pools in a system for the first time. For details about the number of cache management devices required for creating HDP pools, see the *Provisioning Guide*. Thin Image must reserve 4,096 cache management devices out of 8,192. When you create Thin Image pairs in volumes for the first time, confirm that at least 4,097 cache management devices are reserved. If the number is less than 4,097, pairs might not be created.

For VSP E series, the system can use 65,536 cache management devices.

Use the following formula:

```
Number of cache management devices that you must reserve =
ceil (Size of P-VOL [TB] / 2.6)
```

If the amount of pool usage for the P-VOL exceeds 70 percent of the total capacity of the cache management devices reserved for the P-VOL, you must reserve another cache management device. You can reserve a maximum of 256 cache management devices for each P-VOL.

Calculating the Thin Image pair capacity for DP pools

For the Virtual Storage Platform 5000 series, when creating a DP pool, you can set the subscription limit of the V-VOL capacity against the pool capacity. For details about the subscription limit, see the *Provisioning Guide* for your storage system.

When storing snapshot data in a DP pool, set the subscription limit of the V-VOL capacity against the DP pool by calculating the V-VOL capacity of a Thin Image pair (Thin Image pair capacity) using the following formula.

```
Thin Image pair capacity = Σ↑(P-VOL capacity (MB)
× Number of pairs × 2 ÷ 42 (MB))↑ × 42 (MB) + Σ↑(P-VOL capacity (MB) × Number of
pairs
× 2 ÷ 2,921,688 (MB))↑ × 175,434 (MB)
```

Decimal places of the value enclosed by arrows (↑*value*↑) are rounded up.

As for *Number of pairs* in the formula, allocated pages are not released if you delete pairs. Because of this, use the maximum number of TI pairs you want to create in the applicable snapshot tree as *Number of pairs* instead of using the number of pairs currently created in the applicable snapshot tree.

If a pair or snapshot data is deleted, allocated pages are not released. As a result, if you delete pairs or snapshot data, the TI pair capacity is not decreased. To decrease the TI pair capacity by releasing allocated pages, you must delete all TI pairs and snapshot data created in the applicable snapshot tree.

The following example illustrates how the TI pair capacity is calculated.
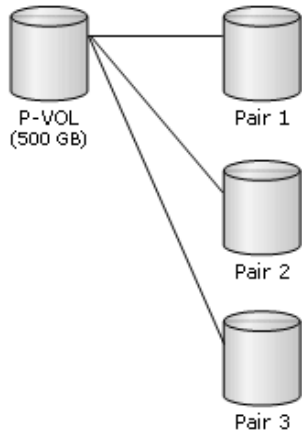
When you create three TI pairs using the 500 GB (500 x 1024 MB) volume as the P-VOL, the TI pair capacity is calculated as follows:

```
↑(500 × 1,024 × 3 × 2 ÷ 42)↑ × 42 + ↑(500 × 1,024 × 3 × 2 ÷ 2,921,688)↑
× 175,434 = 3,422,874 (MB)
```
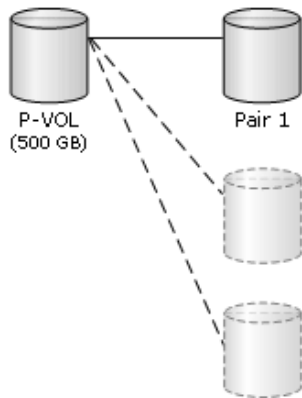

Afterward, if you delete two pairs, the maximum number of TI pairs you can create in the applicable snapshot tree is the same: The TI pair capacity does not change.
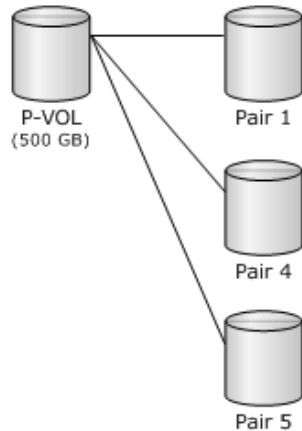
Also, if you you split pairs twice, the maximum number of TI pairs you can create in the snapshot tree is the same, and the TI pair capacity remains unchanged.

Thin Image cache management device requirements

The following table shows the cache management device requirements for performing Thin Image tasks.

For information about DP tasks, see the *Provisioning Guide* for your storage system.

Task	Number of cache management devices required
Initially create an HTI pool. (VSP 5000 series)	8,192* *HTI assigns 4,096 of the 8,192 devices that are available.
Create a volume.	1
Create a P-VOL.	256
Initially create an HTI pair for a volume. (VSP 5000 series)	4,097

The number of cache management devices that can be used in a system for each model is as follows:

- VSP 5000 series: 65,280
- VSP E series: 65,536

Calculating and assigning pool capacity

Use these formulas to calculate and assign pool capacity.

Use the following formula to calculate the capacity of the snapshot data that you can store in the Thin Image pool:

```
Capacity of the snapshot data that you can store in the pool =
Total capacity of pool-VOLs in the pool - Capacity of V-VOL management areas
```

The capacity of V-VOL management areas is 3% of the pool capacity.

> **Note:** The capacity of V-VOL management areas varies depending on the P-VOL capacity and the number of pairs. Use the following formula to calculate the capacity of V-VOL management areas for each P-VOL of a Thin Image pair. To calculate the capacities of V-VOL management areas for all Thin Image pairs, add up the capacity calculated for each P-VOL.
>
> ```
> Capacity of V-VOL management areas for each P-VOL (MB) = (4 + ceiling ((2
> × Updated volume type × Number of pairs + 64) × (Volume capacity (MB) ÷
> 3145728 (MB))))× 42
> ```
>
> Details:
>
> Updated volume type: Set to 1 or 2 depending on the volumes to be updated:
>
> - Set to 1 if only P-VOLs are updated.
> - Set to 1 if only S-VOLs are updated.
> - Set to 2 if both P-VOLs and S-VOLs are updated.
>
> Number of pairs: Number of the S-VOLs for each P-VOL
>
> Volume capacity: P-VOL capacity (MB)
>
> Ceiling: The value enclosed in ceiling( ) must be rounded up to the nearest whole number.

Use the following formula to calculate the capacity of the snapshot data that you can store in the DP pool:

```
Capacity of the snapshot data that you can store in the pool =
Total capacity of pool-VOLs in the pool - (Capacity of pool VOLs used by DP-VOLs +
Capacity of V-VOL management areas)
```

Use the following formula to calculate the pool capacity:

```
Capacity of the pool [MB] =
Total number of pages * 42 - 4200
```

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Use the following formula to calculate the total number of pages:

```
Total number of pages =
Sigma (floor (floor (pool-VOL number of blocks / 512) / 168)) for each pool-VOL
```

floor( ): Truncates the value calculated from the formula in parentheses after the decimal point.

Estimate pool-VOL capacity in multiples of 42 MB. Specifying a pool-VOL capacity in other multiples less than 42 MB truncates the fraction.

Resolving insufficient pool capacity

Make sure you have sufficient pool capacity. If the pool capacity is insufficient, the storage system can suspend Thin Image pairs ("PSUE" status).

> **Note:** When the setting, Suspend TI pairs when depletion threshold is exceeded, is set to Yes in HDvM - SN or in CCI by uisng the command, `raidcom modify pool -suspend_tipair <yes>` for a DP pool, the status of TI pairs using the pool might change to PSUE if the depletion threshold is exceeded. When it is set to No in HDvM - SN or in CCI by uisng the command, `raidcom modify pool -suspend_tipair <no>` for a TI pool or a DP pool, the status of TI pairs using the pool might change to PSUE if the pool becomes full.

Procedure

1. Estimate the capacity of snapshot data to be copied to the pool.

   If the capacity of snapshot data to be copied to the pool varies hour by hour, ensure that the largest capacity is your pool capacity.
2. Assign the pool capacity based on the estimate.

Pool capacity calculations

You can calculate the required pool capacity by estimating the capacity of snapshot data to be copied.

Use the following formula:

```
Capacity of snapshot data to be copied =
Capacity of data written to the same area in the P-VOL during the period from when
snapshot data is stored to when the snapshot data is deleted
```

Although the pool capacity is decided according to the estimation, if the pool capacity exceeds the threshold, address the issue.

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If multiple snapshot data are stored, the data may be shared in a pool. In this case, you can release Thin Image pairs, but the snapshot data cannot be deleted from the pool. If you release all Thin Image pairs that have snapshot data containing the shared data, the snapshot data are also deleted from the pool.

Creating a backup of data

You can create a backup of data using Thin Image. When creating a backup from the S-VOL after storing snapshot data, the target for the backup is only the areas where the snapshot data is stored. Therefore, you can create a backup copy even if the pool capacity is small.

During creation of a backup copy, a significant amount of data is read from the secondary volume. This may increase the accesses to the primary volume and degrade the host I/O performance.

Procedure

1. Store the snapshot data, or clone pairs.
2. Use an S-VOL.

Universal Volume Manager and external volumes used as pool-VOLs

You can use Universal Volume Manager (UVM) to connect VSP 5000 series and VSP E series to other storage systems.

In UVM, VSP 5000 series and VSP E series are referred to as a local storage system, and the other storage systems are referred to as external storage systems. With UVM installed, you can use external and internal volumes as pool-VOLs. Volumes in local storage systems are referred to as internal volumes, and volumes in external storage systems are referred to as external volumes.

📄 **Note:** Using external volumes increases the likelihood of a failure, and disaster recovery is more complex and challenging. Using multiple external volumes as pool-VOLs in a pool increases the likelihood of the pool being blocked.

To minimize the adverse effects of failure, use only one pool per external storage system. An external pool-VOL that is blocked due to a failure blocks the pool. You must restore blocked pools.

For more information about external storage systems and disaster recovery methods for external volumes, see the *Hitachi Universal Volume Manager User Guide*.

Simultaneous processing of multiple Thin Image pair tasks

Some Thin Image pair task operations are processed in the background after the requested task is accepted. The total number of instances of each pair task that can be simultaneously processed in a storage system is limited by the number of MP units in the storage system.

For each of the following pair tasks, the number of simultaneous instances processed in the background is equal to the total number of MP units in the storage system.

Item	Number of CBX Pairs	Creating Pairs	Restoring Pairs	Deleting snapshot data and pairs
Number of pairs that can be processed simultaneously	1	30	60	60*
	2	62	124	124*
	3	62	124	124*
* The total number of Deleting snapshot data and Deleting pairs.				

When you execute additional pair task operations above these limits, the tasks are processed in the order requested.

Pair operations when pairs are cascaded

The following table explains pair operations according to the pair status. The status of pair B is SMPL.

Pair type	Pair A status	Operation for pair B						
		Pair with snapshot attribute				Pair with clone attribute		Snapshot / clone attribute common
		Create	Split	Resync	Restore	Create	Split	Delete
With the snapshot attribute	COPY(P D)	N	N	N	N	N	N	YN
	PAIR	Y	N	N	N	Y	N	YN
	PSUS	Y	N	N	N	Y	N	YN
	COPY(R S)	N	N	N	N	N	N	YN
	COPY(R S-R)	N	N	N	N	N	N	YN
	PSUE	N	N	N	N	N	N	YN
	SMPL(P D)	N	N	N	N	N	N	YN
With the clone attribute	COPY(P D)	N	N	N	N	N	N	YN
	PAIR	Y	N	N	N	Y	N	YN

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Pair type	Pair A status	Operation for pair B						
		Pair with snapshot attribute				Pair with clone attribute		Snapshot / clone attribute common
		Create	Split	Resync	Restore	Create	Split	Delete
	PSUS(SP)	Y	N	N	N	Y	N	YN
	PSUE	N	N	N	N	N	N	YN
	SMPL(PD)	N	N	N	N	N	N	YN

Y: Operation successful.

YN: Operation not performed, process terminated.

N: Process terminated abnormally.

The following table explains operations of cascaded pair B when pair B has the snapshot attribute, and its pair status is COPY(PD).

Pair Type	Pair A status	Operation for pair B						
		Pair with snapshot attribute				Pair with clone attribute		Snapshot / clone attribute common
		Create	Split	Resync	Restore	Create	Split	Delete
With the snapshot attribute	COPY(PD)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	PAIR	YN	N	YN	YN	N	N	N
	PSUS	YN	N	YN	YN	N	N	N
	COPY(RS)	YN	N	YN	YN	N	N	N
	COPY(RS-R)	YN	N	YN	YN	N	N	N
	PSUE	YN	N	YN	YN	N	N	N
	SMPL(PD)	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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| Pair Type | Pair A status | Operation for pair B | | | | | | |
| | | Pair with snapshot attribute | | | | Pair with clone attribute | | Snapshot / clone attribute common |
		Create	Split	Resync	Restore	Create	Split	Delete
With the clone attribute	COPY(PD)	YN	N	YN	YN	N	N	N
	PAIR	YN	N	YN	YN	N	N	N
	PSUS(SP)	YN	N	YN	YN	N	N	N
	PSUE	YN	N	YN	YN	N	N	N
	SMPL(PD)	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Y: Operation successful.

YN: Operation not performed, process terminated.

N: Process terminated abnormally.

The following table explains operations of cascaded pair A when pair B has the snapshot attribute, and its pair status is COPY(PD).

| Pair Type | Pair A status | Operation for pair A | | | | | | |
| | | Pair with snapshot attribute | | | | Pair with clone attribute | | Snapshot / clone attribute common |
		Create	Split	Resync	Restore	Create	Split	Delete
With the snapshot attribute	COPY(PD)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	PAIR	N	Y	YN	YN	N	N	N
	PSUS	N	YN	Y	Y	N	N	N
	COPY(RS)	YN	N	YN	YN	N	N	N
	COPY(RS-R)	YN	N	YN	YN	N	N	N

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Pair Type	Pair A status	Operation for pair A						
		Pair with snapshot attribute				Pair with clone attribute		Snapshot / clone attribute common
		Create	Split	Resync	Restore	Create	Split	Delete
	PSUE	YN	N	YN	YN	N	N	N
	SMPL(PD)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
With the clone attribute	COPY(PD)	N	N	N	N	N	N	N
	PAIR	N	N	N	N	N	Y	N
	PSUS(SP)	N	N	N	N	N	YN	N
	PSUE	N	N	N	N	N	N	N
	SMPL(PD)	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Y: Operation successful.

YN: Operation not performed, process terminated.

N: Process terminated abnormally.

The following table explains operations of cascaded pair B when pair B has the clone attribute, and its pair status is COPY(PD).

Pair Type	Pair A status	Operation for pair B						
		Pair with snapshot attribute				Pair with clone attribute		Snapshot / clone attribute common
		Create	Split	Resync	Restore	Create	Split	Delete
With the snapshot attribute	COPY(PD)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	PAIR	N	N	N	N	N	N	Y
	PSUS	N	N	N	N	N	N	Y

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Pair Type	Pair A status	Operation for pair B						
		Pair with snapshot attribute				Pair with clone attribute		Snapshot / clone attribute common
		Create	Split	Resync	Restore	Create	Split	Delete
	COPY(RS)	N	N	N	N	N	N	Y
	COPY(RS-R)	N	N	N	N	N	N	Y
	PSUE	N	N	N	N	N	N	Y
	SMPL(PD)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
With the clone attribute	COPY(PD)	N	N	N	N	N	N	Y
	PAIR	N	N	N	N	N	N	Y
	PSUS(SP)	N	N	N	N	N	N	Y
	PSUE	N	N	N	N	N	N	Y
	SMPL(PD)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Y: Operation successful.								
N: Process terminated abnormally.								

The following table explains operations of cascaded pair A when pair B has the clone attribute, and its pair status is COPY(PD).

Pair type	Pair A status	Operation for pair A						
		Pair with snapshot attribute				Pair with clone attribute		Snapshot / clone attribute common
		Create	Split	Resync	Restore	Create	Split	Delete
With the snapshot attribute	COPY(PD)	N/A	N/A	N/A	N/A	N/A	N/A	N/A

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Pair type	Pair A status	Operation for pair A						
		Pair with snapshot attribute				Pair with clone attribute		Snapshot / clone attribute common
		Create	Split	Resync	Restore	Create	Split	Delete
	PAIR	N	Y	YN	YN	N	N	N
	PSUS	N	YN	Y	Y	N	N	N
	COPY(RS)	YN	N	YN	YN	N	N	N
	COPY(RS-R)	YN	N	YN	YN	N	N	N
	PSUE	N	N	N	N	N	N	N
	SMPL(PD)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
With the clone attribute	COPY(PD)	N	N	N	N	N	N	N
	PAIR	N	N	N	N	N	Y	N
	PSUS(SP)	N	N	N	N	N	YN	N
	PSUE	N	N	N	N	N	N	N
	SMPL(PD)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Y: Operation successful.								
YN: Operation not performed, process terminated.								
N: Process terminated abnormally.								

The following table explains operations of cascaded pair B when pair B has the snapshot attribute and its pair status is PAIR.

Pair type	Pair A status	Operation for pair B						
		Pair with snapshot attribute				Pair with clone attribute		Snapshot / clone attribute common
		Create	Split	Resync	Restore	Create	Split	Delete
With the snapshot attribute	COPY(PD)	N	N	YN	YN	N	N	Y
	PAIR	N	N	YN	YN	N	N	Y
	PSUS	N	Y	YN	YN	N	N	Y
	COPY(RS)	N	N	YN	YN	N	N	Y
	COPY(RS-R)	N	N	YN	YN	N	N	Y
	PSUE	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	SMPL(PD)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
With the clone attribute	COPY(PD)	N	N	YN	YN	N	N	Y
	PAIR	N	N	YN	YN	N	N	Y
	PSUS(SP)	N	Y	YN	YN	N	N	Y
	PSUE	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	SMPL(PD)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Y: Operation successful.								
YN: Operation not performed, process terminated.								
N: Process terminated abnormally.								

The following table explains operations of cascaded pair A when pair B has the snapshot attribute, and its pair status is PAIR.

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Pair type	Pair A status	Operation for pair A						
		Pair with snapshot attribute				Pair with clone attribute		Snapshot / clone attribute common
		Create	Split	Resync	Restore	Create	Split	Delete
With the snapshot attribute	COPY(PD)	YN	N	YN	YN	N	N	N
	PAIR	N	Y	YN	YN	N	N	N
	PSUS	N	YN	Y	Y	N	N	N
	COPY(RS)	YN	N	YN	YN	N	N	N
	COPY(RS-R)	YN	N	YN	YN	N	N	N
	PSUE	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	SMPL(PD)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
With the clone attribute	COPY(PD)	N	N	N	N	N	N	N
	PAIR	N	N	N	N	N	Y	N
	PSUS(SP)	N	N	N	N	N	YN	N
	PSUE	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	SMPL(PD)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Y: Operation successful.								
YN: Operation not performed, process terminated.								
N: Process terminated abnormally.								

The following table explains operations of cascaded pair B when pair B has the clone attribute and its pair status is PAIR.

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Pair type	Pair A status	Operation for pair B						
		Pair with snapshot attribute				Pair with clone attribute		Snapshot / clone attribute common
		Create	Split	Resync	Restore	Create	Split	Delete
With the snapshot attribute	COPY(PD)	N	N	N	N	N	N	Y
	PAIR	N	N	N	N	N	N	Y
	PSUS	N	N	N	N	N	Y	Y
	COPY(RS)	N	N	N	N	N	N	Y
	COPY(RS-R)	N	N	N	N	N	N	Y
	PSUE	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	SMPL(PD)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
With the clone attribute	COPY(PD)	N	N	N	N	N	N	Y
	PAIR	N	N	N	N	N	Y	Y
	PSUS(SP)	N	N	N	N	N	Y	Y
	PSUE	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	SMPL(PD)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Y: Operation successful.								
YN: Operation not performed, process terminated.								
N: Process terminated abnormally.								

The following table explains operations of cascaded pair A when pair B has the clone attribute, and its pair status is PAIR.

Pair type	Pair A status	Operation for pair A						
		Pair with snapshot attribute				Pair with clone attribute		Snapshot / clone attribute common
		Create	Split	Resync	Restore	Create	Split	Delete
With the snapshot attribute	COPY(PD)	YN	N	YN	YN	N	N	N
	PAIR	N	Y	YN	YN	N	N	N
	PSUS	N	YN	Y	Y	N	N	N
	COPY(RS)	YN	N	YN	YN	N	N	N
	COPY(RS-R)	YN	N	YN	YN	N	N	N
	PSUE	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	SMPL(PD)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
With the clone attribute	COPY(PD)	N	N	N	N	N	N	N
	PAIR	N	N	N	N	N	Y	N
	PSUS(SP)	N	N	N	N	N	YN	N
	PSUE	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	SMPL(PD)	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Y: Operation successful.								
YN: Operation not performed, process terminated.								
N: Process terminated abnormally.								

The following table explains operations of cascaded pair B when the status of pair B is not SMPL, COPY(PD), and PAIR.

Pair type	Pair A status	Pair B status	Operation for pair B							
			Pair with snapshot attribute				Pair with clone attribute		Snapshot / clone attribute common
			Create	Split	Resync	Restore	Create	Split	Delete
With the snapshot attribute	PSUS	PSUS [1]	N	YN	Y	Y	N	N	Y
	PSUS	COPY(RS) [1]	YN	N	YN	YN	N	N	N
	PSUS	COPY(RS-R) [1]	YN	N	YN	YN	N	N	N
	PSUS	PSUE [1]	N	N	Y	N	N	N	Y
	PSUS	SMPL(PD) [1]	N	N	N	N	N	N	YN
	PSUS	PSUS(SP) [2]	N	N	N	N	N	N	Y
With the clone attribute	PSUS(SP)	PSUS(SP) [2]	N	N	N	N	N	N	Y
	PSUS(SP)	PSUE [2]	N	N	N	N	N	N	Y
	PSUS(SP)	SMPL(PD) [2]	N	N	N	N	N	N	YN
	PSUS(SP)	PSUS [1]	N	YN	Y	Y	N	N	N

Y: Operation successful.

YN: Operation not performed, process terminated.

N: Process terminated abnormally.

Notes

1. Pair B has snapshot attribute.
2. Pair B has clone attribute.

The following table explains operations of cascaded pair A when the status of pair B is not SMPL, COPY(PD), and PAIR.

Pair type	Pair A status	Pair B status	Operation for pair A						
			Pair with snapshot attribute				Pair with clone attribute		Snapshot / clone attribute common
			Create	Split	Resync	Restore	Create	Split	Delete
With the snapshot attribute	PSUS	PSUS [1]	N	YN	N	N	N	N	N
	PSUS	COPY(RS) [1]	N	YN	N	N	N	N	N
	PSUS	COPY(RS-R) [1]	N	YN	N	N	N	N	N
	PSUS	PSUE [1]	N	YN	N	N	N	N	N
	PSUS	SMPL(PD) [1]	N	YN	N	N	N	N	N
	PSUS	PSUS(SP) [2]	N	YN	N	N	N	N	N
With the clone attribute	PSUS(SP)	PSUS(SP) [2]	N	N	N	N	N	YN	N
	PSUS(SP)	PSUE [2]	N	N	N	N	N	YN	N
	PSUS(SP)	SMPL(PD) [2]	N	N	N	N	N	YN	N
	PSUS(SP)	PSUS [1]	N	N	N	N	N	YN	N

Y: Operation successful.

YN: Operation not performed, process terminated.

N: Process terminated abnormally.

Notes

1. Pair B has snapshot attribute.
2. Pair B has clone attribute.

Pair operations when pairs are not cascaded

The following table explains pair operations according to the pair status.

Chapter 2: Thin Image system and planning requirements

Pair type	Pair A status	Operation for pair A						
		Pair with snapshot attribute				Pair with clone attribute		Snapshot / clone attribute common
		Create	Split	Resync	Restore	Create	Split	Delete
N/A	SMPL	Y	N	N	N	Y	N	YN
With the snapshot attribute	COPY(PD)	YN	N	YN	YN	N	N	N
	PAIR	N	Y	YN	YN	N	N	Y
	PSUS	N	YN	Y	Y	N	N	Y
	COPY(RS)	YN	N	YN	YN	N	N	N
	COPY(RS-R)	YN	N	YN	YN	N	N	N
	PSUE	N	N	Y	N	N	N	Y
	SMPL(PD)	N	N	N	N	N	N	YN
With the clone attribute	COPY(PD)	N	N	N	N	N	N	Y
	PAIR	N	N	N	N	N	Y	Y
	PSUS(SP)	N	N	N	N	N	YN	Y
	PSUE	N	N	N	N	N	N	Y
	SMPL(PD)	N	N	N	N	N	N	YN
Y: Operation successful.								
YN: Operation not performed, process terminated.								
N: Process terminated abnormally.								

Chapter 2: Thin Image system and planning requirements

Pair operations when the root volume is shared by multiple pairs

Root volume

Pair A

Pair B

The following table explains pair operations according to the pair status.

Pair type	Pair status of Pair A	Operation for Pair B						
		Pair with snapshot attribute				Pair with clone attribute		Snapshot / clone attribute common
		Create	Split	Resync	Restore	Create	Split	Delete
With the snapshot attribute	COPY(PD)	Y	Y	Y	Y	Y	Y	Y
	PAIR	Y	Y	Y	Y	Y	Y	Y
	PSUS	Y	Y	Y	Y	Y	Y	Y
	COPY(RS)	Y	Y	Y	Y	Y	Y	Y
	COPY(RS-R)	Y	N	Y	N	Y	N	Y
	PSUE	N	Y	Y	Y	N	Y	Y
	SMPL(PD)	Y	Y	Y	Y	Y	Y	Y
With the clone attribute	COPY(PD)	Y	Y	Y	Y	Y	Y	Y
	PAIR	Y	Y	Y	Y	Y	Y	Y
	PSUS(SP)	Y	Y	Y	Y	Y	Y	Y
	PSUE	N	Y	Y	Y	N	Y	Y
	SMPL(PD)	Y	Y	Y	Y	Y	Y	Y

Pair type	Pair status of Pair A	Operation for Pair B						
		Pair with snapshot attribute				Pair with clone attribute		Snapshot / clone attribute common
		Create	Split	Resync	Restore	Create	Split	Delete
Y: Operation successful.								
N: Process terminated abnormally.								

Pair operations when a node volume is shared by multiple pairs
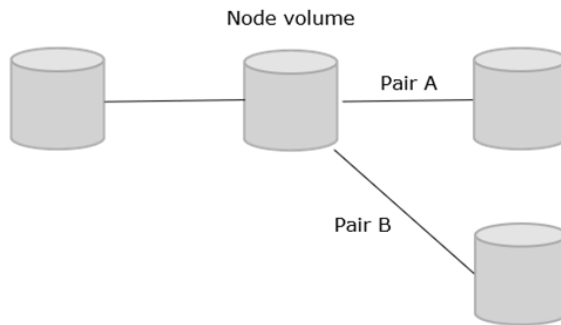
The following table lists pair operations according to the pair status.

Pair type	Pair status of Pair A	Operation for Pair B						
		Pair with snapshot attribute				Pair with clone attribute		Snapshot/clone attribute common
		Create	Split	Resync	Restore	Create	Split	Delete
With the snapshot attribute	COPY(PD)	Y	Y	Y	Y	Y	Y	Y
	PAIR	Y	Y	Y	Y	Y	Y	Y
	PSUS	Y	Y	Y	Y	Y	Y	Y
	COPY(RS)	Y	Y	Y	Y	Y	Y	Y
	COPY(RS-R)	Y	N	Y	N	Y	N	Y
	PSUE	N	Y	Y	Y	N	Y	Y

Chapter 2: Thin Image system and planning requirements

Pair type	Pair status of Pair A	Operation for Pair B						
		Pair with snapshot attribute				Pair with clone attribute		Snapshot/clone attribute common
		Create	Split	Resync	Restore	Create	Split	Delete
	SMPL(PD)	Y	Y	Y	Y	Y	Y	Y
With the clone attribute	COPY(PD)	Y	Y	Y	Y	Y	Y	Y
	PAIR	Y	Y	Y	Y	Y	Y	Y
	PSUS(SP)	Y	Y	Y	Y	Y	Y	Y
	PSUE	N	Y	Y	Y	N	Y	Y
	SMPL(PD)	Y	Y	Y	Y	Y	Y	Y
Y: Operation successful								
N: Process terminated abnormally								

Data backup and recovery differences between ShadowImage and Thin Image

The following table lists and describes the differences between data backup and recovery for ShadowImage (SI) and Thin Image (HTI).

Item	ShadowImage	Thin Image
P-VOL physical failures such as hard disks	P-VOL data can be recovered using the S-VOL.	P-VOL data cannot be guaranteed.
P-VOL logical failures such as data update errors or viruses	P-VOL data can be recovered using the S-VOL.	P-VOL data can be recovered using the S-VOL.
Capacity required for backup	More capacity is required for backup because all data in the P-VOL is retained.	Less capacity is required for backups because only differential data of the P-VOL is retained.[1]

Item	ShadowImage	Thin Image
Impact on P-VOL performance when accessing backed up data	P-VOL performance is not affected because the P-VOL and the S-VOL can be disconnected.	P-VOL performance is affected because data in the P-VOL is shared.[2]
S-VOL or pool physical failures	If a physical failure occurs in an S-VOL, data in the S-VOL cannot be guaranteed.	If a physical failure occurs in a pool[3], data in all S-VOLs that use the pool cannot be guaranteed.

Notes:

1. For snapshot pairs. When a cloned pair is created, all data in the P-VOL is retained and more capacity is required for backup.

2. For snapshot pairs. When a cloned pair is created, the P-VOL and the S-VOL can be separated and the P-VOL performance is not affected.

3. When a pool is full (the depletion threshold is exceeded in a pool for which the capacity for TI pairs is limited), data in all S-VOLs using the pool cannot be guaranteed.

Recommended usage

To maintain backed up data for long periods, save it on magnetic tapes or other media. For temporary backups use HTI or SI. When backing up data to magnetic tapes use SI. To reduce the capacity necessary for backups use HTI, but note that this affects P-VOL performance.

Use SI to minimize the impact from P-VOL physical failures. If you need four or more generations of backups, use both SI and HTI as shown in the following figure.

Chapter 2: Thin Image system and planning requirements
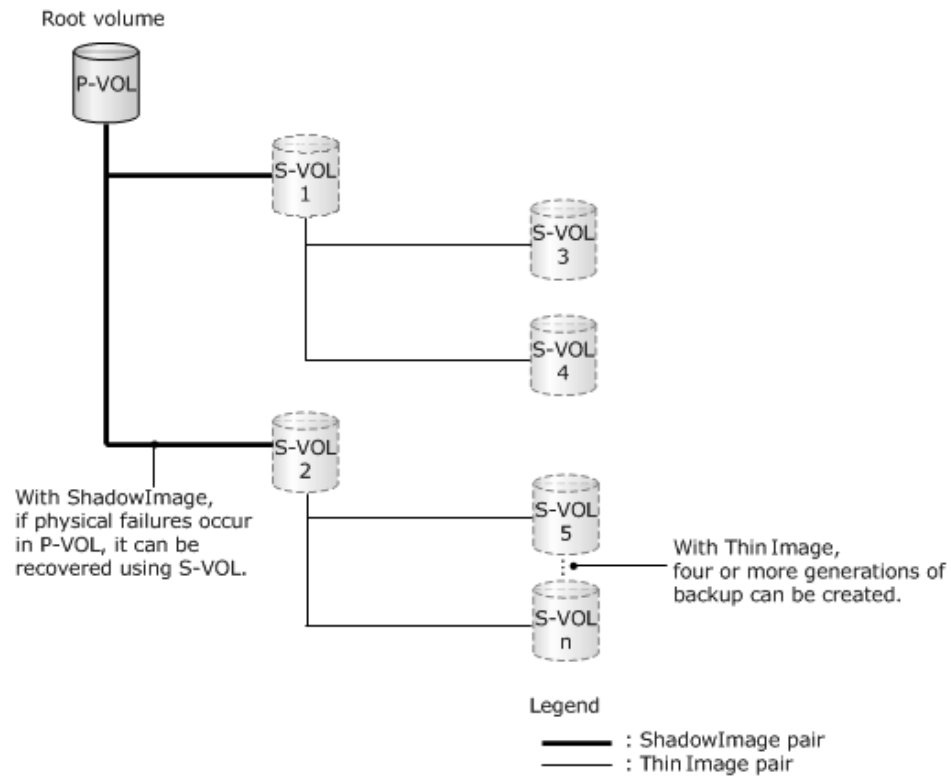
Use HTI to minimize P-VOL logical failures.

Removing Thin Image

Use this procedure to remove Thin Image from HDvM - SN.

1. Delete all Thin Image pairs.
2. Delete all HTI pools and all HDP pools that contain HTI pairs.
3. Disable or remove the Thin Image license. For details about disabling and removing licenses, see the *System Administrator Guide* for your storage system.

Chapter 3: Configuring Thin Image

You can create data pools, LDEVs, and apply settings of the command device to configure Thin Image.

Prerequisites for configuring Thin Image

Before you perform Thin Image configuration tasks, complete the following tasks:

- Install a sufficient amount of shared memory.

  For more information about installing shared memory, contact customer support.

- Create a V-VOL management area in the shared memory. This area is automatically created when you install additional shared memory.

Workflow for configuring Thin Image

Use this workflow to configure Thin Image.

The following image shows the configuration tasks workflow and the workflow for creating and managing Thin Image pairs.
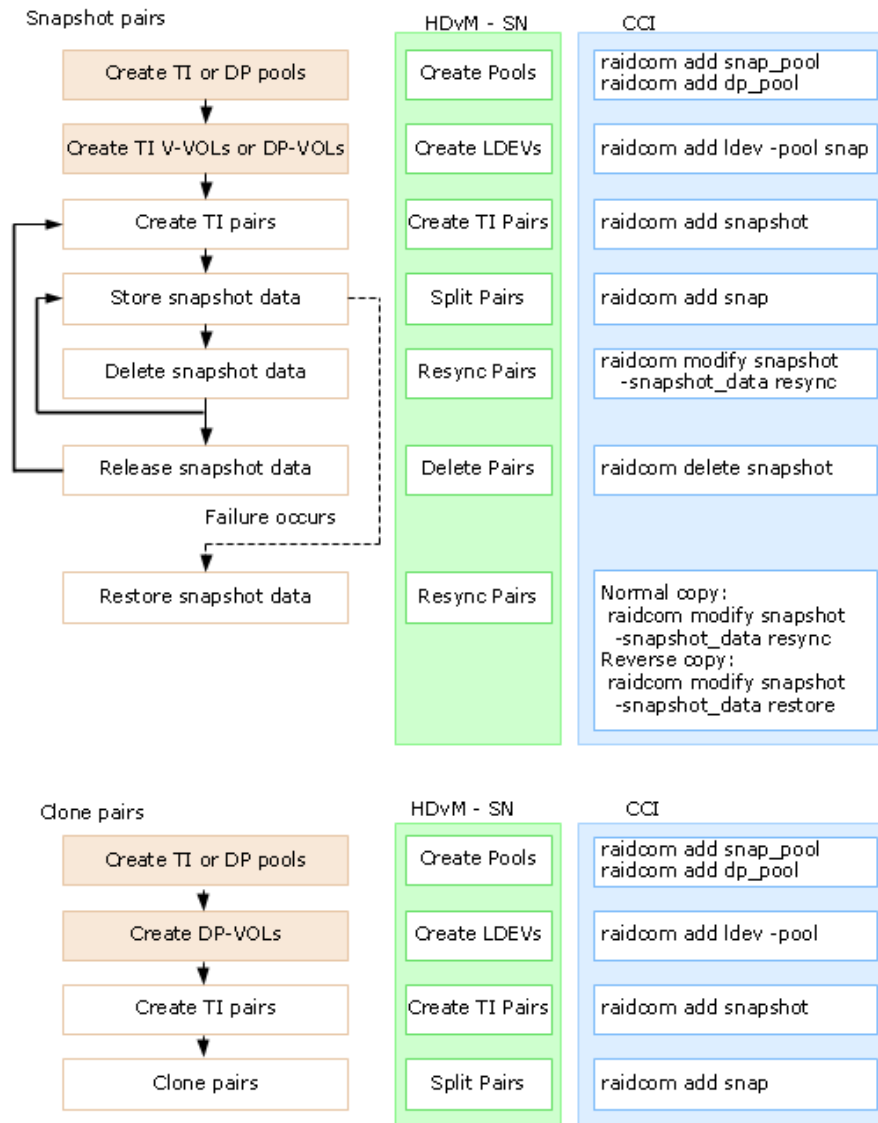
Steps for configuring Thin Image:

📄 **Note:** The V-VOL management area must be created in shared memory. It is created automatically when shared memory is added. For details, contact customer support.

1. Create the Thin Image data pools (see Creating Thin Image data pools (on page 105)).
2. Create and register the V-VOLs for the pair (see Workflow for registering virtual volumes (on page 109)).
3. Review the local replica options and change settings as needed (see Changing local replica options that affect Thin Image performance (on page 121)).
4. Create and manage the Thin Image pairs (see Workflow for creating and managing Thin Image pairs (on page 123)).

Creating Thin Image data pools

You can create Thin Image data pools using HDvM - SN. For information about the creation of DP pools, see the *Provisioning Guide* for your storage system.

According to the capacity of the pool to create, you must add shared memory. For details about the relation between shared memory to add and the pool capacity, see Thin Image shared memory requirements (on page 68).

> **Note:** You can only register volumes that you have not already registered as a pool-VOL.

For more information about data pool requirements, including the maximum number of pool-VOLs, see Thin Image data pool requirements (on page 73).

You can add external and internal volumes to data pools.

> **Note:** There are limitations to adding external and internal volumes to data pools. For more information about these limitations, see the requirements for Thin Image pool-VOLs listed in Thin Image volume requirements (on page 69).

Before you begin

You must have the Storage Administrator (Provisioning) role.

In CCI, use the `raidcom add snap_pool` command.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, and then click **Pools**.
2. In the **Pools** window, select **Create Pools**.

3. In the **Create Pools** window of the **Create Pools** wizard, complete the following items for the pool you want to create, and then click **Add**:

    ▪ **Pool Type**

    Select **Thin Image** as the pool type.

    Default: **Dynamic Provisioning**

    Required: Yes

    ▪ **System Type**

    Value: **Open**

    Default: **Open**

    ▪ **Pool Volume Selection**

    Select the pool volume you want to use for the pool. Complete the following:

    Drive Type/RPM: Select your pool-VOL's data drive. Select **External Storage** when you use external volumes (for HTI pool-vols).

    RAID Level: Select your pool-VOL's RAID level. If you selected **External Storage** in the previous step, a hyphen (-) is displayed for this item and this item is unavailable.

    Default: **Mixable**

    Required: Yes

    ▪ **Pool Name**

    Enter a name for the pool, using 32 alphanumeric characters or fewer. This field is case sensitive.

    ▪ **Initial Pool ID**

    The initial pool identifier. Enter 0 and an integer number.

    Integer number range: 0 - 127

    Default: The smallest available number displays as the default. If no available pool ID exists, no number appears. If an already registered pool ID is entered, the smallest available pool ID that is larger than the one entered is used.

    ▪ **Warning Threshold**

    The data pool capacity threshold.

    Range (%): 20 - 95

    Default (%): 80

    The pool-VOL is added to the **Selected Pools** table of the **Create Pools** window. Up to 1,024 volumes can be added to a pool.

    > 📄 **Note:** If you are adding an LDEV belonging to a parity group for which accelerated compression is enabled, see the related section in the *Provisioning Guide* for your storage system.

4. Click **Finish**, and then confirm the settings.
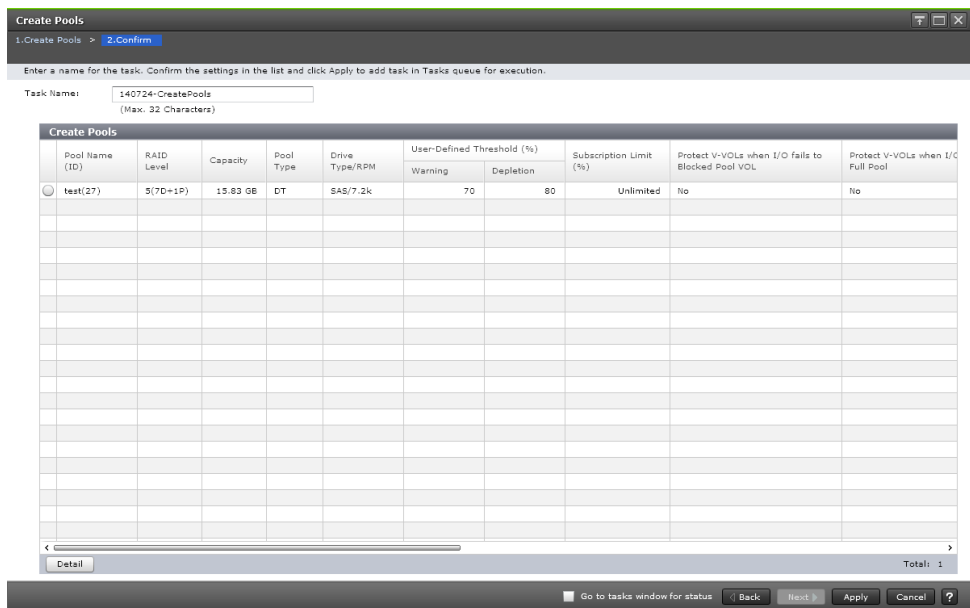
5. Accept the default task name or enter a unique name.

    You can enter up to 32 letters, numbers, and symbols, except the following:

    \ / : , ; * ? " < > |

6. If you want to monitor the task after submitting it, select **Go to tasks window for status**.

7. Click **Apply** to submit the task.

Next steps

Select the pool volumes.

Selecting pool volumes

You can select a pool-VOL to add when creating pools. The selected pool-VOL's information is used to calculate Total Selected Pool Volumes and Total Selected Capacity in the **Create Pools** window.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, and then click **Pools**.

2. In the **Pools** window, select **Create Pools**.
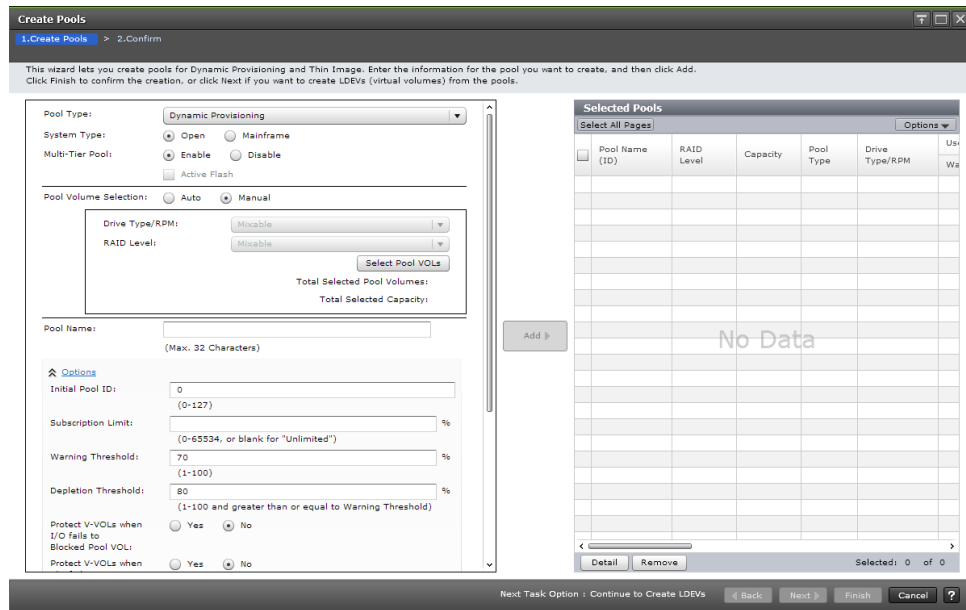
3. In the **Create Pools** window of the **Create Pools** wizard, in the **Pool Volume Selection** section, click **Select Pool VOLs**.
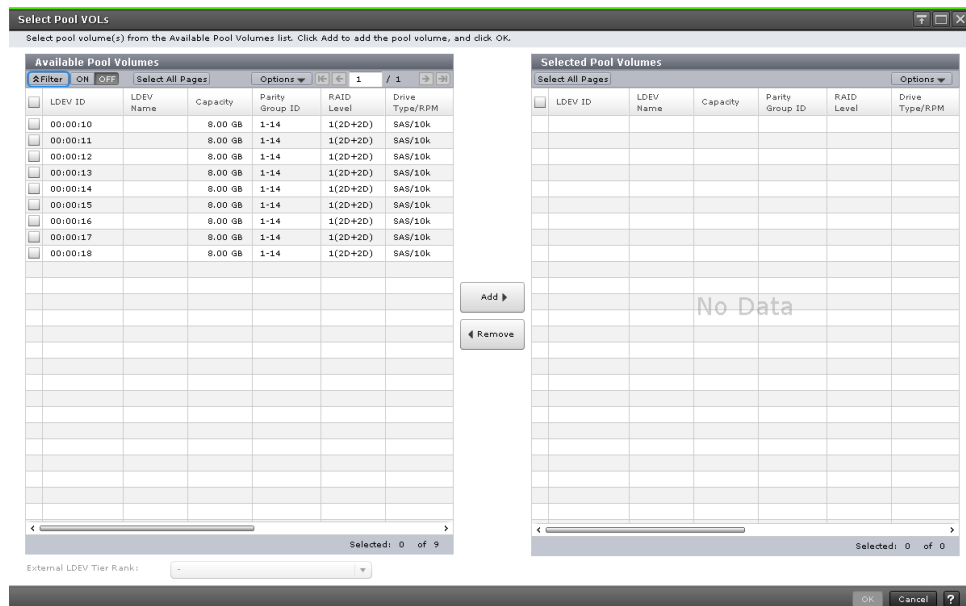
4. In the **Select Pool VOLs** window, from the **Available Pool Volumes** table, select the pool-VOL you want to add to the pool, and then click **Add**.
The pool-VOL is added to the **Selected Pool Volumes** table. You can add a maximum of 1,024 volumes in a pool.

> **Note:** Before you add an LDEV belonging to a parity group which has the accelerated compression setting enabled, see the information about whether accelerated compression can be enabled in the *Provisioning Guide for Open Systems*.

> 📄 **Note:** Note the following when you add an external volume:
>
> - External volumes with cache mode enabled and external volumes with cache mode disabled cannot be contained in the same pool.
>
> - External volumes with cache mode disabled and internal volumes cannot be contained in the same pool.
>
> - When setting the tier rank of an external volume to a value other than **Middle**, select the tier rank from **External LDEV Tier Rank**, and then click **Add**.

> 📄 **Note:**
>
> - To specify conditions to display pool volumes, click **Filter** to open the menu, specify the filtering conditions, and then click **Apply**.
>
> - To select all pool-VOLs in the table, click **Select All Pages**. To cancel the selection, click **Select All Pages** again.
>
> - To specify the unit or the number of rows to be displayed, click **Options**.

5. Click **OK**.

Result

The selected pool-VOL is shown in the Selected Pools table in the **Create Pools** window.

Pool creation and data drive type priority

Creating pools automatically sets the new pool-VOL with system area according to the priority of data drive types.

The following table shows the priority of pool-VOLs with system area when creating pools.

Priority	Data drive type
1	HDD/7.2Krpm
2	HDD/10Krpm
4	SSD
5	External volume

If more than one pool-VOL of the same data drive type exists in the storage system, the pool-VOL priority is determined according to the storage system's internal index information.

Workflow for registering virtual volumes

Use this workflow to register virtual volumes.

1. (VSP 5000 series) Check the SSID of the V-VOL you want to register to the pool-VOL's paired volume, and edit the SSID as needed (see <u>Editing the SSID for virtual volumes (on page 110)</u>).

2. Check the V-VOL settings and change the settings as needed (see <u>Changing V-VOL settings (on page 112)</u>).

3. Register the V-VOL (see <u>Creating V-VOLs for Thin Image S-VOLs (on page 114)</u>).

4. If you plan to use an existing V-VOL that has capacity saving enabled and assigned pages as an S-VOL of a clone pair, prepare the V-VOL first (see <u>Using an existing V-VOL as an S-VOL in a clone pair (on page 121)</u>).

Editing the SSID for virtual volumes

Before registering a V-VOL, you may need to edit the control unit's (CU) SSID, which you use to create new LDEVs. Use the Change SSIDs window to edit a V-VOL's SSID.

Before you begin

You must have the Storage Administrator (Provisioning) role.

For more information about registering V-VOLs, see <u>Creating V-VOLs for Thin Image S-VOLs (on page 114)</u>.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, and then click **Pools**.

2. In the **Pools** window, in the **Pools** tab, click **Create LDEVs**.

3. In the **Create LDEVs** window of the **Create LDEVs** wizard, in the **Selected LDEVs** table, click **Edit SSIDs**.

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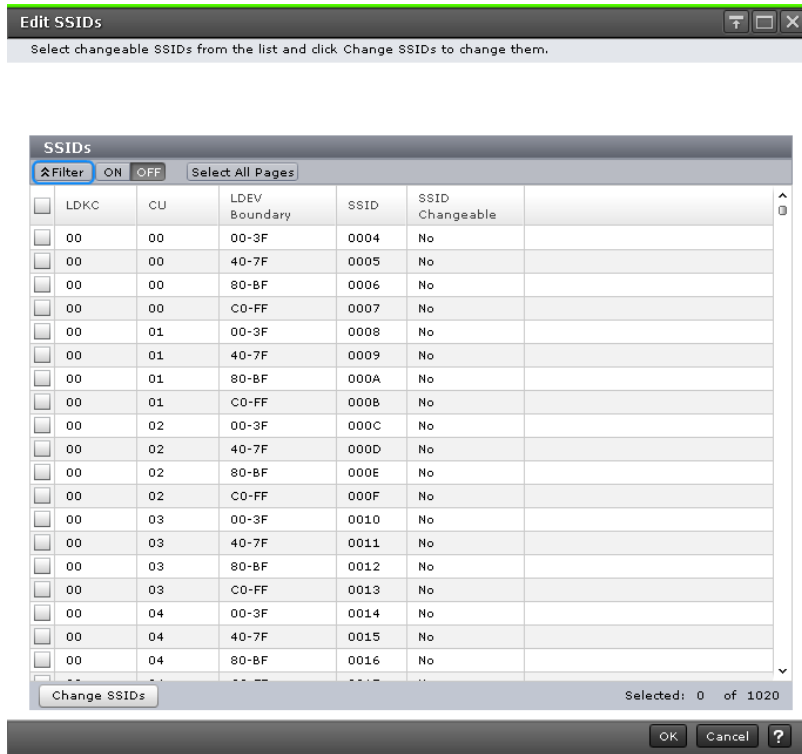
In the **Edit SSIDs** window, in the **SSIDs** table, existing SSIDs and those to be generated are shown in the list.

4. In the **Edit SSIDs** window, select the row of the SSID you want to edit, and then click **Change SSIDs**.
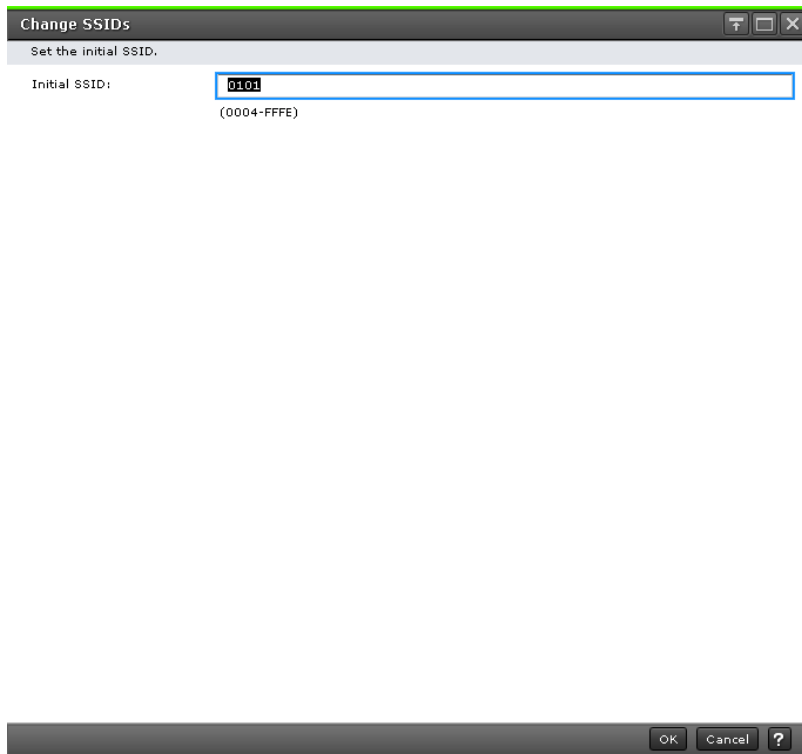
5. In the **Change SSIDs** window, for **Initial SSID**, enter the new SSID and click **OK**.

   The available numbers are assigned to the subsequent SSIDs in ascending order.

6. In the **Edit SSIDs** window, click **OK**.

7. Click **Finish**, and then confirm the settings.
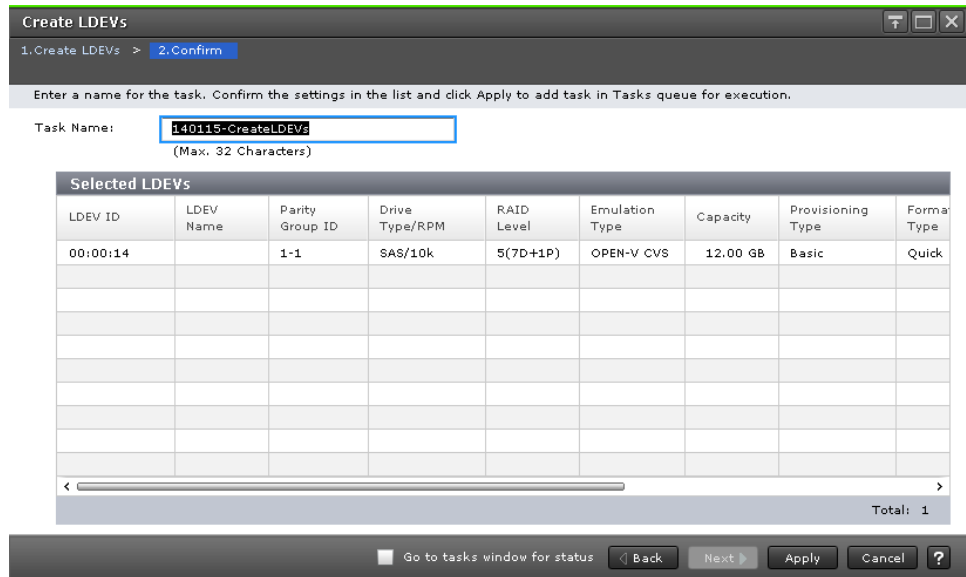
Changing V-VOL settings

You can edit the V-VOL settings before registering a V-VOL.

Before you begin

You must have the Storage Administrator (Provisioning) role.

In CCI, use the `raidcom modify ldev` command.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, and then click **Pools**.

