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Hitachi Universal Storage Platform V
Hitachi Universal Storage Platform VM
Dynamic Provisioning User's Guide

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MK-96RD641-19

Contents

Preface

This document describes and provides instructions for installing and using the Hitachi Dynamic Provisioning software for the Hitachi Universal Storage Platform V and Hitachi Universal Storage Platform VM (USP V/VM) storage systems.

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

This preface includes the following information:

Notice: The use of Dynamic Provisioning software and all other Hitachi Data Systems products is governed by the terms of your agreement(s) with Hitachi Data Systems.

Intended Audience

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

This document assumes the user:

- Is familiar with the operating system and web browser software on the system hosting the Hitachi Storage Navigator software.
- Has a background in data processing and understands RAID storage systems and their basic functions.
- Is familiar with the USP V and USP VM storage systems and has read and understands the *User and Reference Guide* for the storage systems.

All of the functions described in this document are for storage administrators only. For more information on user access, see the *Storage Navigator User's Guide*.

Product Version

This document revision applies to USP V/VM microcode 60-08-0X and higher.

Document Revision Level

Revision	Date	Description
MK-96RD641-01	May 2007	Initial release
MK-96RD641-02	July 2007	Revision 2, supersedes and replaces MK-96RD641-01
MK-96RD641-03	September 2007	Revision 3, supersedes and replaces MK-96RD641-02
MK-96RD641-04	November 2007	Revision 4, supersedes and replaces MK-96RD641-03
MK-96RD641-05	January 2008	Revision 5, supersedes and replaces MK-96RD641-04
MK-96RD641-06	March 2008	Revision 6, supersedes and replaces MK-96RD641-05
MK-96RD641-07	May 2008	Revision 7, supersedes and replaces MK-96RD641-06
MK-96RD641-08	August 2008	Revision 8, supersedes and replaces MK-96RD641-07
MK-96RD641-09	November 2008	Revision 9, supersedes and replaces MK-96RD641-08
MK-96RD641-10	January 2009	Revision 10, supersedes and replaces MK-96RD641-09
MK-96RD641-11	February 2009	Revision 11, supersedes and replaces MK-96RD641-10
MK-96RD641-12	May 2009	Revision 12, supersedes and replaces MK-96RD641-11
MK-96RD641-13	August 2009	Revision 13, supersedes and replaces MK-96RD641-12
MK-96RD641-14	November 2009	Revision 14, supersedes and replaces MK-96RD641-13
MK-96RD641-15	February 2010	Revision 15, supersedes and replaces MK-96RD641-14
MK-96RD641-16	July 2010	Revision 16, supersedes and replaces MK-96RD641-15

Revision	Date	Description
MK-96RD641-17	September 2010	Revision 17, supersedes and replaces MK-96RD641-16
MK-96RD641-18	December 2010	Revision 18, supersedes and replaces MK-96RD641-17
MK-96RD641-19	April 2011	Revision 19, supersedes and replaces MK-96RD641-18

Source Documents for this Revision

- MK-96RD641-18
- MK-96RD641-19b

Changes in this Revision

- Added new information about pool capacity consumption on Windows Server 2003 and Windows Server 2008 (see Table 3-1).
- Added notes about RAID level (see Table 3-2 Pool-VOL RequirementsTable 3-2).
- Added information about SOMs that can be used with Dynamic Provisioning (see System Option Modes).
- Added troubleshooting information concerning causes and solutions for when you cannot release the Protection attribute of the V-VOLs (see Table 6-1).

Document Organization

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

Chapter	Description
Chapter 1 - Overview of Dynamic Provisioning	Describes the general features and functions of Dynamic Provisioning.
Chapter 2 - About Dynamic Provisioning Operations	Contains a technical overview of Dynamic Provisioning.
Chapter 3 - Preparing for Dynamic Provisioning Operations	This chapter describes the necessary environment for Dynamic Provisioning.
Chapter 4 - Using the Dynamic Provisioning GUI	Describes the Dynamic Provisioning windows and dialog boxes.
Chapter 5 - Performing Dynamic Provisioning Operations	Provides instructions for performing Dynamic Provisioning Operations.
Chapter 6 - Troubleshooting	Describes how to troubleshoot Dynamic Provisioning problems.
Acronyms and Abbreviations	Defines the acronyms and abbreviations used in this document.

Chapter	Description
Index	Lists the topics in this document in alphabetical order.

Referenced Documents

Hitachi USP V/VM documents:

- *Hitachi Command Control Interface User and Reference Guide,* MK-90RD011
- *Hitachi Copy-on-Write Snapshot User's Guide,* MK-96RD607
- *Hitachi Cache Residency Manager User's Guide,* MK-96RD609
- *Hitachi Database Validator User's Guide,* MK-96RD611
- *Hitachi Data Retention Utility User's Guide,* MK-96RD612
- *Hitachi Storage Navigator Messages*, MK-96RD613
- *Hitachi LUN Manager User's Guide,* MK-96RD615
- *Hitachi LUN Expansion User's Guide,* MK-96RD616
- *Hitachi Performance Manager User's Guide,* MK-96RD617
- *Hitachi ShadowImage User's Guide,* MK-96RD618
- *Hitachi SNMP User and Reference Guide,* MK-96RD620
- *Hitachi Storage Navigator User's Guide,* MK-96RD621
- *Hitachi TrueCopy User and Reference Guide,* MK-96RD622
- *Hitachi Universal Replicator User and Reference Guide,* MK-96RD624
- *Hitachi Universal Volume Manager User's Guide,* MK-96RD626
- *Hitachi Virtual Partition Manager User's Guide,* MK-96RD629
- *Hitachi Virtual LVI/LUN and Volume Shredder User's Guide,* MK-96RD630
- *User and Reference Guide,* MK-96RD635

Hitachi Storage Command Suite documents:

- *Hitachi Device Manager Server Configuration and Operation Guide*, MK-08HC157
- *Storage Command Suite Server Installation Guide (includes Device Manager, Provisioning Manager, and Tiered Storage Manager),* MK-98HC150
- *Hitachi Tuning Manager Software User's Guide*, MK-92HC022
- *Hitachi Tiered Storage Manager User's Guide*, MK-94HC090

Document Conventions

The terms "Universal Storage Platform V" and "USP V" and "USP VM" refer to all models of the Hitachi Universal Storage Platform VM, unless otherwise noted.

This document uses the following typographic conventions:

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

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

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

Convention for Storage Capacity Values

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

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

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

1 KB = 1,024 (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 block = 512 bytes

Getting Help

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

- The circumstances surrounding the error or failure.
- The exact content of any error message(s) displayed on the host system(s).
- The exact content of any messages displayed on Storage Navigator.
- The Storage Navigator configuration information (use the FD Dump Tool). This information is used by service personnel for troubleshooting purposes.
- The service information messages (SIMs), including reference codes and severity levels, displayed by Storage Navigator and/or logged at the host.

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

Comments

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

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

1

Overview of Dynamic Provisioning

This chapter describes the general features and functions of Dynamic Provisioning.

- ☐ Dynamic Provisioning Features
- ☐ Dynamic Provisioning Benefits
- ☐ Complementary Software

Dynamic Provisioning Features

Dynamic Provisioning is a new advanced thin-provisioning software product that provides "Virtual Storage Capacity" to simplify administration and addition of storage, eliminate application service interruptions, improved overall throughput, and reduce costs.

For companies faced with ongoing rapid growth of their data storage requirements and escalating storage and storage management expenses, Dynamic Provisioning software greatly simplifies the application storage provisioning process and saves money on storage purchases.

Dynamic Provisioning allows storage to be allocated to an application without actually being physically mapped until it is used. This 'as-needed' method means storage allocations can exceed the amount of storage physically installed. It also decouples the provisioning of storage to an application from the physical addition of storage capacity to the storage system. Both significantly simplify the storage provisioning process.

As it is needed, physical storage is non-disruptively added to the storage system and placed in a central pool available to all thin provisioned volumes. As an application requires additional capacity, the storage system automatically allocates the needed additional physical storage to the volume. Behind the scenes Dynamic Provisioning software monitors storage resources and proactively alerts you before more physical storage is required.

Dynamic Provisioning software also simplifies performance optimization by transparently spreading many hosts' individual I/O patterns across many physical disks, thereby reducing performance management concerns and optimizing performance/throughput.

With Dynamic Provisioning, overall storage utilization rates improve and the entire storage system is tuned for maximum efficiency. In addition, in tiered storage environments it offers a useful low-cost tier option.