2. In the **Pools** window, in the **Pools** tab, click **Create LDEVs**.
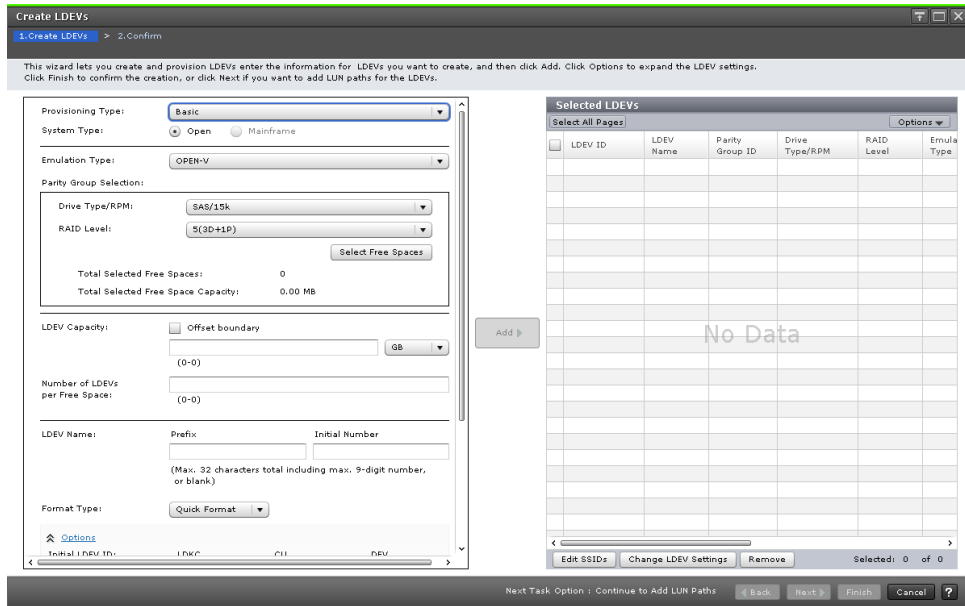
3. In the **Create LDEVs** window of the **Create LDEVs** wizard, in the **Selected LDEVs** table, select an LDEV, and then click **Change LDEV Settings**.
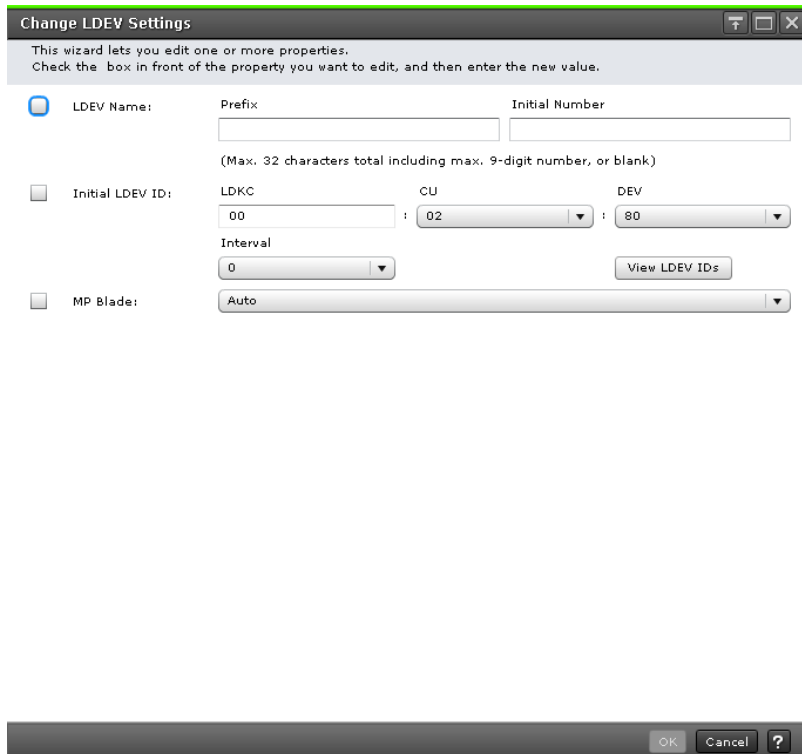
4. In the **Change LDEV Settings** window, complete the following items, and then click **OK**:

   ▪ **LDEV Name**

   Enter the prefix characters and the initial number for the LDEV. The available numbers are assigned to the subsequent LDEV names in ascending order.

   ▪ **Initial LDEV ID**

   Enter the LDKC, CU, and LDEV numbers, and the interval. To confirm used LDEVs, click **View LDEV IDs**. The available IDs are assigned to the subsequent LDEV IDs in ascending order with the specified interval.

   ▪ **MP Unit ID**

   Select the MP Unit ID to which you want to assign the LDEV. To specify an MP Unit ID, select the MP Unit ID. To assign an arbitrary MP Unit ID, click **Auto**. The MP Unit ID that you can select depends on the storage system model.

5. Click **Finish**, and then confirm the settings.

6. Accept the default task name or enter a unique name.

   You can enter up to 32 letters, numbers, and symbols, except the following:

   \ / : , ; * ? " < > |

7. If you want to monitor the task after submitting it, select **Go to tasks window for status**.

8. Click **Apply** to submit the task.

Creating V-VOLs for Thin Image S-VOLs

Depending on the types of pairs with which you are working, there are two options for creating a V-VOL for a Thin Image S-VOL. For pairs with the snapshot attribute (snapshot pairs) for which the cascade attribute is enabled (cascaded pairs) or for clone pairs, create a DP-VOL. You can use a non-cascaded snapshot tree (using only root volumes and leaf volumes) even when you create snapshot pairs that are cascaded. For information about creating a DP-VOL, see the *Provisioning Guide* for your storage system. For snapshot pairs for which the cascade attribute is disabled, create a Thin Image V-VOL.

Before you begin

You must have the Storage Administrator (Provisioning) role.

Change the pair status of V-VOLs you want the host server to recognize to PSUS or unpaired.

In CCI, use the `raidcom add ldev -pool snap` command.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, and then click **Pools**.

2. In the **Pools** window, in the **Pools** tab, click **Create LDEVs**.

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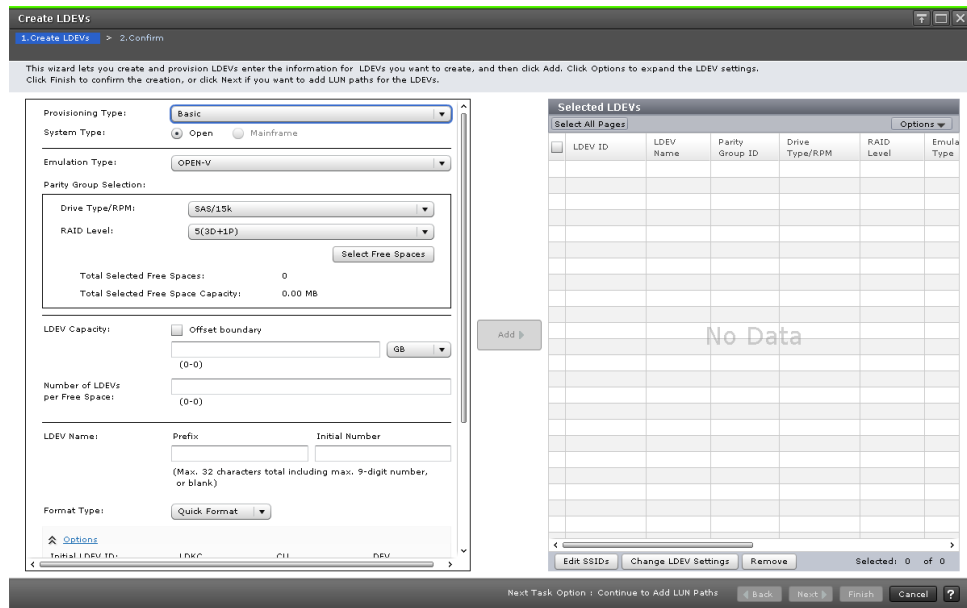
3. In the **Create LDEVs** window of the **Create LDEVs** wizard, complete or review the following items, and then click **Options**:

    ▪ **Provisioning Type**

    Confirm that **Snapshot** is selected.

    Required: Yes

    ▪ **System Type**

    Verify that **Open** is selected.

    Required: Yes

    ▪ **Emulation Type**

    Confirm that **OPEN-V** is selected.

    Required: Yes

    ▪ **Capacity Compatibility Mode (Offset boundary)**

    Specify if you want to offset the specified LDEV capacity by boundary.

    Values: **ON** or **OFF**

    Default: **OFF**

    ▪ **LDEV Capacity**

    Complete the following:

    - Enter the amount of the LDEV capacity you want to create. Then enter a number within the range of the figures displayed under the text box. You can enter values up to two decimal places.

    - Click the unit capacity menu to choose the capacity unit, TB, GB, MB, or block.

Chapter 3: Configuring Thin Image

▪ **Number of LDEVs**

Enter the number of LDEVs you want to create.

Range: (Shown below the text box.)

Required: Yes

▪ **LDEV Name**

Enter a name for the V-VOL.

- For **Prefix**, enter the case-sensitive alphanumeric characters, which become the fixed characters that precede the V-VOL number.

- For **Initial Number**, enter the initial number for V-VOL, up to 9 digits. The available numbers are assigned to the subsequent LDEV names in ascending order.

- You can enter up to 32 characters in total for **Prefix** and **Initial Number**.

4. In the **Create LDEVs** window of the **Create LDEVs** wizard, complete the following additional items, and then click **Add**:

▪ **Initial LDEV ID**

Confirm that an LDEV identification number has been set. The available numbers are assigned to the subsequent LDEV IDs in ascending order. To confirm the used number and unavailable number, complete the following steps:

a. Click **View LDEV IDs**.

b. In the **View LDEV IDs** window, confirm the LDEV ID, and then click **Close**.

▪ **Initial SSID**

Enter a 4-digit representation of a hexadecimal number. The available numbers are assigned to the subsequent SSIDs in ascending order.

Range: 0004 to FFFE

Default: 0004

▪ Complete the following steps to confirm generated SSIDs:

a. Click **View SSIDs**.

b. In the **View SSIDs** window, confirm the SSID, and then click **Close**.

▪ **CLPR**

Select **CLPR**.

Required: No

▪ **MP Unit ID**

Select the MP Unit ID to which you want to assign the LDEV. To specify an MP Unit ID, select the MP Unit ID. To assign an arbitrary MP Unit ID, click **Auto**. The MP Unit ID that you can select depends on the VSP storage system model.

Required: No

The created LDEVs are added to the **Selected LDEVs** table.

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> **Note:**
> The **Provisioning Type**, **System Type**, **Emulation Type**, **LDEV Capacity**, and **Number of LDEVs** fields must be set. If these items are not set, you cannot click **Add**.

5. Click **Finish**, and then confirm the settings.

> **Note:** To continue setting the LU path, click **Next**.
>
> For more information about setting the LU path, see the *Provisioning Guide* for your storage system.
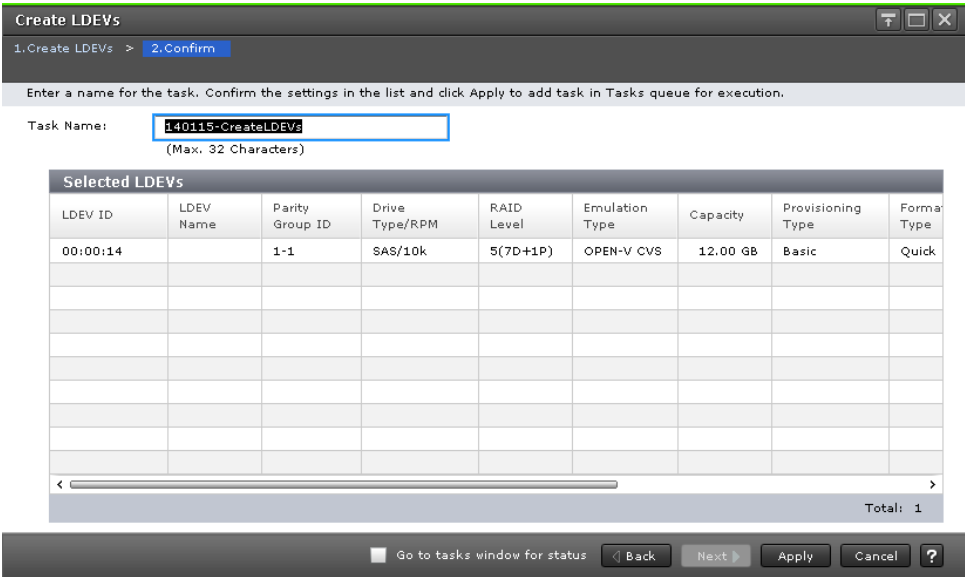
6. (Optional) To change the settings of the V-VOLs, you can complete the following:

 a. (VSP 5000 series) To select a storage system identifier and edit the SSID properties, click **Edit SSIDs**.

 b. To change the LDEV settings, click **Change LDEV Settings**.

c. In the **Change LDEV Settings** window, change the desired settings, and then click **OK**:

d. Click **Finish**, and then confirm the settings.

7. Accept the default task name or enter a unique name.

   You can enter up to 32 letters, numbers, and symbols, except the following:

   \ / : , ; * ? " < > |

8. If you want to monitor the task after submitting it, select **Go to tasks window for status**.

9. Click **Apply** to submit the task.

Removing LDEVs from registering tasks

The LDEVs that are shown in the Selected LDEVs table in the **Create LDEVs** window are those that are set to be registered and created. You can choose to not register the LDEV by removing the LDEV from the registering task.

Before you begin

- You must have the Storage Administrator (Provisioning) role.

- In CCI, use the `raidcom delete ldev` command.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, and then click **Pools**.

2. In the **Pools** window, click **Create LDEVs**.
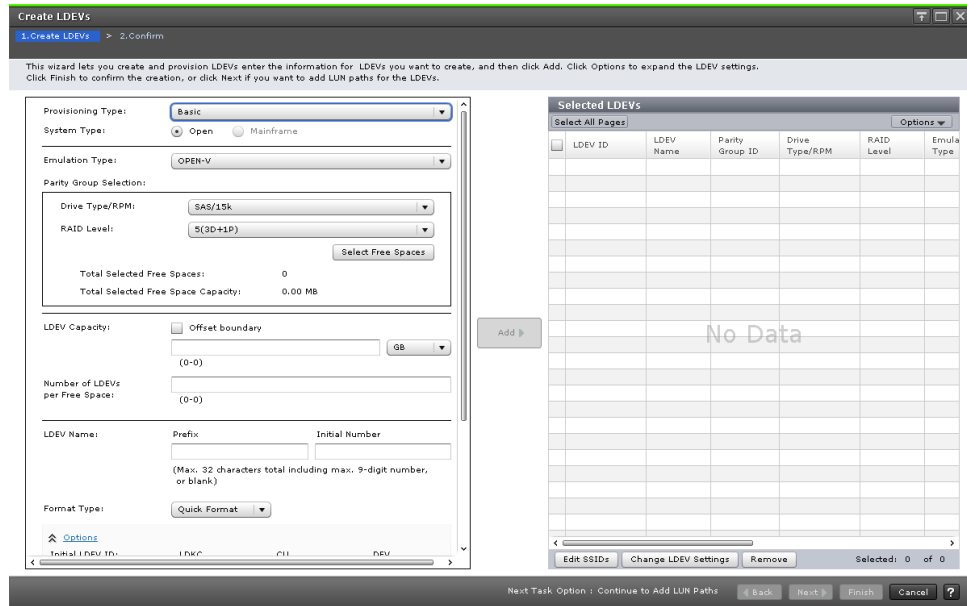
3. In the **Create LDEVs** window, in the **Selected LDEVs** table, complete the following:

   a. Select the check box for the LDEV you want to remove from the registering task, and then click **Remove**.

   b. In the warning message that appears, click **OK** to confirm that you want to remove the selected LDEV.

4. Click **Finish**, and then confirm the settings.
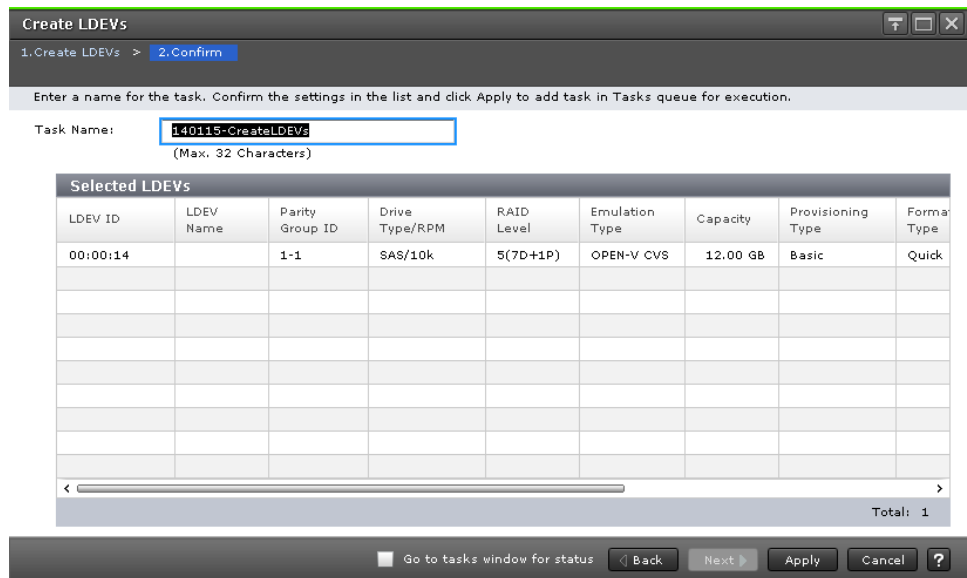
5. Accept the default task name or enter a unique name.

   You can enter up to 32 letters, numbers, and symbols, except the following:

   \ / : , ; * ? " < > |

6. If you want to monitor the task after submitting it, select **Go to tasks window for status**.

7. (Optional) To open the next task window, click **Next**.

8. To register the settings to the storage system, click **Apply**.
   The LDEV is removed from the registering task. The LDEV is not registered and created.

Recognizing devices from the host server

Complete these steps to restart a host server, such as HP-UX or Solaris, or to run commands to V-VOLs to recognize devices from the host server.

> **Note:** Do not change the volume of the recognized device by the host server to a V-VOL.

Procedure

1. Create the Thin Image pairs.
2. Split the pair to store the snapshot data using one of the available methods.
3. Ensure that the V-VOL recognized by the host server is in "PSUS" status.
4. Complete one of the following:

   - Boot or reboot the host server.

   - Run the command for recognizing devices.

Host server stoppages and device recognition issues

If you boot or reboot host servers, such as HP-UX or Solaris, or if you use the host server to run the read command on a V-VOL to recognize a device, keep the following items in mind.

- You cannot change the volume of the device recognized by the host server to a V-VOL.

- Before booting or rebooting the host server or running the command for recognizing devices, complete the following:

  1. Create the Thin Image pair.
  2. Store the snapshot data (or clone pairs).
  3. Ensure the V-VOL pair recognized by the host server is in "PSUS" status or an unpaired volume.

If you do not fulfill all of the conditions listed above, the devices may not be recognized, or failures can occur and the host server can stop.

If you booted or rebooted host servers, or if you used the host server to run the commands to recognize devices and the host server was stopped, use the following workflow to run the commands:

1. Forcibly stop the process of the command and those of its parent process.
2. Create the Thin Image pair.
3. Store the snapshot data (or clone pairs).
4. Rerun the command to recognize devices.

On the server (including CCI), the emulation type of the V-VOL is shown with a zero (0), such as OPEN-0V. If you create a Thin Image pair, specify a volume whose emulation type is shown with a zero (0) for the S-VOL, such as OPEN-0V.

Using an existing V-VOL as an S-VOL in a clone pair

If you want to use an existing V-VOL as an S-VOL in an HTI clone pair and the V-VOL has capacity saving enabled and has assigned pages, use the following procedure to prepare the V-VOL.

Procedure

1. Perform LDEV formatting on the volume you want to use as the S-VOL.

   If you create a pair without performing LDEV formatting, the initialization is performed during the copy operation, which might increase the required time for copying or might raise the processor operating rate.

2. Set the capacity saving mode that you want to use on the S-VOL to the mode that satisfies your user requirements.

   - Set the post-process mode if the user requirement is to suppress the impact on the I/O performance.

     Using this mode, the S-VOL requires the pool capacity to be as large as the P-VOL because capacity saving is performed after the pair is created.

   - Set the inline mode if the user requirement is to suppress the required pool capacity.

     The required time for copying might be longer or the processor operating rate might be greater than that in the post-process mode. Consider applying the post-process mode to suppress the required time or processor operating rate.

     If you use any of the following DKCMAIN firmware versions and create a pair without performing LDEV formatting, the post-process mode is applied even if you set the inline mode. Therefore, ensure that the pool capacity is as large as the P-VOL.

     - VSP 5000 series: Earlier than 90-05-04-xx/xx

     - VSP 5000 series: 90-06-01-xx.xx or later, earlier than 90-06-21-xx/xx

     - VSP E series: Earlier than 93-04-02-xx/xx

Changing local replica options that affect Thin Image performance

You can set the local replica options that affect Thin Image performance using Device Manager - Storage Navigator, as described here, or Command Control Interface.

For details about how to change local replica options using Command Control Interface, see the *Command Control Interface User and Reference Guide*.

Before you begin

- You must have the Storage Administrator (Local Copy) role.

- In CCI, use the `raidcom modify local_replica_opt` command.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, and then click **Replication**.

2. In the **Replication** window, click **Edit Options** > **Local Replication**.
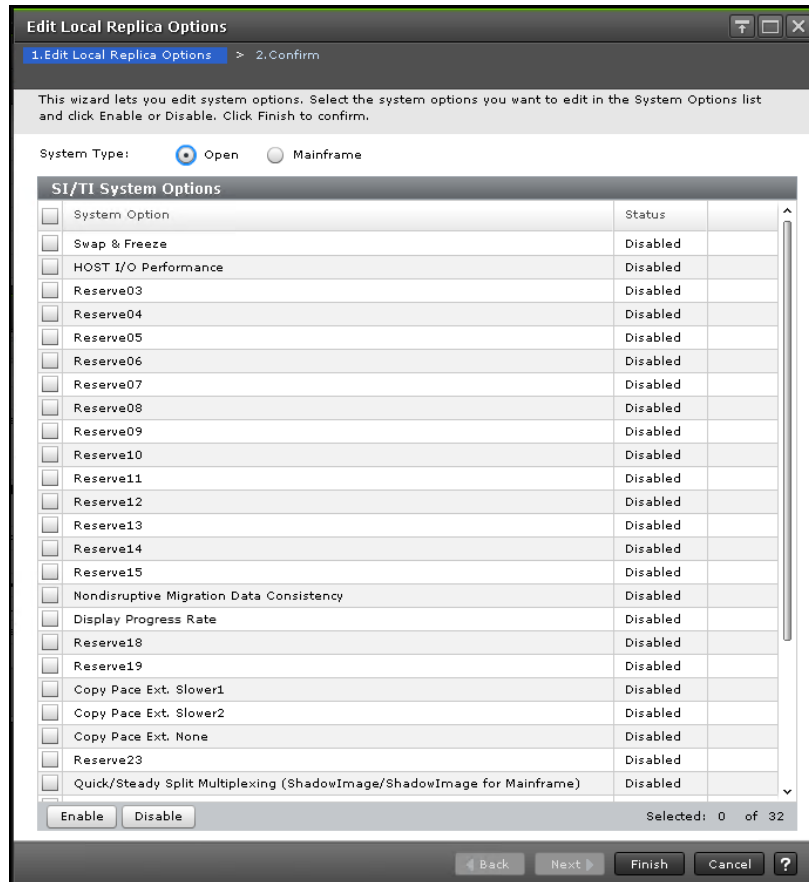
3. (VSP 5000 series) In the **Edit Local Replica Options** window of the **Edit Local Replica Options** wizard, for **System Type**, confirm that **Open** is selected.

   Default: Open

4. In the **SI/TI System Options** table, select the system option you want to change, and then click **Enable** or **Disable**.

   For VSP 5000 series
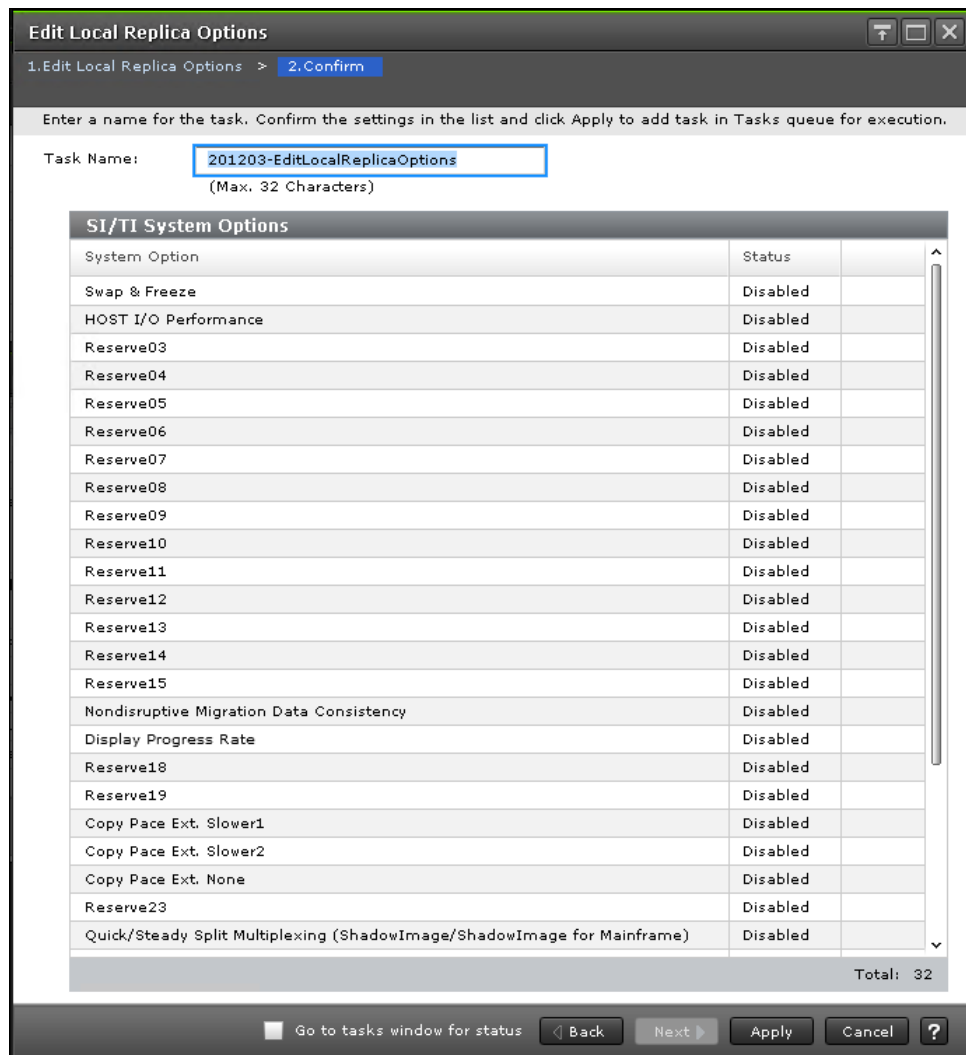
5. Click **Finish**, and then confirm the settings.

6. Accept the default task name or enter a unique name.

   You can enter up to 32 letters, numbers, and symbols, except the following:

   \ / : , ; * ? " < > |

7. If you want to monitor the task after submitting it, select **Go to tasks window for status**.

8. Click **Apply** to submit the task.

Workflow for creating and managing Thin Image pairs

Use this workflow to create and manage Thin Image pairs.

1. Create the Thin Image pairs (see).

2. Split the Thin Image pair to store the snapshot data using one of the available methods (see).

Chapter 3: Configuring Thin Image

3. If a failure occurs and the pair is suspended ("PSUE" status), complete the following:

   a. Recover the data by recovering the Thin Image pair (see Restoring suspended Thin Image pairs (on page 139)).

   b. Restore the pair, which writes snapshot data over the P-VOL (see Restoring Thin Image pairs (on page 137)).

4. Maintain the Thin Image pair status (see How Thin Image pair status changes (on page 38)).

5. Delete the Thin Image pairs (see Deleting Thin Image pairs (on page 142)).

For pairs with the snapshot attribute, create a Thin Image pair to store snapshot data. Note, however, that you can create up to 1,024 pairs for a P-VOL. Therefore, you must delete snapshot data or Thin Image pairs that are no longer necessary. When you delete a Thin Image pair, snapshot data stored by the pair is also deleted from the pool.

When a failure occurs, if you perform restoration, snapshot data can be overwritten in the P-VOL. If a Thin Image pair is already being restored, another Thin Image pair might not be restored.

For details about operations and statuses for Thin Image pairs, see How Thin Image pair status changes (on page 38). For details about how to create DP pools, see the *Provisioning Guide for Open Systems*.

Overview of using CCI to run commands through in-band connections

Use CCI to run commands through an in-band connection to perform Thin Image tasks. To run the command through an in-band connection, reserve a volume for use as a command device.

If you use CCI to run commands through an out-of-band connection, you do not need to reserve a volume.

> ⚠️ **Caution:** For maximum host I/O performance, use CCI to run commands through an in-band connection.

For more information about reserving a volume for use as a command device, see the *Command Control Interface User and Reference Guide*.

In the future, pair*xx* commands and raidcom commands will be merged. Use raidcom commands especially when you create a batch job.

For more information about CCI commands that correspond to actions in the HDvM - SN GUI, see CCI command reference for Thin Image (on page 219).

Deleting LU paths or namespaces set for Thin Image paired volumes

The following table outlines the specifications for deleting the last LU path from the Thin Image paired volumes.

Pair Volume	Deleting the last specified LU path	Deleting all LU paths in a batch by specifying multiple ports simultaneously
Thin Image paired volumes with the cascade attribute disabled	Disabled	Enabled*
Thin Image paired volumes with the cascade attribute enabled	Enabled	Enabled
*If you delete all LU paths, the pair cannot be displayed and the pair operations cannot be performed. Set at least one LU path to display the pair information and perform the pair operations after deleting all LUN paths.		

The following table lists whether deleting a namespace or an NVM subsystem port is enabled or disabled if a Thin Image pair volume is assigned to the namespace for NVMe.

Pair Volume	Deleting a namespace	Deleting all NVM subsystem ports from the NVM subsystem containing a namespace
Thin Image paired volumes with the cascade attribute disabled	Disabled	Disabled
Thin Image paired volumes with the cascade attribute enabled	Enabled	Enabled

Chapter 4: Managing Thin Image Pairs

You can perform the following tasks on Thin Image pairs:

- Create Thin Image pairs.

- View Thin Image pair status.

- Split Thin Image pairs to store snapshot data.

- Change the Thin Image pair status, if the pair is defined in a consistency group.

- Restore Thin Image pairs.

- Restore suspended Thin Image pairs, if the storage system suspends the pair ("PSUE" status) while you are restoring the pair.

- Resynchronize Thin Image pairs.

- Delete Thin Image pairs.

Workflow for creating and managing Thin Image pairs

Use this workflow to create and manage a Thin Image pair.

1. Create the data pool (see Creating Thin Image data pools (on page 105)).
2. Create the V-VOL for the pair (see Creating V-VOLs for Thin Image S-VOLs (on page 114)).
3. Create the Thin Image pair in one of the following ways:

    - Create the pair using HDvM - SN.

    - Create the pair using CCI and assign the pair to a snapshot group.

4. If you have assigned the pair to a consistency group, split the Thin Image pair using the consistency group to store snapshot data.
5. Delete the snapshot data in one of the following ways.

    - Delete the Thin Image pairs (see Deleting Thin Image pairs (on page 142)).

    - Delete only the snapshot data (see Resynchronizing Thin Image pairs (on page 140)).

Workflow for creating Thin Image pairs using Device Manager - Storage Navigator

In HDvM - SN, the pairs are configured based on the amount of snapshot data corresponding to the P-VOL, or the number of S-VOLs that are assigned to snapshot data. Thin Image uses MU numbers 0 to 1,023, and they are assigned in the order of 3 to 1,023, followed by 0 to 2.

The following image shows this configuration.
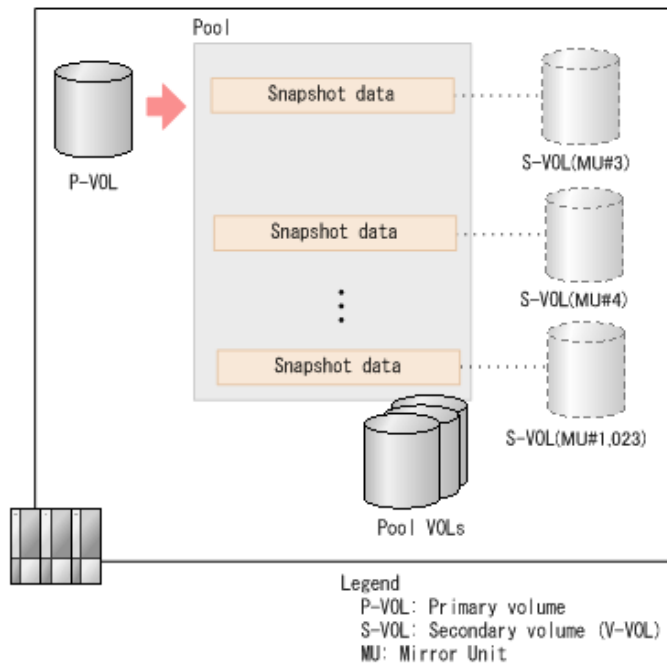
Creating Thin Image pairs using HDvM - SN involves the following steps.

1. Select the P-VOL.
2. Assign the S-VOL to snapshot data.
3. Confirm that you want to create the pair.

Creating Thin Image pairs using Device Manager - Storage Navigator

You can create a Thin Image pair and define the pair in a consistency group (CTG). You can create up to 32,768 Thin Image pairs at the same time on VSP 5000 series and on VSP E series.

When you create a pair, you specify the pool to be used. A Thin Image pair consists of a P-VOL and up to 1,024 S-VOLs. The MU numbers are assigned in the order of 3 to 1,023, followed by 0 to 2. If you use the CCI `raidcom add snapshot` command to create a pair, you can specify the MU number. If you use CCI commands, see Pair tasks using CCI or Device Manager - Storage Navigator (on page 219).

> ⚠ **Caution:** If the host server is down or has failed, a CTG that contains no Thin Image pairs might be created. Under such conditions, if you are using CCI to create a pair for CTG pair-split by running the `paircreate` command, the command might be rejected. In this case, look for a CTG in which an error occurred on the Consistency Groups tab in the Local Replication window, and then intentionally create a pair in the specified CTG.
>
> Additionally, if the host server is down or has failed, many CTGs that contain no Thin Image pairs might be created and there might not be enough available CTGs. In this case, look for a CTG that contains no Thin Image pairs on the Consistency Groups tab in the Local Replication window, and then intentionally create a pair in the specified CTG. After that, delete the pair, thereby also deleting the CTG that contains no Thin Image pairs.

Requirements:

- If you create a Thin Image pair with S-VOLs specified, the P-VOL and S-VOLs you select must be the same size in blocks. If the capacity is displayed in GB or TB, a small difference between P-VOL and S-VOL capacity might not be displayed. To view the capacity in blocks, click Options > Capacity Unit > block in the **Logical Devices** window.

- If you select a P-VOL that is already being used as the P-VOL for another Thin Image pair, you must specify the same pool for both pairs. For example, if you specify three S-VOLs for one P-VOL, specify the same pool for the three Thin Image pairs.

- The value of the T10 PI attribute must be the same for the P-VOL and S-VOL.

- A Thin Image pair cannot be created when the used pool capacity exceeds the warning threshold. In this case, increase the pool capacity first, and then create the pair.

- To prevent the Thin Image pairs from being suspended ("PSUE" status), do not create Thin Image pairs while you are shutting down the storage system.

- When only the P-VOL capacity of a Thin Image pair has been expanded, a cascaded pair cannot be created. Create the cascaded pair after expanding all of the volume capacity used in the pairs.

Before you begin

- You must have the Storage Administrator (Local Copy) role.

- If you are sharing ShadowImage volumes with Thin Image volumes, the SI pair must already exist.

- If you want to use a ShadowImage S-VOL as a Thin Image P-VOL when an available MU number does not exist, you must complete the following before creating the pair:

  1. Delete the Thin Image pairs of MU numbers 0 to 2.
  2. Create the ShadowImage pair.
  3. Re-create the Thin Image pair with an MU number of 3 or greater assigned.

Procedure

1. In the **Explorer** pane, click **Storage Systems**.
2. Expand the storage system tree, expand **Replication**, and then click **Local Replication**.

3. In the **Local Replication** window, select a P-VOL on the **TI Root Volumes** tab or a snapshot group in the **Snapshot Groups** tab, and then click **Create TI Pairs**.

4. In **Create Pairs using Volumes as Root Volumes** or **Use Primary Volumes of Thin Image Pairs**, select **Yes** or **No**.

5. In **Select By**, select **LUN** to create a pair by specifying LUN. Select **LDEV** to create a pair without specifying LUN.

6. From the **Available Primary Volumes** table, select the LDEV you want to assign as the P-VOL.

   > 📄 **Note:** The nondisruptive migration volumes do not appear in the **Available Primary Volumes** table.

7. In **Cascade**, select **Enable** to create a cascaded pair.

8. In **Pair Type**, select **Snapshot** to create a pair with the snapshot attribute. Select **Clone** to create cloned pairs. Skip to step 11 if you selected **No** for **Create Pairs using Volumes as Root Volumes**.

9. Click **Select Pool**.

10. In the **Select Pool** window, select a pool from the **Available Pools** table.

11. Click **OK**.

12. For **Snapshot Group**, select either **Create New** to assign the pair to a new snapshot group, or **Use Existing** to assign the pair to an existing snapshot group. When you create a Thin Image pair, you must assign it to a snapshot group.

    Complete one of the following:

    - For **Create New**, enter values for **Number of Snapshot Data per Primary Volume**, **Prefix**, and **Initial Number**, and then select **Snapshot Group Configuration**.

      When you specify an initial number that was already registered, the smallest available number that is the same as or larger than the specified number is automatically set.

    - For **Use Existing**, select **Snapshot Group Configuration**, and then select the snapshot group to which you want to assign the pair from the **Available Snapshot Groups** table.

      If you select **All**, enter a value in **Number of Snapshot Data per Primary Volume**.

    > 📄 **Note:** To create pairs and assign the pairs to a snapshot group by using CCI, see Adding Thin Image pairs to snapshot or consistency groups using CCI (on page 132).

13. Click **Add**.
    The selected LDEV is moved to the **Selected Primary Volumes** table.

14. Click **Next**.

15. From the **Available LDEVs** table, select the LDEV you want to assign as the S-VOL, and then click **Set**.
    The selected LDEV is displayed in the **Secondary Volumes** column of the **Selected Pairs** table.

Chapter 4: Managing Thin Image Pairs

> 📄 **Note:**
>
> - The nondisruptive migration volumes do not appear in the **Available Primary Volumes** table.
>
> - If you select a capacity in **Capacity**, the **Available LDEVs** and **Selected Pairs** tables display the LDEVs that match the selected capacity.
>
> - If you select a row in the **Available LDEVs** table and a row in the **Selected Pairs** table, and then click **Set**, you can configure a pair.
>
> - If you select LDEVs which were assigned to an S-VOL with the **Exclude Assigned Volumes** check box unchecked, you can change the S-VOL to which snapshot data is assigned.

16. Click **Finish**, and then confirm the settings.

17. Accept the default task name or enter a unique name.

    You can enter up to 32 letters, numbers, and symbols, except the following:

    \ / : , ; * ? " < > |

18. If you want to monitor the task after submitting it, select **Go to tasks window for status**.

19. Click **Apply** to submit the task.

    > 📄 **Note:** After creating a Thin Image pair, the number of pairs shown in the summary section in the **Local Replication** window and the number of pairs shown in the list in the **TI Pairs** tab might be different. Wait until the configuration information has completed processing. If the numbers of pairs still do not match, reload the configuration information (see Reloading Thin Image configuration information (on page 132)).

Selecting a pool as your primary volume

You select a pool when you are creating a Thin Image pair if you are not using the P-VOL of a Thin Image pair (that is, you have selected No for Use Primary Volumes of Thin Image Pairs in the Create TI Pairs window of the Create TI Pairs wizard).

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, expand **Replication**, and then click **Local Replication**.

2. In the **Local Replication** window, select a P-VOL in the **TI Root Volumes** tab or a snapshot group in the **Snapshot Groups** tab, and then click **Create TI Pairs**.

3. In the **Create TI Pairs** window of the **Create TI Pairs** wizard, click **Select Pool**.
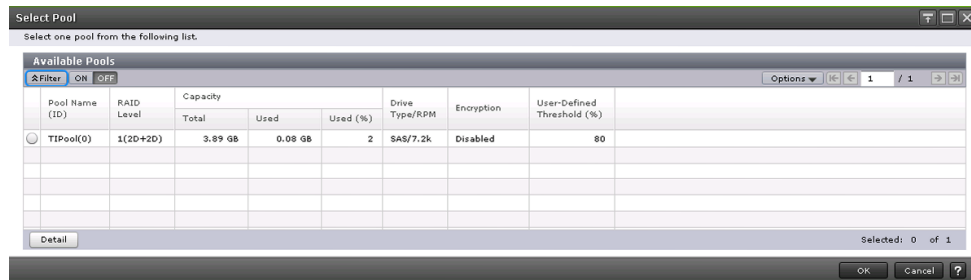
4. In the **Select Pool** window, from the **Available Pools** table, select the pool you want to add, and then click **OK**.
    The selected pool is displayed in **Select Pool** on the **Create TI Pairs** window.

Example of creating complex Thin Image pairs

A complex Thin Image pair is a pair where the P-VOL and S-VOL are not connected one to one. The following is an example of how to create Thin Image pairs of different configurations simultaneously in HDvM - SN.

In this example, one pair of two S-VOLs and another pair of one S-VOL are created simultaneously. Each pair's configuration is specified in the Create TI Pairs window.

1. In **Create Pairs using Volumes as Root Volumes**, select **Yes**.
2. Select two primary volumes from the **Available Primary Volumes** table.
3. In **Cascade**, select **Enable** to create a cascaded pair.
4. In **Pair Type**, select **Snapshot** to create a pair with the snapshot attribute. Select **Clone** to create cloned pairs.
5. Click **Select Pool**, and then select a pool in the **Select Pool** window.
6. Select **Create New** in **Snapshot Group**.
7. Enter 1 for **Number of Snapshot Data per Primary Volume**.
8. Select **Snapshot Group Configuration**.
9. Enter values for **Prefix** and **Initial Number**.
10. Click **Add**.
11. Select **No** for **Create Pairs using Volumes as Root Volumes**.
12. Select a primary volume for which you want to specify two secondary volumes from the **Available Primary Volumes** table.
13. Select **Create New** in **Snapshot Group**.
14. Enter 1 for **Number of Snapshot Data per Primary Volume**.
15. Select **Snapshot Group Configuration**.
16. Enter values for **Prefix** and **Initial Number**.
17. Click **Add**.
18. Click **Next**.
19. Select three secondary volumes in the **Assign Secondary Volumes** window, and then click **Set**.

Chapter 4: Managing Thin Image Pairs

Reloading Thin Image configuration information

After creating a Thin Image pair, you can reload the configuration information if data shown in windows are different.

For example, the number of pairs shown in the summary section in the **Local Replication** window and the number of pairs shown in the list in the TI Root Volumes tab can be different.

Procedure

1. Wait until the configuration information has completed processing.
2. If the numbers remain different, click **File** > **Refresh All**.

Pair operations for each consistency group

To use pairs in a consistency group, use CCI.

Adding Thin Image pairs to snapshot or consistency groups using CCI

You can create pairs and define the pairs in a snapshot group. By specifying an option, pairs can also belong to a consistency group. This task describes how to do this using CCI.

> 📄 **Note:** If the host is down, the CCI command might be rejected and the pair not defined in the group. In this case, you can use Device Manager - Storage Navigator to create the pair and assign it to a group.

The following is an example of using the `raidcom add snapshot` command to create a pair specifying the P-VOL (LDEV#10:10), the S-VOL (LDEV#20:20) and the pool (SnapPool00) in the snapshot group (db1), and to add the pair to the consistency group (CTG):

```
raidcom add snapshot -ldev_id 0x1010 0x2020 -pool SnapPool00 -
snapshotgroup db1 -snap_mode CTG
```

Workflow for defining Thin Image pairs and defining them in snapshot or consistency groups using Device Manager - Storage Navigator

If you use a CCI command to create a pair that should be a target of the consistency group pair-split, and the host is down, the CCI command might be rejected and the pair not defined in the group.

If the command is rejected, use the following process to define the pair to the consistency group:

1. View a list of the consistency groups and locate the consistency group to which you want to assign the pair.

   For more information about how to view a list of consistency groups, see <u>Viewing the list of consistency groups (on page 162)</u>.

2. Create a pair and define it to a consistency group.

   For more information about how to create pairs and define them in consistency groups, see Creating Thin Image pairs using Device Manager - Storage Navigator (on page 127).

Storing snapshot data or cloning pairs

From a P-VOL, a maximum of 1,024 snapshots can be stored or pairs can be cloned. Use one of these two methods to store Thin Image snapshot data or clone pairs.

- Split the Thin Image pair.

  For more information about storing snapshot data by splitting pairs, see Splitting Thin Image pairs to store snapshot data (on page 133).

- Split the Thin Image pair within the consistency group using consistency group pair-split. Complete one of the following:

  - If you are not sharing Thin Image P-VOLs with Universal Replicator or TrueCopy S-VOLs within a storage system, see Workflow for storing snapshot data or clone pairs in consistency groups (on page 134).

  - If you are sharing Thin Image P-VOLs with Universal Replicator or TrueCopy S-VOLs within a storage system, see Using consistency group pair-split with shared volumes (on page 135).

Splitting Thin Image pairs to store snapshot data

This topic explains how to split pairs. Splitting pairs stores snapshot data.

A maximum of 1,024 snapshots can be stored or pairs can be cloned from a P-VOL. If you reach the maximum, delete the unneeded or unused snapshots.

> **Note:** If the amount of snapshot data in selected P-VOLs or the total number of pairs in selected snapshot groups exceeds 37,768, an error message appears when attempting to perform pair tasks.

If you use CCI commands, see Pair tasks using CCI or Device Manager - Storage Navigator (on page 219).

Before you begin

- You must have the Storage Administrator (Local Copy) role.

- The Thin Image pair status must be "PAIR".

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, expand **Replication**, and then click **Local Replication**.

2. In the **Local Replication** window, select a P-VOL in the **TI Root Volumes** tab or a snapshot group in the **Snapshot Groups** tab.

3. Click **Operate TI Pairs**.

4. In the **TI Pairs** window, specify the pair you want to split and then click **Split Pairs**.

   You can specify P-VOLs in Device Manager - Storage Navigator until the total number of snapshots or clones reaches 32,768. You can also specify snapshot groups until the total number of pairs reaches 32,768. For cascaded pairs with layers, start with pairs at the higher layers.

5. Click **Finish**, and then confirm the settings.

6. Accept the default task name or enter a unique name.

   You can enter up to 32 letters, numbers, and symbols, except the following:

   \ / : , ; * ? " < > |

7. If you want to monitor the task after submitting it, select **Go to tasks window for status**.

8. Click **Apply** to submit the task.

Splitting Thin Image pairs to store snapshot data using CCI

Contain only Thin Image pairs that are either assigned to consistency groups or pairs that are not assigned to consistency groups in a group defined by the configuration definition file for CCI.

To specify more than one consistency group, define the same number of groups using the configuration definition file for CCI.

Procedure

1. Run the CCI `pairsplit` command.

Workflow for storing snapshot data or clone pairs in consistency groups

You can split pairs to store snapshot data or clone pairs for a consistency group using CCI (the consistency group pair-split function). This process explains how to use CCI's consistency group pair-split to store snapshot data or clone pairs for each consistency group.

> **Note:** If you cannot change the status of a pair in a Thin Image consistency group, the `raidcom modify snapshot -snapshot_data create` or `raidcom modify snapshot -snapshot_data clone` command might return the error code EX_EWSTOT (timeout), and end abnormally. For details, see Notes on using Thin Image primary volumes as TrueCopy, ShadowImage, or Universal Replicator pair volumes (on page 234).

Use the following process to split Thin Image pairs to store snapshot data or clone pairs:

1. (If the pairs are not created) Create two Thin Image pairs and assign both pairs to the same consistency group. To do this, using CCI, run the following **raidcom** command twice using an option to specify the consistency group ID:

   ```
   raidcom add snapshot
   ```

   A pair is created and defined in a consistency group. This group is the target of the consistency group pair-split. The consistency group ID option you specified automatically enables the consistency group pair-split.

2. Create the pair to store snapshot data for a group. To do this, using CCI, specify the same consistency group ID as step 1 to run either of the following **raidcom** commands:

   ```
   raidcom modify snapshot -snapshot_data create
   ```

   ```
   raidcom modify snapshot -snapshot_data clone
   ```

3. The storage system receives the command. Then it stores the snapshot data for the consistency group that is the target of the consistency group pair-split, or clones pairs when a host issues a write request to the Thin Image pair's P-VOL that is assigned to the consistency group.

4. A host issues a write request to the Thin Image pair's P-VOL that is assigned to the consistency group.

5. The pairs are split and the snapshot data is stored.

Using consistency group pair-split with shared volumes

If you are sharing Thin Image P-VOLs with ShadowImage, Universal Replicator, or TrueCopy S-VOLs within a storage system, you can use consistency group pair-split to split the pairs that are defined in a consistency group to store the snapshot data. Consistency group pair-split maintains consistency for the Thin Image S-VOLs that are defined in the consistency group.

The following figures illustrate these configurations.

The following figure shows the consistency group pair-split configuration when you are sharing Thin Image P-VOLs with Universal Replicator S-VOLs.

Legend
TI: Thin Image
UR: Universal Replicator
JNLVOL: Journal volume
P-VOL: Primary volume
S-VOL: Secondary volume
------ : Journal volume connection
········ : CTG (consistency group)
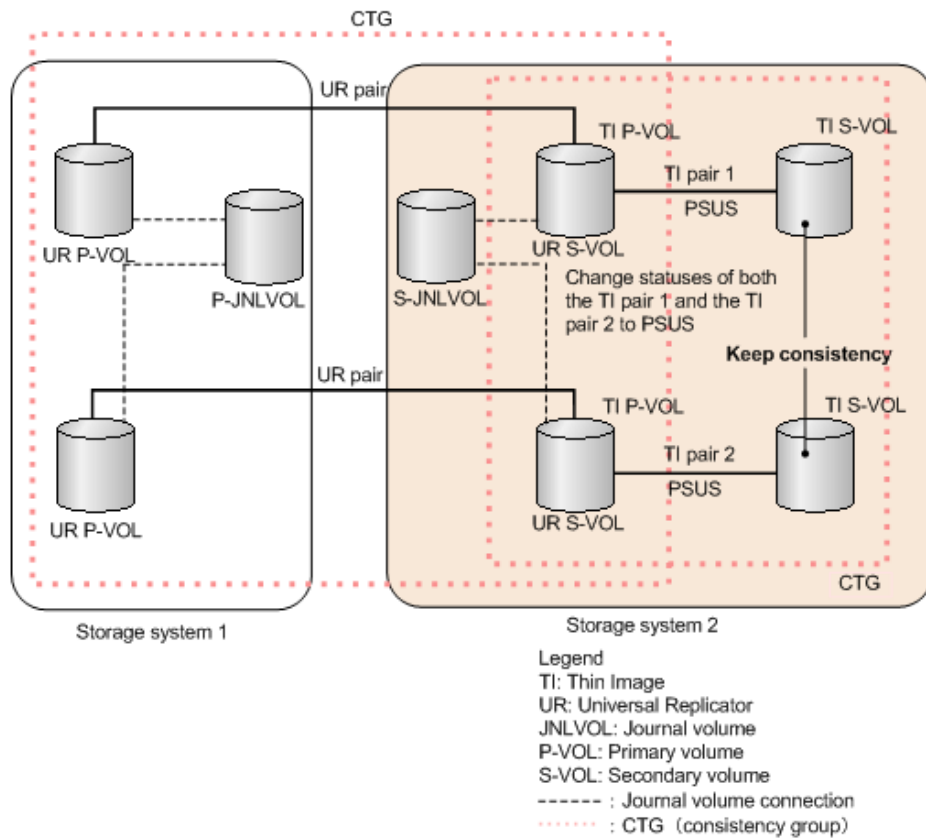
The following figure show the consistency group pair-split configuration when sharing Thin Image P-VOLs with TrueCopy S-VOLs.

Legend
TI: Thin Image
TC: TrueCopy
P-VOL: Primary volume
S-VOL: Secondary volume
········ : CTG (consistency group)
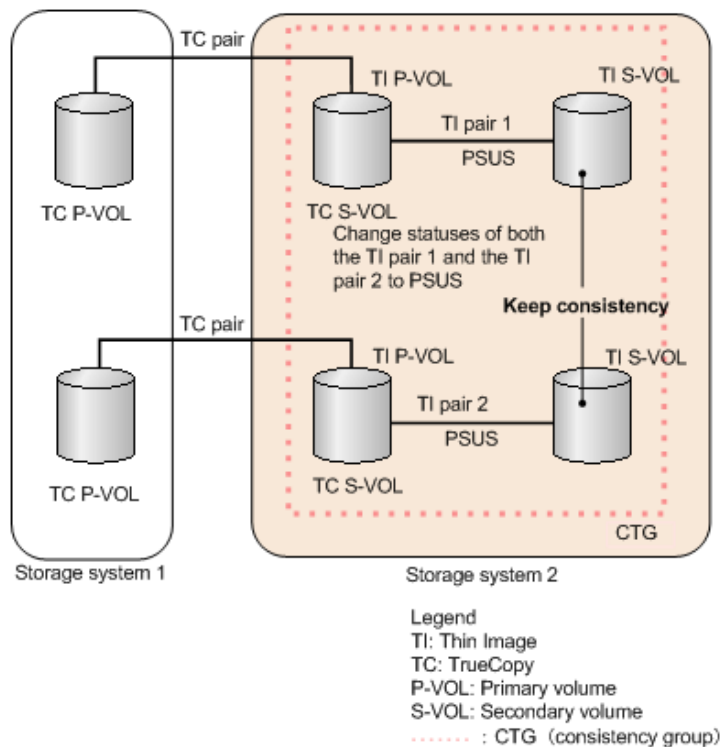
The following table explains when you can use consistency group pair-split with shared volumes.

HTI P-VOL used as	Pair status	Can you use consistency group pair-split?
UR S-VOL	COPY	No
	PAIR	Yes
	PSUS	Yes
TC S-VOL	COPY	No
	PAIR	Yes
	PSUS	Yes
SI S-VOL	COPY	No
	PAIR	No
	COPY(SP)	No
	PSUS(SP)	No
	PSUS	Yes
	COPY(RS)	No
	COPY(RS-R)	No
	PSUE	No

You cannot maintain the consistency of Thin Image S-VOLs that are defined in a consistency group in the following cases:

- You are sharing a Thin Image P-VOL with ShadowImage, TrueCopy, or Universal Replicator S-VOLs, and the statuses of those pairs are not the same.

- You are sharing a Thin Image P-VOL with a Universal Replicator S-VOL and they do not share the same journal.

For more information about Universal Replicator, see the *Hitachi Universal Replicator User Guide*.

Restoring Thin Image pairs

Restoring a Thin Image pair overwrites the existing P-VOL data with the differential data on the S-VOL.

Restoration of a Thin Image pair may end abnormally in either of the following conditions:

- You are storing snapshot data for a consistency group that already includes the pair.

- You are using the P-VOL of the pair as the P-VOL of another Thin Image pair and you are storing snapshot data for a consistency group including the latter pair.

For Thin Image pairs where the cascade attribute is enabled, the information displayed in Synchronization Rate (%) of the View Pair Synchronization Rate window, or the information displayed by the `raidcom get snapshot` command varies depending on the pair status. For details, see View Pair Synchronization Rate window (on page 255).

> ⚠ **Caution:** Failures can occur while restoring Thin Image pairs, which suspends the pairs ("PSUE" status).
>
> For more information about restoring suspended Thin Image pairs, see Restoring suspended Thin Image pairs (on page 139).

The amount of time required for restoration depends on the following, even if the pair synchronization rate is 100 percent:

- The amount of capacity the pool is using.

- The number of pairs being resynchronized concurrently.

For Thin Image pairs where the cascade attribute is enabled, the information displayed in Synchronization Rate (%) of the View Pair Synchronization Rate window, or the information displayed by the raidcom get snapshot command varies depending on the pair status. For details, see View Pair Synchronization Rate window (on page 255).

> 📄 **Note:** The pair synchronization rate may not change when you view the rate while restoring the Thin Image pair. To view the up-to-date rate, wait until the task has completed.
>
> For more information about monitoring the pair synchronization rates, see Viewing pair synchronization rates (on page 160).

> 📄 **Note:** If the amount of snapshot data in selected P-VOLs or the total number of pairs in selected snapshot groups exceeds 37,768, an error message appears when attempting to perform pair tasks.

If you use CCI commands, see Pair tasks using CCI or Device Manager - Storage Navigator (on page 219).

Before you begin

- You must have the Storage Administrator (Local Copy) role.

- The Thin Image pair must be split ("PSUS" status).

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, expand **Replication**, and then click **Local Replication**.
2. In the **Local Replication** window, select a P-VOL in the **TI Root Volumes** tab or a snapshot group in the **Snapshot Groups** tab.

3. Click **Operate TI Pairs**.

4. In the **TI Pairs** window, select the pairs you want to resynchronize, and then click **Resync Pairs**. You can specify P-VOLs until the number of snapshots or clones reaches 32,768. You can also specify snapshot groups until the number of pairs reaches 32,768. For cascaded pairs with layers, specify pairs at the lowest layer, and then higher layers.

5. For **Resync Type**, select **Reverse Copy (Secondary > Primary)** for a full restoration of P-VOL data from the S-VOL.

6. Click **Finish**, and then confirm the settings.

7. Accept the default task name or enter a unique name.

    You can enter up to 32 letters, numbers, and symbols, except the following:

    \ / : , ; * ? " < > |

8. If you want to monitor the task after submitting it, select **Go to tasks window for status**.

9. Click **Apply** to submit the task.

Result

The Thin Image pair is restored ("PAIR" status).

Failure during Thin Image pair restore

If a failure occurs while restoring Thin Image pairs, the pairs are suspended.

During a failure, the storage system does the following:

- Blocks and suspends the Thin Image pair ("PSUE" status), including pairs that have snapshot data in the pool.

- Writes data to the Thin Image pair volumes.

- Exceeds the data pool capacity of snapshot data.

If a failure occurs, delete the unneeded snapshot data by restoring the suspended pairs.

Restoring suspended Thin Image pairs

When pairs are suspended ("PSUE" status) after a failure occurs, they need to be restored.

📄 **Note:** You can only restore one Thin Image pair at a time.

Procedure

1. Delete the snapshot data by resynchronizing the pair.

2. Complete one of the following:

    - Overwrite the backup data to the P-VOL.

    - Format the P-VOL.

    For more information about overwriting backup data to the P-VOL or formatting LDEVs, see the *Provisioning Guide* for your storage system.

Thin Image pair resynchronization

Resynchronizing a Thin Image pair updates the S-VOL with the differential data and deletes the replaced data, the data in the pool. Resynchronizing a pair maintains the relationship between the P-VOL and S-VOLs.

The amount of time required for resynchronization depends on the following, even if the pair resynchronization rate is 100 percent:

- The amount of capacity the pool is using.

- The number of pairs being resynchronized concurrently.

Pair resynchronization methods

You can forward or reverse resynchronize Thin Image pairs. A forward resynchronization resynchronizes the S-VOL from the P-VOL. A reverse resynchronization restores the P-VOL from the S-VOL.

Forward resynchronization

You can use the Normal Copy (Primary > Secondary) method to forward resynchronize pairs.

This method performs a full forward resynchronization of data from the P-VOL to the S-VOL. The differential data is copied to the S-VOL.

Reverse resynchronization

You can use the Reverse Copy (Secondary > Primary) method to restore pairs.

This method performs a full restoration of P-VOL data from the S-VOL.

Resynchronizing Thin Image pairs

You can resynchronize Thin Image pairs that you have split or that the storage system has suspended.

Resynchronizing pairs does the following:

- Updates the S-VOL so that it is again paired with the P-VOL.

- Frees up the P-VOL's snapshot differential data for that P-VOL to reuse.

📄 **Note:** If the amount of snapshot data in selected P-VOLs or the total number of pairs in selected snapshot groups exceeds 37,768, an error message appears when attempting to perform pair tasks.

Before you begin

- You must have the Storage Administrator (Local Copy) role.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, expand **Replication**, and then click **Local Replication**.

2. In the **Local Replication** window, select a P-VOL in the **TI Root Volumes** tab or a snapshot group in the **Snapshot Groups** tab.

3. Click **Operate TI Pairs**.

4. In the **TI Pairs** window, select the pair you want to resynchronize, and then click **Resync Pairs**.

5. For **Resync Type**, select **Normal Copy (Primary > Secondary)** for full forward resynchronization of data from the P-VOL to the S-VOL.

6. Click **Finish**, and then confirm the settings.

7. Accept the default task name or enter a unique name.

   You can enter up to 32 letters, numbers, and symbols, except the following:

   \ / : , ; * ? " < > |

8. If you want to monitor the task after submitting it, select **Go to tasks window for status**.

9. Click **Apply** to submit the task.

Result

The Thin Image pair is resynchronized ("PAIR" status).

Assigning MU numbers to deleted snapshot data

Use this process to assign an MU number to deleted snapshot data.

Procedure

1. Resynchronize the pair using forward resynchronization.
2. Store the data for the Thin Image pair.

Deleting snapshot data

After writing data to a Thin Image pair volume, if the capacity of the snapshot data exceeds the pool capacity, the Thin Image pair changes to the PSUE status (indicating a failure occurred). In the PSUE status, the snapshot data is lost which makes it inaccessible. In this case, you cannot create a new Thin Image pair, and you must delete the snapshot data that is no longer necessary.

You can delete the snapshot data in either of these two ways. You must have the Storage Administrator (Local Copy) role.

Delete the Thin Image pairs
   Deleting Thin Image pairs deletes the snapshot data stored in a pool and cancels the relationship between the P-VOL and the S-VOL.

Delete the snapshot data only
   To delete snapshot data only, use the **Resync Pairs** window to delete snapshot data or restore Thin Image pairs. If you only delete snapshot data, the relationship between

the P-VOL and the S-VOL is maintained. If you only delete snapshot data, you can assign the MU numbers of the snapshot data you deleted when you store snapshot data of the Thin Image pair later.

For details about the **Resync Pairs** window, see <u>Restoring Thin Image pairs (on page 137)</u> or <u>Deleting Thin Image pairs (on page 142)</u>.

> 📄 **Note:** Even if some Thin Image pairs that are created in a snapshot tree or if snapshot data only is deleted, the amount of used pool capacity is not reduced because the pages allocated as the snapshot data in the pool are not released. The pages that are not released are reused when you create new snapshot data. To reduce the amount of used pool capacity, you must defrag the snapshot data area, or delete all Thin Image pairs created in the snapshot tree.

When you delete snapshot data, the pair status changes to PAIR. Even if you update the primary volume from the host, the snapshot data is no longer stored. To resume storing snapshot data, split the Thin Image pair again.

The amount of time required for deleting snapshot data depends on the following, even if the pair synchronization ratio is 100 percent:

- The amount of pool capacity a pair is using.

- The number of pairs being operated concurrently.

The pair synchronization rate shows the rate that S-VOL data matches that of the next generation of the S-VOL. If the S-VOL is the latest one, the synchronization rate is computed by comparing the S-VOL with the P-VOL.

For the Thin Image pair where the cascade attribute is enabled, the information displayed in Synchronization Rate (%) of the View Pair Synchronization Rate window in HDvM - SN, or the `raidcom get snapshot` command in CCI varies depending on the pair status.

Deleting Thin Image pairs

Delete Thin Image pairs when you do not need them or when you want to delete snapshot data using the Delete Pairs window in HDvM - SN, or the corresponding CCI command.

When you delete a pair, the P-VOL and the S-VOL change to SMPL(PD) and they are unpaired. When volumes are unpaired, they are not displayed in the main window. After the deletion, you can use the unpaired volumes in other pairs. You cannot create pairs in the SMPL(PD) status, and you cannot allocate an S-VOL to snapshot data, or cancel or change the allocation. To shorten the time in the SMPL(PD) status, delete snapshot data if any, and delete pairs after the pair status changes to PAIR. When you set a snapshot group, if all pairs in a snapshot group are unpaired, the snapshot group is automatically removed. Make sure that the snapshot group is removed before starting another pair task.

All snapshot data in a P-VOL must be deleted for there to be a decrease in the pool usage rate and an increase in unused capacity.

The amount of time required for deletion depends on the following, even if the pair resynchronization rate is 100 percent:

- The amount of pool capacity a pair is using.

- The number of pairs being operated concurrently.

The pair synchronization rate shows the rate that S-VOL data matches that of the next generation of the S-VOL. If the S-VOL is the latest one, the synchronization rate is computed by comparing the S-VOL with the P-VOL.

For a Thin Image pair where the cascade attribute is enabled, the information displayed in Synchronization Rate (%) of the View Pair Synchronization Rate window in Device Manager - Storage Navigator, or the information displayed by the `raidcom get snapshot` command in CCI, varies depending on the pair status. For details, see View Pair Synchronization Rate window (on page 255).

If you cannot delete Thin Image pairs with Device Manager - Storage Navigator, you can use the `raidcom delete snapshot -range tree` command to forcibly delete all Thin Image cascaded pairs in a snapshot tree. For details about CCI commands, see Pair tasks using CCI or Device Manager - Storage Navigator (on page 219) and the *Command Control Interface Command Reference*.

If forcible deletion of all Thin Image pairs in a snapshot tree is not complete 10 minutes after the command is issued, the pair deletion might have been interrupted due to contention with processing of changing storage system configuration. In this case, run the command again to forcibly delete all Thin Image pairs in the snapshot tree.

> **Note:** After deleting a Thin Image pair, the number of pairs shown in the summary section in the **Local Replication** window and in the list on the TI Root Volumes tab can be different. Wait until the configuration has completed processing. If the numbers do not match, reload the configuration information (see Reloading Thin Image configuration information (on page 132)).

> **Note:** If the amount of snapshot data in selected P-VOLs or the total number of pairs in selected snapshot groups exceeds 37,768, an error message appears when attempting to perform pair tasks.

If you use CCI commands, see Pair tasks using CCI or Device Manager - Storage Navigator (on page 219).

Before you begin

- You must have the Storage Administrator (Local Copy) role.

- The Thin Image pair must be suspended ("PSUE" status), paired ("PAIR" status), or split ("PSUS" status).

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, expand **Replication**, and then click **Local Replication**.

2. In the **Local Replication** window, select a P-VOL in the **TI Root Volumes** tab or a snapshot group in the **Snapshot Groups** tab.

3. Click **Operate TI Pairs**.

4. In the **TI Pairs** window, select the pair you want to delete, and then click **More Actions** > **Delete Pairs**.

   You can specify P-VOLs in Device Manager - Storage Navigator until the total number of snapshots or clones reaches 32,768. In addition, you can specify snapshot groups until the total number of pairs reaches 32,768. For cascaded pairs with layers, specify pairs at the lowest layer, and then higher layers.

5. Click **Finish**, and then confirm the settings.

6. Accept the default task name or enter a unique name.

   You can enter up to 32 letters, numbers, and symbols, except the following:

   \ / : , ; * ? " < > |

7. If you want to monitor the task after submitting it, select **Go to tasks window for status**.

8. Click **Apply** to submit the task.

Result

The pair deletion process begins ("SMPL(PD)" status), and then the pair is deleted.

Accelerating the Thin Image pair deletion process

You can shorten the time that a Thin Image pair is in the process of being deleted ("SMPL(PD)" status). If the pair status is "SMPL(PD)", you cannot recreate a Thin Image pair, and you cannot assign an S-VOL to snapshot data, release an assignment, or change an assignment.

Procedure

1. Delete the snapshot data by resynchronizing the pair.

   This puts the pair in "PAIR" status.

2. Delete the pair.

Removing Thin Image snapshot groups

You can remove snapshot groups by deleting all of the pairs in the group. Remove snapshot groups before performing the next pair task.

📄 **Note:** You can use HDvM - SN only to reference consistency and snapshot groups and to remove snapshot groups. You cannot use HDvM - SN to delete consistency groups.

Procedure

1. Delete all of the Thin Image pairs that are assigned to the snapshot group.

Defragmenting a snapshot data area

After a Thin Image pair is deleted, restored, or resynchronized, or snapshot data is deleted, some areas that store unnecessary data exist in the snapshot data area. These data areas are referred to as garbage. Garbage can be reused only when snapshot data is stored in the same snapshot tree, and it cannot be used for other purposes.

The defrag function consolidates the areas being used to return the pages that store only garbage data to unallocated pages.

> **Important:** SVOS RF 9.4 defragmentation commands only support VSP 5000 series storage.

The following are the effects of defragmentation:

- The free space of the pool increases.
- The released pages can be used for other purposes.

You can specify the root volume and start the defragmentation process (defrag processing). The defrag processing is performed for the snapshot data area, and the processing finishes when the amount of the remaining garbage becomes less than 1 GB.
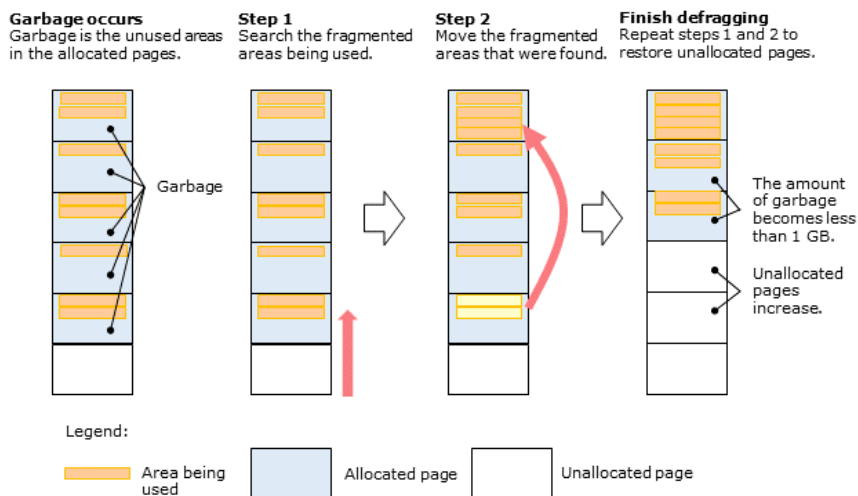
Defragmenting using CCI

You can efficiently use the storage system capacity by regularly defragmenting the storage devices. It is best to perform defragment operations after deleting, restoring, or resynchronizing many Thin Image pairs and after deleting snapshot data.

You can use CCI to regularly perform defrag operations. For example, you can define CCI commands as a batch job and execute the batch job by using the job scheduler. Even if a defrag operation is stopped before it completes, the free capacity of the pool increases as much as the capacity of the pages that were returned to the unallocated state. Because you can stop the defrag operation at a specified time (for example, by using the job scheduler), you can plan the defrag operations during a time period when there are few business activities.

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Note that Storage Navigator cannot be used for defrag operations.

The following table lists and describes the CCI commands for defrag operations. For details about CCI commands, see the *Command Control Interface Command Reference*.

Operation	CCI command	Description

Starting a defrag operation
 	
(Starting deletion of the snapshot garbage data)
	`raidcom modify snapshot`
	
	`-snapshot_data delete_garbage`
		You can specify the root volume, and then start the defrag processing. The snapshot data area is defragged. This command can be executed for every HTI pair regardless of its attribute (cascade or clone).
		
		If the amount of the remaining garbage becomes less than 1 GB, the defrag processing automatically finishes.
		
		Caution: The defrag processing might finish even when the amount of the remaining garbage is 1 GB or more. You can reduce the amount of the remaining garbage to less than 1 GB by performing a defrag operation again.

Stopping a defrag operation
 	
(Stopping deletion of the snapshot garbage data)
	`raidcom modify snapshot`
	
	`-snapshot_data stop_deleting_garbage`
		You can specify the root volume, and then stop the defrag processing.
		
		If the amount of garbage becomes less than 1 GB, the defrag processing automatically finishes. The user can also instruct to stop the defrag processing. Even when the defrag processing is stopped by user instruction, the free capacity of the pool increases as much as the capacity of the pages that were returned to the unallocated state.

Operation	CCI command	Description
Viewing the garbage information and the execution status of the defrag processing (deletion processing of the snapshot garbage data)	`raidcom get ldev`	You can specify the root volume, and then collect the following information items: • [SNAP_GARBAGE(MB)]: The amount of garbage (MB). You cannot collect information of the amount of garbage during defrag processing. Collect information of the amount of garbage before the defrag processing starts or after the defrag processing finishes. • [DELETING_SNAP_GARBAGE]: The execution status of the defrag processing • [DELETING_SNAP_GARBAGE(%)] : The progress of the defrag processing (%)

Execution status of the defrag processing

The following table lists and describes the execution statuses of the defrag processing (deletion processing of the snapshot garbage data) that can be collected by using the `raidcom get ldev` command and indicates whether defrag operations are enabled in each execution status.

Execution status	Description	Whether defrag operations are enabled	
		Start operation	Stop operation
NONE	No defrag processing has been executed.	Yes	No execution
PROCESSING	The defrag processing is being executed. Even when the defrag processing pauses as described in the following topic, the execution status indicates PROCESSING.	No execution	Yes
STOPPING	The defrag processing is being stopped (in transition from PROCESSING to NONE).	No	No execution

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Execution status	Description	Whether defrag operations are enabled	
		Start operation	Stop operation
Legend: • Yes: The defrag operation is enabled. • No execution: The defrag operation is available and the command successfully ends, but the processing is not executed. • No: The defrag operation is disabled.			

Reviewing defrag processing behaviors

Before defragmenting, review the conditions related to defragmentation during a heavy storage system load, when Thin Image pair operations are in progress, when the storage system is powered on or off, and when the defrag process is stopped.

Defrag processing during a heavy system load

If the load placed on the storage system becomes high, the defrag processing automatically pauses to suppress the influence on the host server's I/O performance. When the load becomes low, the defrag processing resumes. The defrag processing pauses when either of the following conditions exist:

- MP usage rate. The usage rate of the owner MP unit for the root volume being defragged is 50% or higher.

- Write pending rate. The write pending rate of the CLPR to which the root volume being defragged belongs is 30% or higher.

Defrag processing and Thin Image pair operations

- The Thin Image pair operations in the snapshot tree that are being defragged are available even during the defrag processing, but the defrag processing pauses if a pair is resynchronized, restored, or deleted. Also, the defrag processing pauses when cloning is completed. The defrag operation resumes when the pair operation finishes. After a paused defrag process resumes, the progress of the defrag processing returns to 0%.

- If you start defrag processing while a pair operation is underway for the snapshot tree to be defragged, the defrag processing starts after the pair operation finishes.

Defrag processing and powering on or off the storage system

If the storage system power is turned off, the defrag processing pauses. When the power is turned on, the defrag processing resumes.

Stopping the defrag processing

If either of the following operations is performed during the defrag processing, the storage system stops the defrag processing:

- All pairs are deleted in the snapshot tree to be defragged.

- The local replication is initialized.

Assigning secondary volumes to Thin Image pair snapshot data

You can assign secondary volumes to Thin Image snapshot data.

Assigning secondary volumes to snapshot data after creating new Thin Image pairs

You can assign an S-VOL to snapshot data after creating a new Thin Image pair.

📄 **Note:** If the amount of snapshot data in selected P-VOLs or the total number of pairs in selected snapshot groups exceeds 37,768, an error message appears when attempting to perform pair tasks.

If you use CCI commands, see Pair tasks using CCI or Device Manager - Storage Navigator (on page 219).

Before you begin

You must have the Storage Administrator (Local Copy) role.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, expand **Replication**, and then click **Local Replication**.
2. In the **Local Replication** window, select a P-VOL in the **TI Root Volumes** tab or a snapshot group in the **Snapshot Groups** tab.
3. Click **Operate TI Pairs**.
4. In the **TI Pairs** window, click **Create TI Pairs**.

    You can specify P-VOLs in Device Manager - Storage Navigator until the total number of snapshots or clones reaches 32,768. In addition, you can specify snapshot groups until the total number of pairs reaches 32,768.
5. In **Use Primary Volumes of Thin Image Pairs**, or **Create Pairs using Volumes as Root Volumes**, select **Yes** or **No**.
6. In **Select By**, select **LUN** to create a pair by specifying LUN. Select **LDEV** to create a pair without specifying LUN.
7. From the **Available Primary Volumes** table, select the LDEV you want to assign as the P-VOL.

    📄 **Note:** The nondisruptive migration volumes do not appear in the **Available Primary Volumes** table.
8. In **Cascade**, select **Enable** to create a cascaded pair.
9. In **Pair Type**, select **Snapshot** to create a pair with the snapshot attribute. Select **Clone** to create a cloned pair. If you selected **No** for **Create Pairs using Volumes as Root Volumes**, go to step 13.
10. Click **Select Pool**.
11. In the **Select Pool** window, select a pool from the **Available Pools** table.

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12. Click **OK**.

13. For **Snapshot Group**, select either **Create New** to assign the pair to a new snapshot group, or **Use Existing** to assign the pair to an existing snapshot group. When you create a Thin Image pair, you must assign it to a snapshot group.

Complete one of the following:

- For **Create New**, enter values for **Number of Snapshot Data per Primary Volume**, **Prefix**, and **Initial Number**, and then select **Snapshot Group Configuration**.

  When you specify an initial number that was already registered, the smallest available number that is the same as or larger than the specified number is automatically set.

- For **Use Existing**, select **Snapshot Group Configuration**, and then select the snapshot group to which you want to assign the pair from the **Available Snapshot Groups** table. If you select **All**, enter a value in **Number of Snapshot Data per Primary Volume**.

  > **Note:** To create pairs and assign the pairs to a snapshot group by using CCI, see Adding Thin Image pairs to snapshot or consistency groups using CCI (on page 132).

14. Click **Add**.
The selected LDEV is moved to the **Selected Primary Volumes** table.

15. Click **Next**.

16. From the **Available LDEVs** table, select the LDEV you want to assign as the S-VOL, and then click **Set**.
The selected LDEV is displayed in the **Secondary Volumes** column of the **Selected Pairs** table.

  > **Note:**
  > - The nondisruptive migration volumes do not appear in the **Available Primary Volumes** table.
  > - If you select a capacity in **Capacity**, the **Available LDEVs** and **Selected Pairs** tables display the LDEVs that match the selected capacity.
  > - If you select a row in the **Available LDEVs** table and a row in the **Selected Pairs** table and then click **Set**, you can configure a pair.

17. Click **Finish**, and then confirm the settings.

18. Accept the default task name or enter a unique name.

You can enter up to 32 letters, numbers, and symbols, except the following:

\ / : , ; * ? " < > |

19. If you want to monitor the task after submitting it, select **Go to tasks window for status**.

20. Click **Apply** to submit the task.

Assigning secondary volumes to snapshot data of existing Thin Image pairs

You can assign an S-VOL to snapshot data of an existing Thin Image pair.

📄 **Note:** If the amount of snapshot data in selected P-VOLs or the total number of pairs in selected snapshot groups exceeds 32,768, an error message appears when attempting to perform pair tasks.

If you use CCI commands, see .

Before you begin

You must have the Storage Administrator (Local Copy) role.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, expand **Replication**, and then click **Local Replication**.

2. In the **Local Replication** window, select a P-VOL in the **TI Root Volumes** tab or a snapshot group in the **Snapshot Groups** tab.

3. Click **Operate TI Pairs**.

4. In the **TI Pairs** window, click **More Actions** > **Assign Secondary Volumes**.

    You can specify P-VOLs in Device Manager - Storage Navigator until the total number of snapshots or clones reaches 32,768. In addition, you can specify snapshot groups until the total number of pairs reaches 32,768.

5. From the **Available LDEVs** table, select the LDEV you want to assign as the S-VOL, and then click **Set**.
   The selected LDEV is displayed in the **Secondary Volumes** column of the **Selected Pairs** table.

    📄 **Note:**

    ▪ The nondisruptive migration volumes do not appear in the **Available Primary Volumes** table.

    ▪ If you select a capacity in **Capacity**, the **Available LDEVs** and **Selected Pairs** tables display the LDEVs that match the selected capacity.

    ▪ If you select a row in the **Available LDEVs** table and a row in the **Selected Pairs** table and then click **Set**, you can configure a pair.

6. Click **Finish**, and then confirm the settings.

7. Accept the default task name or enter a unique name.

    You can enter up to 32 letters, numbers, and symbols, except the following:

    \ / : , ; * ? " < > |

8. If you want to monitor the task after submitting it, select **Go to tasks window for status**.

9. Click **Apply** to submit the task.

Releasing assignment of secondary volumes from Thin Image pair snapshot data

You can release the assignment of S-VOLs from snapshot data of Thin Image pairs.

📄 **Note:** If the amount of snapshot data in selected P-VOLs or the total number of pairs in selected snapshot groups exceeds 32,768, an error message appears when attempting to perform pair tasks.

If you use CCI commands, see Pair tasks using CCI or Device Manager - Storage Navigator (on page 219).

Before you begin

You must have the Storage Administrator (Local Copy Pair Unmap) role.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, expand **Replication**, and then click **Local Replication**.
2. In the **Local Replication** window, select a P-VOL in the **TI Root Volumes** tab or a snapshot group in the **Snapshot Groups** tab.
3. Click **Operate TI Pairs**.
4. In the **TI Pairs** window, select the S-VOL pairs you want to delete, and then click **More Actions** > **Remove Secondary Volumes**.
5. In the **Remove Secondary Volumes** window, confirm the settings.
6. Accept the default task name or enter a unique name.

   You can enter up to 32 letters, numbers, and symbols, except the following:

   \ / : , ; * ? " < > |
7. If you want to monitor the task after submitting it, select **Go to tasks window for status**.
8. Click **Apply** to submit the task.

Changing assignment of secondary volumes to Thin Image pair snapshot data

You can change S-VOLs that are assigned to snapshot data.

📄 **Note:** If the amount of snapshot data in selected P-VOLs or the total number of pairs in selected snapshot groups exceeds 32,768, an error message appears when attempting to perform pair tasks.

If you use CCI commands, see Pair tasks using CCI or Device Manager - Storage Navigator (on page 219).

Before you begin

You must have the Storage Administrator (Local Copy) role.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, expand **Replication**, and then click **Local Replication**.
2. In the **Local Replication** window, select a P-VOL in the **TI Root Volumes** tab or a snapshot group in the **Snapshot Groups** tab.
3. Click **Operate TI Pairs**.
4. In the **TI Pairs** window, click **More Actions** > **Assign Secondary Volumes**.
5. From the **Available LDEVs** table, select the LDEV you want to assign as the S-VOL, and then click **Set**.
   The selected LDEV is displayed in the **Secondary Volumes** column of the **Selected Pairs** table.

   > 📄 **Note:**
   >
   > - The nondisruptive migration volumes do not appear in the **Available Primary Volumes** table.
   >
   > - If you select a capacity in **Capacity**, the **Available LDEVs** and **Selected Pairs** tables display the LDEVs that match the selected capacity.
   >
   > - If you select a row in the **Available LDEVs** table and a row in the **Selected Pairs** table and then click **Set**, you can configure a pair.
   >
   > - If you select LDEVs that were assigned to an S-VOL with the **Exclude Assigned Volumes** check box unchecked, the S-VOL to which snapshot data is assigned can be changed.

6. Click **Finish**, and then confirm the settings.
7. Accept the default task name or enter a unique name.
   You can enter up to 32 letters, numbers, and symbols, except the following:

   \ / : , ; * ? " < > |

8. If you want to monitor the task after submitting it, select **Go to tasks window for status**.
9. Click **Apply** to submit the task.

Chapter 4: Managing Thin Image Pairs

Chapter 5: Monitoring and maintaining Thin Image

When needed, you can view summary and detailed Thin Image pair information, consistency groups, and licenced capacity, and you can manage pools, virtual volumes, and other information for your environment.

Monitoring pair information

Viewing summary replication information

You can view summary replication information in the **Replication** window. This window shows the summary section at the top of the window and the Replica LDEVs tab at the bottom.

From this window you can perform the following tasks:

- Open the window from which you can view local replication summary information.

- Open the window from which you can set the system options that affect performance in Thin Image.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, and then click **Replication**.
2. In the summary section in the **Replication** window, view the following information:

   - **Licensed Capacity:** The used and licensed capacity of each software application.

   - **Number of Replica LDEVs:** The number of LDEVs used for replication.

   - **Number of FCv2/FCSE Relationships:** (VSP 5000 series) The number of FCv2 and FCSE relationships that are in use.

   - **Number of Differential Tables:** The number of differential tables that are in use and the differential table limit in the storage system. This number does not include the number of differential tables that FCv2/FCSE Relationships use.

     > 📄 **Note:** Thin Image does not use differential tables.

3. In the **Replica LDEVs** tab, view the following information:

    ▪ **LDEV ID:** The selected LDEV's identification number. Click the ID to open the **LDEV Properties** window. Use this window to search for pool information.

    ▪ **LDEV Name:** The selected LDEV's name.

    ▪ **Emulation Type:** (VSP 5000 series) The selected LDEV's emulation type.

    ▪ **Capacity:** The selected LDEV's capacity.

    ▪ **Copy Type:** The copy type for the pair you selected.

       Values:

       - **TI**: HTI pair

       HTI, SI, SIz, TC, TCz, UR, URz, and GAD volume status:

       - **Primary**: P-VOL

       - **Secondary**: S-VOL

       FCv2 and FCSE volume status (VSP 5000 series):

       - **S-Normal**: The source volume in the normal status. S means a source volume.

       - **T-Normal**: The target volume in the normal status. T means a target volume.

       - **ST-Normal**: The normal volume which is set for the source volume and the target volume.

       - **S-Failed, S-Full, S-Full & Failed**: The source volume in the abnormal status.

       - **T-Failed, T-Full, T-Full & Failed**: The target volume in the abnormal status.

       - **ST-Failed, ST-Full, ST-full & Failed**: The abnormal volume which is set for the source volume and the target volume.

       If you have not configured a pair, a hyphen (-) is displayed.

4. (Optional) To download table information to a file, click **Export**.

Viewing local replication summary information

You can view summary local replication information, such as the number of pairs for each software application you are using, in the summary section of the **Local Replication** window of HDvM - SN.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, expand **Replication**, and then click **Local Replication**.

2. In the summary section of the **Local Replication** window, view the following information:

    Number of Pairs

       The number of pairs for each local replication software application type. The total number of pairs is shown on the **Total** line.

       Default: ShadowImage, ShadowImage for Mainframe, and Thin Image

Chapter 5: Monitoring and maintaining Thin Image

Number of Consistency Groups

The number of consistency groups that are in use and the consistency groups limit in the storage system.

Snapshot Estimated Manageable Capacity

The Thin Image pair's estimated manageable capacity, which is the estimated pair capacity that you can create using the remaining shared memory capacity. This value varies depending on the number of Thin Image P-VOLs you add or delete and the number of Thin Image pairs you create.

If the value is less than 128.00 TB, the ⚠ icon is shown.

> 📄 **Note:** This value is a rough estimation and changes as you add and delete Thin Image pool-VOLs or pairs. This value does not guarantee that the Thin Image pairs of the indicated capacity have been successfully created.

Number of Pair Tables

The number of pair tables. This number varies depending on the combination of software applications you are using.

Values:

- SI/SIMF/Volume Migration: The number of SI, SIz, and Volume Migration pair tables in use, and the SI, SIz, and Volume Migration pair table limit in the storage system.

- HTI: The number of HTI pair tables in use and the HTI pair table limit in the storage system.

Number of Differential Tables

The number of differential tables that are in use and the differential table limit in the storage system. This number does not include the number of differential tables that FCv2/FCSE Relationships use.

> 📄 **Note:** Differential tables are not used in Thin Image.

Viewing the number of pairs

You can view the number of pairs.

Before you begin

You must have the Storage Administrator (Local Copy) role.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, expand **Replication**, and then click **Local Replication**.
2. In the summary section in the **Local Replication** window, for **Number of Pairs**, view the number of pairs.

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Viewing the list of primary volumes

You can view the list of primary volumes.

Before you begin

- You must have the Storage Administrator (Local Copy) role.

- In CCI, use the `raidcom get snapshot` command to view the list of pairs.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, expand **Replication**, and then click **Local Replication**.

2. In the **Local Replication** window, select the **TI Root Volumes** tab.

Local Replication				Last Updated : 2016/06/24 16:53	

VSP G1000(S/N:1) > Replication > Local Replication

Number of Pairs	ShadowImage	0	Number of Consistency Groups		0 (Max Allowed: 2048)
	ShadowImage for Mainframe	0	Number of Snapshot Groups		13 (Max Allowed: 2048)
	Thin Image	22	Number of Pair Tables	SI/SIMF/Volume Migration	0 (Max Allowed: 32768)
	Total	22		TI	31 (Max Allowed: 1048575)
Snapshot Estimated Manageable Capacity		758.11 TB	Number of Differential Tables		0 (Max Allowed: 419200)

SI Pairs | **TI Root Volumes** | **Consistency Groups** | **Snapshot Groups**

Create TI Pairs | Operate TI Pairs | View Pair Synchronization Rate | More Actions ▼   Selected: 0 of 11

Filter ON OFF   Select All Pages | Column Settings   Options ▼ 1 / 1

	LDEV ID	LDEV Name	Port ID	Host Group Name / iSCSI Target Alias	iSCSI Target Name	LUN ID	Number of Snapshot Data	Number of Pairs in PSUE status	Cascade
☐	00:00:19						5	0	Enabled
☐	00:00:1A						4	0	Enabled
☐	00:00:20						1	0	Enabled
☐	00:00:21						1	0	Enabled
☐	00:00:37	5GB-Jurai-PVOL	CL1-A	1A-G00 (00)	-	0	2	0	Disabled
☐	00:00:38	5GB-Jurai-PVOL	CL1-A	1A-G00 (00)	-	1	2	0	Disabled
☐	00:00:39	1GB-Juurai-PVOL	CL1-A	1A-G00 (00)	-	2	2	0	Disabled
☐	00:00:3A	1GB-Juurai-PVOL	CL1-A	1A-G00 (00)	-	3	2	0	Disabled
☐	00:00:3B	1GB-Juurai-PVOL	CL8-B	8B-G00 (00)	-	0	1	0	Disabled
☐	00:00:3C	1GB-Juurai-PVOL	CL8-B	8B-G00 (00)	-	1	1	0	Disabled
☐	00:00:3F						1	0	Enabled

3. In the **TI Root Volumes** tab, view the list of Thin Image primary volumes.

Viewing pair properties

You can view pair properties and confirm the status of a volume in the **View Pair Properties** window.

Before you begin

▪ You must have the Storage Administrator (Local Copy) role.

▪ In CCI, use the `raidcom get snapshot` command.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, expand **Replication**, and then click **Local Replication**.

2. In the **Local Replication** window, select a P-VOL in the **TI Root Volumes** tab or a snapshot group in the **Snapshot Groups** tab.

3. Click **Operate TI Pairs**.

4. In the **TI Pairs** window, select the pair you want to monitor, and then click **More Actions** > **View Pair Properties**.

Thin Image pair status definitions

The P-VOL and V-VOL access columns in the following table indicate whether the volumes accept read/write.

For more information about the corresponding CCI pair command results, see CCI pair command results (on page 220).

The following table describes the Thin Image pair status definitions, the S-VOL access for the status, and the corresponding status that is shown in CCI.

Pair status	Description	S-VOL access	Status shown in CCI
SMPL(PD)	The pair is in the process of being deleted. You cannot perform pair tasks when the pair is in this status, and you cannot assign an S-VOL to snapshot data, release an assignment, or change an assignment. When the process completes, volumes are unpaired.	Read/write disabled.	SMPL[1]
SMPP (VSP 5000 series)	The cascaded pair or the pair with the clone attribute is in the process of being deleted. You cannot perform pair tasks when the pair is in this process. When the process completes, volumes are unpaired.	Read/write disabled.	SMPL[1]
COPY	The storage system has accepted the `paircreate` CCI command. The P-VOL accepts read/write operations, but the S-VOLs do not accept read/write operations.	Read/write disabled.	COPY

Pair status	Description	S-VOL access	Status shown in CCI
PAIR	The volumes are paired. The S-VOL does not accept read/write operations.	Read/write disabled.	PAIR
PFUL	While the volumes are paired ("PAIR" status), you exceeded the data pool depletion threshold.	Read/write disabled.	PFUL
PFUS	While the pair is split ("PSUS" status), you exceeded the data pool warning threshold.	Read/write enabled.	PFUS
PSUS	The pair with the snapshot attribute is split. The S-VOL can accept read/write operations. The storage system records differential data between the P-VOL and S-VOLs so that you can immediately resynchronize the pair.	Read/write enabled. Can be mounted.	PSUS for P-VOLs SSUS for S-VOLs
PSUS(SP) (VSP 5000 series)	The pair with the clone attribute is split. The S-VOL accepts read/write operations.	Read/write enabled. Can be mounted.	PSUP
COPY(DC)	Indicates that the DiffClone pair used in the VASA environment is being differentially copied.	Read/write disabled	CYPD
RCPY	A Reverse Copy is in progress. The S-VOL does not accept read/write operations[2]. The starting time of the copy depends on the number of pairs in your storage system. Only S-VOL differential data is copied to the P-VOL. The Update Copy operation is not performed during Reverse Copy or Quick Restore.	Read/Write disabled.	RCPY
PSUE	The pair is suspended. The system accepts read/write operations for the P-VOL, but it does not accept read/write operations for the S-VOL.	Read/Write disabled.	PSUE
Notes:			
1. SMPL/SMPP is displayed if the `-key opt` option is specified for the `raidcom get snapshot` command. SMPP appears when cascaded or cloned pairs are being deleted.			
2. Starting time of the copy depends on numbers of pairs and your system environment.			

Viewing pair synchronization rates

You can check the percentage of data that is synchronized between the P-VOL and S-VOLs. The Thin Image synchronization rate shows the rate that S-VOL data matches that of the next new generation of the S-VOL. If the S-VOL is the latest one, the synchronization rate is computed by comparing the S-VOL with the P-VOL.

The synchronization rate is a rough value, and can have a large margin of error. If the P-VOL is written to in the configuration of multiple generation (the configuration between the P-VOL and S-VOLs is 1:N), the synchronization rates for only the S-VOL of the newest generation decrease. If the S-VOL is written to, only the synchronization rates of the written generation decrease.

The following figure shows how to monitor the synchronization rates.
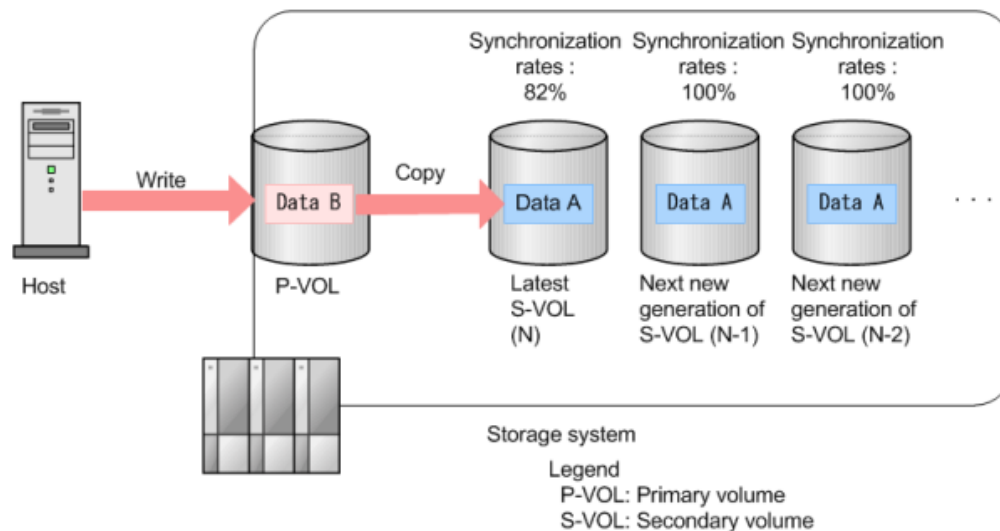
> **Note:** During the Thin Image pair restoration process, the pair synchronization rate may not be up to date. The task must complete for the rate to be up to date.
>
> For the Thin Image pair where the cascade attribute is enabled, the information displayed in Synchronization Rate (%) of the View Pair Synchronization Rate window varies depending on the pair status.
>
> For more information about restoring Thin Image pairs, see Restoring Thin Image pairs (on page 137).

Before you begin

▪ You must have the Storage Administrator (Local Copy) role.

▪ In CCI, use the `raidcom get snapshot` command.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, expand **Replication**, and then click **Local Replication**.

2. In the **Local Replication** window, select a P-VOL in the **TI Root Volumes** tab or a snapshot group in the **Snapshot Groups** tab.

3. Click **Operate TI Pairs**.

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4. In the **TI Pairs** window, select the pair for which you want to monitor synchronization rates, and then click **More Actions** > **View Pair Synchronization Rate**.

5. To check a pair's status and ensure the data is current, click **Refresh**.
   The latest synchronization rates are shown.

   Note: While the TI pair is being restored, the rate might not change. When the restoration completes, the pair synchronization is updated to 100%. For Thin Image pairs of which cascaded pairs are enabled, information displayed in **Synchronization Rate** of the **View Pair Synchronization Rate** window varies depending on the pair status.

Monitoring consistency groups

Viewing the number of consistency groups

You can view the number of consistency groups that are in use in HDvM - SN. CCI does not have a command to perform this task.

Procedure

1. Navigate to one of the following windows:

   ▪ **Local Replication** window.

   For more information about how to view this information on this window, see Viewing local replication summary information (on page 155).

   ▪ **Consistency Group Properties** window.

   For more information about viewing this information on this window, see Viewing consistency group properties (on page 163).

Viewing the list of consistency groups

You can view the list of consistency groups in HDvM - SN. CCI does not have a command to perform this task.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, expand **Replication**, and then click **Local Replication**.

2. In the **Local Replication** window, select the **Consistency Groups** tab.
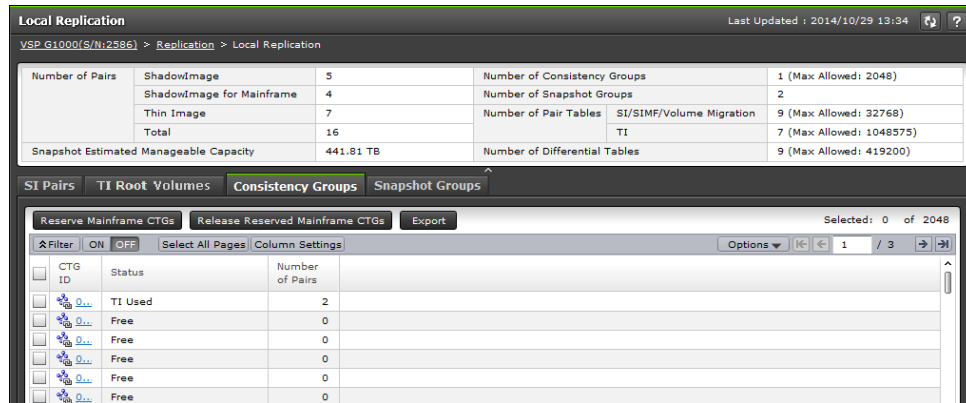
A list of consistency groups is shown in the **Local Replication** window, in the **Consistency Groups** tab.

Viewing consistency group properties

You can view properties of a consistency group using the Consistency Group Properties window in HDvM - SN. CCI does not have a command to perform this task.

Before you begin

- You must have the Storage Administrator (Local Copy) role.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, expand **Replication**, and then click **Local Replication**.

2. In the **Local Replication** window, select the **Consistency Groups** tab.
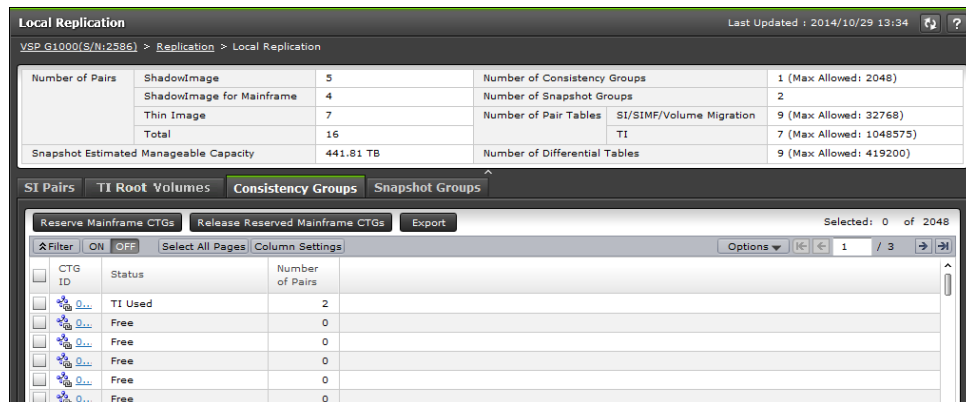
3. In the **Consistency Groups** tab, click the CTG ID for the consistency group for which you want to view properties.

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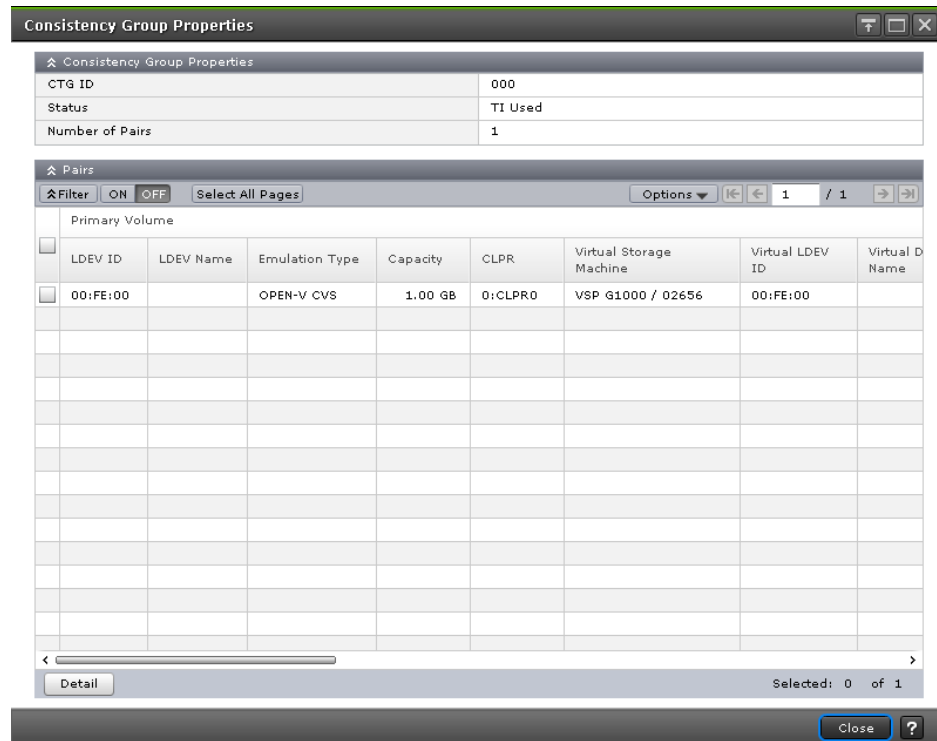
4. In the **Consistency Group Properties** window, view the following consistency group properties:

   ■ **CTG ID:** The consistency group identification number.

   ■ **Status:** The consistency group status.

   Values:

   - **SI Used**: SI is using the consistency group.

   - **SIMF Used (RAID Manager)**: (VSP 5000 series) SIz is using the consistency group and CCI is managing the consistency group.

   - **SIMF Used (PPRC/BCM)**: (VSP 5000 series) SIz is using the consistency group and PPRC and Business Continuity Manager are managing the consistency group.

   - **TI Used**: HTI is using the consistency group.

   - **Mainframe Reserved**: (VSP 5000 series) PPRC and Business Continuity Manager are using the consistency group.

   - **Free**: The consistency group is not being used and is not reserved.

   - **(Changing...)**: The status is in the process of changing.

   ■ **Number of Pairs:** The number of pairs that are assigned to the consistency group.

Viewing Thin Image pair task history

You can review task history, including which tasks you have performed on a pair, in the **History** window in HDvM - SN. You can use audit logs to check the Thin Image pair task history. For details, see *Hitachi Audit Log User Guide*.

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The VSP 5000 series storage system saves a history of the last 1,024,000 Thin Image pair tasks. You can view a maximum of 16,384 pair tasks on each page. If there are more than 16,384 pair tasks available to view, you can view them on the next page. To view the next page, click the right arrow at the top of the page.

For VSP E series, you can view a maximum of the latest 8,192 pair tasks in the **History** window.

> 📄 **Note:** If you use 1,000 or more pairs concurrently, some operation history might not be recorded.

Before you begin

- You must have the Storage Administrator (Local Copy) role.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, and then click **Replication**.

2. In the **Replication** window, click **View History** > **Local Replication**.
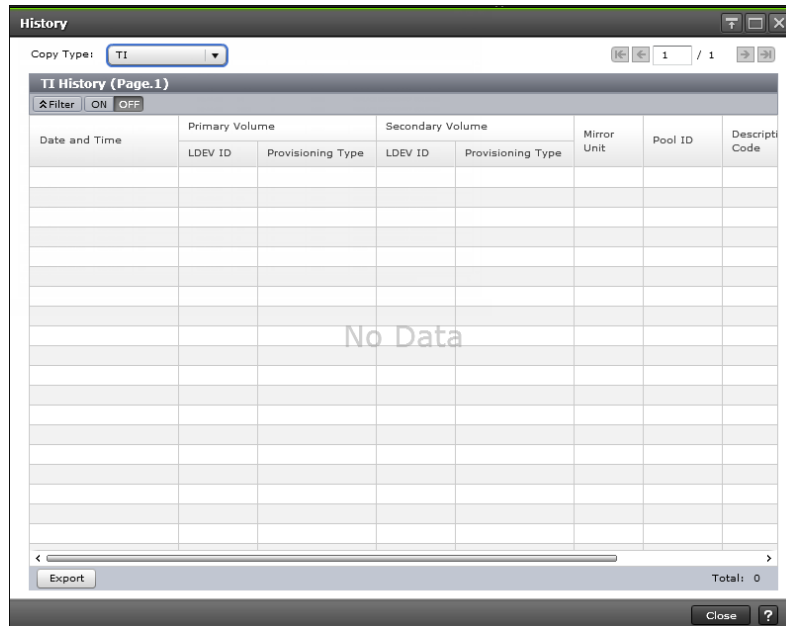
3. In the **History** window, for **Copy Type**, select **TI** as the copy type for the pair you selected.

   For more information about the values for **Copy Type**, see .

4. In the **TI History** table, view the following information:

   - **Date and Time:** The date and time you performed the task.

   - **LDEV ID:** The primary/source volume's LDEV identification number.

- **Provisioning Type:** The P-VOL's provisioning type.

  Values:

  - **Basic**: Internal volume

  - **DP**: DP-VOL

  - **External**: External volume

- **Secondary Volume:** Information about the S-VOL.

- **Mirror Unit:** The mirror unit number.

- **Pool ID:** The pool identification number.

- **Description Code:** The code for the type of task you performed.

- **Description:** The description of the task you performed.

Thin Image task code definitions

The following table lists codes for certain types of tasks (and the descriptions associated with those tasks), that are contained in the TI History table.

Description Code	Description	Explanation
2001	PAIR	The volumes are paired. The pair has been created.
2011	PSUS	The pair was split.
2020	SMPL START	The pair deletion starts.
2021	SMPL END	The pair deletion ended normally.
2030	COPY(RS-R) START	The pair is in the process of being restored.
2031	COPY(RS-R) END	The pair was restored.
2032	COPY(RS-R) ENDED ABNORMAL	The pair restoration process has failed.
2040	INITIALIZE START	Initialization processing starts.
2041	INITIALIZE END	Initialization processing ended.
2042	INITIALIZE ENDED ABNORMAL	Initialization processing ended abnormally.
2050	COPY(RS) START	The pair is in the process of being resynchronized.

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Description Code	Description	Explanation
2051	COPY(RS) END	The pair resynchronization ended normally, and the snapshot data was deleted.
2052	COPY(RS) ENDED ABNORMAL	The pair resynchronization ended abnormally.
2070	PSUE(ABNORMAL END)	A failure occurred and the pair is suspended. The pair status changed to "PSUE".
2080	ASSIGN SECONDARY VOLUMES	An S-VOL is assigned to snapshot data.
2081	REMOVE SECONDARY VOLUMES	The assignment of an S-VOL to snapshot data is released.
2082	REPLACE SECONDARY VOLUMES	The assignment of an S-VOL to snapshot data is changed.
2091	CLONE START	Cloning pairs starts.
2092	CLONE END	Cloning pairs ended normally.
2093	CLONE CANCEL	Cloning pairs was interrupted.
2094	CLONE ENDED ABNORMAL	Cloning pairs ended abnormally.
20A0	DEFRAG START	The defrag processing for the snapshot data area (deletion of the snapshot garbage data by CCI) starts.
20A1	DEFRAG END	The defrag processing for the snapshot data area (deletion of the snapshot garbage data by CCI) ended normally.
20A2	DEFRAG CANCEL	The defrag processing for the snapshot data area (deletion of the snapshot garbage data by CCI) was interrupted.
20A3	DEFRAG ENDED ABNORMAL	The defrag processing for the snapshot data area (deletion of the snapshot garbage data by CCI) ended abnormally.
20B0	DIFFCLONE START	(VSP 5000 series) The DiffClone copy operation used in a VASA environment starts.

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Description Code	Description	Explanation
20B1	DIFFCLONE END	(VSP 5000 series) The DiffClone copy operation used in a VASA environment ended normally.
20B2	DIFFCLONE CANCEL	(VSP 5000 series) The DiffClone copy operation used in a VASA environment was interrupted.
20B3	DIFFCLONE ENDED ABNORMAL	(VSP 5000 series) The DiffClone copy operation used in a VASA environment ended abnormally.

Viewing licensed capacities

You can view the licensed capacities using the **Replication** window in HDvM - SN.

Before you begin

- You must have the Storage Administrator (Local Copy) role.

- In CCI, use the `raidcom get license` command.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, and then click **Replication**.

2. View a list of licensed capacity in the summary section of the **Replication** window.

Viewing the number of cache management devices

You can view the current number of cache management devices that are available and in use and the maximum amount of cache management devices you can create in the storage system in the **View Management Resource Usage** window in HDvM - SN.

For more information, see the **View Management Resource Usage** window in the *Provisioning Guide* for your storage system.

> 📄 **Note:** CCI does not have a command to perform this task.

Procedure

1. From the **Actions** menu, select **View Management Resource Usage**.

Managing pools

Use Thin Image to manage pools, such as monitoring information about a selected pool (for example, the LDEV ID and Used Pool Capacity), viewing used pool capacity by pool or by the Thin Image pair's root volume, viewing the progress of rebalancing the pool usage rates among parity groups, increasing pool volume by adding pool-VOLs to a pool, decreasing the pool volume, and monitoring the pool usage rate.

Monitoring pool information

You can monitor pool information, such as used pool capacity, in the **Summary** section of the **Pools** window and in the **Primary Volumes** tab of the selected pool window.

You can monitor pool information in the **Primary Volumes** tab of the selected pool window.

Before you begin

- You must have the Storage Administrator (Provisioning) role.

- In CCI, use the `raidcom get pool` command or the `raidcom get snap_pool` command

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, and then click **Pools**.

2. In the **Pools** window, in the **Pools** tab, select the pool name for the pool you want to monitor.

3. In the selected pool window, in the **Primary Volumes** tab, view the following information about the selected pool:

    ▪ **LDEV ID:** Shows the combination of the LDKC, CU, and LDEV. Clicking the ID opens the **LDEV Properties** window. Use this window to search for P-VOL information.

    ▪ **LDEV Name:** Shows the LDEV name.

    ▪ **Status:** For more information about this item, see the *Provisioning Guide* for your storage system.

    ▪ **Used Pool Capacity:** Shows the used pool capacity.

    ▪ **Pool Usage(%):** Shows the pool usage rate.