Coupled with the advanced features and reliability of the USP V/VM, Dynamic Provisioning offers reduced capital and management expenses and an improved return on your storage investment.

Symantec Thin Provisioning Reclamation Support

This feature provides active, ongoing reclamation of file system storage. Used in conjunction with the Symantec™ Veritas Storage Foundation's™ Veritas File System (VxFS)™ and the Veritas Thin Provisioning API, Dynamic Provisioning further increases storage savings.

SCSI commands are used to provide a mechanism to allow the server-based file system, such as Symantec VxFS, to notify the array of which pages on a thinly provisioned LUN or volume do not have any data or meaningful data. (VxFS can differentiate between free and used blocks.) The array can then safely disassociate those pages from a thinly provisioned LUN or volume and subsequently make them available for reuse. There are specific VxFS array support libraries (ASLs) required for this support between Symantec and the USP V/VM.

The primary use case for this feature is to operationally keep file systems thin. Through the use of Symantec's VxFS and Dynamic Provisioning, the server and storage array work together to continually, automatically, and transparently optimize storage utilization.

On the USP V/VM side, this feature is handled automatically with no administrator intervention required. More information on usage from the server side can be found in Symantec documentation, for example (but not exclusive to) *Veritas Storage Foundation ™ Administrator's Guide* (working with disks that support thin provisioning), and *Veritas Storage Foundation™ Advanced Features Administrator's Guide* (reclamation of storage on thin reclamation arrays).

Dynamic Provisioning Benefits

In a traditional volume, when you need more storage you must install additional disks and simultaneously change the configuration of both the storage system and the host. This requires extensive careful orchestration, and is disruptive to application I/O.

With Dynamic Provisioning software, when configuring additional storage for an application the administrator draws from the Dynamic Provisioning pool without immediately adding physical disks. Coordination between the creation of a volumes and the physical disk layout are no longer a consideration.

Non-Disruptive Addition of Physical Disks

A Dynamic Provisioning volume will be displayed as a Virtual LVI/LUN volume that has no actual storage capacity. Actual storage capacity from the Dynamic Provisioning pool is assigned when the data is written. Because the application only sees the amount of virtual capacity that is allocated to it, additional physical disk capacity can be installed transparently when needed, without an application service interruption.

Improved Performance

Dynamic Provisioning software effectively combines many applications I/O patterns and spreads the I/O activity across all available physical resources. Prior to Dynamic Provisioning software optimizing to use all spindles was a complex manual task requiring considerable expertise. Avoiding disk 'hot spots' has always been challenging due to the complexity of spreading an application over many spindles as well as predicting when multiple applications that share a limited number of spindles may generate I/O patterns that cause contention and performance bottlenecks.

Dynamic Provisioning software does this automatically. By evenly spreading out hundreds of users' I/O patterns over all available spindles, Dynamic Provisioning software will optimize aggregate throughput and generally deliver the best performance. Individual application balancing and manually matching up drive spindles is no longer necessary.

Reduced Storage Acquisition Costs

Defining a volume larger than the physical disk allows you to plan for additional future storage needs during an initial installation, while only purchasing the required physical disk capacity at the start and adding physical storage capacity incrementally over time. This also provides savings in space, power and cooling requirements.

Figure 1-1 illustrates the difference between purchases made before and after installing Dynamic Provisioning.

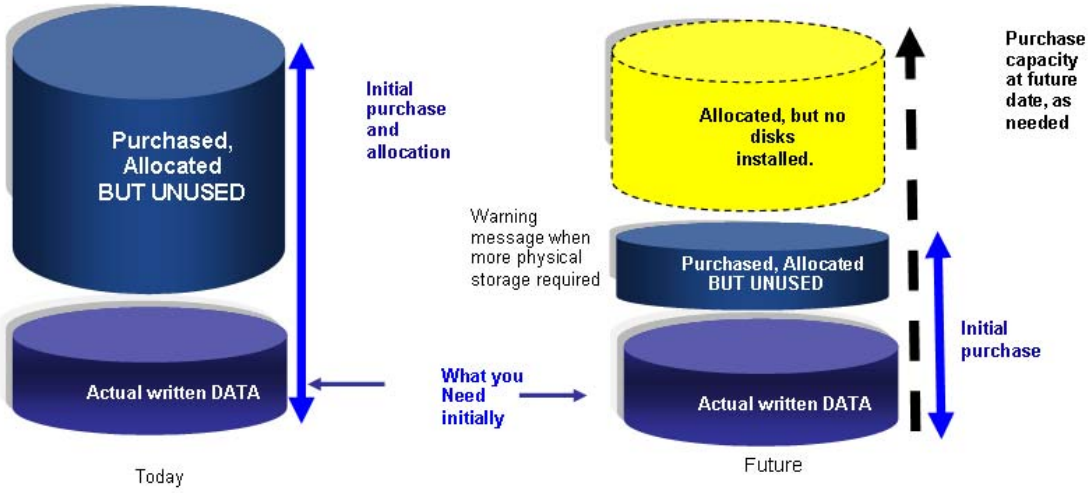

Figure 1-1 Effects of Dynamic Provisioning

Simplified Replication Planning

Because you can define the desired volume capacity without regard to the physical disk capacity, for volumes of 4 TB and smaller you no longer need to use LUSE for volume expansion. This also simplifies creating replication pairs.

Complementary Software

Hitachi Replication Software

The high-speed, non-disruptive technology of any of the Hitachi replication software rapidly creates multiple copies of mission-critical information within Hitachi storage systems while keeping data RAID-protected and fully recoverable and without affecting service or performance levels. For more information about ShadowImage, TrueCopy, and Universal Replicator, see the relevant product *User's Guide*.

Performance Monitor

Performance Monitor gives you detailed point-in-time reporting of the performance metrics of the USP V/VM storage system, so that you can promptly investigate threshold warnings and determine both your virtual and physical storage needs. For more information about Performance Monitor, see the *Performance Monitor User's Guide*.

Hitachi Device Manager

Hitachi Device Manager supports the consolidation of storage operations and management functions in a system that contains multiple heterogeneous Hitachi storage systems (e.g., Hitachi USP V/VM, TagmaStore USP and NSC, Lightning 9900V, TagmaStore AMS/WMS, Thunder 9500V, Lightning 9900, and Thunder 9200). With regard to Dynamic Provisioning, Device Manager gives storage administrators easy access to the monitoring functions, including generating e-mail alerts for threshold punctures, and issuing reports on Dynamic Provisioning virtual volumes, pool volumes, and pools.

For information about using Device Manager to perform alert notification, see the *Hitachi Device Manager Server Installation and Configuration Guide*.

For information about using Device Manager with Dynamic Provisioning Virtual Volumes and Pool Volumes, see the *Hitachi Device Manager Server Configuration and Operation Guide*.

Hitachi Tuning Manager

Hitachi Tuning Manager software monitors storage capacity and performance metrics from the host application to the storage device. The programs of the Tuning Manager series monitor performance data based on thresholds that are predefined in Main Console. When performance data values reach the threshold values, the Main Console notifies the designated recipient of the system status. The alert notification can be generated either by e-mail or by command execution, which allows the alert recipient to take appropriate action to improve performance.

For information about using Tuning Manager to perform alert notification, see the *Hitachi Tuning Manager Software User's Guide*. Also see the *Hitachi Tiered Storage Manager User's Guide*.

2

About Dynamic Provisioning Operations

This chapter contains a technical overview of Dynamic Provisioning.

- ☐ Dynamic Provisioning Components
- ☐ Managing Pool Capacity
- ☐ Interoperability with Other Products and Functions

Dynamic Provisioning Components

Relationship between V-VOLs, Pools, and Pool-VOLs

Dynamic Provisioning stores data in one or more pools, using V-VOLs. V-VOLs are virtual volumes, which are used for both Copy-on-Write Snapshot and Dynamic Provisioning. A Dynamic Provisioning V-VOL is also called a DP-VOL.

Figure 2-1 illustrates the relationship between a Dynamic Provisioning volume and a Dynamic Provisioning pool.