    ▪ **Number of Paths:** Shows the number of alternate paths.

    ▪ **CLPR:** Shows the identifier and name of the CLPR in *ID*:*CLPR* format.

    ▪ **Pool Management Task:** Shows the pool management task being performed on the pool.

    ▪ **Virtual Storage Machine:** Shows information about the virtual storage machine.

4. (Optional) To export the information in the table, click **Export**.

Viewing used pool capacity

You can view used pool capacity by pool or by the Thin Image pair's root volume.

Viewing used capacity by pool

You can view used pool capacity by pool.

For more information, see the **Pools** window in the *Provisioning Guide* for your storage system.

Before you begin

▪ You must have the Storage Administrator (Provisioning) role.

▪ In CCI, use the `raidcom get pool` command or the `raidcom get snap_pool` command

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, and then click **Pools**.

2. View the used capacity of the pool in the **Used** column of the **Pools** tab.

Viewing the used capacity of the physical capacity by pool

You can view the used capacity of the physical capacity by the pool.

For more information, see the **Pools** window in the *Provisioning Guide* for your storage system.

Before you begin

- You must have the Storage Administrator (Provisioning) role.

- In CCI, use the `raidcom get pool` command or the `raidcom get snap_pool` command.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, and then click **Pools**.
2. View the used capacity of the pool in the **Physical Capacity** column of the **Pools** tab. This column is not displayed by default. To see this column, add this using the Column Settings window.

Viewing used pool capacity by Thin Image pair's root volume

You can view used capacity of the pool which has the Thin Image pool type by checking the Thin Image pair's root volume.

For more information, see the volume tabs on the **Pools** window in the *Provisioning Guide* for your storage system.

Before you begin

- You must have the Storage Administrator (Provisioning) role.

- In CCI, use the `raidcom get snap_pool` command.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, and then click **Pools**.
2. In the **Pools** table, click the name of the pool for which you want to see the used capacity.
3. Select the **TI Root Volumes** tab.

Result

The used pool capacity of each root volume (used capacity of the pool which has the Thin Image pool type) appears in the Used or Used Pool Capacity column, depending on your storage system.

Viewing formatted pool capacity and pool usage rates

You can view the progress of rebalancing the pool usage rates among parity groups using the **View Pool Management Status** window.

For more information about the formatted pool capacity and pool usage rates, and the **View Pool Management Status** window, see the *Provisioning Guide* for your storage system.

Before you begin

- You must have the Storage Administrator (Provisioning) role.

- In CCI, use the `raidcom get pool` command.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, and then click **Pools**.

2. In the **Pools** window, in the **Pools** tab, select the check box for the pool for which you want to view capacity from the list, and then click **More Actions** > **View Pool Management Status**.

3. In the **View Pool Management Status** window, view the following items:

   Capacity

   - **Used/Total:** The formatted pool capacity.

   - **Free:** The pool usage rate.

4. Click **Close**.

Increasing pool capacity

Adding pool-VOLs to a pool increases, or expands, the pool's capacity. Check the pool's available capacity and expand the pool as needed.

Use the following formula to calculate the pool capacity:

```
Pool capacity = Total capacity of pool-VOLs in the pool - Management area size of the
```

```
pool-VOL with the system area
```

You can add up to 1,024 pool-VOLs (including volumes already in a pool) to a pool.

Adding pool-VOLs to pools to expand pool capacity moves data to the added space on a per-page basis, which rebalances the usage rate among parity groups of the pool-VOLs.

> ⚠ **Caution:** Moving existing data to the added space on a per-page basis can decrease host I/O performance.

> 📄 **Note:** You can only increase the capacity for one pool at a time.

Before you begin

- You must not be currently decreasing the pool capacity.

- You must have the Storage Administrator (Provisioning) role.

- In CCI, use the `raidcom add dp_pool` command or the `raidcom add snap_pool`.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, and then click **Pools**.

2. In the **Pools** tab, select the check box for the pool to which you want to add a pool-VOL from the list, and then click **Expand Pool**.

3. In the **Expand Pool** window of the **Expand Pool** wizard, click **Select Pool VOLs**.

4. In the **Select Pool VOLs** window, complete the following, and then click **OK**:

   a. (Optional) To filter rows, in the **Available Pool Volumes** table, select **ON** in the **Filter** component.

   b. (Optional) To select all of the pool-VOLs in the list, in the **Available Pool Volumes** table, click **Select All Pages**.

   c. (Optional) To specify the capacity unit and the number of rows to display, in the **Available Pool Volumes** table, click **Options**.

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d. In the **Available Pool Volumes** table, select the LDEV you want, and then click **Add**.
The LDEV is moved to the **Selected Pool Volumes** table.

> 📄 **Note:** If you are adding an LDEV belonging to a parity group for which accelerated compression is enabled, see the related section in the *Provisioning Guide* for your storage system.

5. In the **Expand Pool** window of the **Expand Pool** wizard, click **Finish**, and then confirm the settings.

6. Accept the default task name or enter a unique name.

You can enter up to 32 letters, numbers, and symbols, except the following:

\ / : , ; * ? " < > |

7. If you want to monitor the task after submitting it, select **Go to tasks window for status**.

8. Click **Apply** to submit the task.

Failure of available pool capacity formatting and pool capacity increase

Pool capacity formatting and increase can fail in some circumstances.

The following are the circumstances under which the available pool capacity is not formatted and the available pool capacity is not increased:

- You are formatting a pool-VOL other than the one that you have selected to format.

  For more information about formatting LDEVs, see the *Provisioning Guide* for your storage system.

- The pool usage rate has reached the warning threshold (see <u>Editing the data pool warning threshold (on page 179)</u>).

- The I/O loads on the storage system are high.

- One of the following is blocked:

  - The selected pool.

  - The cache memory.

  - The pool-VOLs in the selected pool.

  - The external pool-VOLs in the selected pool.

- The access attribute on the pool-VOL in the selected pool has been corrected.

- You are not operating the format function for available pool capacity.

The following are circumstances under which the formatted pool capacity might decrease:

- New pages are being allocated.

- Correction copy is being executed.

Decreasing pool capacity

You can decrease the pool capacity for up to eight tasks at the same time.

For more information about decreasing pool capacity, formatting LDEVs, and the **Shrink Pool** window, see the *Provisioning Guide* for your storage system.

If processing ends abnormally, check the Tasks window.

Before you begin

- The used capacity of the pool-VOL must be below the pool threshold.

- If you are deleting pool-VOLs with system area, there must be more than 4.2 GB of available capacity.

- You must not be currently performing any of the following tasks:
  - Creating a pool.
  - Deleting a pool.
  - Increasing a pool.
  - Deleting a pool-VOL to decrease the pool capacity.
  - Recovering a pool.
  - Stopping the process of decreasing pool capacity.
  - Editing a data pool warning threshold.
  - Simultaneously running CCI commands to decrease the pool capacity.
- You must not be maintaining the cache memory.
- The cache memory must be up and running.
- The I/O load to the V-VOL related to the pool must be low.
- In CCI, use the `raidcom delete pool` command.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, and then click **Pools**.
2. In the **Pools** tab, click the name of the pool for which you want to decrease capacity.

3. In the *Pool Name* window, in the **Pool Volumes** tab, from the list of volumes, select the check box for the pool that contains the pool-VOLs you want to delete to decrease pool capacity, and then click **Shrink Pool**.

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> 📄 **Note:** You can select one or more pool volumes.

4. In the **Prediction Result of Shrinking** table, confirm the pool capacity, the used pool capacity, and the free pool capacity, before and after shrinking.

5. Accept the default task name or enter a unique name.

   You can enter up to 32 letters, numbers, and symbols, except the following:

   \ / : , ; * ? " < > |

6. If you want to monitor the task after submitting it, select **Go to tasks window for status**.

7. Click **Apply** to submit the task.

Result

The tiers in pools are deleted and the pool capacity is decreased.

Stopping the process of decreasing pool capacity

You can stop the process of decreasing pool capacity.

For more information about the **Stop Shrinking Pools** window, see the *Provisioning Guide* for your storage system.

Before you begin

- You must have the Storage Administrator (Provisioning) role.

- In CCI, use the `raidcom modify pool -status stop_shrinking` command.

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Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, and then click **Pools**.

2. In the **Pools** tab, click the name of the pool for which you want to stop decreasing capacity.
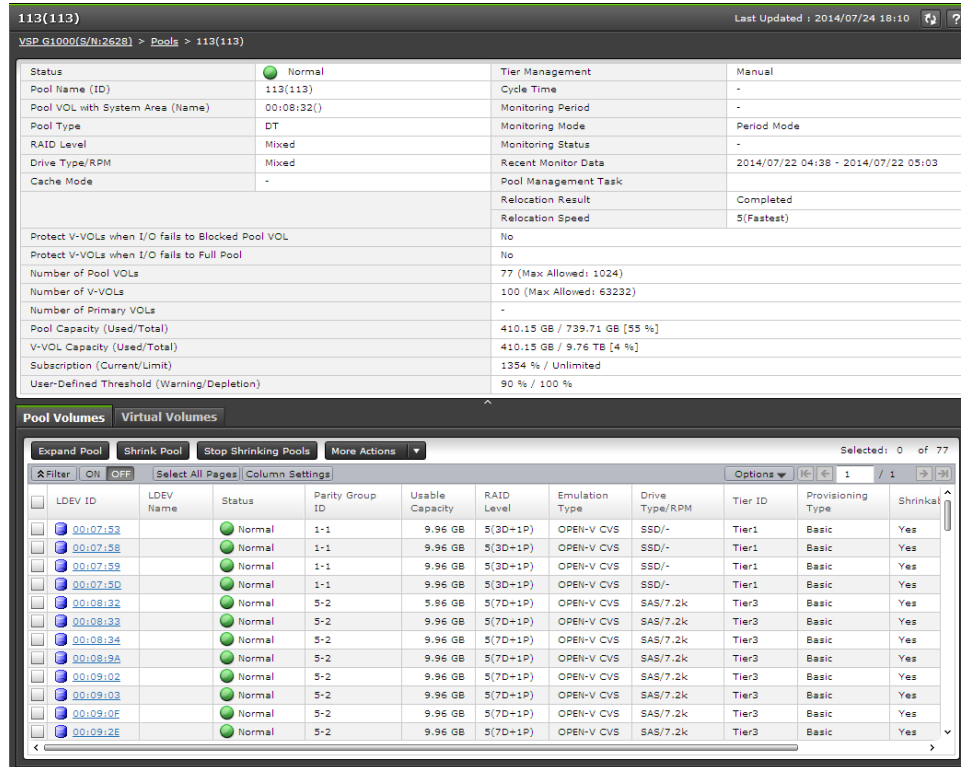
3. In the *Pool Name* window, in the **Pool Volumes** tab, from the list of volumes, select the check box for the pool that contains the pool-VOLs for which you want to stop decreasing pool capacity, and then click **Stop Shrinking Pool**.

> **Note:** You can select one or more pool volumes.
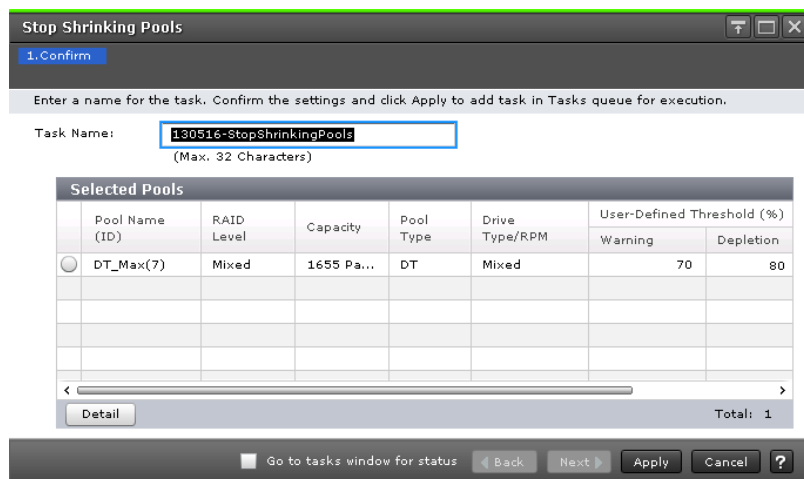
4. In the **Stop Shrinking Pools** window, confirm the settings.

   If you select a row and click **Detail**, the **Pool Properties** window will be displayed.

5. Accept the default task name or enter a unique name.

   You can enter up to 32 letters, numbers, and symbols, except the following:

   \ / : , ; * ? " < > |

6. If you want to monitor the task after submitting it, select **Go to tasks window for status**.

7. Click **Apply** to submit the task.

Editing the data pool warning threshold

You can prevent the pool from reaching full capacity by monitoring the pool usage rate.

For more information about checking alerts and checking the details of a SIM, see the *System Administrator Guide* for your storage system.

For more information about SNMP, see the *Hitachi Alert Notification Guide*.

Before you begin

- You must not be decreasing the pool capacity.

- You must have the Storage Administrator (Provisioning) role.

- In CCI, use the `raidcom modify pool -user_threshold` command.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, and then click **Pools**.

2. In the **Pools** tab, from the list of pools, select the check box for the pool with the warning threshold that you want to change, and then click **More Actions** > **Edit Pools**.

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3. In the **Edit Pools** window of the **Edit Pools** wizard, complete the following:

   Warning Threshold

   ■ Enter the data pool warning threshold.

   ■ Range: 20% - 95%, in 1% increments.

   ■ Default: 80%

   > ⚠ **Caution:** Excessive pool usage rates (rates over 50%) are rounded down to the closest integer. Therefore, excessive pool usage in SIM and SNMP might be reported when the actual pool usage rate exceeds the threshold, even though the value shown is only 50%.

4. Click **Finish**, and then confirm the settings.
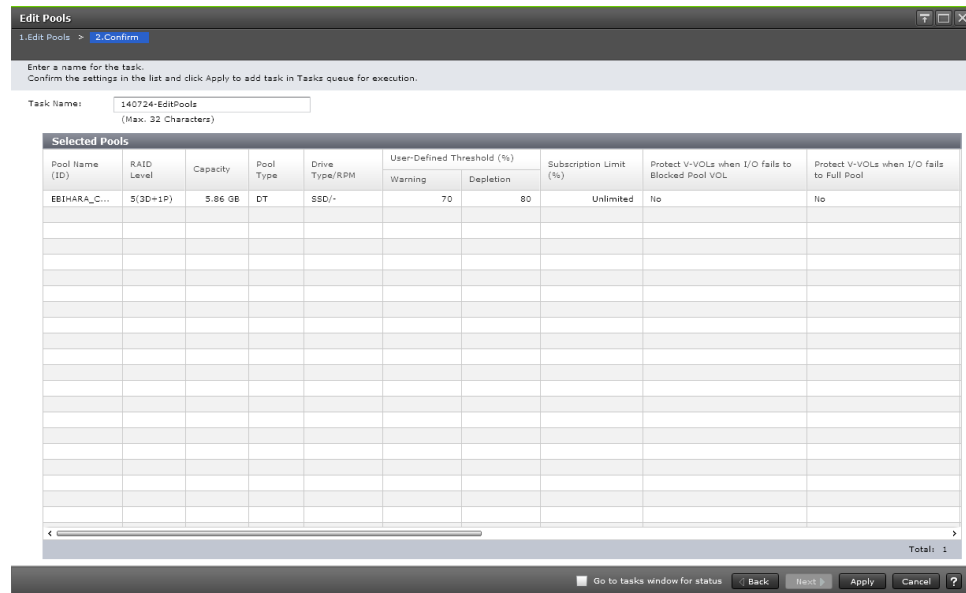
5. Accept the default task name or enter a unique name.

   You can enter up to 32 letters, numbers, and symbols, except the following:

   \ / : , ; * ? " < > |

6. If you want to monitor the task after submitting it, select **Go to tasks window for status**.

7. Click **Apply** to submit the task.

Editing pool names

You can change the properties of a selected pool, such as its name.

Before you begin

- You must have the Storage Administrator (Provisioning) role.

- In CCI, use the `raidcom modify pool -pool` command.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, and then click **Pools**.

2. In the **Pools** tab, from the list of pools, select the check box for the pool whose name you want to change, and then click **More Actions** > **Edit Pools**.

3. In the **Edit Pools** window of the **Edit Pools** wizard, complete the following items for **Pool Name**:

   ▪ **Prefix**

   Enter the new alphanumeric characters that precede the pool number. This field is case sensitive.

   ▪ **Initial Number**

   Enter the pool's new initial number, using 9 digits or fewer.

   The character limit for both fields together is 32 alphanumeric characters.

4. Click **Finish**, and then confirm the settings.
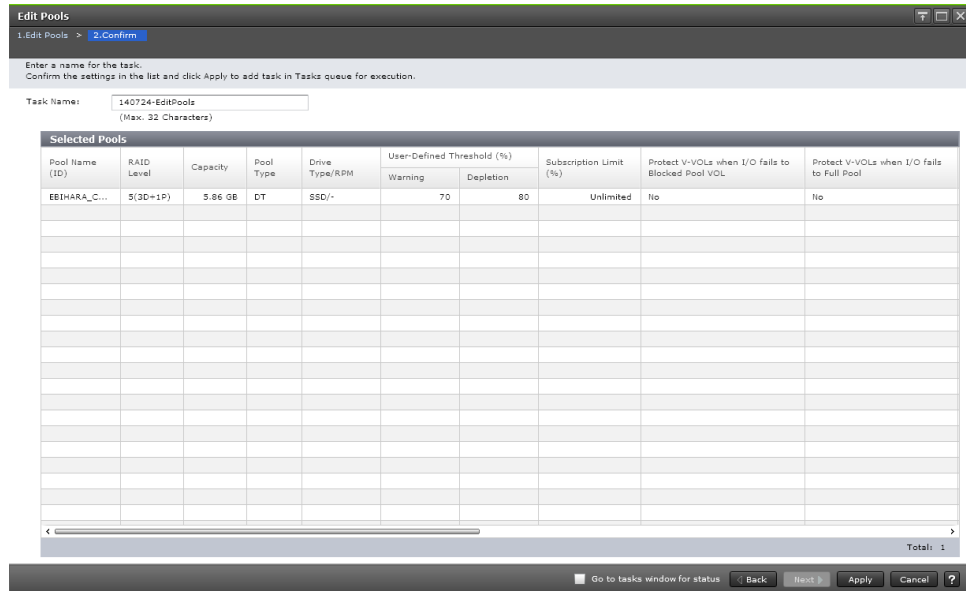
5. Accept the default task name or enter a unique name.

   You can enter up to 32 letters, numbers, and symbols, except the following:

   \ / : , ; * ? " < > |

6. If you want to monitor the task after submitting it, select **Go to tasks window for status**.

7. Click **Apply** to submit the task.

Workflow for recovering blocked pools

When a pool is blocked, you must recover the pool volume, pool, Thin Image pairs, and then V-VOL in that order. This section describes how to recover a blocked pool.

Recovering blocked pool volumes

When a pool volume is blocked, contact customer support.

Recovering the pools

Recover the pool by using one or both of the following methods:

- Add additional pool-VOLs.

- Decrease the pool usage rate by deleting the P-VOL's snapshot data.

Recovering Thin Image pairs

When a pool is blocked, all Thin Image pairs that contain snapshot data of the blocked pool switch to the PSUE status. To recover these pairs, delete and then re-create them.

Recovering blocked pools

You can recover blocked pools using the **Restore Pools** window.

The pool recovery time depends on pool or V-VOL usage and system workload. Calculate roughly 20 minutes of recovery time for every 100 TB of pool or V-VOL usage.

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> ⚠️ **Caution:** Recover blocked pools for disaster recovery purposes only.

Before you begin

- You must have the Storage Administrator (Provisioning) role.

- In CCI, use the `raidcom modify pool -status nml` command.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, and then click **Pools**.

2. In the **Pools** tab, from the list of pools, select the check box for the pool that you want to recover, click **More Actions** > **Restore Pools**, and then confirm the settings.

3. Accept the default task name or enter a unique name.

   You can enter up to 32 letters, numbers, and symbols, except the following:

   \ / : , ; * ? " < > |

4. If you want to monitor the task after submitting it, select **Go to tasks window for status**.

5. Click **Apply** to submit the task.

Workflow for decreasing pool capacity

Use this process to delete pool volumes.

1. Delete all of the Thin Image pairs.

2. Delete the pool volumes.

3. (Optional) Erase data from the volume (volume shredding).

   For more information about volume shredding, see the *Hitachi Volume Shredder User Guide*.

Deleting pools

You can delete pools that have a 0% usage rate and that are not assigned for DP-VOLs.

Deleting a pool blocks its pool-VOLs (LDEVs). To use blocked pool-VOLs, format the volumes.

📄 **Note:** If the blocked pool-VOL is an external volume, select Normal Format when formatting the volume.

When you specify an LDEV belonging to an accelerated compression-enabled parity group by using HDvM - SN or CCI to shrink a pool that contains the LDEV, for VSP E series, the pool auto-expansion function of the parity group to which the LDEV specified for shrinking the pool belongs is disabled. After the pool is shrunk, if you enable the automatically adding pool volumes function in the parity group where the LDEV specified when shrinking the pool belongs, disable accelerated compression of the pool first, and then enable it again. If the SIM code is 601*xxx* or 602*xxx* (where *xxx* is a pool number) , enable accelerated compression without performing the countermeasure for the SIM.

For more information about DP-VOL requirements, see the *Provisioning Guide* for your storage system.

Before you begin

- You must have the Storage Administrator (Provisioning) role.

- In CCI, use the `raidcom delete pool` command.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, and then click **Pools**.
2. In the **Pools** tab, from the list of pools, select the check box for the pool that you want to delete, and then click **More Actions** > **Delete Pools**.
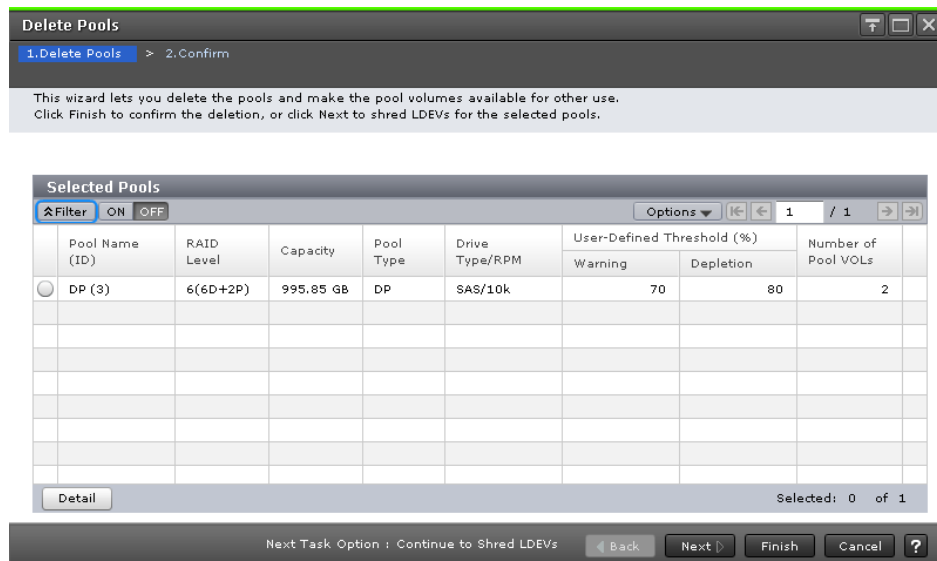
3. In the **Delete Pools** window of the **Delete Pools** wizard, click **Finish**, and then confirm the settings.

   Click **Next** if you want to perform volume shredding to erase data from the volume.

   For details on volume shredding operations, see the *Hitachi Volume Shredder User Guide*.

4. Accept the default task name or enter a unique name.

   You can enter up to 32 letters, numbers, and symbols, except the following:

   \ / : , ; * ? " < > |

5. If you want to monitor the task after submitting it, select **Go to tasks window for status**.

6. Click **Apply** to submit the task.

Managing virtual volumes

Editing virtual volume names

You can edit a virtual volume's name and you can view information about LDEVs from the **Pools** window.

Before you begin

- You must have the Storage Administrator (Provisioning) role.

- In CCI, use the `raidcom modify ldev` command.

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, and then click **Pools**.

2. In the **Pools** tab, click the name of the pool for which you want to edit virtual volumes.

3. In the *Pool Name* window, select the **Virtual Volumes** tab.
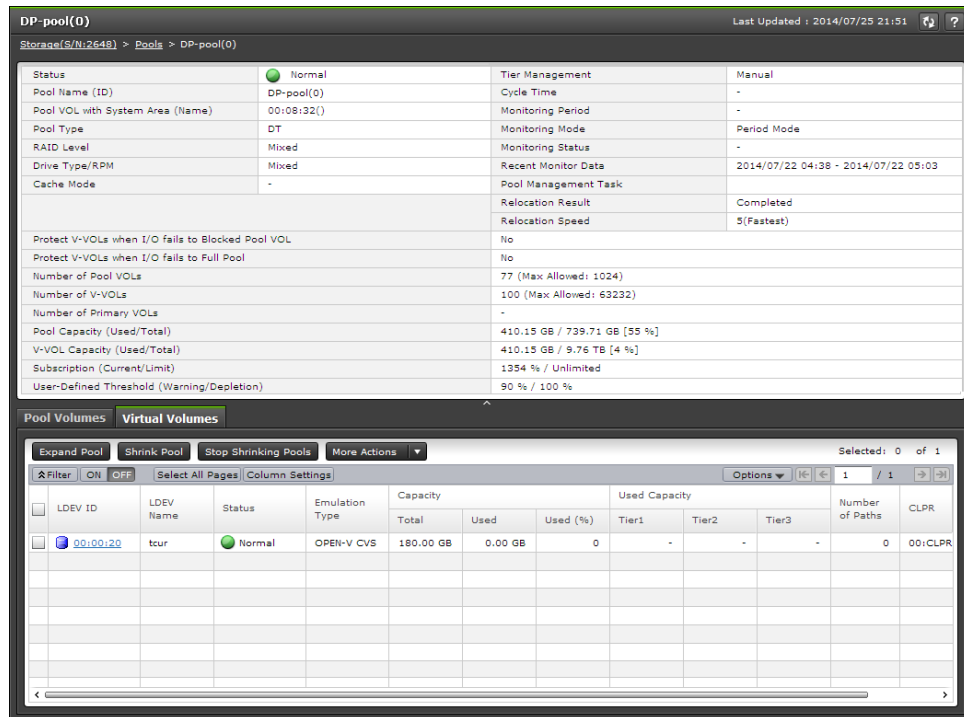
4. In the **Virtual Volumes** tab, from the list of volumes, select the check boxes for the V-VOLs you want to change, and then click **More Actions** > **Edit LDEVs**.
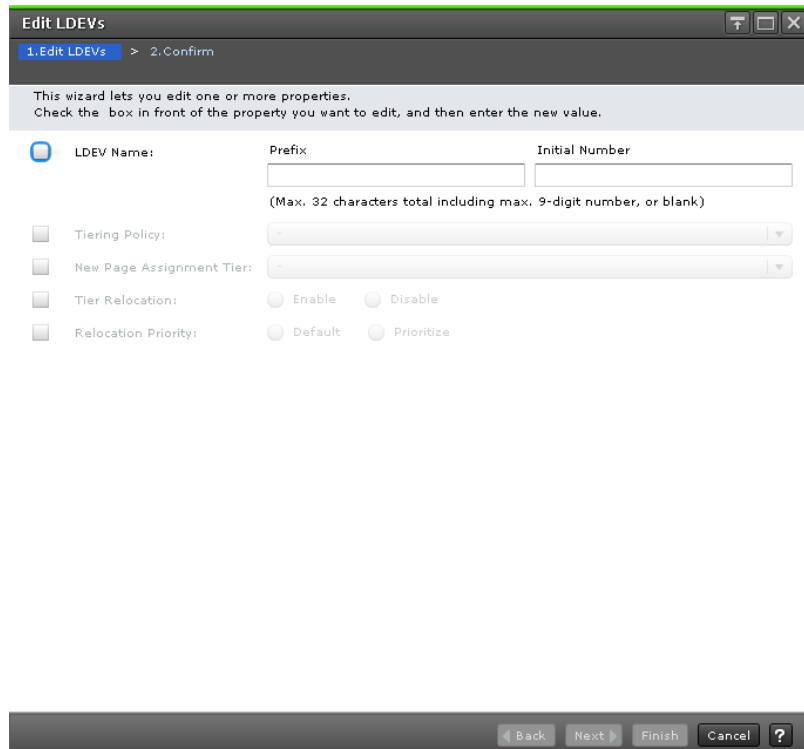
5. In the **Edit LDEVs** window of the **Edit LDEVs** wizard, for **LDEV Name**, enter the prefix and the initial number.

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6. Click **Finish**, and then confirm the settings.

7. Accept the default task name or enter a unique name.

   You can enter up to 32 letters, numbers, and symbols, except the following:

   \ / : , ; * ? " < > |

8. If you want to monitor the task after submitting it, select **Go to tasks window for status**.

9. Click **Apply** to submit the task.

Workflow for deleting V-VOLs specified for Thin Image S-VOLs

Typically, you cannot delete V-VOLs and V-VOL groups that are specified for Thin Image S-VOLs. If the groups are specified for S-VOLs, complete this workflow.

1. Delete the Thin Image pairs.

2. Delete the V-VOL.

Deleting virtual volumes

You can use the **Delete LDEVs** window to remove virtual volumes.

For more information about the **Delete LDEVs** window, see the *Provisioning Guide* for your storage system.

Before you begin

▪ You must have the Storage Administrator (Provisioning) role.

▪ In CCI, use the `raidcom delete ldev` command.

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Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, and then click **Logical Devices**.

2. In the **Logical Devices** window, from the list of volumes, select the check boxes for the V-VOLs that you want to delete, click **More Actions** > **Delete LDEVs**, and then confirm the settings.
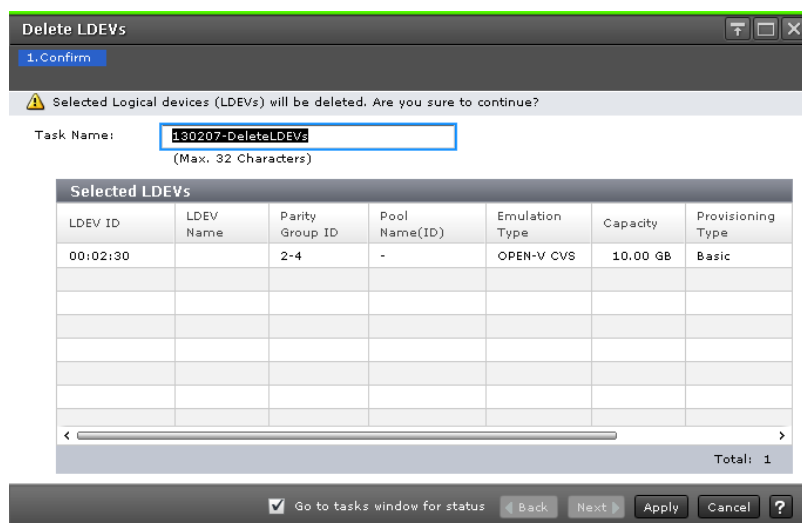
3. Accept the default task name or enter a unique name.

   You can enter up to 32 letters, numbers, and symbols, except the following:

   \ / : , ; * ? " < > |

4. If you want to monitor the task after submitting it, select **Go to tasks window for status**.

5. Click **Apply** to submit the task.

Expanding the DP-VOL capacity while keeping the pair status

You can expand the capacity of a DP-VOL used in the GAD, TrueCopy, Universal Replicator, ShadowImage, or Thin Image pair created between or on the following storage systems while keeping the pair status in each software product.

Storage system	Microcode version
VSP 5000 series	90-04-04-00/00 or later
VSP E series	93-02-03-x0/00 or later

Expanding DP-VOL capacity used in a Thin Image pair

You can expand the capacity of a DP-VOL used only as a Thin Image pair volume. If you want to expand the DP-VOL capacity when the HTI pair shares volumes with other replication software, see the User Guide for that replication software.

Before you begin

- A V-Vol to be expanded is not an external volume.

- The LDEV format is being performed on a V-Vol to be expanded.

- A pool containing a V-Vol to be expanded meets any of the following conditions:

  - Normal condition

  - The used capacity of the pool exceeds the depletion threshold.

  - The pool is being shrunk.

- A V-Vol to be expanded is a volume created on the storage systems described in Expanding DP-VOL capacity while keeping the pair status (on page 189).

- A V-Vol to be expanded is not used in a pair with the clone attribute.

- The following numbers required after the expansion do not exceed the maximum number allowed on the storage system:

  - The snapshot estimated manageable capacity

  - The number of cache management devices

  - The subscription limit of the V-VOL capacity

Calculating the snapshot estimated manageable capacity, the number of cache management devices, and the subscription limit of the V-VOL capacity

1. Snapshot estimated manageable capacity required for expanding the Thin Image volume capacity

   To expand the capacity of a Thin Image root volume, verify that the snapshot estimated manageable capacity is available. Calculate the snapshot estimated manageable capacity required for expanding the capacity of a Thin Image root volume using the following formulas:

   ```
   Snapshot-estimated-manageable-capacity-for-root-volume-expansion = Snapshot-
   estimated-manageable-capacity-after-root-volume-expansion - Snapshot-estimated-
   manageable-capacity-before-root-volume-expansion
   ```

   ```
   Snapshot-estimated-manageable-capacity = (Root-volume-capacity [TB] / 2.6 [TB])
   x 3,024 [GB] + (168 [GB] x 2(consumed-shared-memory [GB]))
   ```

   Expanding the volumes other than a root volume does not consume the snapshot estimated manageable capacity. You can check the snapshot estimated manageable capacity in the Local Replication window.

2. The number of cache management devices required for expanding the Thin Image volume capacity.

To expand the capacity of a Thin Image root volume, verify that the cache management devices are available. Calculate the maximum number of cache management devices required for expanding the capacity of a Thin Image root volume using the following formula:

```
number-of-cache-management-devices-for-root-volume-expansion = ceiling ((Root-
volume-capacity-after-expansion [TB] / 2.6 [TB])) – ceiling ((Root-volume-
capacity-before-expansion [TB] / 2.6 [TB]))
```

In the example, 'ceiling' refers to rounding up the value enclosed in parenthesis ( ) to the next integer. Expanding the volumes other than a root volume does not consume the cache management devices.

3. The subscription limit of the V-VOL capacity in a DP pool required for expanding the Thin Image volume capacity.

To expand the capacity of a Thin Image root volume, verify that the capacity after the expansion does not exceed the subscription limit of the V-VOL capacity contained in a DP pool.

Calculate the V-VOL capacity to be added by expanding the capacity of a Thin Image root volume using the following formulas:

```
V-VOL-capacity-added-by-root-volume-expansion = Thin-Image-pair-capacity-
calculated-based-on- root-volume-capacity-after-expansion - Thin-Image-pair-
capacity-calculated-based-on-root-volume-capacity-before-expansion
```

```
Thin-Image-pair-capacity = Σ ceiling ((Root-volume-capacity [MB] × number-of-
pairs* × 2/ 42 [MB])) × 42 [MB] + Σ ceiling ((Root-volume-capacity [MB] × number-
of-pairs* × 2/ 2,921,688 [MB])) × 175,434 [MB]
```

* *number-of-pairs*: The allocated pages are not released if you delete some pairs. Therefore, use the maximum number of HTI pairs to be created in the applicable snapshot tree as *number-of-pairs* instead of the number of pairs currently created in the applicable snapshot tree.

Round up the value enclosed in ceiling ( ) to the next integer.

Expanding the volumes other than a root volume does not add the V-VOL capacity contained in a DP pool in Thin Image.

Procedure

1. Verify that all of the volumes used in HTI meet the prerequisites.

If only one volume capacity used in an HTI pair can be expanded, while the other cannot be expanded, the resync operation of the HTI pair cannot be performed after the expansion because the capacity of both the volumes is not the same.

If the resync operation of the HTI pair cannot be performed, complete the procedure in (1) Recovery procedure from failure if one volume capacity used in Thin Image pair cannot be expanded.

2. Verify the pair statuses of the HTI pairs.

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The HTI pair volume capacity can be expanded when the HTI pairs are in the PAIR or PSUS status. Verify the current pair statuses of the HTI pairs. If the pair statuses are not PAIR or PSUS, perform the pair operations, and then make sure that the pair statuses change to PAIR or PSUS.

> 📄 **Note:** If the statuses remain PSUE or change to PSUE, this indicates an error condition.

3. If the cascade attribute of the volume to be expanded is enabled, proceed to the next step. If the cascade attribute of the volume to be expanded is disabled, release the assignment of the S-VOL to snapshot data of the HTI pair.

   If the multiple S-VOLs are included, release the assignment of the S-VOL to snapshot data for each volume. Skip this operation if the assignment of the S-VOL to snapshot data has already been released.

4. Expand the P-VOL capacity used in the HTI pair.

   ▪ When using CCI, add the `-request_id auto` option to the `raidcom extend ldev` command to specify the asynchronous command processing. For example, to expand the capacity of LDEV#44:44 by 10GB:

   ```
   raidcom extend ldev -ldev_id 0x4444 -capacity 10G -request_id auto -IH1
   ```

   ▪ When using HDvM - SN, expand the capacity in the **Expand V-VOLs** window.

5. Verify that expanding the P-VOL capacity used in the HTI pair is complete.

   ▪ When using CCI, use the `raidcom get command_status` command to verify that the `raidcom extend ldev` command processing is complete, and then verify that the LDEV capacity is correct using the `raidcom get ldev` command. For example:

   ```
   raidcom get command_status -IH1
   raidcom get ldev -ldev_id 0x4444 -fx -IH1
   ```

   ▪ When using HDvM - SN, select **Logical devices** from the **Storage Systems** tree, and then display the **LDEV** tab. Verify that the capacity with the target LDEV number is correct.

6. If the cascade attribute of the volume to be expanded is disabled, proceed to step 8. If the cascade attribute of the volume to be expanded is enabled, expand the S-VOL capacity of the HTI pair in the same way as the P-VOL capacity.

   If the S-VOL capacity used in the HTI pair cannot be expanded, perform the procedure in (1) Recovery procedure from failure if one volume capacity used in Thin Image pair cannot be expanded.

7. Verify that expanding the S-VOL capacity used in the HTI pair is complete in the same way as the P-VOL capacity

8. If the cascade attribute of the volume to be expanded is enabled, proceed to step 9.

   If the cascade attribute of the volume to be expanded is disabled, prepare the LDEV with the same capacity as that after the expansion, and then assign the LDEV as the S-VOL to snapshot data of the HTI pair.

   If the multiple HTI pairs are included, assign the S-VOL to snapshot data of each HTI pair. Skip this operation if the assignment of the S-VOL to snapshot data is not required.

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9. Verify that the volume capacity used in the HTI pair is not being expanded.

   ▪ When using CCI, check if the **P** column in the `pairdisplay` command or `raidcom get snapshot` command displays **N**. Following are examples of each command:

   ```
   # pairdisplay -g ti -fxce -IM3
   Group   PairVol(L/R) (Port#,TID, LU-M) ,Seq#,LDEV#.P/S,Status,   % ,P-LDEV# M
   CTG CM EM      E-Seq# E-LDEV# DM P


   ti      ti00(L)     (CL1-C-0,28,   0-0 )500003  2000.P-VOL PAIR,  100    3000
   -   - S -             -        - - N
   ti      ti00(R)     (CL1-C-0,28,   1-0 )500003  3000.S-VOL PAIR,  100    2000
   -   - S -             -        - - N
   ```

   ```
   # raidcom get snapshot -ldev_id 0x1000 -key opt -fx SnapShot_name P/S STAT
   Serial# LDEV# MU# PLDEV#
   PID % MODE SPLT-TIME SLU C_LDEV# P
   ti P-VOL PAIR 500001 1000 3 1100 5 100 ---- - - - N
   ```

   The **P** column displays the status of the volume capacity that is being expanded:

   ▪ **N**: The volume capacity is not being expanded.

   ▪ **E**: The volume capacity is being expanded.

   This status has been displayed for a while (30 seconds or so) after the expansion of the P-VOL or the S-VOL capacity is complete, and then this status is changed to **N**.

   ▪ When using HDvM - SN, in the **Local Replication** window, select a P-VOL containing a volume to be expanded in the **TI Root Volumes** tab, and then click **Operate TI Pairs**. Check if the **Processing Status** field in the **TI Pairs** window is blank. (**Expanding** displays when the volume capacity is being expanded.) If the volume capacity is being expanded, wait until the expansion is complete, and then verify the status.

Expanding DP-VOL capacity when a Thin Image pair shares the same volume with other software

When the HTI pair shares the same volumes with other software, there is an order in which you must expand the DP-VOL capacity. For more information about the specific expansion order, see the User Guide for the remote replication that is used with the HTI pair.

You can expand the capacity of DP-VOLs used in an HTI pair and each software pair when an HTI pair shares the same volumes with the following software:

- TrueCopy (TC)

- global-active device (GAD)

- Universal Replicator (UR)

- ShadowImage (SI)

When an HTI pair shares the same volumes with other software, the order in which you expand the DP-VOL capacity consists of the following two expansion orders:

- Expansion order in a point to point configuration of the HTI pair

- Expansion order in a point to point configuration with each software product

The following describes the guidelines for the order in which you expand the DP-VOL capacity when an HTI pair shares the same volumes with other software.
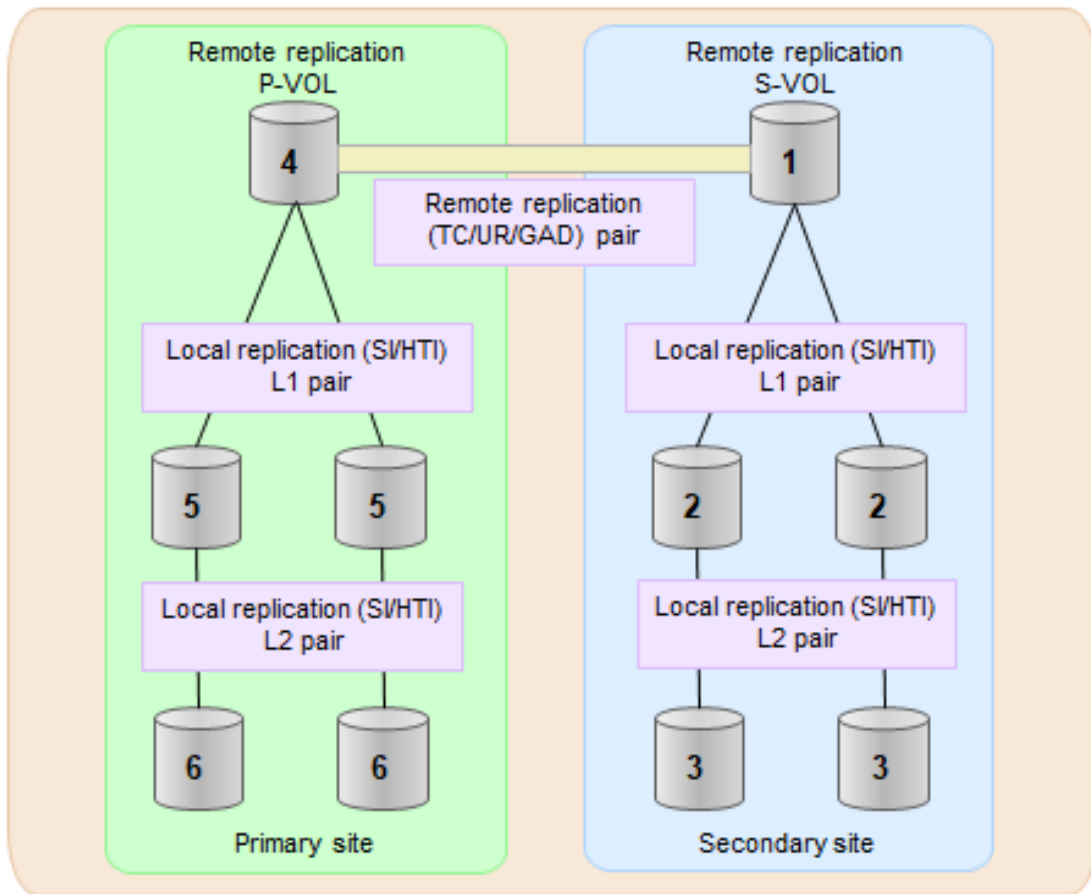
Legend
  TC: TrueCopy
  UR: Universal Replicator
  GAD: global-active device
  SI: ShadowImage
  HTI: Thin Image

Figure 1 Expansion order when TC/UR/GAD pair shares the same volumes with local replication

1. When a remote replication (TC/UR/GAD) is included, expand first the S-VOL capacity on the end of the remote replication, and finally expand the P-VOL capacity.

2. When a remote replication (TC/UR/GAD) shares the same volumes with a local replication (SI/HTI), expand the capacity in each following group. Expand first the capacity of the S-VOL group in the remote replication, and then expand the capacity of the P-VOL group in the remote replication:

   a. S-VOL group that consists of the S-VOL of the remote replication and all volumes of the local replication with which the S-VOL shares the same volume.

    b. P-VOL group that consists of the P-VOL of the remote replication and all volumes of the local replication with which the P-VOL shares the same volume.

    The expansion order in each group follows the expansion order in the local replication.

3. In the local replication (SI/HTI), expand the capacity in the order from the highest layer to the lowest. The expansion order is not specified for the volumes in the same layer.

Troubleshooting the expansion of DP-VOL capacity

Refer to the following troubleshooting information if an issue occurs during the expansion of the DP-VOL capacity.

Recovery procedure from failure if one volume capacity used in the Thin Image pair cannot be expanded

If only one volume capacity used in an HTI pair can be expanded, while the other cannot be expanded, the resync operation of the HTI pair cannot be performed after the expansion because the capacity of both the volumes is not the same.

When an HTI pair is used with TC, GAD, UR, or SI, if the capacity of the P-VOL and the S-VOL used in one of the software products cannot be expanded, which causes the invalid state that the expansion of the entire volume capacity is not complete.

The following describes the procedure for recovering from the invalid state.

1. Verify that both the P-VOL and the S-VOL used in an HTI pair meet the prerequisites for expanding the DP-VOL capacity described in <u>Expanding DP-VOL capacity used in a Thin Image pair (on page 189)</u>.

When an HTI pair is used with TC, GAD, UR, or SI, the capacity of the P-VOLs and the S-VOLs in all of the used software products must be expanded.

Verify that all of the volumes meet the prerequisites for expanding the capacity described in the User Guide for each software product. If the prerequisites are not met, proceed to step 4.

2. When the prerequisites for expanding the DP-VOL capacity are met, retry the expansion, and make sure that the capacity of the P-VOL and the S-VOL used in the HTI pair is the same. If there is not enough free space, increase the free space, and then expand the DP-VOL capacity.

When the HTI pair is used with TC, GAD, UR, or SI, retry the expansion of the volume capacity in all of the used software products, and make sure that the capacity of the P-VOL and the S-VOL used in each software product is the same.

As a result of the above operations, do one of the following:

- If the expansion can be performed, proceed to step 3.

- If the expansion cannot be performed, proceed to step 4.

3. Verify that the HTI pair is not being expanded.

As a result, the recovery procedure from the failure is complete.

4. Delete the HTI pair, expand the volume capacity in the SMPL status, and then recreate the HTI pair.

   If you want to restore it to the conditions before the expansion due to a capacity input error and others, delete the HTI pair, and then recreate the LDEV with the correct capacity. After that, recreate the HTI pair.

   If the capacity of the P-VOL and the S-VOL used in the HTI pair or the SI pair is not the same, you can only delete the HTI pair or the SI pair. You can read the S-VOL data used in the HTI pair or the SI pair before the expansion. If you want to use the data before the expansion, delete all pairs after the data reading is complete.

Recovery procedure from failure if one volume capacity used in the Thin Image pair has been expanded

Use the procedure to recover from a failure if only one volume capacity used in an HTI pair can be expanded, while a failure occurs on the other volume before the expansion.

Make sure to recover from the failure first by following the recovery procedure in .

However, depending on the operations during the recovery procedure, the following actions are required as shown in the table below.

Operation during recovery procedure	Action
Resynchronizing an HTI pair	The resync operation cannot be performed because the capacity of the P-VOL and the S-VOL used in the HTI pair is not the same. Perform the "Additional Steps" described below immediately before the HTI pair resync operation.
Deleting an HTI pair Recovering from a volume failure Recreating an HTI pair	The HTI pair cannot be created because the capacity of the target P-VOL and the S-VOL is not the same when recreating the HTI pair. Perform the "Additional Steps" described below immediately before the HTI pair resync operation.
Deleting an HTI pair Deleting a volume Creating a volume Recreating an HTI pair	The HTI pair cannot be created because the capacity of the target P-VOL and S-VOL is not the same when recreating the HTI pair. Make sure that the capacity of the P-VOL and the S-VOL is the same when creating the volumes.

Additional Steps

Expand the capacity of volumes whose capacity has not been expanded, and then make sure that the capacity of the P-VOL and the S-VOL used in the HTI pair is the same.

When an HTI pair is used with other software, make sure to expand the capacity of the P-VOLs and the S-VOLs in all of the used software products. For more information about the expansion procedure, see the User Guide for the remote replication used with the HTI pair.

Chapter 5: Monitoring and maintaining Thin Image

Viewing snapshot data capacity

(VSP 5000 series) You can use the `raidcom` command to view the snapshot data capacity for each P-VOL.

This capacity indicates the pool capacity which is used as snapshot data stored from the P-VOL, but it does not include all of the information required to manage snapshot data. Although snapshot data is assigned from the pool in 42 MB blocks, Thin Image stores snapshot data from a P-VOL in 256 KB blocks. Therefore, the snapshot data capacity is not always consistent with each pool's used capacity.

The following example shows how to use the `raidcom` command to view snapshot data capacity.

```
#raidcom get ldev -ldev_id 640
Serial# : 63502
LDEV : 640
SL : 0
CL : 0
VOL_TYPE : OPEN-V-CVS
VOL_Capacity(BLK) : 2181120
VOL_Capacity(cyl) : 22720
NUM_LDEV : 1
LDEVs : 640
NUM_PORT : 1
```

```
PORTs : CL2-E-0 14 Linux_X86
F_POOLID : NONE
VOL_ATTR : CVS : VVOL : QS
:
TIER_Alloc_level : H
TIER#1_Alloc_rate : MAX : 50 : MIN : 30
TIER#3_Alloc_rate : MAX : 50 : MIN : 30
Snap_Used_Pool(MB) : 2181
```

For more information about the `raidcom` command, see the *Command Control Interface Command Reference*.

Maintaining pairs during storage system maintenance

You can maintain pairs when you switch off the storage system power and when you replace the microcode.

Switching off the power supply

Use this workflow to switch off the power supply.

1. Stop the host I/O.
2. Switch off the power supply.

When power is restored, the behavior of Thin Image depends on the following:

- The power supply and having data in shared memory.
- The power supply and losing data in shared memory.

Power supply and existing shared memory

After you switch off the power supply, you can use the pools and pairs if data in the shared memory exists and the data is not blocked.

The storage system checks the status of the pool and pool-VOLs. If the pool-VOLs are blocked at the time you switch off the power supply, the pool is blocked and the pairs are suspended ("PSUE" status).

If you interrupt the workflow of storing snapshot data or cloning pairs by consistency groups by switching off the power supply and the status of all the pairs in a consistency group has not completely changed, the workflow does not resume when you switch the power supply on again. The status of some pairs may remain unchanged.

If the pool is blocked and the pairs are suspended, complete the following:

1. Restore the power.
2. Recover the pools.

Power supply and losing data in shared memory

If you lose power and the data in shared memory is lost, the VSP 5000 series storage system saves the data to SSD at the time the power supply is switched off, but for VSP E series, you must recreate the pools and pairs.

You can still use the pool and Thin Image pairs with VSP 5000 series storage, because the data is restored to shared memory from SSD after switching the power supply back on.

For VSP E series, first restore the power, then recreate the pools and pairs.

Using storage system functionality with a VASA provider

A volume with the SLU attribute is created by Hitachi Storage Provider for VMware vCenter (hereinafter referred to as "VASA provider").

If you are not using a VASA provider, do not operate on an HTI pair that is composed of volumes with the SLU attribute from Storage Navigator.

If you need to change the configuration of an HTI pair that is composed of volumes with the SLU attribute, contact customer support.

To check whether an HTI pair is composed of volumes with the SLU attribute, check **SLU ID** in the **TI Pairs** window. If the SLU attribute is set for a volume, the SLU ID of the volume is displayed. If the SLU attribute is not set for a volume, a hyphen (-) is displayed.

Definition of failure

When a failure occurs in a cascade configuration, in addition to the volume in which the failure occurs, the following volumes are also suspended:

- Cascaded volumes under the volume in which the failure occurred.

- Volumes (including their cascade volumes) older generationally than the volume in which the failure occurred.

The following figure illustrates the volumes to be suspended when a failure occurs.
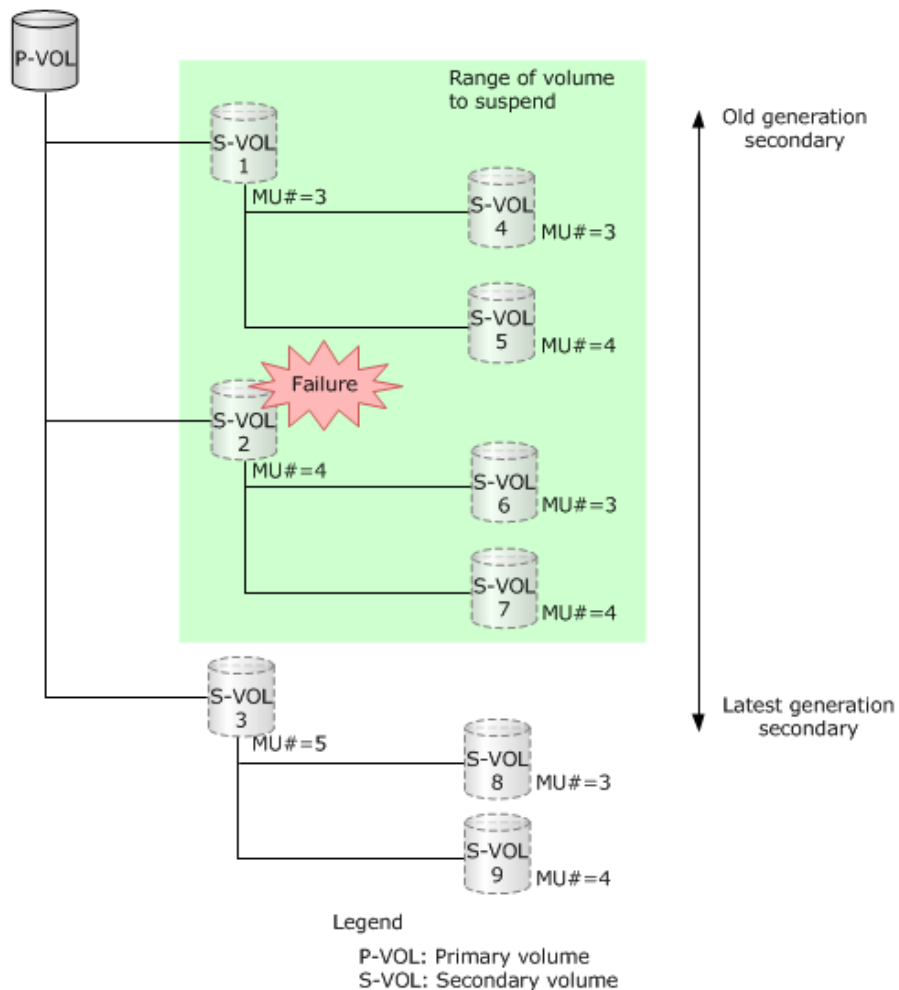
Chapter 6: Troubleshooting Thin Image

If your site experiences workflow, configuration, or management issues while working with Thin Image, such as a volume that is blocked, then you can troubleshoot them by referring to the possible problem causes and solution procedures.