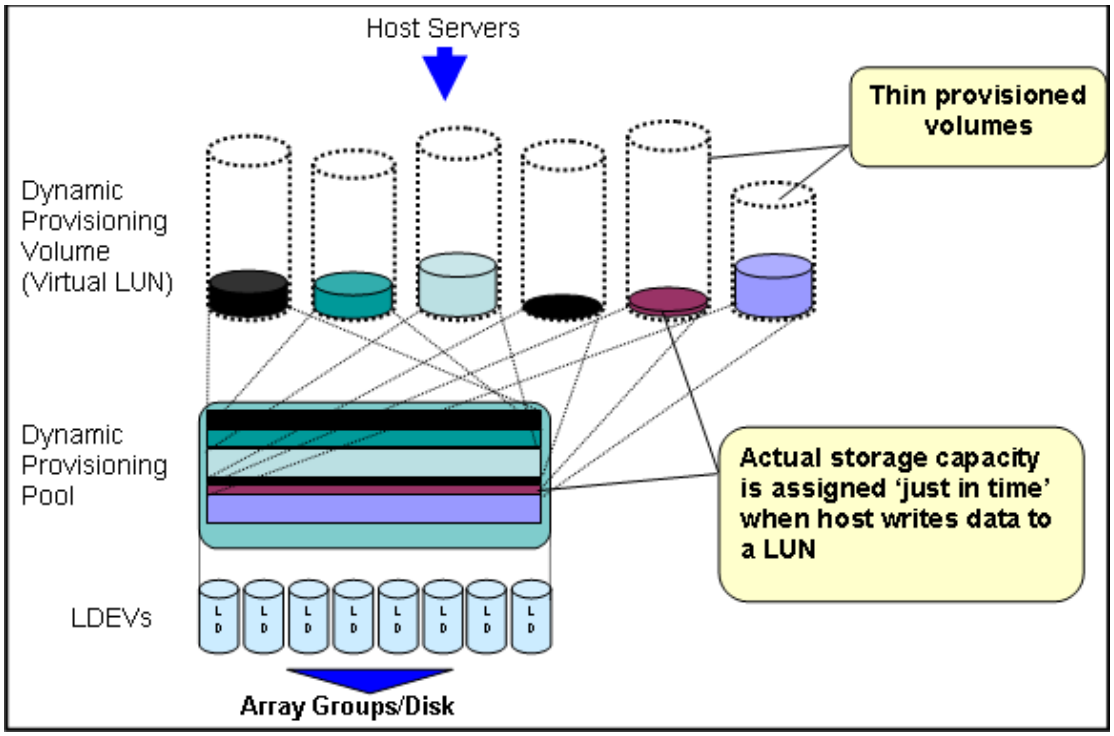

Figure 2-1 Dynamic Provisioning Overview

Supported Configurations

Table 2-1 Supported Dynamic Provisioning Configurations

Items	Supported Configurations
DP-VOL capacity	46 MB to 4 TB: 46 MB to 4194303 MB, or 96000 blocks to 8589934592 blocks, or 50 to 4473924 cylinders
Maximum number of V-VOLs	8192 per pool
Maximum number of pools	128 per subsystem, 128 deducted from the maximum number of COW pools.
Maximum number of Pool-VOLs	1024 per pool
Capacity per Pool-VOL	8 GB to 4 TB

Pools

Dynamic Provisioning requires the use of pools. A USP V/VM storage system supports up to 128 pools, each of which can contain up to 1024 pool-VOLs and 8192 V-VOLs. Each pool requires a unique pool ID.

Copy-on-Write Snapshot also uses pools. The 128-pool maximum per storage system applies to the total number of both Copy-on-Write Snapshot pools and Dynamic Provisioning pools. For more information about Copy-on-Write Snapshot, see the *Copy-on-Write Snapshot User's Guide*.

The total pool capacity is the total capacity of the registered Dynamic Provisioning pool-VOLs.

Pool capacity is calculated by the following formula:

- Total Number of pages = $\Sigma(\downarrow\downarrow$pool-VOL number of blocks $\div$ 512$\downarrow \div$ 168$\downarrow)$ for each pool-VOL.
- The capacity of the pool (MB) = Total number of pages $\times$ 42 $-$ (4116 + 84 $\times$ Number of pool-VOLs)

$\downarrow\downarrow$: truncate the part of the formula between the arrows after the decimal point.

If you increase the pool capacity by adding a pool-VOL, existing data in the pool automatically migrates from an older pool-VOL(s) to the newly added pool-VOL, balancing the usage levels of all the pool-VOLs. If you do not want to automate balancing of the usage levels of pool-VOLs, call the Hitachi Data Systems Technical Support Center (see Calling the Hitachi Data Systems Technical Support Center).

Dynamic Provisioning automatically balances the usage levels among pool-VOLs in the pool created with microcode version 60-05-0x or later. Dynamic Provisioning does not automatically balance the usage levels among pool-VOLs if the cache memory is not redundant or if the pool usage level is more than the pool thresholds.