Overview

Types of troubleshooting tasks are categorized as follows:

- General troubleshooting

- Procedures for recovering from pool failures (SIM = 601xxx, 602xxx, 604xxx, 605xxx, 606xxx)

- Troubleshooting the source of SIM codes

Failures in a cascaded configuration

If a failure occurs in a cascaded configuration, the following volumes are suspended in addition to the volume where the failure occurred:

- Cascaded volumes under the failed volume.

- Volumes of which generation are older than the failed volume and cascaded volumes under the older generation volumes.

The following figure illustrates the volumes to be suspended when a failure occurs.
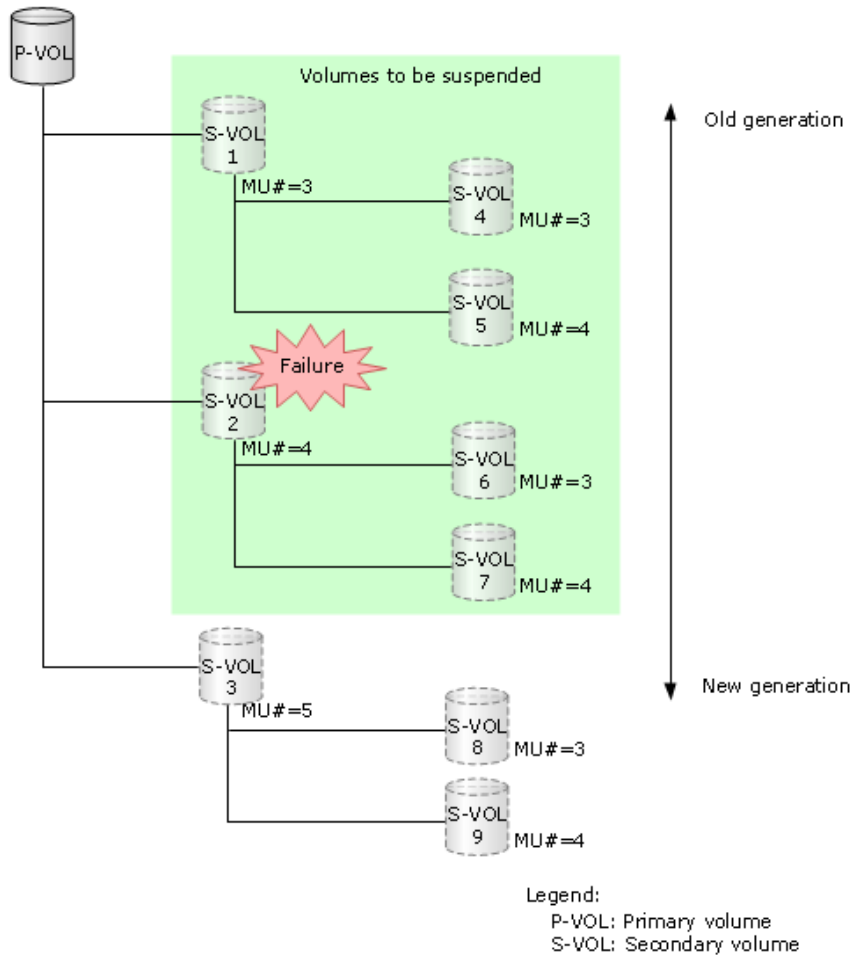
Troubleshooting the source of SIM codes

The SVP reports all SIMS related to Thin Image operations. All SIMs are recorded in the SVP, and are reported to the management client. For details, see the *System Administrator Guide*.

When SNMP is installed for a storage system, an SNMP trap is triggered by each SIM, and is sent to the applicable hosts. For details about SNMP information, see the *Hitachi Alert Notification Guide*. For details about SIM reference codes, see the *Hitachi Alert Notification Guide*, the *SIM Reference Guide*, or the *System Administrator Guide*.

Troubleshooting pools, pairs, and volumes related to Thin Image

This table lists problems related to Thin Image that can occur, along with their causes and solutions.

Problem	Causes and solutions
Pool information is not displayed.	Cause: The pool is blocked. Solution: Recover the blocked pool (see <u>Workflow for recovering blocked pools (on page 183)</u>).
An HTI pool is blocked.	Solution: Perform <u>Workflow for fixing errors when pool-related SIMs are reported (on page 215)</u>. For information about troubleshooting DP pools, see the *Provisioning Guide* for your storage system.
The HTI pool usage rate of the pool capacity or the capacity ensured for writing exceeds the threshold.	Solution: Perform <u>Workflow for fixing errors when pool-related SIMs are reported (on page 215)</u>. For more information about the pool capacity and the capacity ensured for writing, and for information about troubleshooting DP pools, see the *Provisioning Guide* for your storage system.
You cannot add pool-VOLs to HTI pools.	Causes: ▪ You have reached the maximum amount of pool-VOLs that can be added to a pool (see <u>Increasing pool capacity (on page 172)</u>). ▪ Available pool management block in the V-VOL management area in the SM is insufficient. ▪ Pool-VOL requirements were not followed. Solutions: ▪ Add pool-VOLs to another pool. ▪ Initialize the V-VOL management area. ▪ Check pool-VOL requirements. For information about troubleshooting DP pools, see the *Provisioning Guide* for your storage system.
You cannot create HTI pairs.	Causes: ▪ You have reached the maximum amount of cache management devices. ▪ You have not met the prerequisites to create the pair. ▪ The status of the specified volume is not displayed because you are deleting the HTI pair.

Problem	Causes and solutions

	Solutions:
	
	▪ Make sure that you have enough cache management devices to create the pairs (see <u>Thin Image cache management device requirements (on page 81)</u>).
	
	▪ If cache management devices are running out, complete one of the following:
	
	   · Delete unnecessary external volumes.
	
	   · Delete unnecessary V-VOLs.
	
	   · Delete the HTI pairs related to the P-VOL.
	
	▪ Complete the following:
	
	   1. Fulfill the conditions to create the pair.
	   2. Create the pair.
	
	▪ Execute the `inqraid` CCI command and verify that the volume is not used by HTI, and then try the pair creation again.

A timeout occurs and the CCI command ends abnormally (error code `EX_EWSTOT`).	Cause: The consistency group contains an HTI pair whose status cannot be changed. Solution: Resolve the error condition and perform pair tasks (see <u>Notes on using Thin Image primary volumes as TrueCopy, ShadowImage, or Universal Replicator pair volumes (on page 234)</u> and <u>Notes on storing snapshot data, and on cloning pairs (on page 235)</u>).
HTI pairs are not displayed in the volume list.	Causes: ▪ You have not created the HTI pairs. ▪ The filtering function is prohibiting the displaying of the pairs. Solutions: ▪ Create the HTI pairs. ▪ Change the settings in the **Display Filter** dialog box.
An error occurred while restoring the pair.	Cause: A volume is blocked because a failure occurred in the data drive. Solution: 1. Delete the blocked HTI pair (see <u>Deleting Thin Image pairs (on page 142)</u>). 2. Contact customer support.
A volume is blocked.	Causes: ▪ A failure occurred in at least two data drives. ▪ The breaker was turned off once and then the power supply switched on. Solution: Contact customer support.

Chapter 6: Troubleshooting Thin Image

Problem	Causes and solutions
A problem occurred in the host application for monitoring the volumes.	Cause: Access to the volume is rejected. Solution: 1. Stop the host application monitoring the volumes. 2. Split all of the pairs ("PSUS" status or an unpaired volume) (see Splitting Thin Image pairs to store snapshot data (on page 133)). 3. Start the monitoring application on the host and check whether the host has access to pair volumes (see How Thin Image pair status changes (on page 38)).
A virtual volume cannot be recognized correctly after the host server is booted/rebooted or the command for recognizing a device is performed.	Cause: Access to the volume is rejected. Solution: 1. Stop the host application monitoring the volumes. 2. Split all of the pairs ("PSUS" status or an unpaired volume) (see Splitting Thin Image pairs to store snapshot data (on page 133)). 3. Reboot the host server or run a command that causes the system to recognize the device. 4. Start the monitoring application on the host and check whether the host has access to pair volumes (see How Thin Image pair status changes (on page 38)).
The host computer attempts to access the port and an error occurs.	Cause: A port may go offline because access to a volume on another port has been rejected. Solutions: ▪ Wait until the process has completed, and then retry the task. ▪ If a host application is installed to monitor the volume, stop the application.
HDvM - SN times out frequently.	Causes: ▪ HDvM - SN cannot respond to the SVP because the load is too heavy. ▪ The time-out period is not an adequate length. Solutions: ▪ Wait until the process has completed and then retry the task. ▪ Verify the values for the HDvM - SN RMI time-out period. For more information about how to set RMI time-out period, see the *System Administrator Guide* for your storage system.

Chapter 6: Troubleshooting Thin Image

Problem	Causes and solutions
The pair information in the **Local Replication** window is not updated. The date and time in Last Updated is not updated.	Cause: HTI processing may be in progress. Solution: The update will complete sometime after the HTI processing finishes.
After a host completes a write operation, the used pool capacity shown in the Summary section of the **Pools** window and in the list in the Primary Volumes tab of the selected pool do not match.	Cause: The copy processing is running. Solution: Wait until the copy processing is completed. The used pool capacity shown in the Summary section of the **Pools** window and in the list in the Primary Volumes tab of the selected pool match. For more information about viewing the used pool capacity in this section and on this tab, see <u>Monitoring pool information (on page 169)</u>.
You cannot resynchronize a suspended HTI pair ("PSUE" status).	Causes: ▪ The HTI pair cannot be defined because the pair entered the PSUE status while being created. ▪ All the HTI pairs under the P-VOL are in the PSUE status. Solution: 1. Delete the HTI pairs related to the P-VOL (see <u>Deleting Thin Image pairs (on page 142)</u>). 2. Create the HTI pair (see <u>Creating Thin Image pairs using Device Manager - Storage Navigator (on page 127)</u>).
The automatically adding pool volumes function in an accelerated compression-enabled parity group does not work.	Causes: ▪ The automatically adding pool volumes function for the pool is disabled. ▪ The automatically adding pool volumes function for the parity group is disabled. ▪ Available LDEV IDs are insufficient. ▪ Available cache management devices are insufficient. ▪ Maintenance work is still under way. ▪ Shared memory is insufficient. Solution: ▪ Enable the automatically adding pool volumes function for the pool. ▪ After the pool failed to shrink, if the automatically adding pool volumes function in a parity group is disabled, disable accelerated compression of the pool to be shrunk first, and then enable accelerated compression of the pool again.

Chapter 6: Troubleshooting Thin Image

Problem	Causes and solutions
	▪ Delete LDEVs that are not used.
	▪ Stop the maintenance work.
	▪ Delete pools that are not used.
	▪ Delete V-VOLs that are not used.
	▪ Delete all HTI pairs that contain P-VOLs of unnecessary HTI pairs.

If the solutions in this table do not work, or if your problem is not included in this table, contact customer support.

Workflow for correcting pool-related failures (SIM = 601xxx, 602xxx, 604xxx, 605xxx, and 606xxx)

The following figure explains how to correct Thin Image pool failures. 601*xxx* is not output for VSP E series.
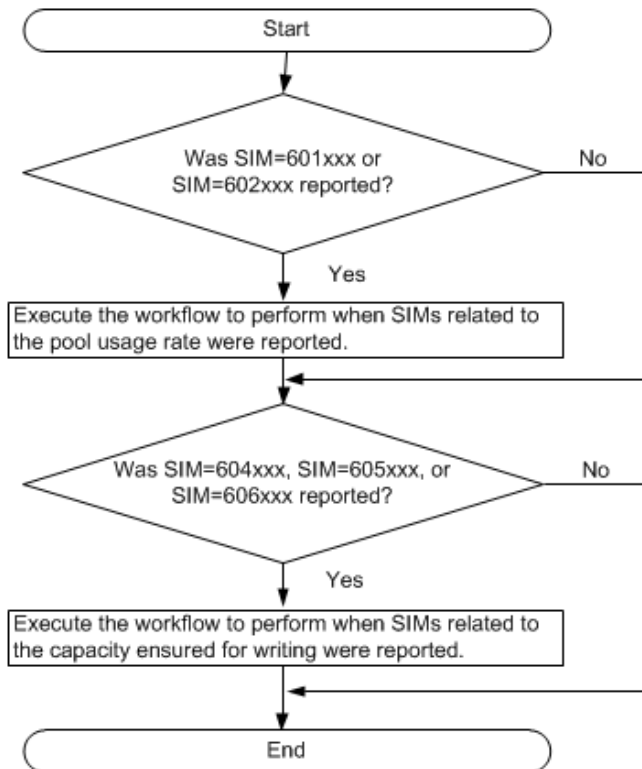
Workflow to perform when SIMs related to the pool usage rate were reported

The following figure explains how to take action when 601*xxx* or 602*xxx* has occurred. 601*xxx* is not output for VSP E series.

Chapter 6: Troubleshooting Thin Image

(VSP 5000 series)

```
                    ┌─────────────────────────┐
                    │          Start          │
                    └─────────────────────────┘
                                 │
                                 ▼
                         ╱───────────────╲
                        ╱                 ╲            Yes
                       ╱ Was SIM=601xxx    ╲──────────────────────┐
                       ╲   reported?       ╱                      │
                        ╲                 ╱                       │
                         ╲───────────────╱                       │
                                 │ No                            │
                                 ▼                               │
                    ┌─────────────────────────┐                 │
                    │ Check the pool volume    │                │
                    │        status            │                 │
                    └─────────────────────────┘                 │
                                 │                               │
                                 ▼                               │
                         ╱───────────────╲     Yes (Pool volume is full)
                        ╱                 ╲──────────────────────┐
                       ╱ Is pool volume    ╲                     │
                       ╲   normal ?        ╱                     ▼
                        ╲                 ╱                    ( 1 )
                         ╲───────────────╱
                                 │ No
                                 ▼
                    ┌─────────────────────────────┐
                    │ Restore the pool volume      │
                    │ (Call the customer support   │
                    │  when the pool volume is     │
                    │  blocked)                    │
                    └─────────────────────────────┘
                                 │
                                 ▼
                         ╱───────────────╲        No
                        ╱                 ╲──────────────┐
                       ╱ Is the pool       ╲             │
                       ╲   blocked?        ╱             │
                        ╲                 ╱              │
                         ╲───────────────╱               │
                                 │ Yes                   │
                                 ▼                        │
                    ┌─────────────────────────────┐      │
                    │ Restore the pool             │      │
                    │ (See the workflow for        │      │
                    │  recovering blocked pools)   │      │
                    └─────────────────────────────┘      │
                                 │◄─────────────────────┘
                                 ▼
                    ┌─────────────────────────────┐
                    │ Restore the TI pair          │
                    │ (See the workflow for        │
                    │  recovering blocked pools)   │
                    └─────────────────────────────┘
                                 │
                                 ▼
                    ┌─────────────────────────┐
                    │          End            │
                    └─────────────────────────┘
```

Chapter 6: Troubleshooting Thin Image

①

Does the pool have LDEVs that belong to a parity group with accelerated compression enabled?

Yes

No

Can accelerated compression be enabled?

Yes

Enable accelerated compression of the parity group which belongs to the LDEV of corresponding pool

No

Perform either of the following:
· Add pool volumes
· Delete all TI pairs which corresponds to the P-VOL of unnecessary TI pair

Perform either of the following:
· Add pool volume
· Delete all TI pairs which corresponds to the P-VOL of unnecessary TI pair

Was SIM=4b3xyy reported?

No

Yes

Resynchronize ThinImage pair

Did it end without an error?

Yes

No

Delete the TI pair and create them again

Did it end without an error?

Yes

No

Contact the customer support

End

Chapter 6: Troubleshooting Thin Image

(VSP E series)

(VSP 5000 series) The pool capacity required for resolving SIMs is calculated as follows:

```
required-capacity = (capacity-used-by-pool / pool-threshold) - pool-capacity-before-
expansion
```

When you expand a pool using LDEVs created from parity groups of which accelerated compression is enabled, the total amount of the LDEVs should meet the following conditions:

```
total-capacity-of-LDEVs-to-be-created ≤ (physical-amount-of-parity-group / (1 -
deletion-rate)) -
```

```
- capacity-of-pool-volumes-belonging-to-applicable-parity-group-of-pool-before-
expansion
```

Determine whether to expand a pool by comparing the results calculated by using the above formulas.

When

```
required-capacity ≤ total-capacity-of-LDEVs-to-be-created
```

Chapter 6: Troubleshooting Thin Image

The insufficient capacity can be reserved by using the available capacity in a parity group of which accelerated compression is enabled.

When

```
required-capacity > total-capacity-of-LDEVs-to-be-created
```

To reserve the insufficient capacity, add a parity group to create an LDEV, and then expand the pool.

Note that the threshold and the deletion rate used for the calculation are expressed as a fraction converted from a percent. For example, if the threshold is 80%, enter 80/100 as the pool threshold for the calculation.

Workflow to perform when SIMs related to the pool capacity or the capacity ensured for writing were reported

The following figures explain how to take action when 604*xxx*, 605*xxx*, or 606*xxx* has occurred.

Workflow to perform when SIMs related to the pool capacity or the capacity ensured for writing were reported

```
                        ┌──────────────┐
                        │    Start     │
                        └──────┬───────┘
                               │
                               ▼
                      ◇ Did the pool status ◇        No
                      ◇ exceed the threshold? ◇ ──────────────┐
                               │                               │
                               │ Yes                           │
                               ▼                               │
        ┌───────────────────────────────────────┐             │
        │ Perform either of the following:      │             │
        │ · Add pool volumes*                   │             │
        │ · Delete all TI pairs which corresponds to the │    │
        │   P-VOLs of unnecessary TI pair       │             │
        └───────────────────┬───────────────────┘             │
                            │                                  │
                            ▼◄─────────────────────────────────┘
                    ◇ Was SIM=4b3xyy      ◇       No
                    ◇ reported?           ◇ ────────────────┐
                            │                                │
                            │ Yes                            │
                            ▼                                │
        ┌───────────────────────────────────────┐           │
        │        Resynchronize the TI pair      │           │
        └───────────────────┬───────────────────┘           │
                            │                                │
                            ▼                                │
                    ◇ Did it end without  ◇      Yes         │
                    ◇ an error?           ◇ ────────────────┤
                            │                                │
                            │ No                             │
                            ▼                                │
        ┌───────────────────────────────────────┐           │
        │ Delete the TI pair and create them again │        │
        └───────────────────┬───────────────────┘           │
                            │                                │
                            ▼                                │
                    ◇ Did it end without  ◇      Yes         │
                    ◇ an error?           ◇ ────────────────┤
                            │                                │
                            │ No                             │
                            ▼                                ▼
                ┌──────────────────────┐          ┌──────────────┐
                │ Contact the customer │          │     End      │
                │      support         │          └──────────────┘
                └──────────────────────┘
```

(VSP E series)

*To resolve SIMs, add parity groups to create LDEVs, and then expand the pool. The required physical capacity can be calculated by using the following formula:

```
required-physical-capacity = (physical-capacity-of-pool /
pool-threshold) – physical-capacity-of-pool-before-expansion
```

Note the threshold and the deletion rate used for the calculation are expressed as a fraction converted from a percent. For example, if the threshold is 80%, enter 80/100 as the pool threshold for the calculation.

Workflow for fixing errors when SIMs related to cache management devices are reported

The `Reference code 670000` SIM (service information message) is issued if the number of the remaining cache management devices falls below 4,096.

For more information about SIM reference codes, contact customer support.

You can view SIMs that occur in the storage system in an HDvM - SN window.

For more information about checking alerts and the details of a SIM, see the *System Administrator Guide* for your storage system.

You must reserve enough cache management devices. If a warning SIM is issued before you deplete cache management devices, a problem has not necessarily occurred. Using the storage system and depleting the cache management devices blocks the Thin Image pair and suspends the pair ("PSUE" status) and snapshot data cannot be stored or pairs cannot be cloned. In addition, you cannot create a new Thin Image pair using another P-VOL.

> 📄 **Note:** You cannot store snapshot data or create additional Thin Image pairs using other P-VOLs while the pair is suspended.

Use the following workflow to fix errors when the warning SIMs related to cache management devices are reported:

1. Confirm that the number of remaining cache management devices meets the threshold for your storage system is at least 4,096.
2. Remove unneeded V-VOLs.
3. Remove all of the snapshots in the unneeded P-VOLs by resynchronizing the pairs.
4. (VSP 5000 series) Manually complete the SIMs related to cache management devices.

Calculating the number of remaining cache management devices

Use this formula to calculate the number of remaining cache management devices.

remaining-cache-management-devices = available-cache-management-devices - cache-management-devices-being-used

The number of available cache management devices depends on the storage system:

- VSP 5000 series: 65,280
- VSP E series: 65,536

Workflow for fixing errors when pool-related SIMs are reported

If the pool capacity (or the capacity ensured for writing) exceeded the threshold, a pool was blocked, or there is no free space in shared memory, Service Information Messages (SIMs) below are issued. This topic provides information about SIMs related to Thin Image pools. For SIMs related to DP pools, and for details about the pool usage capacity and the capacity ensured for writing, see the *Provisioning Guide* for your storage system.

Fix pool-related errors by referencing the following Service Information Messages (SIMs):

- Reference code 601*xxx*, 604*xxx*, or 606*xxx*: The pool usage rate of capacity (or the capacity ensured for writing) exceeds the threshold.

- Reference code 602*xxx* or 605*xxx*: The pool is blocked.

- Reference code 602ffe: Multiple pools are blocked.

- Reference code 603000: The Snapshot Estimated Manageable Capacity meets either of the following conditions:

  - Reached less than 5% of the capacity supported by the installed shared memory.

  - Remains less than 5% of the capacity supported by the installed shared memory even after 8 hours since the output of reference code 603000.

- Reference code 624000: You have reached capacity in the shared memory.

xxx indicates the pool ID. For details about reference codes of SIMs, contact customer support.

For VSP 5000 series, you can check the SIMs occurring in storage systems from a Device Manager - Storage Navigator window. For information about the Device Manager - Storage Navigator windows you can use for checking SIMS, see the *Provisioning Guide* for your storage system.

Use the following workflow to implement fixes:

1. Complete one of the following:

    ▪ **For reference code 601xxx, 602xxx, 604xxx, 605xxx, 606xxx, or 602ffe,:** recover the pool ("Normal" status).

       For more information about the countermeasures to take when the pool capacity (or the capacity ensured for writing) exceeds the threshold and when a pool was blocked, see Workflow for correcting pool-related failures (SIM = 601xxx, 602xxx, 604xxx, 605xxx, and 606xxx) (on page 207).

    ▪ **For reference code 624000:** , complete one of the following:

       - Delete unused pools.

       - Delete unused Thin Image pairs.

       - Delete unused DP-VOLs.

       - Shrink the capacity of the HDP, HDT, or active flash pool.

    ▪ **For reference code 603000:** , perform one of the tasks listed for reference code 624000 above. Although task completion is not a requirement, if it is not completed some time after reference code 603000 was issued, then reference code 624000 might be reported. In Device Manager - Storage Navigator, enabling the Disable the alert notification of shared memory space warning option in the Edit Local Replica Options window or using the `raidcom modify local_replica_optset_system_opt` command in CCI to set ID# 30, inhibits the alarm notification of reference code 603000.

2. (VSP 5000 series) Clear the SIM from the storage system. Depending on the SIM's reference code, one of the following occurs:

    ▪ The SIM is automatically completed.

    ▪ You manually complete the SIM.

3. (Optional) Use HDvM - SN to confirm that the SIM completed normally.

For more information about the **Pools** window and the **Complete SIMs** window, see the *Provisioning Guide* for your storage system.

For more information about completing SIMs automatically and manually, see the *System Administrator Guide* for your storage system.

Completing SIMs

(VSP 5000 series) Completing SIMs means changing the SIM status to "Completed". When the cause of a SIM occurrence is solved, change the SIM status to Completed. If you complete a SIM without solving the cause, the SIM might occur again when another operation is performed.

Automatic completion of SIMs

SIMs are automatically completed in these cases.

- **For reference code 620xxx:** The usage level of HDP pool number *xxx* falls below the warning threshold.

  For more information about setting the data pool's warning threshold, see Creating Thin Image data pools (on page 105).

- **For reference code 625000:** The usage level of each HDP pool in all of the pools in the storage system falls below the depletion threshold.

- **For reference code 626xxx:** The usage level of each HDP pool number *xxx* falls below the depletion threshold.

> 📄 **Note:** The data pool's depletion threshold is not a value you can set using Thin Image.

SIM reference codes 620*xxx*, 625000, and 626*xxx* are automatically completed if you increase the pool capacity by adding pool-VOLs. Increasing the pool capacity removes the condition that causes these SIMs.

Manually completing SIMs

You can manually complete the SIMs related to cache management devices to clear them from the storage system and process pool-related SIMs.

For more information about completing SIMs automatically and manually, see the *System Administrator Guide*.

Use the procedure described below to manually complete the following SIMs. If any problems occur with the SIM that are not resolved, then the SIM cannot be complete.

- A SIM associated with a pool in the normal status
- A SIM associated with a removed pool

Procedure

1. In the **Explorer** pane, click **Storage Systems**, expand the storage system tree, and then click **Pools**.
2. In the **Pools** window, click **More Actions** > **Complete SIMs**.
3. Accept the default task name or enter a unique name.
   You can enter up to 32 letters, numbers, and symbols, except the following:

   \ / : , ; * ? " < > |

4. If you want to monitor the task after submitting it, select **Go to tasks window for status**.
5. Click **Apply** to submit the task.

Result

The SIMs are completed ("Completed" status).

You can confirm whether a SIM has been completed normally by checking the system information and status in HDvM - SN.

For more information about checking alerts for SIMs, see the *System Administrator Guide*.

Appendix A: CCI command reference for Thin Image

This appendix describes CCI commands corresponding to actions in the HDvM - SN GUI. Use CCI to perform Thin Image tasks by entering commands from a host.

Pair tasks using CCI or Device Manager - Storage Navigator

You can use CCI as well as Device Manager - Storage Navigator (HDvM - SN) to perform pair tasks. When you use CCI, perform tasks by running pair*xx* commands for pair tasks or CCI commands.

Use CCI commands to store a minimum of 65 snapshots, clone a minimum of 65 pairs, or use a minimum of 64 MU numbers. Use the pair*xx* commands only for TI pairs with an MU number (0 through 63).

> **Note:** If you use pair*xx* commands,
>
> - Do not use both pair*xx* commands and CCI commands for a pair. For example, if you create a pair using the paircreate command, do not store snapshot data using the **raidcom modify snapshot -snapshot_data create** command.
>
> - In the future, pair*xx* commands and raidcom commands will be merged. Use raidcom commands especially when you create a batch job.

The following table shows the pair tasks you can perform, the CCI commands you can use to perform the task, and the HDvM - SN wizard and windows from which to start the task.

Pair task	CCI command	HDvM - SN
Create pair	`paircreate`	Create TI Pairs wizard
	`raidcom add snapshot`	
Create and split pair	`paircreate –split`	**Split Pairs** wizard
Split pair, store snapshot data, clone pairs	`pairsplit`	**Split Pairs** wizard
	`raidcom modify snapshot -snapshot_data create`	
	`raidcom modify snapshot -snapshot_data clone`	

Appendix A: CCI command reference for Thin Image

Pair task	CCI command	HDvM - SN
	`raidcom modify snapshot -snapshot_data split`	
Normal Copy	`pairresync`	**Resync Pairs** wizard
	`raidcom modify snapshot -snapshot_data resync`	
Reverse Copy	`pairresync -restore`	**Resync Pairs** wizard
	`raidcom modify snapshot -snapshot_data restore`	
Delete pair	`pairsplit -S`	**Delete Pairs** window
	`raidcom delete snapshot`	
Assign an S-VOL to snapshot data	`raidcom map snapshot`	Create TI Pairs wizard **Assign Secondary Volumes** wizard
Release the assignment of an S-VOL to snapshot data	`raidcom unmap snapshot`	**Remove Secondary Volumes** window
Change the assignment of an S-VOL to snapshot data	`raidcom replace snapshot`	**Assign Secondary Volumes** wizard

For more information about using the CCI, see the *Command Control Interface Command Reference*.

CCI pair command results

To avoid getting mixed results, run CCI commands on pairs that are in the required status.

The following table shows the results of running commands on pairs depending on their status.

Status	CCI command						
	paircreate	paircreate -split	pairsplit	pairresync	pairresync -restore	pairsplit -S*	pairsplit -E
SMPL	Ok	Ab	Ab	Ab	Ab	Np	Ab

Status	CCI command						
	paircreate	paircreate -split	pairsplit	pairresync	pairresync -restore	pairsplit -S*	pairsplit -E
COPY	Np	Ab	Ab	Np	Np	Ab	Ab
PAIR/ PFUL	Np	Ok	Ok	Np	Np	Ok	Ab
PSUS/ PFUS	Ab	Np	Np	Ok	Ok	Ok	Ab
RCPY	Np	Ab	Ab	Np	Np	Ab	Ab
PSUE	Ab	Ab	Ab	Ok	Ab	Ok	Ab

*Terminates normally, regardless of the pair status, when the snapshot tree is specified as the range to be deleted.

Legend:

Ok: The command ends normally and the task is performed.

Np: The command is not rejected and ends normally but the task is not performed.

Ab: The command is rejected and ends abnormally.

Do not specify noread mode (-m noread) for S-VOLs using CCI. If you do, the command ends normally but the noread mode does not take effect.

If a CCI command is rejected and ends abnormally and the host is running the HP-UX operating system, sense bytes (SSB) are output to the CCI error log file. Sense bytes indicate the cause of the error.

For more information about SSB and error causes, see .

Parameter ranges for CCI options

The following table lists the valid ranges of parameters for CCI options. For details, see the *Command Control Interface Command Reference*.

Parameter	Range
Mirror ID (MU#)	0 to 1,023
CTG ID	0 to 2,047

Troubleshooting with Command Control Interface

To identify the cause of errors that occur when you run CCI commands, refer to the log displayed in the CCI window or the CCI operation log file.

Procedure

1. Find the error code in the log displayed in the CCI window or the CCI operation log file. The CCI log file's default location is `/HORCM/log*/curlog/horcmlog_HOST/ horcm.log`, where the asterisk (*) is the instance number and *HOST* is the host name.

    The following figure shows an example of a log displayed in the CCI window.

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

    SSB1   SSB2
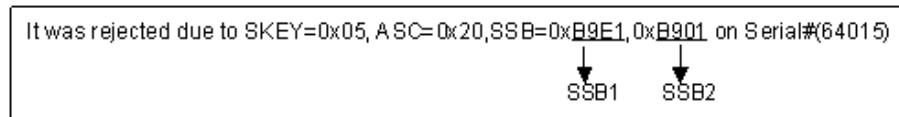
    An error code string in the CCI operation log file looks like the following example:

    `11:06:03-37897-10413- SSB = 0xB901,4A96`

2. Locate the SSB1 and SSB2 codes. In the examples above, the error codes appear to the right of "SSB =".

    -   The last four digits to the left of the comma (,) are the SSB1 code (B9E1).

    -   The last four digits to the right of the comma (,) are the SSB2 code (B901).

3. Locate the description of the SSB1/SSB2 error code combination in the table in Command Control Interface SSB2 codes (on page 222). For error codes not described in this table, call customer support.

Command Control Interface SSB2 codes

This table lists the SSB2 codes when SSB1 is 2E11, 2E30, 2E31, 2EBE, B901, B9A8, B9A9, B9AD, or B9AE, the related CCI command, and the cause of the error.

SSB2	CCI command	Cause of error
020C	raidcom add snapshot	You cannot create a pair with the SLU attribute because a volume with the SLU attribute has been specified as a secondary volume.
020D	raidcom add snapshot	You cannot create a pair because a volume with the ALU attribute has been specified as a primary volume or a secondary volume.
0210	raidcom modify snapshot	You cannot operate on the specified volume because it is not the root volume of the Thin Image pair.
800F	raidcom modify snapshot	You cannot perform the operation because there is an unsupported microcode version of the MP (processor) in the storage system.

SSB2	CCI command	Cause of error
801D	raidcom modify snapshot	You cannot perform the operation because the storage system is in internal process, or the configuration changing processes are conflicting. Wait a while, and then retry the operation.
801E	raidcom modify snapshot	You cannot perform the operation because the local replication pair is being initialized.
9100	All commands	You cannot run the command because the user authentication is not performed.
9685	paircreate	You cannot create the HTI pair because of a shortage of pair tables.
9700	paircreate	You cannot create the HTI pair because the pool is not available.
9702	paircreate	You cannot create the HTI pair because you specified a pool ID different from the pool ID used by existing pairs with the specified P-VOL.
9703	paircreate	You cannot create the HTI pair because the volume you specified as the P-VOL is already used by another HTI S-VOL.
9704	paircreate	You cannot create the HTI pair because the volume you specified as the S-VOL is already used by another HTI P-VOL.
9705	paircreate	You cannot create the HTI pair because the volume you specified as the S-VOL is already used by another HTI S-VOL.
9706	paircreate/add snapshot	You cannot create the HTI pair because another HTI pair is using the MU number you specified. If you create a new HTI pair with an S-VOL for an existing HTI pair, you cannot create the HTI pair because the S-VOL for the existing HTI pair is using the MU number zero (0) you specified.
9707	paircreate	You cannot create the HTI pair because the capacity of the pair that you are trying to create exceeds the amount of licensed capacity you have reserved.
9708	raidcom modify snapshot	The execution status of the snapshot garbage data deletion processing (defragmentation processing) of the specified root volume is not in an operable status.
9718	All commands	The command ended abnormally. You tried to use a command other than **paircreate** for the volume in the pair other than the HTI pair.

SSB2	CCI command	Cause of error
		This error can also occur if you run the command with an unsupported parameter specified.
9719	All commands	The command ended abnormally because the pair is in a status that the command does not accept. This error can also be reported if you run the command with an unsupported parameter specified.
971A	paircreate	You cannot create the HTI pair because you do not have sufficient SM capacity.
971F	pairresync - restore	You cannot restore the HTI pair because the volume you specified as the P-VOL has an S-VOL Disable attribute.
9722	paircreate, pairsplit, pairresync, pairresync - restore	The command ended abnormally because you specified either of the following for the HTI P-VOL. ▪ External volume for which the Data Direct Mapping attribute is enabled. ▪ Normal volume for which accelerated compression is enabled. These volumes can only be used as pool volumes.
9723	All commands	The command ended abnormally because shared memory (Base) is not added
9724	All commands	The command ended abnormally because shared memory (Base or greater) is not added.
9725	All commands	The command ended abnormally because the LDEV number of the volume you specified as the HTI P-VOL is beyond the specified range.
9726	All commands	The command ended abnormally because you specified an unmounted volume as the HTI P-VOL.
9727	paircreate, pairsplit, pairresync, pairresync - restore	The command ended abnormally because you specified a blocked volume as the HTI P-VOL.
9728	paircreate, pairsplit, pairresync, pairresync - restore	The command ended abnormally because you specified a volume that is in the process of being shredded or formatted as the HTI P-VOL.

SSB2	CCI command	Cause of error
9729	paircreate, pairsplit, pairresync, pairresync - restore	The command ended abnormally because you specified a volume as the HTI P-VOL, and that volume has an emulation type other than OPEN-V.
972A	paircreate	You cannot create the HTI pair because the volume you specified as the HTI P-VOL has the command device setting.
972C	paircreate	You cannot create the HTI pair because the capacity of the volume you specified as the HTI P-VOL exceeds the supported size.
972E	paircreate	You cannot create the HTI pair because the capacity of the volume you specified as the HTI S-VOL exceeds the supported size.
972F	paircreate	You cannot create the HTI pair because you specified a V-VOL as the HTI P-VOL.
9730	paircreate	You cannot create the HTI pair because you specified a pool-VOL as the HTI P-VOL.
9731	pairresync - restore	You cannot restore the HTI pair because the HTI P-VOL and TC P-VOL share a volume, and the TC pair is not split ("PSUS" status) or is suspended and blocked ("PSUE" status).
9732	pairresync - restore	You cannot restore the HTI pair because the HTI P-VOL and UR P-VOL share a volume, and the UR pair is not split ("PSUS" status) or is suspended and blocked ("PSUE" status).
9733	pairresync - restore	You cannot restore the HTI pair because the HTI P-VOL and TC S-VOL share a volume.
9734	pairresync - restore	You cannot restore the HTI pair because the HTI P-VOL and UR S-VOL share a volume.
9735	paircreate	You cannot create the HTI pair because you specified a UR journal volume as the HTI P-VOL.
973B	All commands	The command ended abnormally because the LDEV number of the volume you specified as the HTI S-VOL is beyond the specified range.
973C	All commands	The command ended abnormally because you specified an unmounted volume as the HTI S-VOL.

Appendix A: CCI command reference for Thin Image

SSB2	CCI command	Cause of error
973D	paircreate, pairsplit, pairresync, pairresync - restore	The command ended abnormally because you specified a blocked volume as the HTI S-VOL.
973E	paircreate, pairsplit, pairresync, pairresync - restore	The command ended abnormally because you specified a volume that is in process of being shredded or formatted as the HTI S-VOL.
973F	paircreate, pairsplit, pairresync, pairresync - restore	The command ended abnormally because you specified a volume whose emulation type is other than OPEN-V as the HTI S-VOL.
9740	paircreate	You cannot create the HTI pair because the volume you specified as the HTI S-VOL has the command device setting.
9742	paircreate	You cannot create the HTI pair because you specified an external volume as the HTI S-VOL.
9744	pairsplit -S, unmap snapshot, replace snapshot	The command ended abnormally because the volume you specified as the S-VOL was grouped with a datastore of Hitachi Storage Provider for VMware vCenter.
9745	paircreate	You cannot create the HTI pair because you specified a volume other than a V-VOL as the HTI S-VOL.
9746	paircreate	You cannot create the HTI pair because you specified a pool-VOL as the HTI S-VOL.
9747	paircreate	You cannot create the HTI pair because you specified a TC P-VOL as the HTI S-VOL.
9748	paircreate	You cannot create the HTI pair because you specified a TC S-VOL as the HTI S-VOL.
9749	paircreate	You cannot create the HTI pair because you specified a UR data volume or journal volume in the intermediate site of 3DC cascading configuration as the HTI S-VOL.
974A	paircreate	You cannot create the HTI pair because you specified a UR P-VOL as the HTI S-VOL.
974B	paircreate	You cannot create the HTI pair because you specified a UR S-VOL as the HTI S-VOL.

SSB2	CCI command	Cause of error
974C	paircreate	You cannot create the HTI pair because you specified a UR journal volume as the HTI S-VOL.
974F	All commands	The command ended abnormally because the volume you specified as the HTI S-VOL has an S-VOL Disable attribute.
9752	paircreate, pairsplit, pairresync, pairresync - restore	The command ended abnormally because the Max LBA size of the volumes you specified as the HTI P-VOL and S-VOL is different.
9753	paircreate, pairsplit, pairresync, pairresync - restore	The command ended abnormally because the number of slots of the volumes you specified as the HTI P-VOL and S-VOL is different.
9754	paircreate	You cannot create the HTI pair because you specified a DP-VOL as the HTI S-VOL.
9756	paircreate, pairsplit, pairresync, pairresync - restore	The command ended abnormally because you specified either of the following for the HTI S-VOL. ▪ External volume for which the Data Direct Mapping attribute is enabled. ▪ Normal volume for which accelerated compression is enabled. These volumes can only be used as pool volumes.
9757	All commands	The command ended abnormally because you specified a Volume Migration V2 source volume as the HTI P-VOL. For more information about using Volume Migration V2, contact customer support.
9758	All commands	The command ended abnormally because you specified a Volume Migration V2 target volume as the HTI P-VOL. For more information about using Volume Migration V2, contact customer support.
975A	All commands	The command ended abnormally because you specified an SI P-VOL as the HTI S-VOL.
975B	All commands	The command ended abnormally because you specified an SI S-VOL as the HTI S-VOL.

Appendix A: CCI command reference for Thin Image

SSB2	CCI command	Cause of error
975C	paircreate, pairsplit, pairresync, pairresync - restore	The command ended abnormally because you specified a DP-VOL for which the Data Direct Mapping attribute is enabled as the HTI S-VOL.
975D	All commands	The command ended abnormally because you specified a Volume Migration V2 source volume as the HTI S-VOL. For more information about using Volume Migration V2, contact customer support.
975E	All commands	The command ended abnormally because you specified a Volume Migration V2 target volume as the HTI S-VOL. For more information about using Volume Migration V2, contact customer support.
976A	paircreate	An unavailable parameter (unsupported parameter) is specified in the command.
976C	pairsplit	You cannot store the snapshot data because you have run the command when the pair is suspended and blocked ("PSUE" status).
976E	pairsplit	The snapshot data cannot be stored because the HTI P-VOL and a TC S-VOL share the volume, and the status of the TC pair is "COPY".
976F	pairsplit	Snapshot data cannot be stored because the HTI P-VOL and a UR S-VOL share the volume, and the status of the UR pair is "COPY".
9772	paircreate	The HTI pair cannot be created because you specified a UR delta resync pair volume as the HTI S-VOL.
9774	paircreate	The HTI pair cannot be created because the HTI P-VOL and an SI P-VOL share the volume, and the MU number you specified for the HTI pair is already used by the SI pair.
9777	paircreate	The HTI pair cannot be created because the HTI P-VOL and an SI S-VOL share the volume, and you specified MU number zero (0) for the HTI P-VOL.
977A	paircreate, pairsplit	The command ended abnormally because the HTI P-VOL and an SI P-VOL share the volume, and the SI pair was in the process of resynchronization.
977B	paircreate, pairsplit	The command ended abnormally because the HTI P-VOL and an SI S-VOL share the volume, and the SI pair status is not "PSUS".

SSB2	CCI command	Cause of error
977C	pairresync - restore	You cannot restore the HTI pair because the HTI P-VOL and an SI P-VOL share the volume, and the SI pair is not split ("PSUS" status) or is suspended and blocked ("PSUE" status).
977D	pairresync - restore	The HTI pair cannot be restored because the HTI P-VOL and an SI S-VOL share the volume, and the SI pair is not split ("PSUS" status).
977E	pairsplit	Snapshot data cannot be stored because the pool or the pool-VOL is blocked.
9783	pairresync - restore	You cannot restore the HTI pair because of one of the following reasons: ▪ You are storing snapshot data for the HTI pair that you want to restore using the consistency group to which the pair is assigned. ▪ You are using the P-VOL of the HTI pair you want to restore as the P-VOL for another HTI pair, and you are storing the snapshot data of the latter pair using the consistency group in which the pair is defined.
9786	All commands	The command ended abnormally because you specified a global-active device volume for quorum disk as the HTI P-VOL.
9787	All commands	The command ended abnormally because you specified a global-active device volume for quorum disk as the HTI S-VOL.
978A	paircreate	You cannot create the HTI pair using the consistency group ID because of one of the following reasons: ▪ SI is using the specified consistency group ID. ▪ You have reached the maximum number of pairs that can be created for a consistency group. ▪ A pair that uses the same P-VOL is assigned to the specified consistency group.
978B	paircreate	You cannot create the HTI pair because the consistency group ID you specified is not within range.
9790	All commands	The command ended abnormally because a DP-VOL whose capacity is being expanded was specified as the P-VOL in an HTI pair.

Appendix A: CCI command reference for Thin Image

SSB2	CCI command	Cause of error
9793	paircreate	You cannot create the HTI pair because a DP-VOL that is processing the Unmap command issued with system option mode 905 ON has been specified as the HTI P-VOL
9796	paircreate, pairsplit, pairresync, pairresync - restore	The command ended abnormally because you specified a volume that does not have an LU path definition or a volume that is not assigned to a namespace for NVMe as the HTI P-VOL.
9797	paircreate, pairsplit, pairresync, pairresync - restore	The command ended abnormally because you specified a volume that does not have an LU path definition or a volume that is not assigned to a namespace for NVMe as the HTI S-VOL.
97A1	paircreate	If you have reached the maximum number of HTI pairs, you cannot create new pairs.
97A2	paircreate, pairsplit, pairresync, pairresync-restore	The command ended abnormally because you specified a volume that uses two mirrors in a three UR data center configuration as the P-VOL.
97A3	paircreate, pairsplit, pairresync, pairresync-restore	The command ended abnormally because the volume specified as the S-VOL uses two mirrors in a three UR data center configuration.
97A4	paircreate	You cannot create the HTI pair because you have specified a DP-VOL in the initialization process as the HTI P-VOL.
97A5	All commands	The command ended abnormally because you specified a volume that was undergoing online data migration as the HTI P-VOL.
97A6	All commands	The command ended abnormally because you specified a volume that was undergoing online data migration as the HTI S-VOL.
97B4	paircreate	You cannot create the pair and use the specified consistency group because you have you have reached the maximum number of consistency groups that can be created.
97B5	paircreate	You cannot create the HTI pair for the specified P-VOL because the maximum number of snapshot ID (MU number) was used.

SSB2	CCI command	Cause of error
97B6	paircreate	You cannot create the HTI pair because of one of the following reasons: ▪ You were in the process of creating a new snapshot group but you reached the maximum number of snapshot groups that can be created. ▪ You have specified a snapshot group which has reached the maximum number of pairs allowed in a group.
97B7	paircreate	You cannot create the HTI pair because the HDP pool is being initialized.
97B9	paircreate, pairsplit, pairresync, pairresync - restore	The command ended abnormally because the status of the pairs using the P-VOL you specified is suspended ("PSUE" status).
97BD	map snapshot/ unmap snapshot	The command ended abnormally because you specified a P-VOL that is not an HTI P-VOL.
97BE	map snapshot/ unmap snapshot/ replace snapshot replace snapshot is for VSP 5000 series	The command ended abnormally because you specified a volume that does not exist.
97BF	paircreate	You cannot create the HTI pair from the consistency group to which the specified snapshot group belongs because of one of the following reasons: ▪ SI is using the specified consistency group. ▪ You have reached the maximum number of pairs that can be created for a consistency group. ▪ A pair that uses the same P-VOL exists already in the specified snapshot group.
97C2	All commands	The command ended abnormally because you specified an MU number outside the allowable range.
97C4	All commands	The command ended abnormally because of one of the following reasons: ▪ You have specified a pool that is neither an HTI pool nor a DP pool. ▪ You have specified a pool that does not exist.

Appendix A: CCI command reference for Thin Image

SSB2	CCI command	Cause of error
97C6	paircreate, pairsplit, pairresync, or pairresync - restore	The command ended abnormally because HTI is not installed.
97C7	paircreate	You cannot create the HTI pair because the capacity of cache management devices is insufficient.
97C8	paircreate	You cannot create the HTI pair because the capacity of the volume you specified as the P-VOL or the S-VOL of the HTI pair is more than the supported size.
97CB	All commands	The command ended abnormally because you specified a pool that is neither an HTI pool nor a DP pool.
97CD	paircreate/map snapshot	The command ended abnormally because you specified a deduplication system data volume (fingerprint) as the P-VOL of a Thin Image pair.
97CE	paircreate/map snapshot	The command ended abnormally because you specified a deduplication system data volume (fingerprint) as the S-VOL of a Thin Image pair.
97CF	paircreate	You cannot create the HTI pair because an HTI group is already using the CG number you specified.
97D4	All commands	The command ended abnormally because you are in the process of turning off the power.
97D5	All commands	You cannot run the command because even though the specified serial number matches the virtual storage machine, the physical storage system's serial number that corresponds with the virtual storage machine's serial number does not match when the virtual storage machine's serial number is specified for P-VOL and S-VOL.
97D6	All commands	You cannot run the command because the model, serial number, or virtual LDEV ID of the volume specified as P-VOL is being changed.
97D7	All commands	You cannot run the command because the model, serial number, or virtual LDEV ID of the volume specified as S-VOL is being changed.

Appendix A: CCI command reference for Thin Image

SSB2	CCI command	Cause of error
97D8	All commands	The pair operation was rejected because one of the following conditions holds for the volume that is specified as the HTI P-VOL: ▪ The volume is used as a global-active device pair volume and does not accept pair operations. ▪ The volume is specified reservation attribute of a global-active device.
97D9	All commands	The pair operation was rejected because one of the following conditions holds for the volume that is specified as the HTI S-VOL: ▪ The volume is used as a global-active device pair volume. ▪ The volume is specified reservation attribute of a global-active device.
97DA	paircreate, map snapshot	The command ended abnormally because the T10 PI settings for the P-VOL and S-VOL did not match.
97DD	unmap snapshot/ replace snapshot	The command ended abnormally because you specified a pair to which an S-VOL is not assigned.
97DE	map snapshot/ unmap snapshot/ replace snapshot	The operation failed because different DKCMAIN microcode versions are mixed. Confirm DKCMAIN microcode version.
97DF	map snapshot	The command ended abnormally because you specified an S-VOL that is assigned to a pair.
97F1	replace snapshot	The command ended abnormally because the pair cannot be identified from snapshot data and the P-VOL that you specified.
97F1	map snapshot/ replace snapshot	The command ended abnormally because you specified a pair to which an S-VOL is assigned.
97FA	unmap snapshot/ replace snapshot	The command ended abnormally because you specified an S-VOL that is not assigned to a pair.
9E03	raidcom add snapshot	You cannot create a pair because both of a Clone option and an SLU option have been specified.
B912	paircreate, pairsplit, pairresync	The HTI pair task failed because you specified the incorrect S-VOL.
B9A7	All commands	You cannot retrieve the consistency group information because HTI is not installed.

Appendix A: CCI command reference for Thin Image

SSB2	CCI command	Cause of error
FF58	pairsplit, pairresync, pairresync - restore	The command ended abnormally because the specified pair is a cascaded pair.
FF59	paircreate	The command ended abnormally because the specified P-VOL is used by a cascaded pair.
FF68	All commands	The command ended abnormally because a DP-VOL whose capacity is being expanded was specified as the S-VOL in an HTI pair
FF6D	paircreate	The command ended abnormally because the specified P-VOL is used by a cascaded pair.
FF72	paircreate, pairsplit, pairresync, pairresync - restore	The Thin Image pair task failed because a snapshot tree is being deleted.
FF7A	paircreate	The Thin Image pair could not be created because the V-VOL capacity exceeded the subscription limit for the pool.
FF7C	paircreate	The Thin Image pair whose snapshot data is stored in the DP pool could not be created because system option mode 1120 is set to ON.
FF82	paircreate／map snapshot	The command ended abnormally because the deduplication system data volume (data store) is specified as the Thin Image P-VOL.
FF83	paircreate／map snapshot	The command ended abnormally because the deduplication system data volume (data store) is specified as the Thin Image S-VOL.

Notes on using Thin Image primary volumes as TrueCopy, ShadowImage, or Universal Replicator pair volumes

The `raidcom modify snapshot -snapshot_data create` or `raidcom modify snapshot -snapshot_data clone` CCI command might return the error code `EX_EWSTOT` (timeout) and terminate abnormally when the status of a pair in a Thin Image consistency group cannot be changed.

Following are possible reasons why the pair status cannot be changed:

- The Thin Image primary volume is used as a Universal Replicator S-VOL, and you are reaching the UR journal volume capacity limit.

- The Thin Image license is invalid.

- The Thin Image pair volumes are blocked.

- The current status of the Thin Image pair does not allow the **raidcom modify snapshot -snapshot_data create** or **raidcom modify snapshot -snapshot_data clone** command to run on the pair.

- The current status of the Thin Image, ShadowImage, TrueCopy, or Universal Replicator pair does not allow the **raidcom modify snapshot -snapshot_data create** or **raidcom modify snapshot -snapshot_data clone** command to run on the pair.

After resolving these error conditions, make sure that all pairs in the consistency group are in "PAIR" status before running the **raidcom modify snapshot -snapshot_data create** or **raidcom modify snapshot -snapshot_data clone** command again. For details about Thin Image pairs, see How Thin Image works (on page 30).

Notes on storing snapshot data, and on cloning pairs

There are some situations in which storing snapshot data or cloning pairs might end abnormally.

The **raidcom modify snapshot -snapshot_data create** or **raidcom modify snapshot -snapshot_data clone** CCI command might terminate abnormally, as shown below, if the consistency group includes a pair in a status other than "PAIR."

- The command is rejected.

- Timeout occurs with the error code EX_EWSTOT.

- The pair is suspended with the error code EX_EWSUSE.

If you perform an operation other than pairsplit (for example, deletion of snapshot data or a Thin Image pair) on a pair in the consistency group while the **raidcom modify snapshot -snapshot_data create** or **raidcom modify snapshot -snapshot_data clone** command is running, consistency of snapshot data to be stored or the S-VOL in which pairs are cloned cannot be maintained. Therefore, the **raidcom modify snapshot -snapshot_data create** or **raidcom modify snapshot -snapshot_data clone** command might end abnormally as shown below.

- Timeout might occur with the error code EX_EWSTOT.

- The pair might be suspended with the error code EX_EWSUSE.

Restoring a Thin Image pair might end abnormally in either of the following conditions.

- Snapshot data for a consistency group including the pair is being acquired.

- The primary volume of the pair is also used as the primary volume of another Thin Image pair. In addition, snapshot data for a consistency group including the latter pair is being acquired.

Appendix A: CCI command reference for Thin Image

Appendix B: Thin Image GUI windows and wizards

This section describes Thin Image (HTI) windows and dialog boxes.

Replication window

Use this window to perform the following tasks:

- Viewing replication summary information (see <u>Viewing summary replication information (on page 154)</u>).

- Opening the window from which you can view local replication summary information (see <u>Viewing local replication summary information (on page 155)</u>).

- Opening the window from which you can set the system options that affect performance in Thin Image (see <u>Changing local replica options that affect Thin Image performance (on page 121)</u>).

- Opening the window from which you can review the tasks that have been performed on a pair (see <u>Viewing Thin Image pair task history (on page 164)</u>).

The following image shows the **Replication** window with the summary section at the top of the window and the Replica LDEVs tab at the bottom.
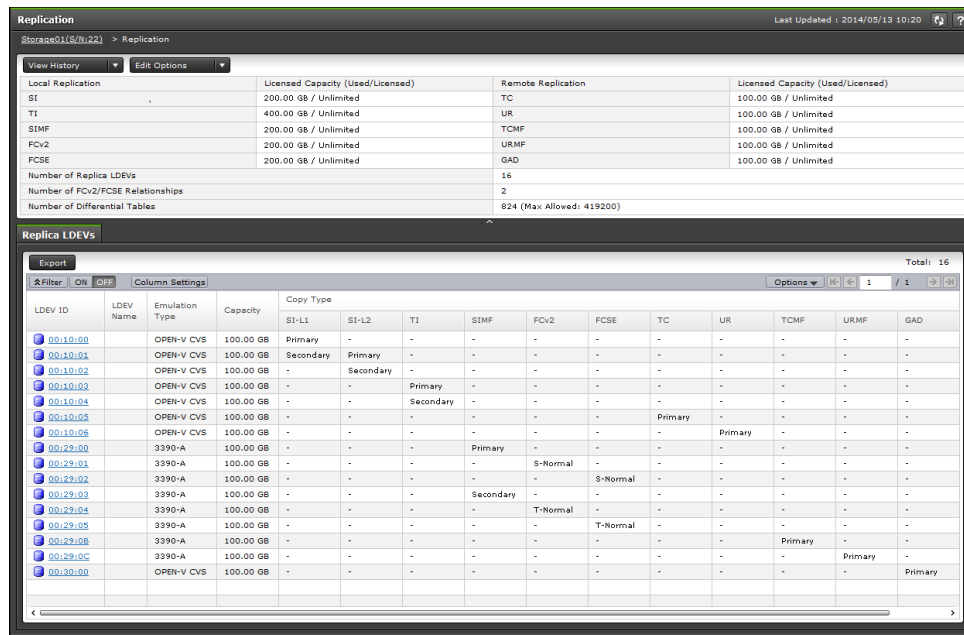
Summary

This section is the table at the top of the **Replication** window that shows summary information about replication.

The following table lists the items in this section of the **Replication** window.

Item	Description
Licensed Capacity	The used and licensed capacity of each software application.
Number of Replica LDEVs	The number of LDEVs used for replication.
Number of FCv2/FCSE Relationships (VSP 5000 series)	The number of FCv2 and FCSE relationships that are in use.
Number of Differential Tables	The number of differential tables in use and the differential table limit, for local replication. Differential tables in use for remote replication are not included. Because differential tables are not used for all operations, the number of differential tables does not change when you execute the following operations: ▪ Thin Image pair operations. ▪ SIz pair operations for a DP-VOL that exceeds 262,668 cylinders. ▪ SI pair operations for a DP-VOL that exceeds 4 TB. ▪ Compatible FlashCopy® V2 or Hitachi Compatible FlashCopy® relationship operations.
View History > Local Replication	Click to open the **View History** window for local replication.
View History > Remote Replication	Click to open the **View History** window for remote replication.
Edit Options > Local Replication	Click to open the **Edit Local Replica Options** wizard.
Edit Options > Remote Replication	Click to open the **Edit Remote Replica Options** wizard. For more information about using this wizard to set the number of volumes, path blockade, and other options, see the *Hitachi TrueCopy® User Guide*.

Appendix B: Thin Image GUI windows and wizards

Item	Description
Edit Options > SCP Time (VSP 5000 series)	Click to open the **Edit SCP Time** wizard. For more information about the tasks you can perform using this wizard, see the *Hitachi TrueCopy® User Guide*.

Replica LDEVs tab

This tab shows only pairs that consist of the P-VOL and S-VOLs (the source and target volumes for FCv2 or FCSE) allocated to each user.

The following table lists the items on the Replica LDEVs tab.

Item	Description
LDEV ID	The selected LDEV's identification number, which is a combination of the LDKC, CU and LDEV. Click the ID to open the **LDEV Properties** window, from which you can view the properties assigned to the selected LDEV. For more information about this window, see the *Provisioning Guide* for your storage system.
LDEV Name	The selected LDEV's name.
Emulation Type (VSP 5000 series)	The selected LDEV's emulation type.
Capacity	The selected LDEV's capacity.
Copy Type	The volume's copy type. Values: ▪ **TI:** HTI pair HTI volume status: ▪ **Primary:** P-VOL ▪ **Secondary:** S-VOL If you have not configured a pair, a hyphen (-) is displayed.
Virtual Storage Machine*	Information about the virtual storage machine to which the LDEV belongs.

Item	Description
	Values: ▪ **Model/Serial Number:** The model type and serial number of the volume's virtual storage machine. ▪ **LDEV ID:** The identification number of the volume's virtual LDEV. If no virtual LDEV ID is assigned, a blank is displayed. ▪ **Device Name:** The name of the volume's virtual device, in a combined format of "virtual emulation type", "number of virtual LUSE volumes", and "virtual CVS attribute". Each of these three items is displayed only if it is specified. If none of them are specified, a blank is displayed. ▪ **SSID:** The virtual SSID of the volume. If no virtual SSID is specified, a blank is displayed.
Export button	Click to open a dialog from which you can download table information to a file.
* These items are not shown in the table by default. You must add them using the **Column Settings** window. For more information about how to add items to a table using this window, see the *System Administrator Guide*.	

Local Replication window

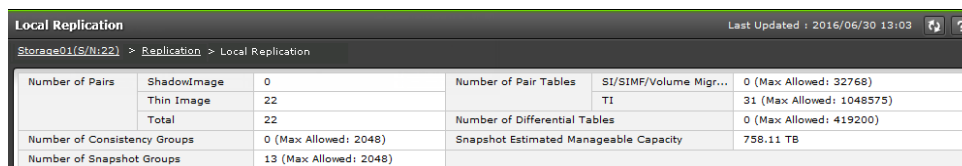Summary information about local replication.

This window includes the following section and tabs:

Summary

This section is the table at the top of the **Local Replication** window that shows summary information about local replication.

The following image shows the summary section of the **Local Replication** window.

The following table lists the items in this section of the **Local Replication** window.

Item	Description
Number of Pairs	The number of pairs for each local replication software application type. The total number of pairs is shown on the Total line.
Number of Consistency Groups	The number of consistency groups that have a status other than "Free", and the consistency group limit in your storage system.
Number of Snapshot Groups	The number of snapshot groups that are in use and the snapshot group limit in your storage system.
Number of Pair Tables	The number of pair tables. This number varies depending on the combinations of software applications you are using. Values: ▪ **SI/Volume Migration:** The number of SI and Volume Migration pair tables in use, and the SI and Volume Migration pair table limit in your storage system model. ▪ **SI/SI MF/Volume Migration V2:** The number of SI, SIz, and Volume Migration V2 pair tables in use and the SI, SIz, and Volume Migration V2 pair table limit in your storage system. ▪ **TI:** The number of HTI pair tables in use and the HTI pair table limit in your storage system.
Number of Differential Tables	The number of differential tables that are in use and the differential table limit in your storage system. Because differential tables are not used for all operations, the number of differential tables does not change when you execute the following operations: ▪ Thin Image pair operations. ▪ SIz pair operations for a DP-VOL that exceeds 262,668 cylinders. ▪ SI pair operations for a DP-VOL that exceeds 4 TB.

Item	Description
Snapshot Estimated Manageable Capacity	The HTI pair's estimated manageable capacity, which is the estimated HTI pair capacity that you can create using the remaining shared memory capacity. This value varies depending on the amount of HTI P-VOLs you add or delete and the number of HTI pairs you create. The ⚠ icon is displayed if this item is less than 5% of the capacity supported by the installed shared memory. **Note:** This value does not guarantee that the HTI pairs of the indicated capacity have been successfully created.

SI Pairs tab

This tab only shows SI pairs to which you are allocated the P-VOL or the S-VOLs.

The following image shows this tab on the **Local Replication** window.
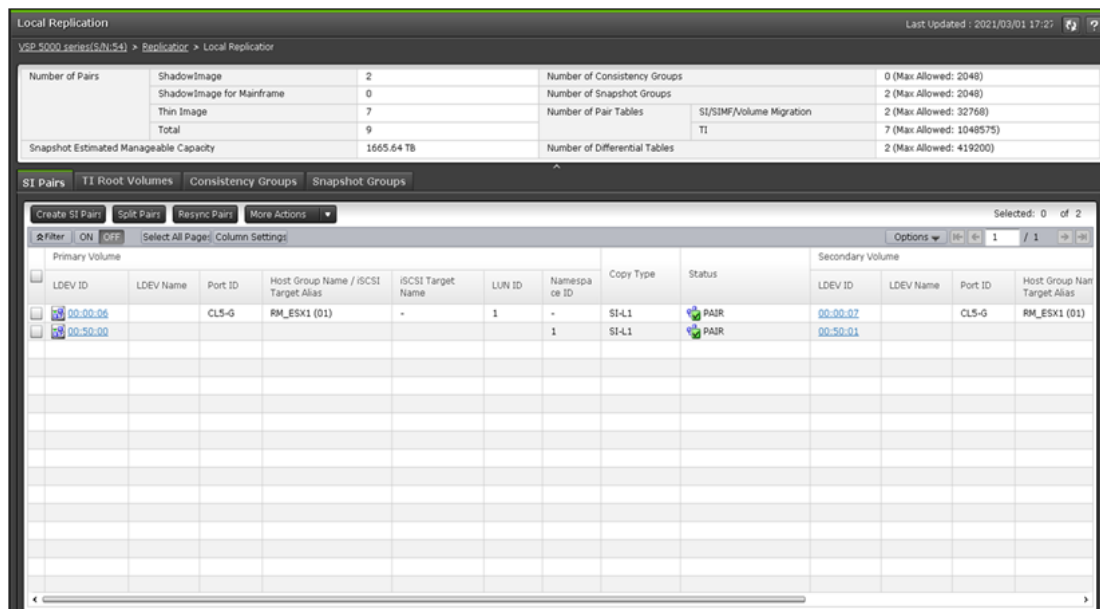
The following table lists the items on this tab.

Item	Description
Primary Volume	The SI P-VOL information.

Item	Description

	Values:
	
	▪ **LDEV ID:** The P-VOL's LDEV identification number. Click to open the **LDEV Properties** window. Use this window to search for P-VOL information.
	
	▪ **LDEV Name:** The P-VOL's LDEV name.
	
	▪ **Port ID:** The port name of the P-VOL LDEV's LUN path. If the path is not defined, a blank is displayed.
	
	(VSP 5000 series) SI only. For SIz, a hyphen (-) is displayed.
	
	▪ **Host Group Name / iSCSI Target Alias:** The host group name and ID or iSCSI target alias and ID of the P-VOL LDEV's LUN path. If the path is not defined, a blank is displayed.
	
	(VSP 5000 series) SI only. For SIz, a hyphen (-) is displayed.
	
	▪ **iSCSI Target Name:** The P-VOL's iSCSI target name. If the LUN path is not defined, a blank is displayed.
	
	(VSP 5000 series)SI only. For SIz, a hyphen (-) is displayed.
	
	▪ **LUN ID:** The LUN identification number of the P-VOL LDEV's LUN path. If the path is not defined, a blank is displayed.
	
	(VSP 5000 series) SI only. For SIz, a hyphen (-) is displayed.
	
	▪ **Namespace ID:** The namespace ID of the P-VOL. If the LDEV of the P-VOL is not registered as a namespace, a hyphen (-) is displayed. Namespace ID is not displayed for VSP E series other than VSP E1090.
	
	▪ **Provisioning Type*:** The P-VOL's provisioning type.
	
	   • **Basic:** Internal volume
	
	   • **DP:** DP-VOL
	
	   • **External:** External volume
	
	   • **External MF:** (VSP 5000 series) Migration volume
	
	▪ **Emulation Type*:** (VSP 5000 series) The P-VOL's emulation type.
	
	▪ **Attribute*:** The P-VOL's attribute.
	
	▪ **Capacity*:** The P-VOL's capacity.
	
	▪ **CLPR*:** The P-VOL's CLPR ID.

Appendix B: Thin Image GUI windows and wizards

Item	Description

	▪ **Encryption*:** The P-VOL's encryption information.
	
	• **Enabled:** Encryption is enabled for the parity group to which the P-VOL's LDEV belongs, or a V-VOL is associated with a pool in which a pool volume has encryption enabled.
	
	• **Disabled:** Encryption is disabled for the parity group to which the P-VOL's LDEV belongs, or a V-VOL is associated with a pool in which a pool volume has encryption disabled.
	
	• **Mixed:** The pool to which the P-VOL's LDEV belongs contains two or more of the following:
	
	    ▪ Volume for which encryption is enabled
	
	    ▪ Volume for which encryption is disabled
	
	    ▪ External volume
	
	Note: Data encryption is not ensured in an LDEV with Mixed encryption status.
	
	(VSP 5000 series) If the LDEV is an external volume or migration volume, a hyphen (-) is displayed.
	
	For DP-VOLs, the pool to which an LDEV belongs is an external volume or blocked.
	
	▪ **Capacity Saving*:** Information about the P-VOL's capacity saving function.
	
	• **Compression:** The compression function is used.
	
	• **Deduplication and Compression:** The deduplication function and the compression function are used.
	
	• **Disabled:** The capacity saving function is not used.
	
	▪ **Compression Acceleration*:** Information on the compression accelerator.
	
	• Enabled: Compression accelerator is enabled.
	
	• Disabled: Compression accelerator is disabled.
	
	• - (hyphen): Compression accelerator is not available for an LDEV. Alternatively, compression accelerator is available for an LDEV whose capacity saving setting is Disabled and whose capacity saving status is Disabled.
	
	▪ **T10 PI*:** The P-VOL's T10 PI attribute information.
	
	• **Enabled:** The P-VOL's T10 PI attribute is enabled.
	
	• **Disabled:** The P-VOL's T10 PI attribute is disabled.
	
	▪ **Virtual Storage Machine*:** The model type and serial number of the virtual storage machine to which the P-VOL belongs.
	
	▪ **Virtual LDEV ID*:** The identification number of the P-VOL's virtual LDEV. If no virtual LDEV ID is assigned, a blank is displayed.

Appendix B: Thin Image GUI windows and wizards

Item	Description
	▪ **Virtual Device Name*:** The name of the P-VOL's virtual device, in a combined format of "virtual emulation type", "number of virtual LUSE volumes", and "virtual CVS attribute". Each of these three items is displayed only if it is specified. If none of them are specified, a blank is displayed. ▪ **Virtual SSID*:** The virtual SSID of the P-VOL. If no virtual SSID is specified, a blank is displayed.
Copy Type	The SI volume's copy type. Values: ▪ **SI-L1:** SI L1 pair ▪ **SI-L2:** SI L2 pair ▪ **SIMF:** SIz pair
Status	The SI pair status.

Item	Description
	The following icons and pair statuses are shown:
	▪ The SI pair is in the process of being deleted.
	Status:
	• **SI:** SMPL(PD)
	• **SIz:** Deleting/TRANS
	▪ This icon is used for the following:
	You are copying the pair.
	Status:
	• **SI:** COPY(PD)/COPY
	• **SIz:** PENDING
	You are resynchronizing the pair.
	Status:
	• **SI:** COPY(RS)/COPY
	• **SIz:** Resync/PENDING
	You are restoring the pair.
	Status:
	• **SI:** COPY(RS-R)/RCPY
	• **SIz:** Resync-R/REVRSY
	You are in the process of Steady Split.
	Status:
	• **SI:** COPY(SP)/COPY
	• **SIz:** SP-Pend/TRANS
	▪ The volumes are paired.
	Status:
	• **SI:** PAIR
	• **SIz:** DUPLEX

Appendix B: Thin Image GUI windows and wizards

Item	Description
	▪ 🖳 This icon is used for the following: The pair is split. Status: • **SI:** PSUS • **SIz:** Split/SUSPOP You are splitting the pair in Quick Split mode. Status: • **SI:** PSUS(SP)/PSUS • **SIz:** V-Split/SUSPVS ▪ 🛡 The pair is suspended. Status: • **SI:** PSUE • **SIz:** Suspend/SUSPER For more information about SI or SIz pair status, see the *System Administrator Guide*.
Processing Status	The processing status for a pair volume is displayed. Expanding: The capacity of an SI pair volume is being expanded. If the volume capacity is not being expanded, or if V-VOLs other than DP-VOLs are used as pair volumes, this field remains blank.
Secondary Volume	SI S-VOL information. Values: ▪ **LDEV ID:** The S-VOL's LDEV identification number. Click to open the **LDEV Properties** window. ▪ **LDEV Name:** The S-VOL's LDEV name. ▪ **Port ID:** The port name of the S-VOL LDEV's LUN path. If the path is not defined, a blank is displayed. (VSP 5000 series) SI only. For SIz, a hyphen (-) is displayed. ▪ **Host Group Name / iSCSI Target Alias:** The host group name and ID or iSCSI target alias and ID of the S-VOL LDEV's LUN path. If the path is not defined, a blank is displayed. (VSP 5000 series) SI only. For SIz, a hyphen (-) is displayed. ▪ **iSCSI Target Name:** The S-VOL's iSCSI target name. If the LUN path is not defined, a blank is displayed. (VSP 5000 series) SI only. For SIz, a hyphen (-) is displayed.

Appendix B: Thin Image GUI windows and wizards

Item	Description

	▪ **LUN ID:** The LUN identification number of the S-VOL LDEV's LUN path. If the path is not defined, a blank is displayed.
	
	(VSP 5000 series) SI only. For SIz, a hyphen (-) is displayed.
	
	▪ **Namespace ID:** The namespace ID of the S-VOL. If the LDEV of the S-VOL is not registered as a namespace, a hyphen (-) is displayed. Namespace ID is not displayed for VSP E series other than VSP E1090.
	
	▪ **Provisioning Type*:** The S-VOL's provisioning type.
	
	  • **Basic:** Internal volume
	
	  • **DP:** DP-VOL
	
	  • **External:** External volume
	
	▪ **Emulation Type*:** (VSP 5000 series) The S-VOL's emulation type.
	
	▪ **Attribute*:** The S-VOL's attribute.
	
	▪ **Capacity*:** The S-VOL's capacity.
	
	▪ **CLPR*:** The S-VOL's CLPR ID.
	
	▪ **T10 PI*:** The S-VOL's T10 PI attribute information.
	
	  • **Enabled:** The S-VOL's T10 PI attribute is enabled.
	
	  • **Disabled:** The S-VOL's T10 PI attribute is disabled.
	
	▪ **Encryption*:** The S-VOL's encryption information.
	
	  • **Enabled:** Encryption is enabled for the parity group to which the S-VOL's LDEV belongs, or a V-VOL is associated with a pool in which a pool volume has encryption enabled.
	
	  • **Disabled:** Encryption is disabled for the parity group to which the S-VOL's LDEV belongs, or a V-VOL is associated with a pool in which a pool volume has encryption disabled.
	
	  • **Mixed:** The pool to which the S-VOL's LDEV belongs contains two or more of the following:
	
	    ▪ Volume for which encryption is enabled
	
	    ▪ Volume for which encryption is disabled
	
	    ▪ External volume
	
	Note: Data encryption is not ensured in an LDEV with Mixed encryption status.
	
	If the LDEV is an external volume or migration volume, a hyphen (-) is displayed.
	
	For DP-VOLs, the pool to which an LDEV belongs is an external volume or blocked.

Appendix B: Thin Image GUI windows and wizards

Item	Description
	▪ **Capacity Saving*:** Information about the S-VOL's capacity saving function. • **Compression:** The compression function is used. • **Deduplication and Compression:** The deduplication function and the compression function are used. • **Disabled:** The capacity saving function is not used. ▪ **Compression Acceleration*:** Information on the compression accelerator. • Enabled: Compression accelerator is enabled. • Disabled: Compression accelerator is disabled. • - (hyphen): Compression accelerator is not available for an LDEV. Alternatively, compression accelerator is available for an LDEV whose capacity saving setting is Disabled and whose capacity saving status is Disabled. ▪ **Virtual Storage Machine*:** The model type and serial number of the virtual storage machine to which the S-VOL belongs. ▪ **Virtual LDEV ID*:** The identification number of the S-VOL's virtual LDEV. If no virtual LDEV ID is assigned, a blank is displayed. ▪ **Virtual Device Name*:** The name of the S-VOL's virtual device, in a combined format of "virtual emulation type", "number of virtual LUSE volumes", and "virtual CVS attribute". Each of these three items is displayed only if it is specified. If none of them are specified, a blank is displayed. ▪ **Virtual SSID*:** The virtual SSID of the S-VOL. If no virtual SSID is specified, a blank is displayed.
Copy Pace*	The speed at which the SI S-VOL is copied. Values: Faster, Medium, or Slower
CTG ID*	The identifier of the consistency group to which the SI pair is assigned.
Mirror Unit*	The SI pair's mirror unit number.
Topology ID	The SI LDEV's topology identification number, which consists of the LDEV ID and the mirror unit number. The ID indicates the pair's tier, or location, when the mirror unit locates it. Example: 00:00:00 (MU0-MU1)
Create SI Pairs button	Click to open the Create SI Pairs window.
Split Pairs button	Click to open the **Split Pairs** window.

Appendix B: Thin Image GUI windows and wizards

Item	Description
Resync Pairs button	Click to open the **Resync Pairs** window.
More Actions	Click to view a list of tasks you can perform. Options: ▪ **View Pair Synchronization Rate:** Click to open the **View Pair Synchronization Rate** window. ▪ **View Pair Properties:** Click to open the **View Pair Properties** window. ▪ **Suspend Pairs:** Click to open the **Suspend Pairs** window. ▪ **Delete Pairs:** Click to open the **Delete Pairs** window. ▪ **Export:** Click to open the dialog from which you can download table information to a file.
* These items are not shown in the table by default. You must add them using the **Column Settings** window. For more information about how to add items to a table using this window, see the *System Administrator Guide*.	

TI Root Volumes tab

This tab shows only Thin Image pairs that have P-VOLs to which you are allocated.

The following image shows this tab in the **Local Replication** window.

The following table lists the items on this tab.

Item	Description
LDEV ID	The P-VOL's LDEV identification number.
LDEV Name	The P-VOL's LDEV name.
Port ID	The port identification number of the P-VOL LDEV's LUN path. If the path is not defined, a blank is displayed.
Host Group Name / iSCSI Target Alias	The host group name and ID or iSCSI target alias and ID of the P-VOL LDEV's LUN path. If the path is not defined, a blank is displayed.
iSCSI Target Name	The P-VOL's iSCSI target name. If the LUN path is not defined, a blank is displayed.
LUN ID	The LUN identification number of the P-VOL LDEV's LUN path. If the path is not defined, a blank is displayed.
Namespace ID	Displays a namespace ID of the LDEV. If the LDEV is not registered as a namespace, a hyphen (-) is displayed. Namespace ID is not displayed for VSP E series other than VSP E1090.
Attribute*	The P-VOL's attribute.
Capacity*	The P-VOL's capacity.
CLPR*	The P-VOL's CLPR ID.

Encryption*	The P-VOL's encryption information.
	
	▪ **Enabled:** Encryption is enabled for the parity group to which the P-VOL's LDEV belongs, or a V-VOL is associated with a pool in which a pool volume has encryption enabled.
	
	▪ **Disabled:** Encryption is disabled for the parity group to which the P-VOL's LDEV belongs, or a V-VOL is associated with a pool in which a pool volume has encryption disabled.
	
	▪ **Mixed:** The pool to which the P-VOL's LDEV belongs contains two or more of the following:
	
	  • Volume for which encryption is enabled
	  • Volume for which encryption is disabled
	  • External volume
	
	Note: Data encryption is not ensured in an LDEV with Mixed encryption status.
	
	(VSP 5000 series) If the LDEV is an external volume or migration volume, a hyphen (-) is displayed.

Appendix B: Thin Image GUI windows and wizards

Item	Description
	For DP-VOLs, the pool to which an LDEV belongs is an external volume or blocked.
Capacity Saving*	Information about the P-VOL's capacity saving function. ▪ **Compression:** The compression function is used. ▪ **Deduplication and Compression:** The deduplication function and the compression function are used. ▪ **Disabled:** The capacity saving function is not used.
Compression Acceleration*	Information on the compression accelerator. ▪ Enabled: Compression accelerator is enabled. ▪ Disabled: Compression accelerator is disabled. ▪ - (hyphen): Compression accelerator is not available for an LDEV. Alternatively, compression accelerator is available for an LDEV whose capacity saving setting is Disabled and whose capacity saving status is Disabled.
Pool Name (ID)*	The pool name and identification number.
Number of Snapshot Data	The number of snapshot data to which the P-VOL belongs.
Number of Pairs in PSUE status	The number of pairs that are in PSUE status.
Number of Pairs in Expanding status*	The number of pairs in Expanding status.
Cascade (VSP 5000 series)	Indicates whether a cascaded pair can be created ▪ **Enabled:** Cascaded pairs can be created. ▪ **Disabled:** Cascaded pairs cannot be created.
T10 PI*	The P-VOL's T10 PI attribute information. ▪ **Enabled:** The P-VOL's T10 PI attribute is enabled. ▪ **Disabled:** The P-VOL's T10 PI attribute is disabled.
Virtual Storage Machine*	Information about the virtual storage machine to which the P-VOL belongs. Values: ▪ **Model/Serial Number:** The model type and serial number of the P-VOL's virtual storage machine. ▪ **LDEV ID:** The identification number of the P-VOL's virtual LDEV. If no virtual LDEV ID is assigned, a blank is displayed.

Item	Description
	▪ **Device Name:** The name of the P-VOL's virtual device, in a combined format of "virtual emulation type", "number of virtual LUSE volumes", and "virtual CVS attribute". Each of these three items is displayed only if it is specified. If none of them are specified, a blank is displayed. ▪ **SSID:** The virtual SSID of the P-VOL. If no virtual SSID is specified, a blank is displayed.
Create TI Pairs button	Click to open the Create TI Pairs window.
Operate TI Pairs button	Click to open the Operate TI Pairs window.
View Pair Synchronization Rate button	Click to open the **View Pair Synchronization Rate** window.
More Actions	Click to view a list of tasks you can perform. Options: ▪ **View Pair Properties:** Click to open the **View Pair Properties** window. ▪ **View LDEV Properties:** Click to open the **View LDEV Properties** window. ▪ **Split Pairs:** Click to open the **Split Pairs** window. ▪ **Resync Pairs:** Click to open the **Resync Pairs** window. ▪ **Assign Secondary Volumes:** Click to open the **Assign Secondary Volumes** window. ▪ **Remove Secondary Volumes:** Click to open the **Remove Secondary Volumes** window. ▪ **Delete Pairs:** Click to open the **Delete Pairs** window. ▪ **Export:** Click to open the dialog from which you can download table information to a file.
* These items are not shown in the table by default. You must add them using the **Column Settings** window. For more information about how to add items to a table using this window, see the *System Administrator Guide*.	

Consistency Groups tab

The following image shows this tab of the **Local Replication** window.

The following table lists the items on this tab.

Item	Description
CTG ID	The consistency group identification number. Click the identification number to open the **Consistency Group Properties** window.
Status	The consistency group status. Values: • **SI Used:** SI is using the consistency group. • **SIMF Used (RAID Manager):** (VSP 5000 series) SIz is using the consistency group, and you are managing the group with CCI. • **SIMF Used (PPRC/BCM):** (VSP 5000 series) SIz is using the consistency group, and you are managing the group with PPRC or Business Continuity Manager. • **TI Used:** HTI is using the consistency group. • **Mainframe Reserved:** (VSP 5000 series) The consistency group is reserved for PPRC or Business Continuity Manager. • **Free:** The consistency group is not being used and is not reserved. • **(Changing...):** The status is in the process of changing.
Number of Pairs	The number of pairs assigned to the consistency group for each local replication software application type.
Reserve Mainframe CTGs (VSP 5000 series)	Click to open the **Reserved Mainframe CTGs** window.

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Item	Description
Release Reserved Mainframe CTGs (VSP 5000 series)	Click to open the **Release Reserved Mainframe CTGs** window.
Export button	Click to open a dialog from which you can download table information to a file.

Snapshot Groups tab

The following image shows this tab of the **Local Replication** window.

The following table lists the items on this tab.

Item	Description
Snapshot Group	The snapshot group name. Click the snapshot group name to open the TI Pairs window.
Number of Pairs	The number of pairs assigned to the snapshot group.
Create TI Pairs button	Click to open the Create TI Pairs window.
Operate TI Pairs button	Click to open the TI Pairs window.
View Pair Synchronization Rate button	Click to open the **View Pair Synchronization Rate** window.
More Actions	Click to view a list of tasks you can perform. Options: • **Split Pairs:** Click to open the **Split Pairs** window. • **Resync Pairs:** Click to open the **Resync Pairs** window.

Item	Description
	▪ **Assign Secondary Volumes:** Click to open the **Assign Secondary Volumes** window.
	▪ **Remove Secondary Volumes:** Click to open the **Remove Secondary Volumes** window.
	▪ **Delete Pairs:** Click to open the **Delete Pairs** window.
	▪ **Export:** Click to open the dialog from which you can download table information to a file.

View Pair Synchronization Rate window

This window includes the Pairs table.

The following image shows this window.
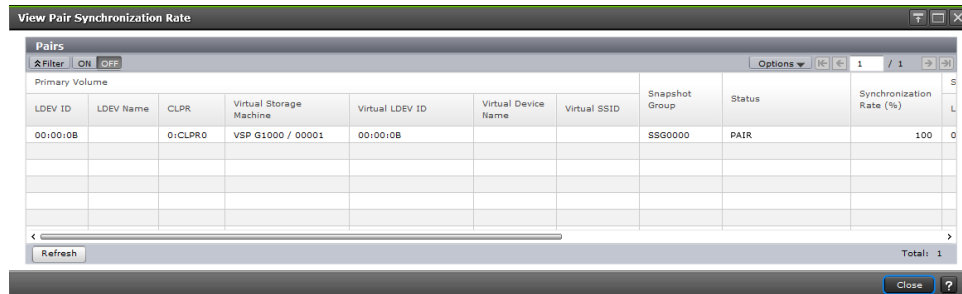
Pairs table

The following table lists the items in this table on the **View Pair Synchronization Rate** window.

Item	Description
Primary Volume	The P-VOL information. Values: ▪ **LDEV ID:** The P-VOL's LDEV identification number. Click to open the **LDEV Properties** window. Use this window to search for P-VOL information. ▪ **LDEV Name:** The P-VOL's LDEV name. ▪ **CLPR:** The P-VOL's CLPR ID. ▪ **Virtual Storage Machine:** The model type and serial number of the virtual storage machine to which the P-VOL belongs.

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Item	Description
	▪ **Virtual LDEV ID:** The identification number of the P-VOL's virtual LDEV. If no virtual LDEV ID is assigned, a blank is displayed. ▪ **Virtual Device Name:** The name of the P-VOL's virtual device, in a combined format of "virtual emulation type", "number of virtual LUSE volumes", and "virtual CVS attribute". Each of these three items is displayed only if it is specified. If none of them are specified, a blank is displayed. ▪ **Virtual SSID:** The virtual SSID of the P-VOL. If no virtual SSID is specified, a blank is displayed.
Copy Type	The SI volume's copy type. Values: ▪ **SI-L1:** SI L1 pair ▪ **SI-L2:** SI L2 pair ▪ **SIMF:** SIz pair
Snapshot Group	The HTI snapshot group name. If you have not configured a snapshot group for the HTI pair, this item is blank.
Status	The pair status. For more information about HTI pair status, see Thin Image pair status definitions (on page 158).
Synchronization Rate (%)	For SI ▪ If the pair status is COPY(PD)/COPY, COPY(SP)/COPY, or PSUS (SP)/PSUS, the copy progress rate is displayed. ▪ If the pair status is PAIR, PSUS, COPY(RS-R)/RCPY, or PSUE, the synchronization rate between P-VOL and S-VOL is displayed. ▪ If the pair status is COPY(RS)/COPY changed from PSUE, the copy progress rate is displayed. ▪ If the pair status is COPY(RS)/COPY changed from other than PSUE, the synchronization rate between P-VOL and S-VOL is displayed. ▪ If the pair status is SMPL(PD), a hyphen is displayed.

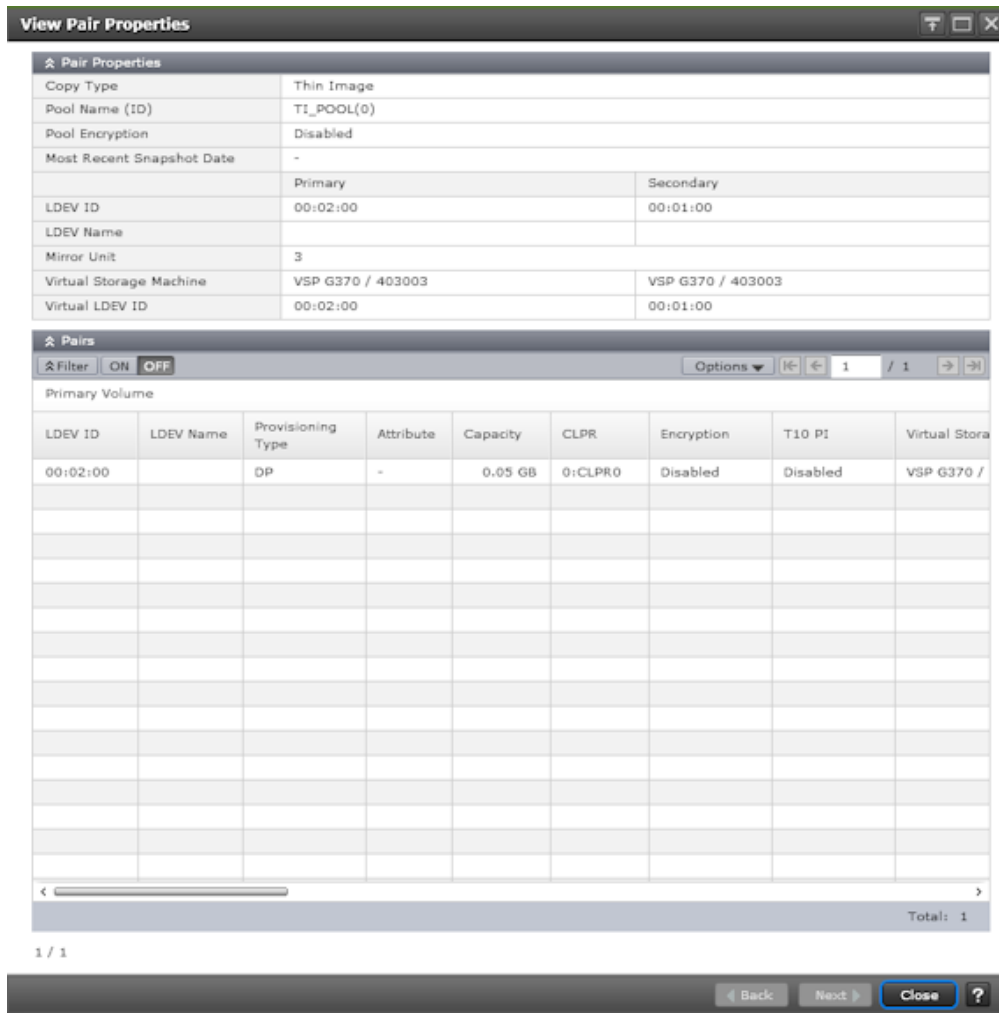| Item	Description
	SIz: ▪ If the pair status is PENDING, SP-Pend/TRANS, or V-Split/SUSPVS, the copy progress rate is displayed. ▪ If the pair status is DUPLEX, Split/SUSPOP, Resync-R/REVRSY, or Suspend/SUSPER, the synchronization rate between P-VOL and S-VOL is displayed. ▪ If the pair status is Resync/PENDING, changed from Suspend/SUSPER, the copy progress rate is displayed. ▪ If the pair status is Resync/PENDING, changed from other than Suspend/SUSPER, the synchronization rate between P-VOL and S-VOL is displayed. ▪ If the pair status is Deleting/TRANS, a hyphen is displayed.

Item	Description
	For Thin Image pairs, the displayed information depends on whether the cascade attribute is enabled or disabled.
	▪ For Thin Image pairs where the cascade attribute is enabled, the following information is displayed depending on the pair status:
	• If the pair status is PAIR, PSUS, or PSUE, the pair synchronization rate shows the rate that current S-VOL data matches that of the next generation of the S-VOL. If the S-VOL is the latest one, the synchronization rate is computed by comparing the S-VOL with the P-VOL.
	• If the pair status is COPY, PSUS(SP), RCPY, or SMPL(PD), the progress rate of each process is displayed.
	• For Thin Image pairs with the cascade attribute disabled, the pair synchronization rate that the current S-VOL data matches that of the next generation of the S-VOL is displayed. If the S-VOL is the latest one, the synchronization rate is computed by comparing the S-VOL with the P-VOL.
	To display the progress rate, enable Display Progress Rate of the system option #17 in the **Edit Local Replica Options** window.
	▪ If the pair status is COPY, RCPY, or SMPL(PD), the progress rate for each process is displayed.
	▪ If the pair status is PAIR, PSUS, or PSUE, the synchronization rate is displayed in the same way as when the system option #17 is not set.
	For information about how to enable the local replica options, see <u>Changing local replica options that affect Thin Image performance (on page 121)</u>.
Secondary Volume	The S-VOL information.
	Values:
	▪ **LDEV ID:** The S-VOL's LDEV identification number. Click to open the **LDEV Properties** window.
	▪ **LDEV Name:** The S-VOL's LDEV name.
	▪ **CLPR:** The S-VOL's CLPR ID.
	▪ **Virtual Storage Machine:** The model type and serial number of the virtual storage machine to which the S-VOL belongs.

Item	Description
	▪ **Virtual LDEV ID:** The identification number of the S-VOL's virtual LDEV. If no virtual LDEV ID is assigned, a blank is displayed. ▪ **Virtual Device Name:** The name of the S-VOL's virtual device, in a combined format of "virtual emulation type", "number of virtual LUSE volumes", and "virtual CVS attribute". Each of these three items is displayed only if it is specified. If none of them are specified, a blank is displayed. ▪ **Virtual SSID:** The virtual SSID of the S-VOL. If no virtual SSID is specified, a blank is displayed.
Mirror Unit	The mirror unit number.
Cascade	Indicates whether a cascaded pair can be created ▪ **Enabled:** Cascaded pairs can be created. ▪ **Disabled:** Cascaded pairs cannot be created. A hyphen (-) is displayed for non-HTI pairs.
Type	The pair type. ▪ **Snapshot:** A pair with the snapshot attribute. ▪ **Clone:** A pair with the clone attribute or diff clone attribute. In the **TI Pairs** window, if **Diff Compare Volume** displays the LDEV ID, the diff clone attribute is set for the pair. If **Diff Compare Volume** displays a hyphen (-), the clone attribute is set for the pair. A hyphen (-) is displayed for non-HTI pairs.
Topology ID	The topology ID, which indicates the layer of the pair based on the mirror unit. The topology ID consists of the LDEV ID of the volume (root volume for Thin Image pairs) and the mirror unit number.
Refresh button	Click to update the information in this table.

View Pair Properties window

Use this window to monitor pair properties and to confirm the status of a volume.

The following image shows this window.

Pair Properties table

The following table lists the items in this table.

Item	Description
Copy Type	The volume's copy type. Values: ▪ **ShadowImage:** SI pair ▪ **Thin Image:** HTI pair ▪ **ShadowImage for Mainframe:** SIz pair.
Pool Name (ID)	The pool name and identification number. For non-HTI pairs, a hyphen (-) is displayed.

Item	Description

Pool Encryption	The pool's encryption information.
	
	▪ **Enabled:** A pool was created by the pool volume for which encryption is enabled.
	
	▪ **Disabled:** A pool was created by the pool volume for which encryption is disabled.
	
	▪ **Mixed:** A pool contains two or more of the following:
	
	  · Volume for which encryption is enabled
	
	  · Volume for which encryption is disabled
	
	  · External volume
	
	Note: Data encryption is not ensured in an LDEV with Mixed encryption status.
	
	For pools created in external volumes, blocked pools, and non-HTI pairs, a hyphen (-) is displayed.
	
	For DP-VOLs, the pool to which an LDEV belongs is an external volume or blocked.

Most Recent Snapshot Date	The most recent date and time you created the pair to store snapshot data. For non-HTI pairs, a hyphen (-) is displayed.
LDEV ID	The identification number of the LDEV for the P-VOL and S-VOLs.
LDEV Name	The name of the LDEV for the P-VOL and S-VOLs.
Mirror Unit	The mirror unit number.
Virtual Storage Machine	The model type and serial number of the virtual storage machine to which the P-VOL and S-VOL belong.
Virtual LDEV ID	The identification number of the virtual LDEV for the P-VOL and S-VOLs. If no virtual LDEV ID is assigned, a blank is displayed.

Pairs table

This table shows a list of all pairs related to a pair shown in the Pair Properties table.

The following table lists the items in this table.

Item	Description
Primary Volume	The P-VOL information.

Item	Description
	Values:
	▪ **LDEV ID:** The P-VOL's LDEV identification number.
	▪ **LDEV Name:** The P-VOL's LDEV name.
	▪ **Provisioning Type:** The P-VOL's provisioning type.
	• **Basic:** Internal volume
	• **DP:** DP-VOL
	• **External:** External volume
	▪ **Attribute:** The P-VOL's attribute.
	▪ **Emulation Type:** (VSP 5000 series) The P-VOL's emulation type.
	▪ **Capacity:** The P-VOL's capacity.
	▪ **CLPR:** The P-VOL's CLPR ID.
	▪ **Encryption:** The P-VOL's encryption information. **Note:** Data encryption is not ensured in an LDEV with Mixed encryption status.
	• **Enabled:** Encryption is enabled for the parity group to which the P-VOL's LDEV belongs, or a V-VOL is associated with a pool in which a pool volume has encryption enabled.
	• **Disabled:** Encryption is disabled for the parity group to which the P-VOL's LDEV belongs, or a V-VOL is associated with a pool in which a pool volume has encryption disabled.
	• **Mixed:** The pool to which the P-VOL's LDEV belongs contains two or more of the following:
	▪ Volume for which encryption is enabled
	▪ Volume for which encryption is disabled
	▪ External volume
	(VSP 5000 series) If the LDEV is an external volume or migration volume, a hyphen (-) is displayed.
	For DP-VOLs, the pool to which an LDEV belongs is an external volume or blocked.
	▪ **T10 PI:** The P-VOL's T10 PI attribute information.
	• **Enabled:** The P-VOL's T10 PI attribute is enabled.
	• **Disabled:** The P-VOL's T10 PI attribute is disabled.

Item	Description
	▪ **Virtual Storage Machine:** The model type and serial number of the virtual storage machine to which the P-VOL belongs.
	▪ **Virtual LDEV ID:** The identification number of the P-VOL's virtual LDEV. If no virtual LDEV ID is assigned, a blank is displayed.
	▪ **Virtual Device Name:** The name of the P-VOL's virtual device, in a combined format of "virtual emulation type", "number of virtual LUSE volumes", and "virtual CVS attribute". Each of these three items is displayed only if it is specified. If none of them are specified, a blank is displayed.
	▪ **Virtual SSID:** The virtual SSID of the P-VOL. If no virtual SSID is specified, a blank is displayed.
Snapshot Group	The snapshot group name.
	Information is displayed for this item only if you have configured a snapshot group for the HTI pair.
Status	The pair status.
	For more information about HTI pair status, see Thin Image pair status definitions (on page 158).
Processing Status	The processing status for a pair volume is displayed.
	Expanding: The capacity of an HTI pair volume is being expanded.
	If the volume capacity is not being expanded, or if V-VOLs other than DP-VOLs are used as pair volumes, this field remains blank.
Snapshot Date	The date and time you created the pair to store snapshot data.
Secondary Volume	The S-VOL information.
	Values:
	▪ **LDEV ID:** The S-VOL's LDEV identification number. Click to open the **LDEV Properties** window.
	▪ **LDEV Name:** The S-VOL's LDEV name.

Item	Description

	▪ **Provisioning Type:** The S-VOL's provisioning type.
	
	• **Basic:** Internal volume
	
	• **DP:** DP-VOL
	
	• **External:** External volume
	
	• **Snapshot:** HTI volume
	
	▪ **Emulation Type:** (VSP 5000 series) The S-VOL's emulation type.
	
	▪ **Attribute:** The S-VOL's attribute.
	
	▪ **Capacity:** The S-VOL's capacity.
	
	▪ **CLPR:** The S-VOL's CLPR ID.
	
	▪ **Encryption:** The S-VOL's encryption information.
	
	• **Enabled:** Encryption is enabled for the parity group to which the S-VOL's LDEV belongs, or a V-VOL is associated with a pool in which a pool volume has encryption enabled.
	
	• **Disabled:** Encryption is disabled for the parity group to which the S-VOL's LDEV belongs, or a V-VOL is associated with a pool in which a pool volume has encryption disabled.
	
	• **Mixed:** The pool to which the S-VOL's LDEV belongs contains two or more of the following:
	
	  ▪ Volume for which encryption is enabled
	
	  ▪ Volume for which encryption is disabled
	
	  ▪ External volume
	
	Note: Data encryption is not ensured in an LDEV with Mixed encryption status.
	
	If the LDEV is an external volume or migration volume, a hyphen (-) is displayed.
	
	For DP-VOLs, the pool to which an LDEV belongs is an external volume or blocked.

Item	Description
	▪ **Mode:** Indicates whether the S-VOL has been written to.
	• **For SI:** W is displayed if the S-VOL has been written to, but it cannot be read when its pair status is PSUS(SP)/PSUS or PSUS.
	• N is displayed when the S-VOL cannot be read because "-m noread" is specified using CCI.
	• A hyphen (-) is displayed if the S-VOL has not been written to, and it can be read.
	• **For HTI:** W is displayed if the S-VOL has been written to when its pair status is PSUS.
	• A hyphen (-) is displayed if the S-VOL has not been written to.
	• **For SIz:** W is displayed if the S-VOL has been written to when its pair status is V-Split/SUSPVS or Split/SUSPOP.
	• Protect is displayed if Protect is set from Business Continuity Manager when S-VOL's pair status is Split/SUSPOP, SP-Pend/TRANS, or V-Split/SUSPVS.
	• A hyphen (-) is displayed when the S-VOL has not been written to, and Protect is not set.
	▪ **T10 PI:** The S-VOL's T10 PI attribute information.
	• **Enabled:** The S-VOL's T10 PI attribute is enabled.
	• **Disabled:** The S-VOL's T10 PI attribute is disabled.
	▪ **Virtual Storage Machine:** The model type and serial number of the virtual storage machine to which the S-VOL belongs.
	▪ **Virtual LDEV ID:** The identification number of the S-VOL's virtual LDEV. If no virtual LDEV ID is assigned, a blank is displayed.
	▪ **Virtual Device Name:** The name of the S-VOL's virtual device, in a combined format of "virtual emulation type", "number of virtual LUSE volumes", and "virtual CVS attribute". Each of these three items is displayed only if it is specified. If none of them are specified, a blank is displayed.
	▪ **Virtual SSID:** The virtual SSID of the S-VOL. If no virtual SSID is specified, a blank is displayed.
CTG ID	The consistency group identification number.
Copy Pace	The speed at which the S-VOL is copied.

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Item	Description
	A hyphen (-) is displayed.
Mirror Unit	The mirror unit number.
Cascade	Indicates whether a cascaded pair can be created. ▪ **Enabled:** Cascaded pairs can be created. ▪ **Disabled:** Cascaded pairs cannot be created. A hyphen (-) is displayed for non-HTI pairs.
Type	The pair type. ▪ **Snapshot:** A pair with the snapshot attribute. ▪ **Clone:** A pair with the clone attribute or diff clone attribute. In the **TI Pairs** window, if **Diff Compare Volume** displays the LDEV ID, the diff clone attribute is set for the pair. If **Diff Compare Volume** displays a hyphen (-), the clone attribute is set for the pair. A hyphen (-) is displayed for non-HTI pairs.
Topology ID	The topology ID, which indicates the layer of the pair based on the mirror unit. The topology ID consists of the LDEV ID of the volume (root volume for Thin Image pairs) and the mirror unit number.

History window

Use this window to view Thin Image pair task history.

The following image shows this window.

Setting fields

The following table lists the items on the **History** window.

Item	Description
Copy Type list	The volume's copy type. Values: ▪ **SI:** SI ▪ **TI:** HTI ▪ **SIMF:** (VSP 5000 series) SIz ▪ **FCv2/FCSE:** (VSP 5000 series) FCv2 and FCSE

TI History table

Only tasks that you have performed on the pairs that consist of the P-VOL and/or S-VOLs to which you are allocated are shown on this table.

The following table lists the items in this table on the **History** window.

Item	Description
Date and Time	The date and time you performed the task.

Primary Volume	The P-VOL information.
	
	Values:
	
	• **LDEV ID:** The primary volume's LDEV identification number.
	
	• **Provisioning Type:** The P-VOL's provisioning type.
	
	   • **Basic:** Internal volume
	
	   • **DP:** DP-VOL
	
	   • **External:** External volume

Secondary Volume	The S-VOL information. LDEV ID: The S-VOL's LDEV identification number. Provisioning Type: The S-VOL's provisioning type. • DP: DP-VOL • Snapshot: Thin Image volume
Mirror Unit	The mirror unit number.
Pool ID	The pool identification number.
Diff Compare Volume	The LDEV ID of the diff compare volume for Diff Clone copy operation used in a VASA environment.
Description Code	The code for the type of task you performed.
Description	The description of the task you performed. For more information about HTI pair tasks, see Viewing Thin Image pair task history (on page 164).
Export button	Click to open a dialog from which you can download table information to a file.

Consistency Group Properties window

The following image shows this window.

Consistency Group Properties table

The following table lists the items in this table on the **Consistency Group Properties** window.

Item	Description
CTG ID	The consistency group identification number.
Status	The consistency group status. Values: ▪ **SI Used:** SI is using the consistency group. ▪ **SIMF Used (RAID Manager):** (VSP 5000 series) SIz is using the consistency group, and you are managing the group with CCI. ▪ **SIMF Used (PPRC/BCM):** (VSP 5000 series) SIz is using the consistency group, and you are managing the group with PPRC or Business Continuity Manager. ▪ **TI Used:** HTI is using the consistency group. ▪ **Mainframe Reserved:** (VSP 5000 series) The consistency group is reserved for PPRC or Business Continuity Manager.

Item	Description
	▪ **Free:** The consistency group is not being used and is not reserved. ▪ **(Changing...):** The status is in the process of changing.
Number of Pairs	The number of pairs that are assigned to the consistency group.

Pairs table

This table shows a list of pairs with P-VOLs and S-VOLs to which you are allocated.

The following table lists the items in this table on the **Consistency Group Properties** window.

Item	Description
Primary Volume	The P-VOL information. Values: ▪ **LDEV ID:** The P-VOL's LDEV identification number. ▪ **LDEV Name:** The P-VOL's LDEV name. ▪ **Emulation Type:** (VSP 5000 series) The P-VOL's emulation type. ▪ **Capacity:** The P-VOL's capacity. ▪ **CLPR:** The P-VOL's CLPR ID. ▪ **Virtual Storage Machine:** The model type and serial number of the virtual storage machine to which the P-VOL belongs. ▪ **Virtual LDEV ID:** The identification number of the P-VOL's virtual LDEV. If no virtual LDEV ID is assigned, a blank is displayed. ▪ **Virtual Device Name:** The name of the P-VOL's virtual device, in a combined format of "virtual emulation type", "number of virtual LUSE volumes", and "virtual CVS attribute". Each of these three items is displayed only if it is specified. If none of them are specified, a blank is displayed. ▪ **Virtual SSID:** The virtual SSID of the P-VOL. If no virtual SSID is specified, a blank is displayed.
Copy Type	The volume's copy type. Values: ▪ **TI:** HTI pair

Item	Description
Snapshot Group	The snapshot group name. Information is displayed for this item only if you have configured a snapshot group for the HTI pair.
Status	The pair status. For more information about pair status, see <u>Thin Image pair status definitions (on page 158)</u>.
Snapshot Date	The date and time that you created the pair to store snapshot data.
Secondary Volume	The S-VOL information. Values: ▪ **LDEV ID:** The S-VOL's LDEV identification number. ▪ **LDEV Name:** The S-VOL's LDEV name. ▪ **Emulation Type:** (VSP 5000 series) The S-VOL's emulation type. ▪ **Capacity:** The S-VOL's capacity. ▪ **CLPR:** The S-VOL's CLPR ID. ▪ **Virtual Storage Machine:** The model type and serial number of the virtual storage machine to which the S-VOL belongs. ▪ **Virtual LDEV ID:** The identification number of the S-VOL's virtual LDEV. If no virtual LDEV ID is assigned, a blank is displayed. ▪ **Virtual Device Name:** The name of the S-VOL's virtual device, in a combined format of "virtual emulation type", "number of virtual LUSE volumes", and "virtual CVS attribute". Each of these three items is displayed only if it is specified. If none of them are specified, a blank is displayed. ▪ **Virtual SSID:** The virtual SSID of the S-VOL. If no virtual SSID is specified, a blank is displayed.
Pool Name (ID)	The pool name and identification number.
Copy Pace	The speed at which the S-VOL is copied. A hyphen (-) is displayed.
Mirror Unit	The mirror unit number.
Cascade	Indicates whether a cascaded pair can be created ▪ **Enabled:** Cascaded pairs can be created. ▪ **Disabled:** Cascaded pairs cannot be created.

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Item	Description
	A hyphen (-) displays for non-HTI pairs.
Type	The pair type. ▪ **Snapshot:** A pair with the snapshot attribute. ▪ **Clone:** A pair with the clone attribute or diff clone attribute. In the **TI Pairs** window, if **Diff Compare Volume** displays the LDEV ID, the diff clone attribute is set for the pair. If **Diff Compare Volume** displays a hyphen (-), the clone attribute is set for the pair. A hyphen (-) displays for non-HTI pairs.
Topology ID	The topology ID, which indicates the layer of the pair based on the mirror unit. The topology ID consists of the LDEV ID of the volume (root volume for HTI pairs), which is the base of the target pair, and the mirror unit number.
Detail button	Click to open the **View Pair Properties** window.

Create TI Pairs wizard

Use this wizard to create Thin Image pairs.

Create TI Pairs window

This is the initial window of the Create TI Pairs wizard, which you can use to select LDEVs that are P-VOLs.

The following image shows this window.
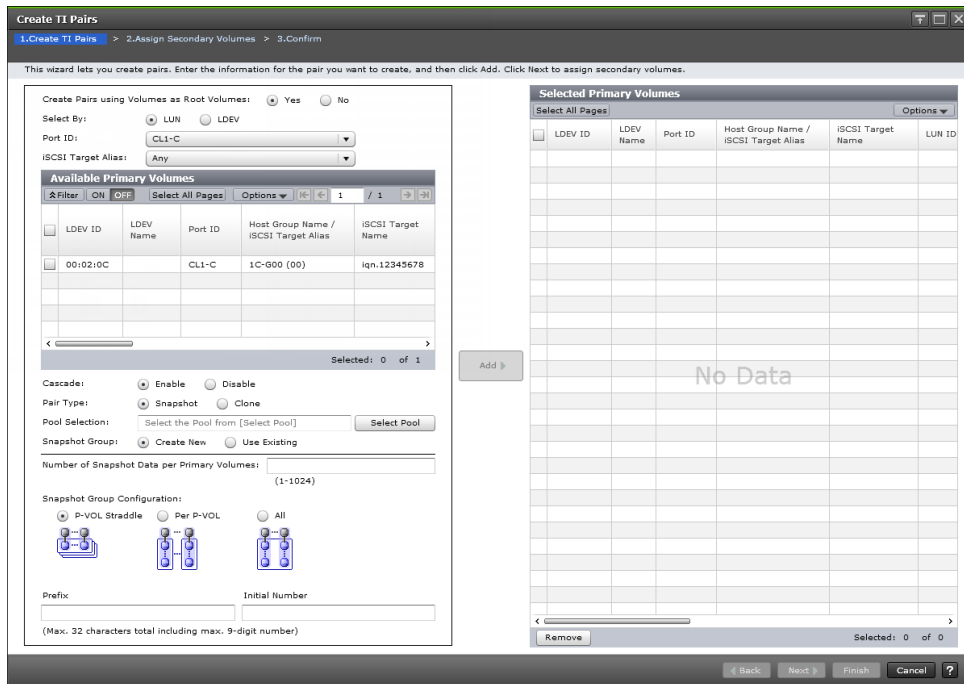
Setting fields

The following table lists the items on this window of the Create TI Pairs wizard.

Item	Description
Create Pairs using Volumes as Root Volumes	Specify whether to create a new pair using the specified volume as the root volume. ▪ **Yes**: Create a pair using the specified volume as the root volume. The **Available Primary Volumes** table lists LDEVs which are not paired, and S-VOLs of the cascaded pairs with the clone attribute. ▪ **No**: Create a pair using the P-VOL of a created pair. The **Available Primary Volumes** table lists P-VOLs of created pairs, and S-VOLs of created cascaded pairs.
Select By	Specify whether to specify LUN to create a pair. ▪ LUN: Specify LUN, and then select an LDEV to create a pair. ▪ LDEV: Select an LDEV to create a pair without specifying LUN.

Item	Description
Selection Object	Filters LDEVs in the Available Primary Volumes table according to port type. This item is displayed when LUN is selected for Select By.
Port ID	Filters LDEVs in the Available Primary Volumes table according to port ID. This item dispays if you select LUN for Select By.
Host Group Name	Used to filter LDEVs to display in the Available Primary Volumes table by host group name. This item is displayed if you select LUN for Select By, and a Fibre Channel port for Port ID. Default: Any
iSCSI Target Alias	Used to filter LDEVs to display in the Available Primary Volumes table by iSCSI target alias. This item is displayed if you select LUN for Select By, and an iSCSI port for Port ID. Default: Any
Cascade	Select to enable or disable creation of cascaded pairs. ▪ **Enable:** Cascaded pairs can be created. ▪ **Disable:** Cascaded pairs cannot be created.
Pair Type	Select the pair type. ▪ **Snapshot:** Creates a pair with the snapshot attribute. ▪ **Clone:** Creates a pair with the clone attribute. This item is available when you select: ▪ No for Create Pairs using Volumes as Root Volumes. ▪ Yes for Create Pairs using Volumes as Root Volumes and Enable for Cascade.
Select Pool button	Click to open the **Select Pool** window.