More information follows about pools including a description of the **Pool** Window, can be seen in page 4-2. For instructions on managing pools, see page 5-3.

DP-VOLs

Dynamic Provisioning requires the use of DP-VOLs, which are virtual volumes with no physical memory space. DP-VOLs can be 46 MB to 4 TB in size.

To create a DP-VOL, use the Storage Navigator V-VOL Window. OPEN-V is the only supported emulation type. You can define multiple V-VOLs and assign them as DP-VOLs to a Dynamic Provisioning HDP Pool. A DP-VOL cannot be associated with more than one pool. For more information, see V-VOL Window and Managing V-VOLs and V-VOL Groups.

If System Option Mode (SOM) 726 is enabled (non-default setting), you can set only one V-VOL in one V-VOL group. The maximum number of V-VOL groups that can be defined in the whole storage system is the same as the maximum number of LDEVs that can be defined in the whole storage system. For details on the number of definable V-VOL groups in the whole system, see the explanation about the **Copy of V-VOL Groups number** textbox in New V-VOL Group Dialog Box.

Growing a DP-VOL

You can grow (increase the LUN capacity dynamically) of a DP-VOL without migrating the data. For instructions, see Increasing V-VOL Capacity.

Reclaiming Pages from a DP-VOL

A DP-VOL used as a migration target from a traditional non-dynamic provisioned volume may have large amounts of capacity dedicated to data that is all binary zeroes. The Dynamic Provisioning Pool capacity used for the binary zero data written to the DP-VOL can be reclaimed and returned as available Pool capacity. Capacity is provided to DP-VOLs from the Dynamic Provisioning Pool in 42MB sized pages. Reclamation of capacity will require that the 42MB page has only binary zero data written to it. For instructions on how to perform this reclamation see Releasing Pages in a DP-VOL.

Note, however, that while releasing pages in a DP-VOL, performance of the host I/O to the DP-VOL decreases temporarily.

You cannot reclaim pages taken up by a DP-VOL once any non-binary zero data had been written to them. In this case, the pages can be reclaimed only when the DP-VOL is no longer needed and is deleted.

If you perform the binary zero data discard operation, then the system will also automatically rebalance the pool-VOLs usage levels. Dynamic Provisioning automatically balances usage levels among pool-VOLs in the pool. If you do not want to automate balancing of the usage levels of pool-VOLs, call the Hitachi Data Systems Technical Support Center (see Calling the Hitachi Data Systems Technical Support Center).

Dynamic Provisioning automatically balances the usage levels among pool-VOLs in the pool created with microcode version 60-05-0x or later. Dynamic Provisioning does not automatically balance the usage levels among pool-VOLs if the cache memory is not redundant or if the pool usage level is more than the pool thresholds.

V-VOL Management Table

Before you can use Dynamic Provisioning, a V-VOL management table has to be created to associate V-VOLs (virtual volumes) to a pool. The V-VOL management table is created automatically when the required additional shared memory is installed by your Hitachi Data Systems representative.

If data are lost from the shared memory, the V-VOL management table will be restored. The management table will first be restored using data stored in the reserved system areas inside the pool. If this restore is unsuccessful, then a stored copy of shared memory will be copied from the SVP. This process is explained in the table below.

Table 2-2 How the V-VOL Management Table is Stored When Data are Lost from Shared Memory

Items	Microcode Version	
	60-01-xx	60-02-xx or later
Location where V-VOL management table on shared memory is stored	SVP HDD. SOM 460 of the SVP must be set to ON. You are not required to set the System Option because this is the default factory setting.	In addition to SVP HDD, dedicated area that is automatically created in the pool when the pool is created. If the area is already created with microcode version 60-01-xx, there is no need to create the pool again, etc., after upgrading to micro-version 60-02-xx or later.
When the V-VOL management table on shared memory is stored	When you switch off the power supply.	When you switch off the power supply. When the V-VOL management table is updated such as page allocation, pool creation etc. It is also stored for the pool created with microcode version 60-01-xx when microcode exchange is replaced.