Item	Description
	You cannot select this button if you select No for Create Pairs using Volumes as Root Volumes.
Snapshot Group	Specifies whether to create a new snapshot group or to use an existing one. Values: ▪ **Create New:** Enter the values of the snapshot group you want to create in Number of Snapshot Data per Primary Volume, Prefix, and Initial Number, and then select Snapshot Group Configuration. When you specify an initial number that was already registered, the smallest available number that is the same as or larger than the specified number is automatically set. ▪ **Use Existing:** Select Snapshot Group Configuration, and then select the snapshot group you want to use from the Available Snapshot Groups table. If you select All in Snapshot Group Configuration, enter a value for Number of Snapshot Data per Primary Volume.
Number of Snapshot Data per Primary Volume	The number of snapshot data per primary volume.
Snapshot Group Configuration	The configuration of the snapshot data.

Item	Description
	Values:
	▪ **P-VOL Straddle:** When you select Create New in Snapshot Group, creates a snapshot group that straddles multiple primary volumes. When you select Use Existing in Snapshot Group, adds snapshot data to an existing snapshot group that you select in the Available Snapshot Groups table as straddling multiple primary volumes.
	▪ **Per P-VOL:** Creates a snapshot group for each primary volume. You can select this option if you select Create New in Snapshot Group.
	▪ **All:** When you select Create New in Snapshot Group, creates a new snapshot group and adds all snapshot data to it. When you select Use Existing in Snapshot Group, adds all snapshot data to an existing snapshot group.
Prefix	The fixed character prefix of the snapshot group.
Initial number	The initial number of the snapshot group. The available numbers are assigned to the subsequent snapshot groups in ascending order.
Add button	Click to move the selected volumes from the Available Primary Volumes table to the Selected Primary Volumes table.

Available Snapshot Groups table

The following table lists the items in the Available Snapshot Groups table on the Create TI Pairs window.

This table is displayed if you select Use Existing in Snapshot Group.

Item	Description
Snapshot Group	The snapshot group name.
Number of Pairs	The number of snapshot group pairs.

Item	Description
New Snapshot Group	Indicates whether the snapshot group is new or existing. Values: ▪ **Yes:** Newly created snapshot group. ▪ **No:** Already defined snapshot group.

Available Primary Volumes table

The following table lists the items in the Available Primary Volumes table on the Create TI Pairs window.

Item	Description
LDEV ID	The LDEV's identification number which can be specified as the P-VOL.
LDEV Name	The LDEV's name.
Port ID	The port name of the LDEV's LUN path. This item is displayed if you select LUN for Select By.
Host Group Name / iSCSI Target Alias	The host group name and ID or iSCSI target alias and ID of the LDEV's LUN path. This item is displayed if you select LUN for Select By.
iSCSI Target Name	The iSCSI target name. This item is displayed if you select LUN for Select By.
LUN ID	The LUN identification number of the LDEV's LUN path. This item is displayed if you select LUN for Select By. (VSP 5000 series)
Provisioning Type	The LDEV's provisioning type. Values: ▪ **Basic:** Internal volume. ▪ **DP:** DP-VOL. ▪ **External:** External volume. ▪ **ALU:** ALU attribute volume.
Attribute	The LDEV's attribute.

Item	Description
	Values: ▪ **ALU:** ALU attribute volume. ▪ **SLU:** SLU attribute volume. ▪ **Data Direct Mapping:** Data Direct Mapping attribute volume. If the volume does not have any attribute specified, a hyphen (-) is displayed.
Capacity	The capacity of the LDEV.
CLPR	The LDEV's CLPR ID.

Encryption	The LDEV's encryption information.
	
	▪ **Enabled:** Encryption is enabled for the parity group to which the LDEV belongs, or a V-VOL is associated with a pool in which a pool volume has encryption enabled.
	
	▪ **Disabled:** Encryption is disabled for the parity group to which the LDEV belongs, or a V-VOL is associated with a pool in which a pool volume has encryption disabled.
	
	▪ **Mixed:** The pool to which the LDEV belongs contains two or more of the following:
	
	  • Volume for which encryption is enabled
	
	  • Volume for which encryption is disabled
	
	  • External volume
	
	Note: Data encryption is not ensured in an LDEV with Mixed encryption status.
	
	If the LDEV is an external volume or migration volume, a hyphen (-) is displayed. (VSP 5000 series)
	
	For DP-VOLs, the pool to which an LDEV belongs is an external volume or blocked.

Capacity Saving	Information about the LDEV's capacity saving function. ▪ **Compression:** The compression function is used. ▪ **Deduplication and Compression:** The deduplication function and the compression function are used. ▪ **Disabled:** The capacity saving function is not used.

Item	Description
Compression Acceleration	Compression accelerator settings. ▪ Enabled: The compression accelerator setting is enabled. ▪ Disabled: The compression accelerator setting is disabled. ▪ - (hyphen): The compression accelerator setting is not available for an LDEV. Alternatively, the compression accelerator setting is available for an LDEV whose capacity saving setting is Disabled and whose capacity saving status is Disabled.
T10 PI	The LDEV's T10 PI attribute information. ▪ **Enabled:** The LDEV's T10 PI attribute is enabled. ▪ **Disabled:** The LDEV's T10 PI attribute is disabled.
Number of Snapshot Data	The number of snapshot data to which the LDEV belongs.
Cascade	Indicates whether a cascaded pair can be created ▪ **Enabled:** Cascaded pairs can be created. ▪ **Disabled:** Cascaded pairs cannot be created.
TI Pair Position	Indicates that the volume is the P-VOL or S-VOL of the pair.
TI Pair Topology ID	The topology ID, which indicates the layer of the pair based on the mirror unit. The topology ID consists of the LDEV ID of the root volume and the mirror unit number.
Primary Volumes	If you use the LDEV as an S-VOL for an existing pair, information about the P-VOL is displayed. Values: ▪ **LDEV ID:** The LDEV's identification number. ▪ **LDEV Name:** The LDEV's name. ▪ **Port ID:** The port name of the LDEV's LUN path. ▪ **Host Group Name / iSCSI Target Alias:** The host group name and ID or iSCSI target alias and ID of the LDEV's LUN path. ▪ **iSCSI Target Name:** The P-VOL's iSCSI target name.

Item	Description
	▪ **LUN ID:** The LUN identification number of the LDEV's LUN path. ▪ **Capacity:** The LDEV's capacity. ▪ **CLPR:** The LDEV's CLPR ID.
Pool Name (ID)	The pool name and identification number.
Mirror Unit	The mirror unit number. A hyphen (-) is displayed if the volume is not an S-VOL of an existing pair.

Selected Primary Volumes table

The following table lists the items in the Selected LDEVs table on the **Select Primary Volumes** window.

Item	Description
LDEV ID	The selected P-VOL's LDEV identification number.
LDEV Name	The selected P-VOL's LDEV name.
Port ID	The port name of the LDEV's LUN path.
Host Group Name / iSCSI Target Alias	The host group name and ID or iSCSI target alias and ID of the LDEV's LUN path.
iSCSI Target Name	The iSCSI target name.
LUN ID	The LUN identification number of the LDEV's LUN path.
Attribute	The LDEV's attribute. Values: ▪ **ALU:** ALU attribute volume. ▪ **SLU:** SLU attribute volume. ▪ **Data Direct Mapping:** Data Direct Mapping attribute volume. If the volume does not have any attribute specified, a hyphen (-) is displayed.
Capacity	The capacity of the LDEV.

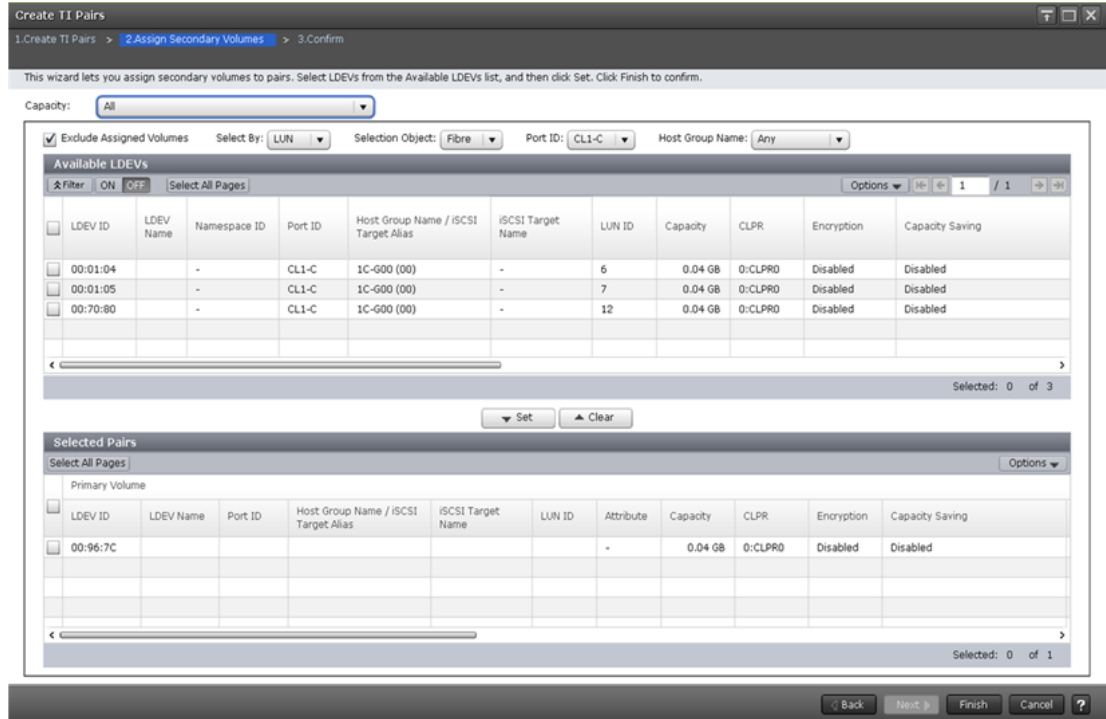| Item	Description
Encryption	The LDEV's encryption information. ▪ **Enabled:** Encryption is enabled for the parity group to which the LDEV belongs, or a V-VOL is associated with a pool in which a pool volume has encryption enabled. ▪ **Disabled:** Encryption is disabled for the parity group to which the LDEV belongs, or a V-VOL is associated with a pool in which a pool volume has encryption disabled. ▪ **Mixed:** The pool to which the LDEV belongs contains two or more of the following: 　• Volume for which encryption is enabled 　• Volume for which encryption is disabled 　• External volume **Note:** Data encryption is not ensured in an LDEV with Mixed encryption status. If the LDEV is an external volume or migration volume, a hyphen (-) is displayed. (VSP 5000 series) For DP-VOLs, the pool to which an LDEV belongs is an external volume or blocked.
Capacity Saving	Information about the LDEV's capacity saving function. ▪ **Compression:** The compression function is used. ▪ **Deduplication and Compression:** The deduplication function and the compression function are used. ▪ **Disabled:** The capacity saving function is not used.
Compression Acceleration	Compression accelerator settings. ▪ Enabled: The compression accelerator setting is enabled. ▪ Disabled: The compression accelerator setting is disabled. ▪ - (hyphen): The compression accelerator setting is not available for an LDEV. Alternatively, the compression accelerator setting is available for an LDEV whose capacity saving setting is Disabled and whose capacity saving status is Disabled.

Appendix B: Thin Image GUI windows and wizards

Item	Description
T10 PI	The LDEV's T10 PI attribute information. ▪ **Enabled:** The LDEV's T10 PI attribute is enabled. ▪ **Disabled:** The LDEV's T10 PI attribute is disabled.
Snapshot Group	The snapshot group name.
New Snapshot Group	Indicates whether the snapshot group is new or existing. Values: ▪ **Yes:** Newly created snapshot group. ▪ **No:** Already defined snapshot group.
Number of Snapshot Data	The number of snapshot data.
Pool Name (ID)	The pool name and identification number.

Pool Encryption	The pool's encryption information.
	
	▪ **Enabled:** A pool was created by the pool volume for which encryption is enabled.
	
	▪ **Disabled:** A pool was created by the pool volume for which encryption is disabled.
	
	▪ **Mixed:** A pool contains two or more of the following:
	
	  • Volume for which encryption is enabled
	
	  • Volume for which encryption is disabled
	
	  • External volume
	
	Note: Data encryption is not ensured in an LDEV with Mixed encryption status.
	
	For pools created in external volumes, or blocked pools, a hyphen (-) is displayed.

Cascade (VSP 5000 series)	Indicates whether a cascaded pair can be created ▪ **Enabled:** Cascaded pairs can be created. ▪ **Disabled:** Cascaded pairs cannot be created.
Pair Type (VSP 5000 series)	Select the pair type. ▪ **Snapshot:** A pair with the snapshot attribute. ▪ **Clone:** A pair with the clone attribute.
Remove button	Click to remove the selected row from the Selected Primary Volumes table.

Assign Secondary Volumes window

Use this window to select the LDEVs that are the S-VOL.

This window is the second window of the Create TI Pairs wizard.

The following image shows this window.

The following table shows the items in this window.

Item	Description
Capacity	Click to select the capacity for which to filter the available LDEVs.
Exclude Assigned Volumes	Hide volumes that are already paired from the Selected Pairs table.
Select By	Filters LDEVs in the Available LDEVs table by the specified object.
Selection Object	Filters LDEVs in the Available LDEVs table according to port type.
Port ID	Filters LDEVs in the Available LDEVs table by the Port ID. This item is displayed if you select LUN for Select By.

Item	Description
Host Group Name	Used to filter LDEVs to display in the Available Primary Volumes table. This item is displayed if you select LUN for Select By. Default: Any
Set button	Click to move an LDEV that you have selected in the Available LDEVs table to the Selected Pairs table. You can also click to configure a pair you have selected in the Available LDEVs table and a pair you have selected in the Selected Pairs table.
Clear button	Click to move the selected S-VOL from the Selected Pairs table back to the Available LDEVs table.

Available LDEVs table

The following table lists the items in the Available LDEVs table on the **Assign Secondary Volumes** window.

Item	Description
LDEV ID	The LDEV identification number, which you can specify as the S-VOL.
LDEV Name	The LDEV's name.
Namespace ID	Displays a namespace ID of the LDEV. If the LDEV is not registered as a namespace, a hyphen (-) is displayed. Namespace ID is not displayed for VSP E series other than VSP E1090.
Port ID	The port name of the LDEV's LUN path. This item is displayed if you select LUN for Select By.
Host Group Name / iSCSI Target Alias	The host group name and ID or iSCSI target alias and ID of the LDEV's LUN path. This item is displayed if you select LUN for Select By.
iSCSI Target Name	The iSCSI target name.

Item	Description
	This item is displayed if you select LUN for Select By.
LUN ID	The LUN identification number of the LDEV's LUN path.
	This item is displayed if you select LUN for Select By.
Capacity	The LDEV's capacity.
CLPR	The LDEV's CLPR ID.
Encryption	Encryption information.
	▪ **Enabled:** Encryption is enabled for the parity group to which P-VOL's LDEV belongs, or a V-VOL is associated with a pool in which a pool volume has encryption enabled
	▪ **Disabled:** Encryption is disabled for the parity group to which P-VOL's LDEV belongs, or a V-VOL is associated with a pool in which a pool volume has encryption disabled.
	▪ **Mixed:** The pool to which the P-VOL's LDEV belongs contains two or more of the following:
	• Volume for which encryption is enabled
	• Volume for which encryption is disabled
	• External volume
	Note: Data encryption is not ensured in an LDEV with Mixed encryption status. If you want to manage data encryption, use LDEVs with the Enabled or Disabled status.
	▪ If the LDEV is an external volume or migration volume, a hyphen (-) is displayed. For DP-VOLs, the pool to which an LDEV belongs is an external volume or blocked.

Item	Description
Capacity Saving	Information about the LDEV's capacity saving function. • **Compression:** The compression function is used. • **Deduplication and Compression:** The deduplication function and the compression function are used. • **Disabled:** The capacity saving function is not used.
Compression Acceleration	Information on the compression accelerator. • Enabled: Compression accelerator is enabled. • Disabled: Compression accelerator is disabled. • - (hyphen): Compression accelerator is not available for an LDEV. Alternatively, compression accelerator is available for an LDEV whose capacity saving setting is Disabled and whose capacity saving status is Disabled.
T10 PI	The LDEV's T10 PI attribute information. • **Enabled:** The LDEV's T10 PI attribute is enabled. • **Disabled:** The LDEV's T10 PI attribute is disabled.
Snapshot Group	The snapshot group name. Information is displayed for this item only if you have configured a snapshot group for the HTI pair.
Status	The pair status. For more information about pair status, see <u>Thin Image pair status definitions (on page 158)</u>.
Snapshot Date	The date and time that you created the pair to store snapshot data.
Primary Volume	The P-VOL information.

Item	Description
	Values: • **LDEV ID:** The P-VOL's LDEV identification number. • **LDEV Name:** The P-VOL's LDEV name. If you have not allocated an LDEV to the S-VOL for an existing pair, a hyphen (-) is displayed. • **Port ID:** The port name of the P-VOL LDEV's LUN path. • **Host Group Name / iSCSI Target Alias:** The host group name and ID or iSCSI target alias and ID of the P-VOL LDEV's LUN path. • **iSCSI Target Name:** The P-VOL's iSCSI target name. • **LUN ID:** The LUN identification number of the P-VOL LDEV's LUN path. • **Capacity:** The P-VOL's capacity. • **CLPR:** The P-VOL's CLPR ID.
Pool Name (ID)	The pool name and identification number.
Mirror Unit	The mirror unit number.

Selected Pairs table

The following table lists the items in this table on the **Assign Secondary Volumes** window.

Item	Description
Primary Volume	The P-VOL information. Values: • **LDEV ID:** The P-VOL's LDEV identification number. • **LDEV Name:** The P-VOL's LDEV name. • **Port ID:** The port name of the P-VOL LDEV's LUN path. • **Host Group Name / iSCSI Target Alias:** The host group name and ID or iSCSI target alias and ID of the P-VOL LDEV's LUN path. • **iSCSI Target Name:** The P-VOL's iSCSI target name. • **LUN ID:** The LUN identification number of the P-VOL LDEV's LUN path.

Appendix B: Thin Image GUI windows and wizards

Item	Description
	▪ **Attribute:** The P-VOL's attribute.
	▪ **Capacity:** The P-VOL's capacity.
	▪ **CLPR:** The P-VOL's CLPR ID.
	▪ **Encryption:** P-VOL's encryption information.
	• **Enabled:** Encryption is enabled for the parity group to which P-VOL's LDEV belongs, or a V-VOL is associated with a pool in which a pool volume has encryption enabled.
	• **Disabled:** Encryption is disabled for the parity group to which P-VOL's LDEV belongs, or a V-VOL is associated with a pool in which a pool volume has encryption disabled.
	• **Mixed:** The pool to which the P-VOL's LDEV belongs contains two or more of the following:
	▪ Volume for which encryption is enabled
	▪ Volume for which encryption is disabled
	▪ External volume
	Note: Data encryption is not ensured in an LDEV with Mixed encryption status. If you want to manage data encryption, use LDEVs with the Enabled or Disabled status.
	• If the LDEV is an external volume or migration volume, a hyphen (-) is displayed.
	For DP-VOLs, the pool to which an LDEV belongs is an external volume or blocked.
	▪ **Capacity Saving:** Information about the P-VOL's capacity saving function.
	• **Compression:** The compression function is used.
	• **Deduplication and Compression:** The deduplication function and the compression function are used.
	• **Disabled:** The capacity saving function is not used.

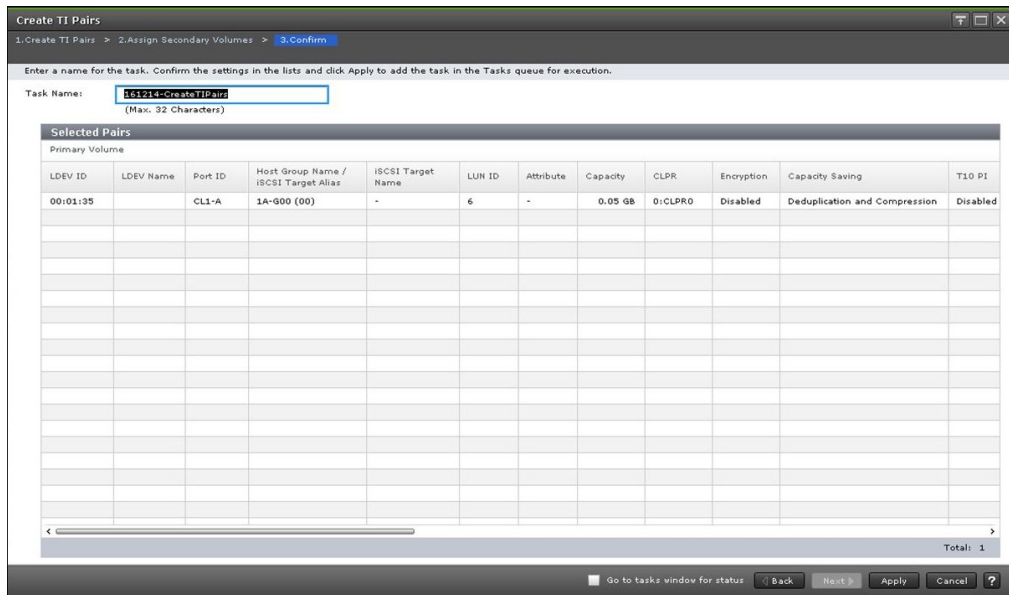| Item	Description
	▪ **Compression Acceleration:** Information on the compression accelerator. • Enabled: Compression accelerator is enabled. • Disabled: Compression accelerator is disabled. • - (hyphen): Compression accelerator is not available for an LDEV. Alternatively, compression accelerator is available for an LDEV whose capacity saving setting is Disabled and whose capacity saving status is Disabled. ▪ **T10 PI:** The P-VOL's T10 PI attribute information. • **Enabled:** The P-VOL's T10 PI attribute is enabled. • **Disabled:** The P-VOL's T10 PI attribute is disabled.
Snapshot Group	The snapshot group name.
Snapshot Data Seq. No.	The sequence number of snapshot data.
Secondary Volume	The S-VOL information. Values: ▪ **LDEV ID:** The S-VOL's LDEV identification number. If you have not allocated an LDEV to the S-VOL, this item is blank. ▪ **LDEV Name:** The S-VOL's LDEV name. If you have not allocated an LDEV to the S-VOL, a hyphen (-) is displayed. ▪ **Port ID:** The port name of the S-VOL LDEV's LUN path. ▪ **Host Group Name / iSCSI Target Alias:** The host group name and ID or iSCSI target alias and ID of the S-VOL LDEV's LUN path. ▪ **iSCSI Target Name:** The S-VOL's iSCSI target name. ▪ **LUN ID:** The LUN identification number of the S-VOL LDEV's LUN path. ▪ **Attribute:** The S-VOL's attribute. ▪ **Capacity:** The S-VOL's capacity. ▪ **CLPR:** The S-VOL's CLPR ID.

Item	Description
	▪ (VSP 5000 series) **Encryption**: S-VOL's encryption information. • **Enabled:** Encryption is enabled for the parity group to which S-VOL's LDEV belongs, or a V-VOL is associated with a pool in which a pool volume has encryption enabled. • **Disabled:** Encryption is disabled for the parity group to which S-VOL's LDEV belongs, or a V-VOL is associated with a pool in which a pool volume has encryption disabled. • **Mixed:** The pool to which S-VOL's LDEV belongs contains two or more of the following: ▪ Volume for which encryption is enabled ▪ Volume for which encryption is disabled ▪ External volume **Note:** Data encryption is not ensured in an LDEV with Mixed encryption status. If you want to manage data encryption, use LDEVs with the Enabled or Disabled status. • If the LDEV is an external volume or migration volume, a hyphen (-) is displayed. For DP-VOLs, the pool to which an LDEV belongs is an external volume or blocked. ▪ **Capacity Saving:** Information about the S-VOL's capacity saving function. • **Compression:** The compression function is used. • **Deduplication and Compression:** The deduplication function and the compression function are used. • **Disabled:** The capacity saving function is not used.

Item	Description
	▪ **Compression Acceleration:** Information on the compression accelerator. 　• Enabled: Compression accelerator is enabled. 　• Disabled: Compression accelerator is disabled. 　• - (hyphen): Compression accelerator is not available for an LDEV. Alternatively, compression accelerator is available for an LDEV whose capacity saving setting is Disabled and whose capacity saving status is Disabled. ▪ **T10 PI:** The S-VOL's T10 PI attribute information. 　• **Enabled:** The S-VOL's T10 PI attribute is enabled. 　• **Disabled:** The S-VOL's T10 PI attribute is disabled.
Pool Name (ID)	The pool name and identification number.
Mirror Unit	The mirror unit number. A hyphen (-) is displayed if the volume is not an S-VOL of an existing pair.
Cascade	Indicates whether a cascaded pair can be created ▪ Enabled: Cascaded pairs can be created. ▪ Disabled: Cascaded pairs cannot be created.
Pair Topology ID	The topology ID, which indicates the layer of the pair based on the mirror unit. The pair topology ID consists of the LDEV ID of the root volume and the mirror unit number.

Create TI Pairs confirmation window

This window is the third and last window of the Create TI Pairs wizard.

The following image shows this window.

Selected Pairs table

The following table lists the items in this table on the **Confirm** window.

Item	Description
Primary Volume	The P-VOL information. Values: - **LDEV ID:** The P-VOL's LDEV identification number. - **LDEV Name:** The P-VOL's LDEV name. - **Port ID:** The port name of the P-VOL LDEV's LUN path. - **Host Group Name/iSCSI Target Alias:** The host group name of the P-VOL LDEV's LUN path. - **iSCSI Target Name:** The P-VOL's iSCSI target name. - **LUN ID:** The LUN identification number of the P-VOL LDEV's LUN path. - **Attribute:** The P-VOL's attribute. - **Capacity:** The P-VOL's capacity. - **CLPR:** The P-VOL's CLPR ID.

Item	Description
	▪ **Encryption:** P-VOL's encryption information.
	• **Enabled:** Encryption is enabled for the parity group to which P-VOL's LDEV belongs, or the P-VOL is a V-VOL associated with a pool in which a pool volume has encryption enabled.
	• **Disabled:** Encryption is disabled for the parity group to which P-VOL's LDEV belongs, or the P-VOL is a V-VOL associated with a pool in which a pool volume has encryption disabled.
	• **Mixed:** The pool to which the P-VOL's LDEV belongs contains two or more of the following:
	▪ Volume for which encryption is enabled
	▪ Volume for which encryption is disabled
	▪ External volume
	Note: Data encryption is not ensured in an LDEV with Mixed encryption status. If you want to manage data encryption, use LDEVs with the Enabled or Disabled status.
	• If the LDEV is an external volume or migration volume, a hyphen (-) is displayed.
	For DP-VOLs, the pool to which an LDEV belongs is an external volume or blocked.
	▪ **Capacity Saving:** Information about the P-VOL's capacity saving function.
	• **Compression:** The compression function is used.
	• **Deduplication and Compression:** The deduplication function and the compression function are used.
	• **Disabled:** The capacity saving function is not used.

Item	Description
	▪ **Compression Acceleration:** Compression accelerator settings. • Enabled: The compression accelerator setting is enabled. • Disabled: The compression accelerator setting is disabled. • - (hyphen): The compression accelerator setting is not available for an LDEV. Alternatively, the compression accelerator setting is available for an LDEV whose capacity saving setting is Disabled and whose capacity saving status is Disabled. ▪ **T10 PI:** The P-VOL's T10 PI attribute information. • **Enabled:** The P-VOL's T10 PI attribute is enabled. • **Disabled:** The P-VOL's T10 PI attribute is disabled.
Snapshot Group	The snapshot group name.
Snapshot Data Seq. No.	The sequence number of snapshot data.
Secondary Volume	The S-VOL information. Values: ▪ **LDEV ID:** The S-VOL's LDEV identification number. If you have not allocated an LDEV to the S-VOL, this item is blank. ▪ **LDEV Name:** The S-VOL's LDEV name. If you have not allocated an LDEV to the S-VOL, a hyphen (-) is displayed. ▪ **Port ID:** Port name of the S-VOL LDEV's LUN path. ▪ **Host Group Name/iSCSI Target Alias:** The host group name of the S-VOL LDEV's LUN path. ▪ **iSCSI Target Name:** The S-VOL's iSCSI target name. ▪ **LUN ID:** The LUN identification number of the S-VOL LDEV's LUN path. ▪ **Attribute:** The S-VOL's attribute. ▪ **Capacity:** The S-VOL's capacity. ▪ **CLPR:** The S-VOL's CLPR ID.

Item	Description

	▪ **Encryption:** S-VOL's encryption information.
	
	• **Enabled:** Encryption is enabled for the parity group to which S-VOL's LDEV belongs, or the P-VOL is a V-VOL associated with a pool in which a pool volume has encryption enabled.
	
	• **Disabled:** Encryption is disabled for the parity group to which S-VOL's LDEV belongs, or the P-VOL is a V-VOL associated with a pool in which a pool volume has encryption disabled.
	
	• **Mixed:** The pool to which S-VOL's LDEV belongs contains two or more of the following:
	
	  ▪ Volume for which encryption is enabled
	
	  ▪ Volume for which encryption is disabled
	
	  ▪ External volume
	
	Note: Data encryption is not ensured in an LDEV with Mixed encryption status. If you want to manage data encryption, use LDEVs with the Enabled or Disabled status.
	
	• If the LDEV is an external volume or migration volume, a hyphen (-) is displayed.
	
	For DP-VOLs, the pool to which an LDEV belongs is an external volume or blocked.
	
	▪ **Capacity Saving:** Information about the S-VOL's capacity saving function.
	
	• **Compression:** The compression function is used.
	
	• **Deduplication and Compression:** The deduplication function and the compression function are used.
	
	• **Disabled:** The capacity saving function is not used.

Item	Description
	▪ **Compression Acceleration:** Compression accelerator settings. • Enabled: The compression accelerator setting is enabled. • Disabled: The compression accelerator setting is disabled. • - (hyphen): The compression accelerator setting is not available for an LDEV. Alternatively, the compression accelerator setting is available for an LDEV whose capacity saving setting is Disabled and whose capacity saving status is Disabled. ▪ **T10 PI:** The S-VOL's T10 PI attribute information. • **Enabled:** The S-VOL's T10 PI attribute is enabled. • **Disabled:** The S-VOL's T10 PI attribute is disabled.
Pool Name (ID)	The pool name and identification number.
Pool Encryption	The pool's encryption information. ▪ **Enabled:** A pool was created by the pool volume for which encryption is enabled. ▪ **Disabled:** A pool was created by the pool volume for which encryption is disabled. ▪ **Mixed:** A pool contains two or more of the following: • Volume for which encryption is enabled • Volume for which encryption is disabled • External volume **Note:** Data encryption is not ensured in an LDEV with Mixed encryption status. For pools created in external volumes, blocked pools, and non-HTI pairs, a hyphen (-) is displayed.
Cascade	Indicates whether a cascaded pair can be created. ▪ **Enabled:** Cascaded pairs can be created. ▪ **Disabled:** Cascaded pairs cannot be created.
Topology ID	The topology ID, which indicates the layer of the pair based on the mirror unit. The topology ID consists of the LDEV ID of the root volume and the mirror unit number.

Appendix B: Thin Image GUI windows and wizards

Remove Secondary Volumes table

This table is displayed if a volume is selected that was already assigned to other snapshot data (by leaving the Exclude Assigned Volumes check box unselected in the **Assign Secondary Volumes** window).

The following table lists the items in this table on the **Confirm** window.

Item	Description
LDEV ID	The LDEV identification number, which you can specify as the S-VOL.
LDEV Name	The LDEV's name.
Attribute	The LDEV's attribute.
Capacity	The LDEV's capacity.
CLPR	The LDEV's CLPR ID.
Remount Device	Indicates whether remounting the device is required.
Snapshot Group	The snapshot group name. Information is displayed for this item only if you have configured a snapshot group for the HTI pair.
Status	The pair status. For more information about pair status, see <u>Thin Image pair status definitions (on page 158)</u>.
Snapshot Date	The date and time that you created the pair to store snapshot data.
Primary Volume	The P-VOL information. Values: ▪ **LDEV ID:** The P-VOL's LDEV identification number. ▪ **LDEV Name:** The P-VOL's LDEV name. If you have not allocated an LDEV to the S-VOL, a hyphen (-) is displayed. ▪ **Attribute:** The P-VOL's attribute. ▪ **Capacity:** The P-VOL's capacity. ▪ **CLPR:** The P-VOL's CLPR ID.
Pool Name (ID)	The pool name and identification number.
Mirror Unit	The mirror unit number. A hyphen (-) is displayed if the volume is not an S-VOL of an existing pair.

Item	Description
Cascade	Indicates whether a cascaded pair can be created. ▪ **Enabled:** Cascaded pairs can be created. ▪ **Disabled:** Cascaded pairs cannot be created.
Type	The pair type. ▪ **Snapshot:** A pair with the snapshot attribute. ▪ **Clone:** A pair with the clone attribute.
Pair Topology ID	The topology ID, which indicates the layer of the pair based on the mirror unit. The pair topology ID consists of the LDEV ID of the root volume and the mirror unit number.

Select Pool window

The following image shows the **Select Pool** window, which includes the Available Pools table.
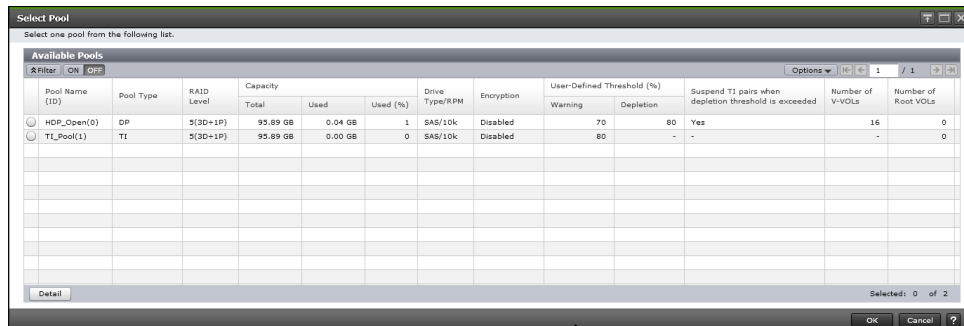
Available Pools table

The following table lists the items in this table on the **Select Pool** window.

Item	Description
Pool Name (ID)	The pool name and identification number.
Pool Type	Indicates the pool type. ▪ **DP:** Dynamic Provisioning ▪ **TI:** Thin Image
RAID Level	The RAID level of the pool.

Item	Description
Capacity	The pool capacity. If the pool-VOL belonging to the parity group in which accelerated compression is enabled, is included in the pool, sometimes the capacity is displayed less than the possible capacity which can be written. Values: ▪ **Total :** The total pool capacity. If the pool-VOL belonging to the parity group for which accelerated compression, is included in the pool, the capacity available for writing data might be less than the displayed capacity. ▪ **Used :** The amount of pool capacity that is used. ▪ **Used (%) :** The percentage of pool capacity that is use. **Note:** This number is truncated to an integer.
Drive Type/RPM	The data drive type and RPM. For VSP E series, this item is displayed as **Drive Type**. For more information about data drive type, see <u>Pool creation and data drive type priority (on page 109)</u>.
Encryption	The pool's encryption information. ▪ **Enabled:** A pool was created by the pool volume for which encryption is enabled. ▪ **Disabled:** A pool was created by the pool volume for which encryption is disabled. ▪ **Mixed:** A pool contains two or more of the following: • Volume for which encryption is enabled • Volume for which encryption is disabled • External volume **Note:** Data encryption is not ensured in an LDEV with Mixed encryption status. For pools created in external volumes, or blocked pools, a hyphen (-) is displayed.
User-Defined Threshold (%)	Indicates the thresholds you set. ▪ **Warning:** Warning thresholds. ▪ **Depletion:** Depletion thresholds.

Appendix B: Thin Image GUI windows and wizards

Item	Description
Suspend TI pairs when the depletion threshold is exceeded	Indicates whether a Thin Image pair copy is suspended when the depletion threshold is exceeded. ▪ **Yes:** Suspended ▪ **No:** Not suspended
Subscription %	Information about the subscription is displayed. Current: The total percentage of the V-VOL capacity currently assigned to the pool is displayed. Limit: The percentage of the subscription amount currently set in the pool is displayed. This item is displayed only for VSP E series.
Number of V-VOLs	Indicates the number of virtual volumes currently associated with a pool and the maximum number of virtual volumes that can be associated with the pool. For a pool with the Data Direct Mapping attribute, "-" is shown for the maximum number of virtual volumes that can be associated with the pool.
Number of Root VOLs	Indicates the number of root volumes for a Thin Image pair. When there are no volumes to be counted, "-" is shown.
Detail button	Click to open the **Pool Property** window. For more information about this window, see the *Provisioning Guide* for your storage system.

Split Pairs wizard

Use this wizard to split pairs.

Split Pairs window

The following image shows this window, which is the first window of the **Split Pairs** wizard.

Appendix B: Thin Image GUI windows and wizards
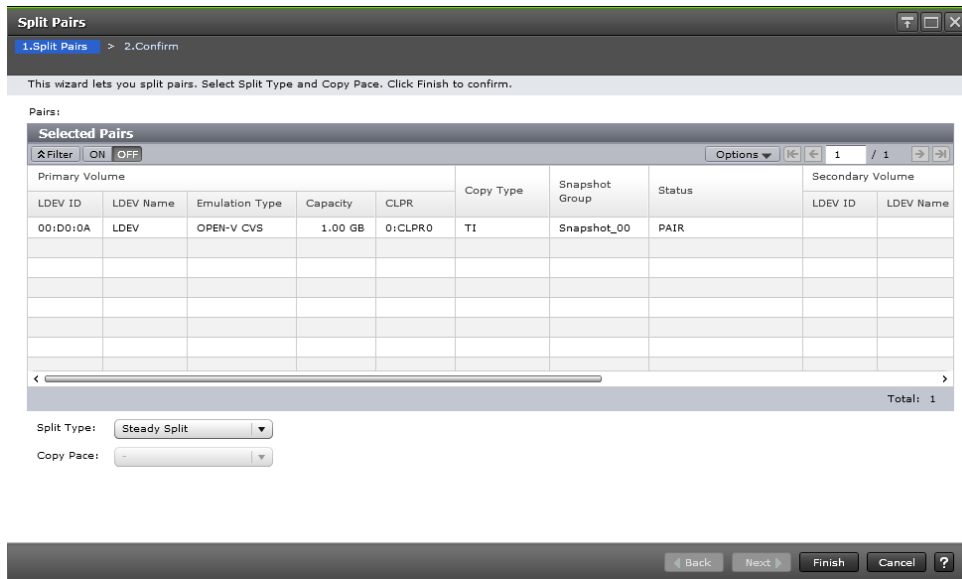
Selected Pairs table

The following table lists the items in this table on the **Split Pairs** window.

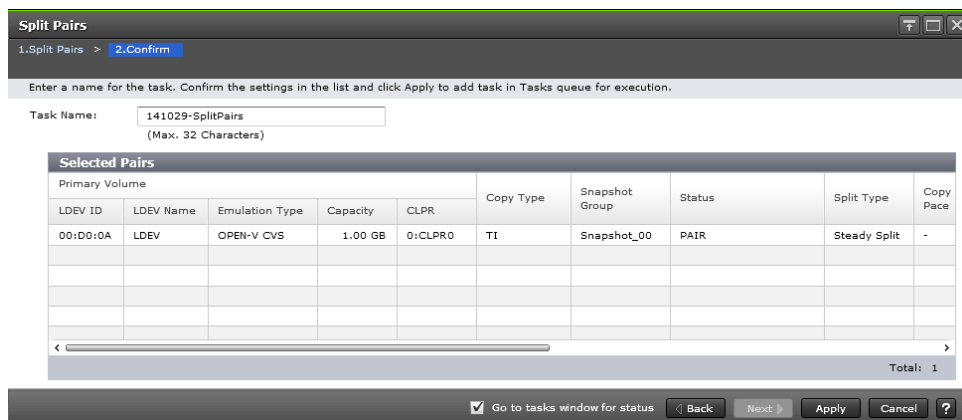| Item	Description
Primary Volume	P-VOL information for the pairs you have selected to split. Values: • **LDEV ID:** The P-VOL's LDEV identification number. • **LDEV Name:** The P-VOL's LDEV name. • **Emulation Type:** (VSP 5000 series) The P-VOL's emulation type. • **Attribute:** The P-VOL's attribute. • **Capacity:** The P-VOL's capacity. • **CLPR:** The P-VOL's CLPR ID.
Copy Type	The volume's copy type. Values: • **TI:** HTI pair
Snapshot Group	The snapshot group name. Information is displayed for this item only if you have configured a snapshot group for the HTI pair.
Status	The pair status. For more information, see Thin Image pair status definitions (on page 158).

Item	Description
Secondary Volume	The S-VOL information for the pairs you have selected to split. Values: ▪ **LDEV ID:** The S-VOL's LDEV identification number. ▪ **LDEV Name:** The S-VOL's LDEV name. ▪ **Emulation Type:** (VSP 5000 series) The S-VOL's emulation type. ▪ **Attribute:** The S-VOL's attribute. ▪ **Capacity:** The S-VOL's capacity. ▪ **CLPR:** The S-VOL's CLPR ID.
Pool Name (ID)	The pool name and identification number.
Mirror Unit	The mirror unit number.
Cascade	Indicates whether a cascaded pair can be created. ▪ **Enabled:** Cascaded pairs can be created. ▪ **Disabled:** Cascaded pairs cannot be created. A hyphen (-) displays for non-HTI pairs.
Type	The pair type. ▪ **Snapshot:** A pair with the snapshot attribute. ▪ **Clone:** A pair with the clone attribute or diff clone attribute. In the **TI Pairs** window, if **Diff Compare Volume** displays the LDEV ID, the diff clone attribute is set for the pair. If **Diff Compare Volume** displays a hyphen (-), the clone attribute is set for the pair. A hyphen (-) displays for non-HTI pairs.
Topology ID	The topology ID, which indicates the layer of the pair based on the mirror unit. The topology ID consists of the LDEV ID of the root volume and the mirror unit number.
Split Type	The mode in which you want to split the selected pairs.

Item	Description
	Values: ▪ **Quick Split:** The pair is split and then remaining differential data is copied to the S-VOL in the background. Specify this value when you want to write to or read from the S-VOL immediately after splitting a pair. ▪ **Steady Split:** The differential data is copied to the S-VOL and then the pair is split. **Note:** This value is only available if you specify the copy type as TI. Default: Steady Split
Copy Pace	The speed at which the S-VOL is copied. For Thin Image pairs with the snapshot attribute, this item cannot be selected. A hyphen (-) is displayed.

Split Pairs confirmation window

The following image shows the **Confirm** window, which is the second and last window of the **Split Pairs** wizard.

Selected Pairs table

The following table lists the items in this table on the **Confirm** window.

Item	Description
Primary Volume	The P-VOL information. Values: ▪ **LDEV ID:** The P-VOL's LDEV identification number. ▪ **LDEV Name:** The P-VOL's LDEV name.

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Item	Description
	▪ **Emulation Type:** (VSP 5000 series) The P-VOL's emulation type.
	▪ **Attribute:** The P-VOL's attribute.
	▪ **Capacity:** The P-VOL's capacity.
	▪ **CLPR:** The P-VOL's CLPR ID.
Copy Type	The volume's copy type.
	Values:
	▪ **TI:** HTI pair
Snapshot Group	The snapshot group name.
	Information is displayed for this item only if you have configured a snapshot group for the HTI pair.
Status	The pair status.
	For more information, see .
Split Type	The split type.
	Values:
	▪ **Quick Split:** The pair is split and then remaining differential data is copied to the S-VOL in the background. Specify this value when you want to write to or read from the S-VOL immediately after splitting a pair.
	▪ **Steady Split:** The differential data is copied to the S-VOL and then the pair is split.
Copy Pace	The speed at which the S-VOL is copied.
	A hyphen (-) is displayed.
Secondary Volume	The S-VOL information.
	Values:
	▪ **LDEV ID:** The S-VOL's LDEV identification number.
	▪ **LDEV Name:** The S-VOL's LDEV name.
	▪ **Emulation Type:** (VSP 5000 series) The S-VOL's emulation type.
	▪ **Attribute:** The S-VOL's attribute.
	▪ **Capacity:** The S-VOL's capacity.
	▪ **CLPR:** The S-VOL's CLPR ID.
Pool Name (ID)	The pool name and identification number.

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Item	Description
Mirror Unit	The mirror unit number.
Cascade	Indicates whether a cascaded pair can be created. ▪ **Enabled:** Cascaded pairs can be created. ▪ **Disabled:** Cascaded pairs cannot be created. A hyphen (-) displays for non-HTI pairs.
Type	The pair type. ▪ **Snapshot:** A snapshot pair. ▪ **Clone:** A pair with the clone attribute or diff clone attribute. In the **TI Pairs** window, if **Diff Compare Volume** displays the LDEV ID, the diff clone attribute is set for the pair. If **Diff Compare Volume** displays a hyphen (-), the clone attribute is set for the pair. A hyphen (-) displays for non-HTI pairs.
Topology ID	The topology ID, which indicates the layer of the pair based on the mirror unit. The topology ID consists of the LDEV ID of the root volume and the mirror unit number.

Resync Pairs wizard

Use this wizard to resynchronize pairs.

Resync Pairs window

The following image shows this window, which is the first window of the **Resync Pairs** wizard.
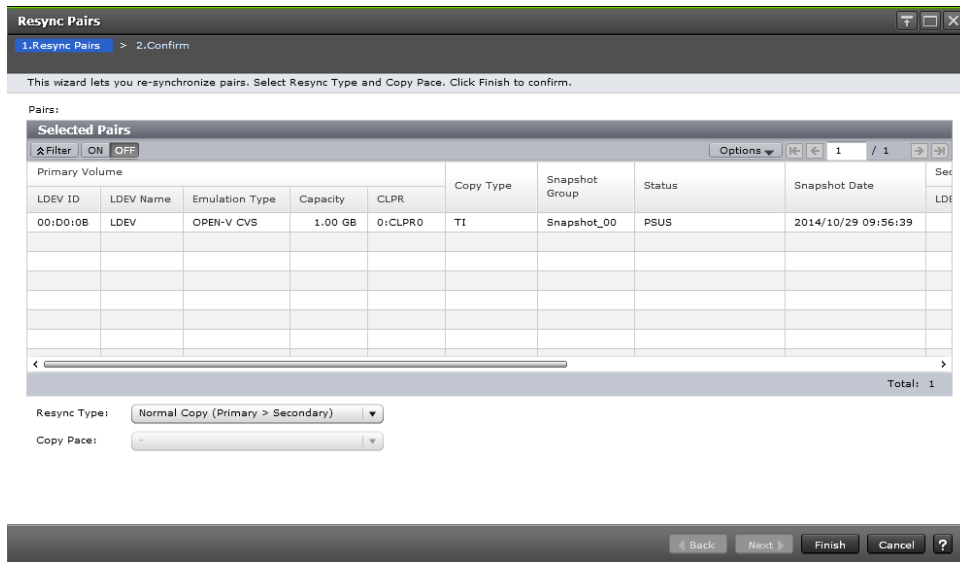
Selected Pairs table

The following table lists the items in this table on the **Resync Pairs** window.

Item	Description
Primary Volume	The P-VOL information. Values: ▪ **LDEV ID:** The P-VOL's LDEV identification number. ▪ **LDEV Name:** The P-VOL's LDEV name. ▪ **Emulation Type:** (VSP 5000 series) The P-VOL's emulation type. ▪ **Attribute:** The P-VOL's attribute. ▪ **Capacity:** The P-VOL's capacity. ▪ **CLPR:** The P-VOL's CLPR ID.
Copy Type	The volume's copy type. Values: ▪ **TI:** HTI pair
Snapshot Group	The snapshot group name. Information is displayed for this item only if you have configured a snapshot group for the HTI pair.
Status	The pair status. For more information, see Thin Image pair status definitions (on page 158).

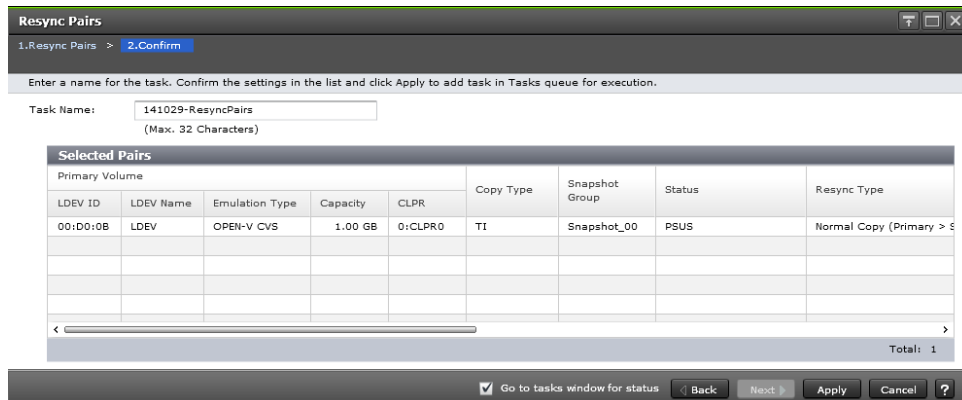| Item	Description
Snapshot Date	The date and time that you created the pair to store snapshot data.
Secondary Volume	The S-VOL information. Values: ▪ **LDEV ID:** The S-VOL's LDEV identification number. ▪ **LDEV Name:** The S-VOL's LDEV name. ▪ **Emulation Type:** (VSP 5000 series) The S-VOL's emulation type. ▪ **Attribute:** The S-VOL's attribute. ▪ **Capacity:** The S-VOL's capacity. ▪ **CLPR:** The S-VOL's CLPR ID.
Pool Name (ID)	The pool name and identification number.
Mirror Unit	The mirror unit number.
Cascade	Indicates whether a cascaded pair can be created ▪ **Enabled:** Cascaded pairs can be created. ▪ **Disabled:** Cascaded pairs cannot be created. A hyphen (-) displays for non-HTI pairs.
Type	The pair type. ▪ **Snapshot:** A pair with the snapshot attribute. ▪ **Clone:** A pair with the clone attribute or diff clone attribute. In the **TI Pairs** window, if **Diff Compare Volume** displays the LDEV ID, the diff clone attribute is set for the pair. If **Diff Compare Volume** displays a hyphen (-), the clone attribute is set for the pair. A hyphen (-) displays for non-HTI pairs.
Topology ID	The topology ID, which indicates the layer of the pair based on the mirror unit. The topology ID consists of the LDEV ID of the root volume and the mirror unit number.
Resync Type	The type of resynchronization.

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Item	Description
	Values: ▪ **Normal Copy (Primary > Secondary):** A full forward resynchronization of data from the P-VOL to the S-VOL. ▪ **Reverse Copy (Secondary > Primary):** A full restoration of P-VOL data from the S-VOL. The differential data is updated on the P-VOL. For more information about the types of pair resynchronization, see the *Hitachi ShadowImage® User Guide*.
Copy Pace	The speed at which the S-VOL is copied. A hyphen (-) is displayed.

Resync Pairs confirmation window

The following image shows the **Confirm** window, which is the second and last window of the **Resync Pairs** wizard.

Selected Pairs table

The following table lists the items in this table in the **Confirm** window of the **Resync Pairs** wizard.

Item	Description
Primary Volume	The P-VOL information. Values: ▪ **LDEV ID:** The P-VOL's LDEV identification number. ▪ **LDEV Name:** The P-VOL's LDEV name.

Item	Description
	▪ **Emulation Type:** (VSP 5000 series) The P-VOL's emulation type. ▪ **Attribute:** The P-VOL's attribute. ▪ **Capacity:** The P-VOL's capacity. ▪ **CLPR:** The P-VOL's CLPR ID.
Copy Type	The volume's copy type. Values: ▪ **TI:** HTI pair
Snapshot Group	The snapshot group name. Information is displayed for this item only if you have configured a snapshot group for the HTI pair.
Status	The pair status. For more information, see <u>Thin Image pair status definitions (on page 158)</u>.
Resync Type	The type of resynchronization. Values: ▪ **Normal Copy (Primary > Secondary):** A full forward resynchronization of data from the P-VOL to the S-VOL. ▪ **Reverse Copy (Secondary > Primary):** A full restoration of P-VOL data from the S-VOL. The differential data is updated on the P-VOL. For more information about the types of pair resynchronization, see the *Hitachi ShadowImage® User Guide*.
Copy Pace	The speed at which the S-VOL is copied. A hyphen (-) is displayed.
Snapshot Date	The date and time that you created the pair to store snapshot data.
Secondary Volume	The S-VOL information. Values: ▪ **LDEV ID:** The S-VOL's LDEV identification number. ▪ **LDEV Name:** The S-VOL's LDEV name. ▪ **Emulation Type:** (VSP 5000 series) The S-VOL's emulation type. ▪ **Attribute:** The S-VOL's attribute.

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Item	Description
	▪ **Capacity:** The S-VOL's capacity.
	▪ **CLPR:** The S-VOL's CLPR ID.
Pool Name (ID)	The pool name and identification number.
Mirror Unit	The mirror unit number.
Cascade	Indicates whether a cascaded pair can be created.
	▪ **Enabled:** Cascaded pairs can be created.
	▪ **Disabled:** Cascaded pairs cannot be created.
	A hyphen (-) displays for non-HTI pairs.
Type	The pair type.
	▪ **Snapshot:** A pair with the snapshot attribute.
	▪ **Clone:** A pair with the clone attribute or diff clone attribute.
	In the **TI Pairs** window, if **Diff Compare Volume** displays the LDEV ID, the diff clone attribute is set for the pair. If **Diff Compare Volume** displays a hyphen (-), the clone attribute is set for the pair.
	A hyphen (-) displays for non-HTI pairs.
Topology ID	The topology ID, which indicates the layer of the pair based on the mirror unit. The topology ID consists of the LDEV ID of the root volume and the mirror unit number.

Delete Pairs window

Use this window to delete pairs and to restore pairs.

For more information about deleting pairs, see .

The following image shows this window.

Selected Pairs table

The following table lists the items in this table in the **Delete Pairs** wizard.

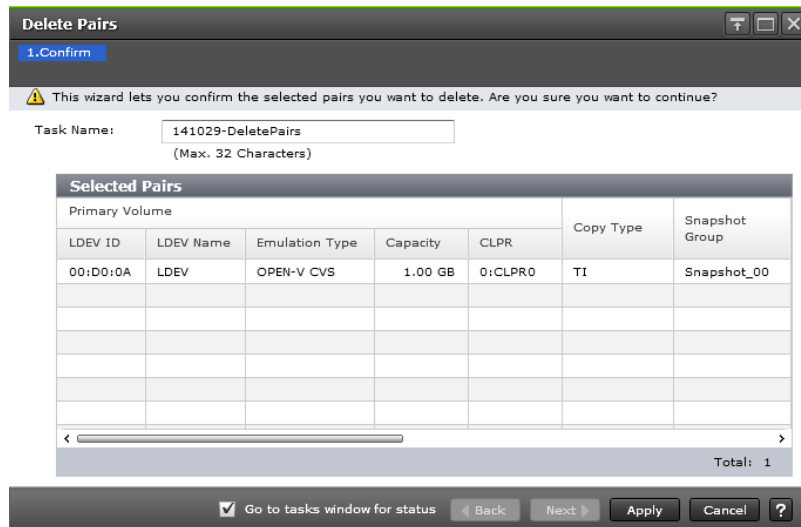| Item	Description
Primary Volume	The P-VOL information. Values: ▪ **LDEV ID:** The P-VOL's LDEV identification number. ▪ **LDEV Name:** The P-VOL's LDEV name. ▪ **Emulation Type:** (VSP 5000 series) The P-VOL's emulation type. ▪ **Attribute:** The P-VOL's attribute. ▪ **Capacity:** The P-VOL's capacity. ▪ **CLPR:** The P-VOL's CLPR ID.
Copy Type	The volume's copy type. Values: ▪ **TI:** HTI pair
Snapshot Group	The snapshot group name. Information is displayed for this item only if you have configured a snapshot group for the HTI pair.
Status	The pair status. For more information, see Thin Image pair status definitions (on page 158).

Item	Description
Snapshot Date	The date and time that you created the pair to store snapshot data.
Secondary Volume	The S-VOL information. Values: ▪ **LDEV ID:** The S-VOL's LDEV identification number. ▪ **LDEV Name:** The S-VOL's LDEV name. ▪ **Emulation Type:** (VSP 5000 series)The S-VOL's emulation type. ▪ **Attribute:** The S-VOL's attribute. ▪ **Capacity:** The S-VOL's capacity. ▪ **CLPR:** The S-VOL's CLPR ID.
Pool Name (ID)	The pool name and identification number.
Mirror Unit	The mirror unit number.
Cascade	Indicates whether a cascaded pair can be created ▪ **Enabled:** Cascaded pairs can be created. ▪ **Disabled:** Cascaded pairs cannot be created. A hyphen (-) displays for non-HTI pairs.
Type	The pair type. ▪ **Snapshot:** A pair with the snapshot attribute. ▪ **Clone:** A pair with the clone attribute or diff clone attribute. In the **TI Pairs** window, if **Diff Compare Volume** displays the LDEV ID, the diff clone attribute is set for the pair. If **Diff Compare Volume** displays a hyphen (-), the clone attribute is set for the pair. A hyphen (-) displays for non-HTI pairs.
Topology ID	The topology ID, which indicates the layer of the pair based on the mirror unit. The topology ID consists of the LDEV ID of the root volume and the mirror unit number.

Edit Local Replica Options wizard

Use this wizard to set the system options that affect performance in HTI.

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Edit Local Replica Options window

This is the first window of the **Edit Local Replica Options** wizard.

The following image shows this window.
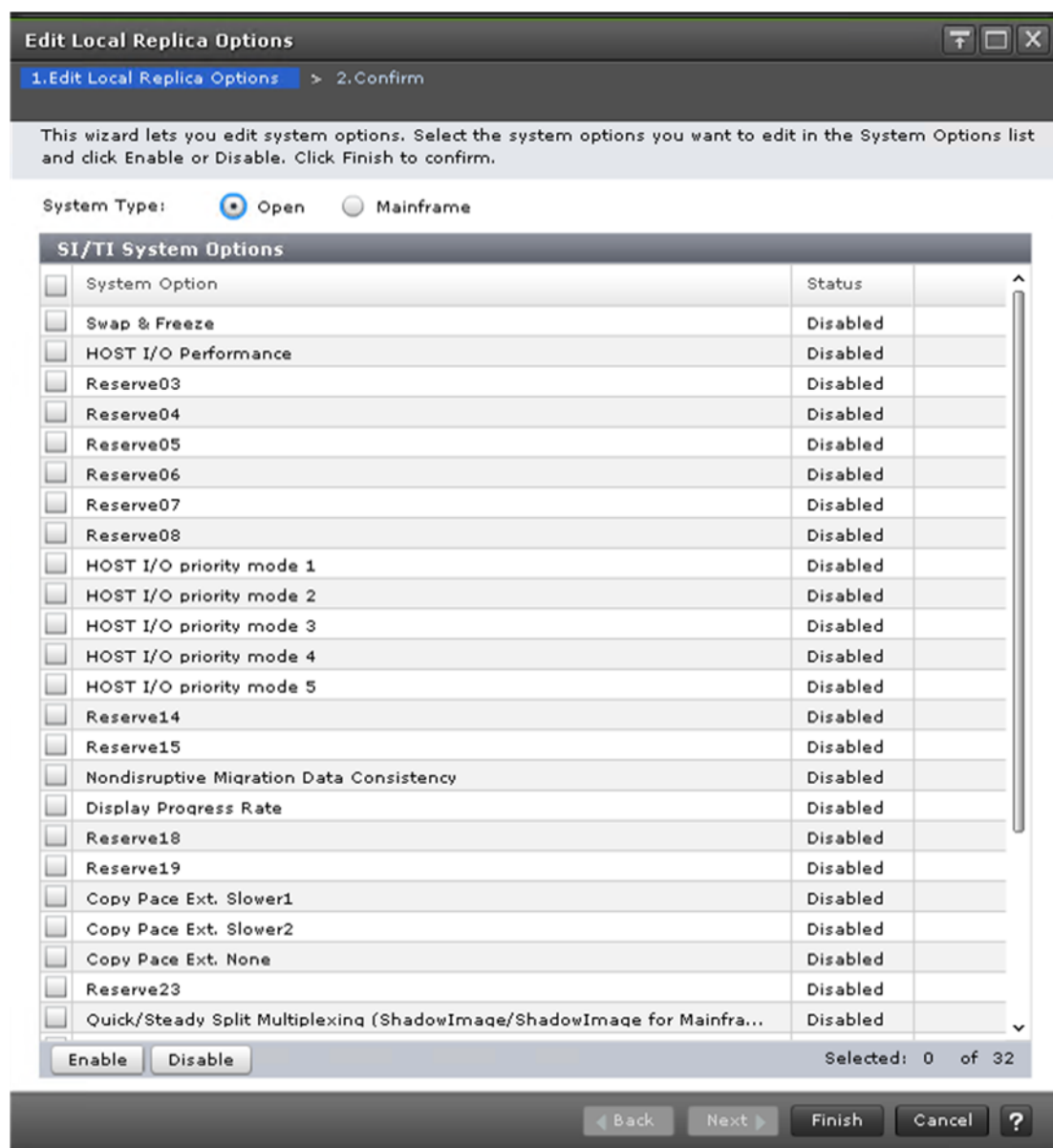
Setting fields (VSP 5000 series)

The following table lists the items in the **Edit Local Replica Options** window of the **Edit Local Replica Options** wizard.

Item	Description
System Type	The storage system type.

Item	Description
	Values: ▪ **Open:** Select when you want to change system options that affect SI and HTI performance. ▪ **Mainframe:** Select when you want to change system options that affect SIz, FCv2, and FCSE performance. Default: Open

SI/TI System Options table

The following table lists the items in this table on the **Edit Local Replica Options** window.

Item	Description
System Option	Displays the system options. The number next to each item is the system option number. Values: ▪ Swap & Freeze (1) Quick Restores and then saves the current data. Used with the Quick Restore, inhibits the Update Copy operation after performing Quick Restore, and the paired S-VOL in "PAIR" status is not updated. ▪ Host I/O Performance (2) Use this option to give weight to I/O response rather than the copy time. This option controls copy operations and improves the host I/O response. ▪ HOST I/O priority mode (9 to 13): Use this option for the host I/O that causes copy processing for SI pairs to make the copy processing for SI pairs fail so that the host I/O is prioritized. This function is performed if the write pending rate does not decrease and the host I/O does not finish within the time period specified by the option. After the copy processing fails, all data is copied as the resynchronization. See <u>Information to know before setting wait time (on page 318)</u>. ▪ Nondisruptive Migration Data Consistency (16) Use this option to keep the latest data in the migration source storage system instead of distributing data in both the destination and source storage systems during data migration.

Item	Description
	▪ Display Progress Rate (17) For Thin Image pairs with the cascade attribute disabled, the pair synchronization rate displayed on HDvM - SN (Synchronization Rate (%) in the **View Pair Synchronization Rate** window) or CCI is switched to the progress rate. However, even if this option is enabled, the synchronization rate is displayed only when the pair status is COPY, RCPY, or SMPL(PD). If this option is enabled, the following information is displayed depending on the pair status: • If the pair status is COPY, RCPY, or SMPL(PD), displays the progress rate for each process. • If the pair status is PAIR, PSUS, or PSUE, displays the pair synchronization rate that the current S-VOL data matches that of the next generation of the S-VOL. If the S-VOL is the latest one, the synchronization rate is computed by comparing the S-VOL with the P-VOL. ▪ Copy Pace Ext. Slower1 (20), Copy Pace Ext. Slower2 (21), Copy Pace Ext. None (22) Reducing the copy volume in "PAIR" status curbs the influence to the I/O performance of the host server. This item is available to all pairs in "PAIR" status. The order of Copy Pace Ext. Slower1, Copy Pace Ext. Slower2, and Copy Pace Ext. None determines the host server's I/O performance. ▪ Quick/Steady Split Multiplexing (ShadowImage/ ShadowImage for Mainframe) (24) Accelerates ShadowImage pair split. The multiplicity (the number of jobs for which copy processing can be executed concurrently) of copy processing for each pair is changed from 1 to 24. ▪ Reverse Copy Multiplexing (ShadowImage/ShadowImage for Mainframe) (25) Accelerates resynchronization (secondary to primary) of ShadowImage pairs. The multiplicity (the number of jobs for which copy processing can be executed concurrently) of copy processing for each pair is changed from 1 to 24. ▪ Normal Resync Multiplexing (ShadowImage/ ShadowImage for Mainframe) (26) Accelerates resynchronization (primary to secondary) of ShadowImage pairs. The multiplicity (the number of jobs for which copy processing can be executed concurrently) of copy processing for each pair is changed from 1 to 24. ▪ Disable the alert notification of shared memory space warning (30) Inhibits the alert notification of SIM reference code 603000.

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Item	Description
Status	Shows whether the system option is currently enabled or disabled.
Enable button	Click to enable the selected option.
Disable button	Click to disable the selected option.

SIMF/FCv2/FCSE System Options table (VSP 5000 series)

The following table lists the items in this table on the **Edit Local Replica Options** window.

Item	Description
System Option	Displays the system options. The number next to each item is the system option number.
	Values:
	▪ **Swap & Freeze (1):** Quick Restores and then saves the current data. Used with the Quick Restore, inhibits the Update Copy operation after performing Quick Restore, and the paired S-VOL (T-VOL for FCv2 or FCSE) is not updated.
	▪ **Host I/O Performance (2):** Use this option to give weight to I/O response rather than the copy time. This option controls copy operations and improves the host I/O response.
	▪ **FC Slower Copy1 (FCv2 or FCSE only) (3):** Reduces the multiplicity of background copy into half.
	▪ **FC Slower Copy 2 (FCv2 or FCSE only) (4):** Reduces the multiplicity of background copy into quarter.
	▪ **HOST I/O priority mode (9 to 13):** Use this option for the host I/O that causes copy processing for SIz pairs to make the copy processing for SIz pairs fail so that the host I/O is prioritized. This function is performed if the write pending rate does not decrease and the host I/O does not finish within the time period specified by the option. After the copy processing fails, all data is copied as the resynchronization. See Information to know before setting wait time (on page 318).
	▪ **Nondisruptive Migration Data Consistency (16):** Use this option to keep the latest data in the migration source storage system instead of distributing data in both the destination and source storage systems during data migration.

Appendix B: Thin Image GUI windows and wizards

Item	Description
	▪ **FC Ext. Slower Copy1 (17):** Inhibits background copy and improves host I/O response when the operating ratio of the MP unit (FCv2 or FCSE S-VOL or T-VOL is allocated) exceeds 65%. ▪ **FC Ext. Slower Copy2 (18):** Inhibits background copy and improves host I/O response when the operating ratio of the MP unit (FCv2 or FCSE S-VOL or T-VOL is allocated) exceeds 50%. ▪ **Copy Pace Ext. Slower1 (20), Copy Pace Ext. Slower2 (21), Copy Pace Ext. None (22):** Reducing the copy volume in the "DUPLEX" status curbs the influence to the I/O performance of the host server. This item is available to all pairs in "DUPLEX" status. The I/O performance of the host server is improved in order of Copy Pace Ext. Slower1, Copy Pace Ext. Slower2, and Copy Pace Ext. None. ▪ **Quick/Steady Split Multiplexing (ShadowImage/ ShadowImage for Mainframe) (24):** Accelerates ShadowImage for Mainframe pair split. The multiplicity (the number of jobs for which copy processing can be executed concurrently) of copy processing for each pair is changed from 1 to 24. ▪ **Reverse Copy Multiplexing (ShadowImage/ ShadowImage for Mainframe) (25):** Accelerates resynchronization (secondary to primary) of ShadowImage for Mainframe pairs. The multiplicity (the number of jobs for which copy processing can be executed concurrently) of copy processing for each pair is changed from 1 to 24. ▪ **Normal Resync Multiplexing (ShadowImage/ ShadowImage for Mainframe) (26):** Accelerates resynchronization (primary to secondary) of ShadowImage for mainframe pairs. The multiplicity (the number of jobs for which copy processing can be executed concurrently) of copy processing for each pair is changed from 1 to 24.
Status	Shows whether the option is currently enabled or disabled.
Enable button	Click to enable the selected option.
Disable button	Click to disable the selected option.

Appendix B: Thin Image GUI windows and wizards

Information to know before setting wait time

You should know that you can set the amount of time the host I/O priority mode option waits before the copy processing for SI or SIz fails. Set the wait time until the copy processing fails so that the time becomes shorter than the timeout time of host I/O. Note that, if you set a time that is extremely short, copy processing might fail even due to a temporary overload. If, for example, the timeout time of host I/O is 60 seconds or more, set the wait time until the copy processing fails to about 30 seconds.

System option	Time until the copy processing fails (seconds)
HOST I/O priority mode 1 (9)	1
HOST I/O priority mode 2 (10)	2
HOST I/O priority mode 3 (11)	4
HOST I/O priority mode 4 (12)	8
HOST I/O priority mode 5 (13)	16

Set the wait time until the copy processing fails by combining system options HOST I/O priority mode 1 (9) to HOST I/O priority mode 5 (13). For example, if you enable HOST I/O priority mode 4 (12) and HOST I/O priority mode 5 (13), the wait time until the copy processing fails becomes 24 seconds.

These system options can be used with the following DCKMAIN versions:

VSP 5000 series

- DCKMAIN 90-08-42 or later

- DCKMAIN 90-08-24 to 90-08-40

- DCKMAIN 90-08-05 to 90-08-20

- DCKMAIN 90-07-05 to 90-08-00

VSP E series

- DCKMAIN 93-06-42 or later

- DCKMAIN 93-06-24 to 93-06-40

- DCKMAIN 93-06-04 to 93-06-20

- DCKMAIN 93-05-07 to 93-05-20

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The time until the copy processing fails differs depending on the configuration as follows:

- When ShadowImage or ShadowImage for Mainframe works alone, the available setting rage of the time is 1 to 31 seconds.

- When the P-VOL of ShadowImage or ShadowImage for Mainframe works with other software:

Configuration		Available setting range of the time until copy processing fails (seconds)
Working with the P-VOL of other software[1]		1 to 31
Working with the S-VOL of other software[1], or working with both the P-VOL and S-VOL of other software[1]	Performing host I/O on the P-VOL of SI or SIz	1 to 31
	Performing host I/O on the P-VOL of other software[1]	1 to 14[2] (for SI) Not available[3] (for SIz)

Note:

1. Only TrueCopy, Universal Replicator, and global-active device apply (for ShadowImage). Only TrueCopy for Mainframe and Universal Replicator for Mainframe apply (for ShadowImage for Mainframe). For other software, the configuration is regarded as the same as when ShadowImage for Mainframe works alone.

2. The function of these options is disabled when host I/O is performed on the P-VOL of Universal Replicator.

3. The function of these options is disabled.

Edit Local Replica Options confirmation window

This window is the second and last window of the **Edit Local Replica Options** wizard.
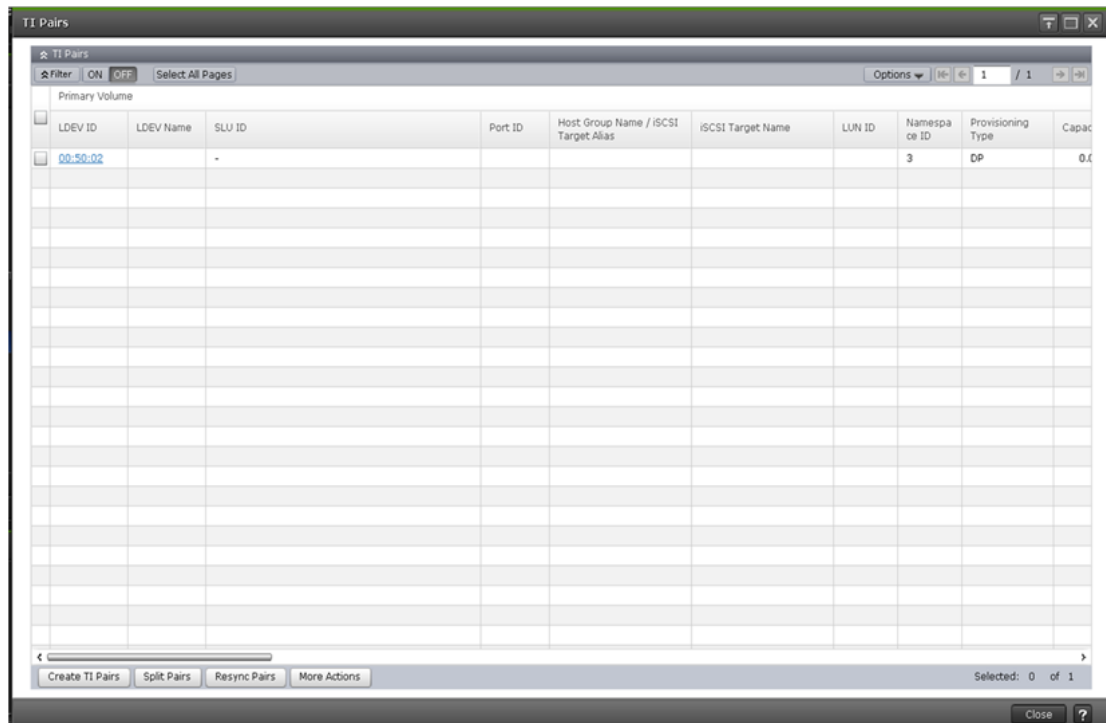
The following image shows this window.
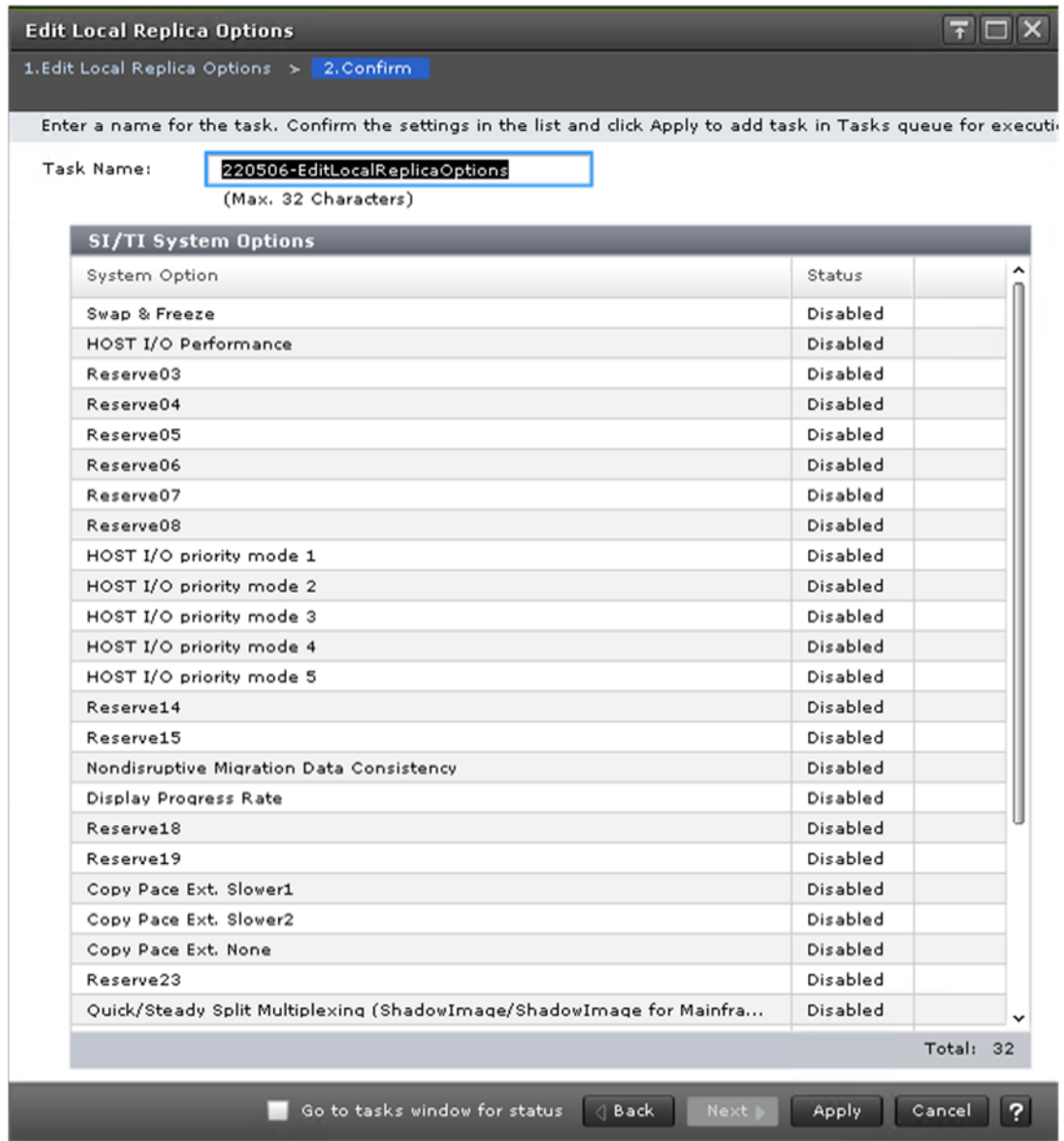
SI/TI or SIMF/FCv2/FCSE System Options table

The following table lists the items in this table on the **Confirm** window of the **Edit Local Replica Options** wizard.

Item	Description
System Option	Options that can be changed.
Status	Shows whether the option is currently enabled or disabled.

TI Pairs window

The following image shows the TI Pairs window.

The following table lists the items in the TI Pairs table on the TI Pairs window.

Item	Description
Primary Volume	The P-VOL information. Values: ▪ **LDEV ID:** The P-VOL's LDEV identification number. ▪ **LDEV Name:** The P-VOL's LDEV name. ▪ **SLU ID:** The P-VOL's SLU ID. If the SLU attribute is not specified for the P-VOL, a hyphen (-) is displayed. ▪ **Port ID:** The port name of the P-VOL LDEV's LUN path. If the path is not defined, a blank is displayed. ▪ **Host Group Name / iSCSI Target Alias:** The host group name and ID or iSCSI target alias and ID of the P-VOL LDEV's LUN path. If the path is not defined, a blank is displayed. ▪ **iSCSI Target Name:** The P-VOL's iSCSI target name. If the LUN path is not defined, a blank is displayed.

Item	Description
	▪ **LUN ID:** The LUN identification number of the P-VOL LDEV's LUN path. If the path is not defined, a blank is displayed.
	▪ **Namespace ID:** The namespace ID of the P-VOL. If the LDEV of the P-VOL is not registered as a namespace, a hyphen (-) is displayed. Namespace ID is not displayed for VSP E series other than VSP E1090.
	▪ **Provisioning Type:** The P-VOL's provisioning type.
	• **Basic:** Internal volume
	• **DP:** DP-VOL
	• **External:** External volume
	▪ **Attribute:** The P-VOL's attribute.
	▪ **Capacity:** The P-VOL's capacity.
	▪ **CLPR:** The P-VOL's CLPR ID.
	▪ **Encryption:** The P-VOL's encryption information.
	• **Enabled:** Encryption is enabled for the parity group to which the P-VOL's LDEV belongs, or the P-VOL is a V-VOL associated with a pool in which a pool volume has encryption enabled.
	• **Disabled:** Encryption is disabled for the parity group to which the P-VOL's LDEV belongs, or the P-VOL is a V-VOL associated with a pool in which a pool volume has encryption disabled.
	• **Mixed:** The pool to which the P-VOL's LDEV belongs contains two or more of the following:
	▪ Volume for which encryption is enabled
	▪ Volume for which encryption is disabled
	▪ External volume
	Note: Data encryption is not ensured in an LDEV with Mixed encryption status. If you want to manage data encryption, use LDEVs with the Enabled or Disabled status.
	If the LDEV is an external volume or migration volume, a hyphen (-) is displayed. (VSP 5000 series)
	For DP-VOLs, the pool to which an LDEV belongs is an external volume or blocked.

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Item	Description

	▪ **Capacity Saving:** Information about the P-VOL's capacity saving function.
	
	   • **Compression:** The compression function is used.
	
	   • **Deduplication and Compression:** The deduplication function and the compression function are used.
	
	   • **Disabled:** The capacity saving function is not used.
	
	▪ **Compression Acceleration:** Compression accelerator settings.
	
	   • Enabled: The compression accelerator setting is enabled.
	
	   • Disabled: The compression accelerator setting is disabled.
	
	   • - (hyphen): The compression accelerator setting is not available for an LDEV. Alternatively, the compression accelerator setting is available for an LDEV whose capacity saving setting is Disabled and whose capacity saving status is Disabled.
	
	▪ **T10 PI:** The P-VOL's T10 PI attribute information.
	
	   • **Enabled:** The P-VOL's T10 PI attribute is enabled.
	
	   • **Disabled:** The P-VOL's T10 PI attribute is disabled.
	
	▪ **Virtual Storage Machine:** The model type and serial number of the virtual storage machine to which the P-VOL belongs.
	
	▪ **Virtual LDEV ID:** The identification number of the P-VOL's virtual LDEV.
	
	▪ **Virtual Device Name:** The name of the P-VOL's virtual device, in a combined format of "virtual emulation type", "number of virtual LUSE volumes", and "virtual CVS attribute". Each of these three items is displayed only if it is specified. If none of them are specified, a blank is displayed.
	
	▪ **Virtual SSID:** The virtual SSID of the P-VOL. If no virtual SSID is specified, a blank is displayed.

Snapshot Group	The snapshot group name.
Status	The pair status. For more information about pair status, see Thin Image pair status definitions (on page 158).
Processing Status	The processing status for a pair volume is displayed.

Appendix B: Thin Image GUI windows and wizards

Item	Description
	Expanding: The capacity of an HTI pair volume is being expanded.
	If the volume capacity is not being expanded, or if V-VOLs other than DP-VOLs are used as pair volumes, this field remains blank.
Snapshot Date	The date and time you split the pairs to store snapshot data.
Snapshot SLU ID	The snapshot data SLU ID. If the SLU attribute is not specified for the snapshot data, a hyphen (-) is displayed.
Secondary Volume	The S-VOL information. Values: ▪ **LDEV ID:** The S-VOL's LDEV identification number. Click to open the **LDEV Properties** window. ▪ **LDEV Name:** The S-VOL's LDEV name. ▪ **Port ID:** The port name of the S-VOL LDEV's LUN path. If the path is not defined, a blank is displayed. ▪ **Host Group Name / iSCSI Target Alias:** The host group name and ID or iSCSI target alias and ID of the S-VOL LDEV's LUN path. If the path is not defined, a blank is displayed. ▪ **iSCSI Target Name:** The S-VOL's iSCSI target name. If the LUN path is not defined, a blank is displayed. ▪ **LUN ID:** The LUN identification number of the S-VOL LDEV's LUN path. If the path is not defined, a blank is displayed. ▪ **Namespace ID:** The namespace ID of the S-VOL. If the LDEV of the S-VOL is not registered as a namespace, a hyphen (-) is displayed. Namespace ID is not displayed for VSP E series other than VSP E1090. ▪ **Attribute:** The S-VOL's attribute. ▪ **Capacity:** The S-VOL's capacity. ▪ **CLPR:** The S-VOL's CLPR ID.

Item	Description
	▪ **Encryption:** S-VOL's encryption information.
	• **Enabled:** Encryption is enabled for the parity group to which S-VOL's LDEV belongs, or the P-VOL is a V-VOL associated with a pool in which a pool volume has encryption enabled.
	• **Disabled:** Encryption is disabled for the parity group to which S-VOL's LDEV belongs, or the P-VOL is a V-VOL associated with a pool in which a pool volume has encryption disabled.
	• **Mixed:** The pool to which S-VOL's LDEV belongs contains two or more of the following:
	▪ Volume for which encryption is enabled
	▪ Volume for which encryption is disabled
	▪ External volume
	Note: Data encryption is not ensured in an LDEV with Mixed encryption status. If you want to manage data encryption, use LDEVs with the Enabled or Disabled status.
	• If the LDEV is an external volume or migration volume, a hyphen (-) is displayed.
	For DP-VOLs, the pool to which an LDEV belongs is an external volume or blocked.
	▪ **Capacity Saving:** Information about the S-VOL's capacity saving function.
	• **Compression:** The compression function is used.
	• **Deduplication and Compression:** The deduplication function and the compression function are used.
	• **Disabled:** The capacity saving function is not used.
	▪ **Compression Acceleration:** Compression accelerator settings.
	• Enabled: The compression accelerator setting is enabled.
	• Disabled: The compression accelerator setting is disabled.
	• - (hyphen): The compression accelerator setting is not available for an LDEV. Alternatively, the compression accelerator setting is available for an LDEV whose capacity saving setting is Disabled and whose capacity saving status is Disabled.

Appendix B: Thin Image GUI windows and wizards

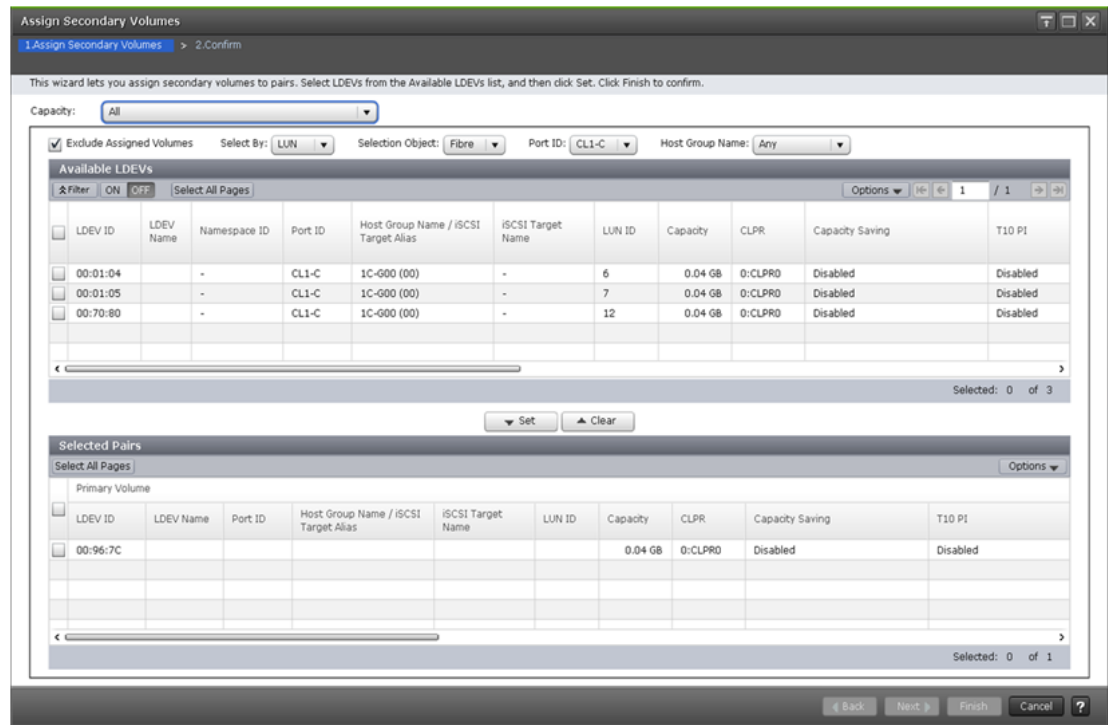| Item	Description

	▪ **T10 PI:** The P-VOL's T10 PI attribute information.
	
	  • **Enabled:** The P-VOL's T10 PI attribute is enabled.
	
	  • **Disabled:** The P-VOL's T10 PI attribute is disabled.
	
	▪ **Virtual Storage Machine:** The model type and serial number of the virtual storage machine to which the S-VOL belongs.
	
	▪ **Virtual LDEV ID:** The identification number of the S-VOL's virtual LDEV.
	
	▪ **Virtual Device Name:** The name of the S-VOL's virtual device, in a combined format of "virtual emulation type", "number of virtual LUSE volumes", and "virtual CVS attribute". Each of these three items is displayed only if it is specified. If none of them are specified, a blank is displayed.
	
	▪ **Virtual SSID:** The virtual SSID of the S-VOL. If no virtual SSID is specified, a blank is displayed.

Pool Name (ID)	The pool name and identification number.

Pool Encryption	The pool's encryption information.
	
	▪ **Enabled:** A pool was created by the pool volume for which encryption is enabled.
	
	▪ **Disabled:** A pool was created by the pool volume for which encryption is disabled.
	
	▪ **Mixed:** A pool contains two or more of the following:
	
	  • Volume for which encryption is enabled
	
	  • Volume for which encryption is disabled
	
	  • External volume
	
	Note: Data encryption is not ensured in an LDEV with Mixed encryption status.
	
	For pools created in external volumes, or blocked pools, a hyphen (-) is displayed.

CTG ID	The consistency group identification number.
Mirror Unit	The mirror unit number.
Cascade	Indicates whether a cascaded pair can be created. ▪ **Enabled:** Cascaded pairs can be created. ▪ **Disabled:** Cascaded pairs cannot be created.

Appendix B: Thin Image GUI windows and wizards

Item	Description
Diff Compare Volume	The LDEV ID of the diff compare volume.
Type	The pair type. ▪ **Snapshot:** A pair with the snapshot attribute. ▪ **Clone:** A pair with the clone attribute or diff clone attribute. In the **TI Pairs** window, if **Diff Compare Volume** displays the LDEV ID, the diff clone attribute is set for the pair. If **Diff Compare Volume** displays a hyphen (-), the clone attribute is set for the pair.
Topology ID	The topology ID, which indicates the layer of the pair based on the mirror unit. The topology ID consists of the LDEV ID of the root volume and the mirror unit number.
Layer	The layer of the pair based on the root volume.
Create TI Pairs button	Click to open the Create TI Pairs window.
Split Pairs button	Click to open the **Split Pairs** window.
Resync Pairs button	Click to open the **Resync Pairs** window.
More Actions	Click to view a list of tasks you can perform. Options: ▪ **Assign Secondary Volumes:** Click to open the **Assign Secondary Volumes** window. ▪ **Remove Secondary Volumes:** Click to open the **Remove Secondary Volumes** window. ▪ **Delete Pairs:** Click to open the **Delete Pairs** window. ▪ **View Pair Synchronization Rate:** Click to open the **View Pair Synchronization Rate** window. ▪ **View Pair Properties:** Click to open the **View Pair Properties** window. ▪ **Export:** Click to open the dialog from which you can download table information to a file.

Assign Secondary Volumes wizard

Assign Secondary Volumes window

This window is the first window of the Assign Secondary Volumes wizard.

The following image shows this window.

The following table lists the items on this window.

Item	Description
Capacity	Click to select the capacity for which to filter the available LDEVs.
Exclude Assigned Volumes	Hide volumes that are already paired from the Selected Pairs table.
Select By	Filters LDEVs in the Available LDEVs table by the specified object.
Selection Object	Filters LDEVs in the Available LDEVs table according to port type.
Port ID	Filters LDEVs in the Available LDEVs table by the Port ID. This item is displayed if you select LUN for Select By.
Host Group Name	Filters LDEVs in the Available LDEVs table by the Host Group Name.

Item	Description
	This item is displayed if you select LUN for Select By. Default: Any
Set button	Click to move an LDEV that you have selected in the Available LDEVs table to the Selected Pairs table. You can also click to configure a pair you have selected in the Available LDEVs table and a pair you have selected in the Selected Pairs table.
Clear button	Click to move the selected S-VOL from the Selected Pairs table back to the Available LDEVs table.

Available LDEVs table

The following table lists the items in this table on the Assign Secondary Volumes window.

Item	Description
LDEV ID	The LDEV identification number, which you can specify as the S-VOL.
LDEV Name	The LDEV's name.
Namespace ID	The namespace ID of the LDEV. If the LDEV is not registered as a namespace, a hyphen (-) is displayed. Namespace ID is not displayed for VSP E series other than VSP E1090.
Port ID	The port name of the LDEV's LUN path. This item is displayed if you select LUN for Select By.
Host Group Name / iSCSI Target Alias	The host group name and ID or iSCSI target alias and ID of the LDEV's LUN path. This item is displayed if you select LUN for Select By.
iSCSI Target Name	The iSCSI target name. This item is displayed if you select LUN for Select By.

Item	Description
LUN ID	The LUN identification number of the LDEV's LUN path. This item is displayed if you select LUN for Select By.
Capacity	The LDEV's capacity.
CLPR	The LDEV's CLPR ID.
Capacity Saving	Information about the LDEV's capacity saving function. • **Compression:** The compression function is used. • **Deduplication and Compression:** The deduplication function and the compression function are used. • **Disabled:** The capacity saving function is not used.
Compression Acceleration	Compression accelerator settings. • Enabled: The compression accelerator setting is enabled. • Disabled: The compression accelerator setting is disabled. • - (hyphen): The compression accelerator setting is not available for an LDEV. Alternatively, the compression accelerator setting is available for an LDEV whose capacity saving setting is Disabled and whose capacity saving status is Disabled.
T10 PI	The LDEV's T10 PI attribute information. • **Enabled:** The LDEV's T10 PI attribute is enabled. • **Disabled:** The LDEV's T10 PI attribute is disabled.
Snapshot Group	The snapshot group name. Information is displayed for this item only if you have configured a snapshot group for the HTI pair.
Status	The pair status. For more information about pair status, see Thin Image pair status definitions (on page 158).

Item	Description
Snapshot Date	The date and time that you created the pair to store snapshot data.
Primary Volume	The P-VOL information. Values: - **LDEV ID:** The P-VOL's LDEV identification number. - **LDEV Name:** The P-VOL's LDEV name. If you have not allocated an LDEV to the S-VOL for an existing pair, a hyphen (-) is displayed. - **Port ID:** The port name of the P-VOL LDEV's LUN path. - **Host Group Name / iSCSI Target Alias:** The host group name and ID or iSCSI target alias and ID of the P-VOL LDEV's LUN path. - **iSCSI Target Name:** The P-VOL's iSCSI target name. - **LUN ID:** The LUN identification number of the P-VOL LDEV's LUN path. - **Capacity:** The P-VOL's capacity. - **CLPR:** The P-VOL's CLPR ID.
Pool Name (ID)	The pool name and identification number.
Mirror Unit	The mirror unit number. A hyphen (-) is displayed if the volume is not an S-VOL of an existing pair.

Selected Pairs table

The following table lists the items in the Selected Pairs table of the Assign Secondary Volumes window.

Item	Description
Primary Volume	The P-VOL information. Values: - **LDEV ID:** The P-VOL's LDEV identification number. - **LDEV Name:** The P-VOL's LDEV name. If you have not allocated an LDEV to the S-VOL, a hyphen (-) is displayed.

Appendix B: Thin Image GUI windows and wizards

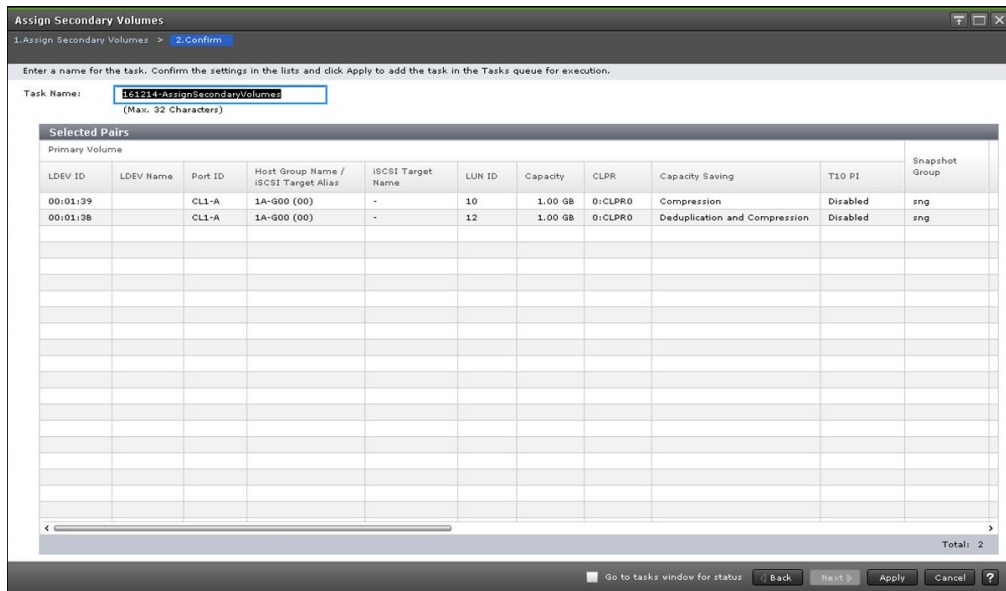| Item	Description

	• **Port ID:** The port name of the P-VOL LDEV's LUN path.
	• **Host Group Name / iSCSI Target Alias:** The host group name and ID or iSCSI target alias and ID of the P-VOL LDEV's LUN path.
	• **iSCSI Target Name:** The P-VOL's iSCSI target name.
	• **LUN ID:** The LUN identification number of the P-VOL LDEV's LUN path.
	• **Attribute:** The P-VOL's attribute.
	• **Capacity:** The P-VOL's capacity.
	• **CLPR:** The P-VOL's CLPR ID.
	• **Capacity Saving:** Information about the P-VOL's capacity saving function.
	  • **Compression:** The compression function is used.
	  • **Deduplication and Compression:** The deduplication function and the compression function are used.
	  • **Disabled:** The capacity saving function is not used.
	• **Compression Acceleration:** Compression accelerator settings.
	  • Enabled: The compression accelerator setting is enabled.
	  • Disabled: The compression accelerator setting is disabled.
	  • - (hyphen): The compression accelerator setting is not available for an LDEV. Alternatively, the compression accelerator setting is available for an LDEV whose capacity saving setting is Disabled and whose capacity saving status is Disabled.
	• **T10 PI:** The P-VOL's T10 PI attribute information.
	  • **Enabled:** The P-VOL's T10 PI attribute is enabled.
	  • **Disabled:** The P-VOL's T10 PI attribute is disabled.

Snapshot Group	The snapshot group name. Information is displayed for this item only if you have configured a snapshot group for the HTI pair.
Status	The pair status. For more information about pair status, see Thin Image pair status definitions (on page 158).

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Item	Description
Snapshot Date	The date and time you created the pair to store snapshot data.

Secondary Volume	The S-VOL information.
	
	Values:
	
	▪ **LDEV ID:** The S-VOL's LDEV identification number. If you have not allocated an LDEV to the S-VOL, this item is blank.
	
	▪ **LDEV Name:** The S-VOL's LDEV name. If you have not allocated an LDEV to the S-VOL, a hyphen (-) is displayed.
	
	▪ **Port ID:** The port name of the S-VOL LDEV's LUN path.
	
	▪ **Host Group Name / iSCSI Target Alias:** The host group name and ID or iSCSI target alias and ID of the S-VOL LDEV's LUN path.
	
	▪ **iSCSI Target Name:** The S-VOL's iSCSI target name.
	
	▪ **LUN ID:** The LUN identification number of the S-VOL LDEV's LUN path.
	
	▪ **Attribute:** The S-VOL's attribute.
	
	▪ **Capacity:** The S-VOL's capacity.
	
	▪ **CLPR:** The S-VOL's CLPR ID.
	
	▪ **Capacity Saving:** Information about the S-VOL's capacity saving function.
	
	  • **Compression:** The compression function is used.
	
	  • **Deduplication and Compression:** The deduplication function and the compression function are used.
	
	  • **Disabled:** The capacity saving function is not used.

Item	Description
	▪ **Compression Acceleration:** Compression accelerator settings. • Enabled: The compression accelerator setting is enabled. • Disabled: The compression accelerator setting is disabled. • - (hyphen): The compression accelerator setting is not available for an LDEV. Alternatively, the compression accelerator setting is available for an LDEV whose capacity saving setting is Disabled and whose capacity saving status is Disabled. ▪ **T10 PI:** The S-VOL's T10 PI attribute information. • **Enabled:** The S-VOL's T10 PI attribute is enabled. • **Disabled:** The S-VOL's T10 PI attribute is disabled.
Pool Name (ID)	The pool name and identification number.
Mirror Unit	The mirror unit number.
Cascade	Indicates whether a cascaded pair can be created. ▪ **Enabled:** Cascaded pairs can be created. ▪ **Disabled:** Cascaded pairs cannot be created.
Topology ID	The topology ID, which indicates the layer of the pair based on the mirror unit. The topology ID consists of the LDEV ID of the root volume and the mirror unit number.

Assign Secondary Volumes confirmation window

This window is the second window of the Assign Secondary Volumes wizard.

The following image shows this window.

Selected Pairs table

The following table lists the items in this table on the **Confirm** window.

Item	Description
Primary Volume	The P-VOL information. Values: ▪ **LDEV ID:** The P-VOL's LDEV identification number. ▪ **LDEV Name:** The P-VOL's LDEV name. If you have not allocated an LDEV to the S-VOL, a hyphen (-) is displayed. ▪ **Port ID:** The port name of the P-VOL LDEV's LUN path. ▪ **Host Group Name / iSCSI Target Alias:** The host group name and ID or iSCSI target alias and ID of the P-VOL LDEV's LUN path. ▪ **iSCSI Target Name:** The P-VOL's iSCSI target name. ▪ **LUN ID:** The LUN identification number of the P-VOL LDEV's LUN path. ▪ **Attribute:** The P-VOL's attribute. ▪ **Capacity:** The P-VOL's capacity. ▪ **CLPR:** The P-VOL's CLPR ID.

Item	Description

	▪ (VSP 5000 series) **Encryption** P-VOL's encryption information.
	
	  • **Enabled:** Encryption is enabled for the parity group to which P-VOL's LDEV belongs, or a V-VOL is associated with a pool in which a pool volume has encryption enabled.
	
	  • **Disabled:** Encryption is disabled for the parity group to which P-VOL's LDEV belongs, or a V-VOL is associated with a pool in which a pool volume has encryption disabled.
	
	  • **Mixed:** The pool to which the P-VOL's LDEV belongs contains both pool volumes for which encryption is enabled and ones for which encryption is disabled..
	
	  Note: Data encryption is not ensured in an LDEV with Mixed encryption status. If you want to manage data encryption, use LDEVs with the Enabled or Disabled status.
	
	  • If the LDEV is an external volume or migration volume, a hyphen (-) is displayed .
	
	  For DP-VOLs, the pool to which an LDEV belongs is an external volume or blocked.
	
	▪ **Capacity Saving:** Information about the P-VOL's capacity saving function.
	
	  • **Compression:** The compression function is used.
	
	  • **Deduplication and Compression:** The deduplication function and the compression function are used.
	
	  • **Disabled:** The capacity saving function is not used.

Item	Description
	▪ **Compression Acceleration:** Compression accelerator settings. • Enabled: The compression accelerator setting is enabled. • Disabled: The compression accelerator setting is disabled. • - (hyphen): The compression accelerator setting is not available for an LDEV. Alternatively, the compression accelerator setting is available for an LDEV whose capacity saving setting is Disabled and whose capacity saving status is Disabled. ▪ **T10 PI:** The P-VOL's T10 PI attribute information. • **Enabled:** The P-VOL's T10 PI attribute is enabled. • **Disabled:** The P-VOL's T10 PI attribute is disabled.
Snapshot Group	The snapshot group name. Information is displayed for this item only if you have configured a snapshot group for the HTI pair.
Status	The pair status. For more information about pair status, see <u>Thin Image pair status definitions (on page 158)</u>.
Secondary Volume	The S-VOL information. Values: ▪ **LDEV ID:** The S-VOL's LDEV identification number. If you have not allocated an LDEV to the S-VOL, this item is blank. ▪ **LDEV Name:** The S-VOL's LDEV name. If you have not allocated an LDEV to the S-VOL, a hyphen (-) is displayed. ▪ **Port ID:** Port name of the S-VOL LDEV's LUN path. ▪ **Host Group Name / iSCSI Target Alias:** The host group name and ID or iSCSI target alias and ID of the S-VOL LDEV's LUN path. ▪ **iSCSI Target Name:** The S-VOL's iSCSI target name. ▪ **LUN ID:** The LUN identification number of the S-VOL LDEV's LUN path. ▪ **Attribute:** The S-VOL's attribute. ▪ **Capacity:** The S-VOL's capacity.

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Item	Description

	• **CLPR:** The S-VOL's CLPR ID.
	
	• (VSP 5000 series) **Encryption** S-VOL's encryption information.
	
	   • **Enabled:** Encryption is enabled for the parity group to which S-VOL's LDEV belongs, or a V-VOL is associated with a pool in which a pool volume has encryption enabled.
	
	   • **Disabled:** Encryption is disabled for the parity group to which S-VOL's LDEV belongs, or a V-VOL is associated with a pool in which a pool volume has encryption disabled.
	
	   • **Mixed:** The pool to which S-VOL's LDEV belongs contains both pool volumes for which encryption is enabled and ones for which encryption is disabled..
	
	   Note: Data encryption is not ensured in an LDEV with Mixed encryption status. If you want to manage data encryption, use LDEVs with the Enabled or Disabled status.
	
	   • If the LDEV is an external volume or migration volume, a hyphen (-) is displayed .
	
	   For DP-VOLs, the pool to which an LDEV belongs is an external volume or blocked.
	
	• **Capacity Saving:** Information about the S-VOL's capacity saving function.
	
	   • **Compression:** The compression function is used.
	
	   • **Deduplication and Compression:** The deduplication function and the compression function are used.
	
	   • **Disabled:** The capacity saving function is not used.

Item	Description
	▪ **Compression Acceleration:** Compression accelerator settings. • Enabled: The compression accelerator setting is enabled. • Disabled: The compression accelerator setting is disabled. • - (hyphen): The compression accelerator setting is not available for an LDEV. Alternatively, the compression accelerator setting is available for an LDEV whose capacity saving setting is Disabled and whose capacity saving status is Disabled. ▪ **T10 PI:** The S-VOL's T10 PI attribute information. • **Enabled:** The S-VOL's T10 PI attribute is enabled. • **Disabled:** The S-VOL's T10 PI attribute is disabled.
Pool Name (ID)	The pool name and identification number.
Mirror Unit	The mirror unit number.
Cascade	Indicates whether a cascaded pair can be created. ▪ **Enabled:** Cascaded pairs can be created. ▪ **Disabled:** Cascaded pairs cannot be created.
Topology ID	The topology ID, which indicates the layer of the pair based on the mirror unit. The topology ID consists of the LDEV ID of the root volume and the mirror unit number.

Remove Secondary Volumes table

This table is displayed if a volume is selected that was already assigned to other snapshot data (by leaving the Exclude Assigned Volumes check box unselected in the **Assign Secondary Volumes** window).
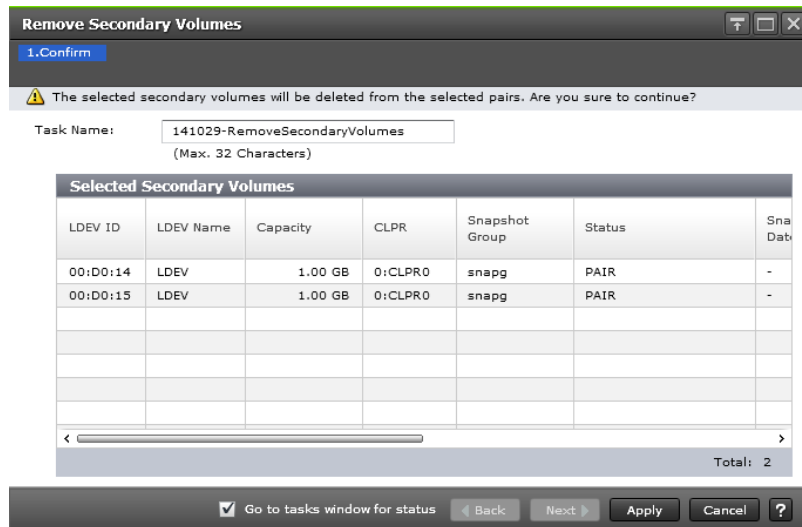
The following table lists the items in this table on the **Confirm** window.

Item	Description
LDEV ID	The LDEV identification number, which you can specify as the S-VOL.
LDEV Name	The LDEV's name.
Attribute	The LDEV's attribute.
Capacity	The LDEV's capacity.

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Item	Description
CLPR	The LDEV's CLPR ID.
Remount Device	Indicates whether remounting the device is required.
Snapshot Group	The snapshot group name. Information is displayed for this item only if you have configured a snapshot group for the HTI pair.
Status	The pair status. For more information about pair status, see <u>Thin Image pair status definitions (on page 158)</u>.
Snapshot Date	The date and time that you created the pair to store snapshot data.
Primary Volume	The P-VOL information. Values: ▪ **LDEV ID:** The P-VOL's LDEV identification number. ▪ **LDEV Name:** The P-VOL's LDEV name. If you have not allocated an LDEV to the S-VOL, a hyphen (-) is displayed. ▪ **Attribute:** The P-VOL's attribute. ▪ **Capacity:** The P-VOL's capacity. ▪ **CLPR:** The P-VOL's CLPR ID.
Pool Name (ID)	The pool name and identification number.
Mirror Unit	The mirror unit number. A hyphen (-) is displayed if the volume is not an S-VOL of an existing pair.
Cascade	Indicates whether a cascaded pair can be created. ▪ **Enabled:** Cascaded pairs can be created. ▪ **Disabled:** Cascaded pairs cannot be created.
Pair Topology ID	The topology ID, which indicates the layer of the pair based on the mirror unit. The topology ID consists of the LDEV ID of the root volume and the mirror unit number.

Remove Secondary Volumes window

The following image shows this window.

Appendix B: Thin Image GUI windows and wizards

Selected Secondary Volumes table

The following table lists the items in this window on the Remove Secondary Volumes window.

Item	Description
LDEV ID	The LDEV identification number, which you can specify as the S-VOL.
LDEV Name	The LDEV's name.
Attribute	The LDEV's attribute.
Capacity	The LDEV's capacity.
CLPR	The LDEV's CLPR ID.
Snapshot Group	The snapshot group name. Information is displayed for this item only if you have configured a snapshot group for the HTI pair.
Status	The pair status. For more information about pair status, see Thin Image pair status definitions (on page 158).
Snapshot Date	The date and time that you created the pair to store snapshot data.
Primary Volume	The P-VOL information. Values: ▪ **LDEV ID:** The P-VOL's LDEV identification number. ▪ **LDEV Name:** The P-VOL's LDEV name. If you have not allocated an LDEV to the S-VOL, a hyphen (-) is displayed.

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Item	Description
	▪ **Capacity:** The P-VOL's capacity. ▪ **CLPR:** The P-VOL's CLPR ID.
Pool Name (ID)	The pool name and identification number.
Mirror Unit	The mirror unit number. A hyphen (-) is displayed if the volume is not an S-VOL of an existing pair.
Cascade	Indicates whether a cascaded pair can be created. ▪ **Enabled:** Cascaded pairs can be created. ▪ **Disabled:** Cascaded pairs cannot be created.
Pair Topology ID	The topology ID, which indicates the layer of the pair based on the mirror unit. The pair topology ID consists of the LDEV ID of the root volume and the mirror unit number.

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