Items	Microcode Version	
	60-01-xx	60-02-xx or later
When the V-VOL management table on shared memory is restored	When you switch on the power supply after shared memory was volatilized.	When you switch on the power supply after shared memory was volatilized. Restoring the data from the dedicated area in the pool may take time compared to that from SVP HDD. Therefore, mode 460 = ON is recommended. In the case of mode 460 = ON, the data is stored to both the SVP HDD and the dedicated area in pool. The time required for restoring the management table from the dedicated area in the pool depends on the pool usage or the V-VOL usage. For example, when the pool usage or the V-VOL usage is 100 TB, powering on takes at least about 20 minutes more than usual time, depending on the condition of the storage system.

Note: Pools are blocked when restoration from both the SVP HDD and the dedicated area in the pool fails (HDD failure, etc.). If this occurs, call the Hitachi Data Systems Technical Support Center (see Calling the Hitachi Data Systems Technical Support Center).

Managing Pool Capacity

One of the key features of Dynamic Provisioning is that you can define V-VOLs that have a greater capacity than the pool capacity. However, if you run out of free space in the pool, the host cannot expand the data written to the DP-VOLs. It is therefore essential to closely monitor pool capacity, so that you can increase it as needed.

You can monitor pool capacity directly, by using the Dynamic Provisioning window (see Dynamic Provisioning Window). You can also use Performance Monitor, CCI (Command Control Interface), Device Manager, and Tuning Manager to monitor used pool capacity. For more information on Performance Monitor, see the *Performance Manager User's Guide*. For more information on CCI see the *Command Control Interface User and Reference Guide*.

Hitachi Device Manager can be configured to output SNMP traps as a log file, which allows you to centrally monitor devices within a storage area and applications. In addition, Device Manager can send alerts by e-mail. For more information on Device Manager SNMP traps and e-mail notification, see the *Hitachi Device Manager Server Configuration and Operation Guide*.

Monitoring Pool Usage Levels

There are several tools available that show both the current pool usage rates and the changes over time for those usage rates. These tools allow you to monitor the pool free space and estimate when you will need to increase the pool capacity.

- Use the Dynamic Provisioning window. For more information, see Dynamic Provisioning Window.
- Use the Command Control Interface (CCI). For more information, see *Hitachi Command Control Interface User and Reference Guide*.
- Use Hitachi Device Manager. For more information, see the *Hitachi Device Manager Server Installation and Configuration Guide*.

  Figure 2-2 illustrates a sample display of the change in pool usage levels.

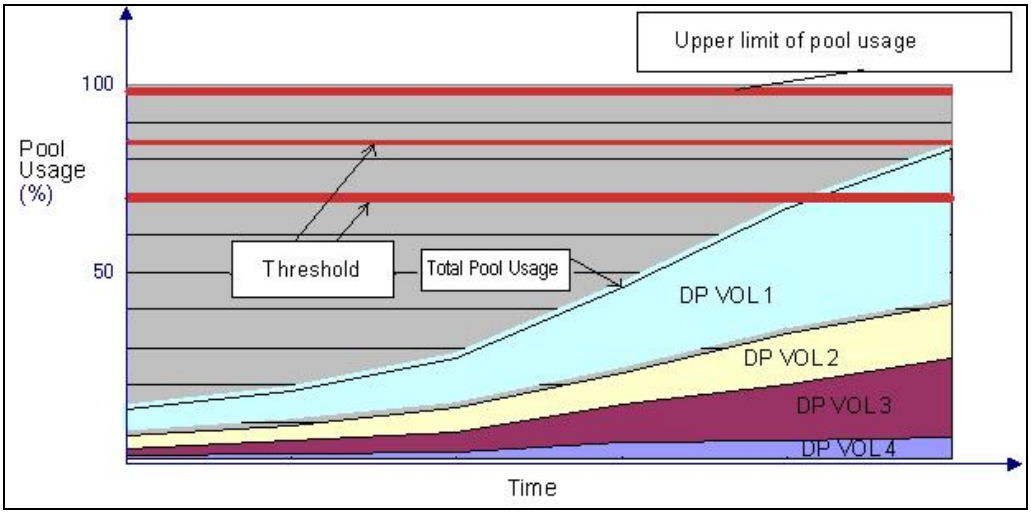

Figure 2-2 Sample Pool Information

- Use both Tuning Manager and Performance Manager to collect I/O data on DP-VOL and pool usage. Use Performance Manager to monitor the following:
  - Frequency of DP-VOL access, read hit ratio and write hit ratio
  - Pool I/O rates in the parity group

  Figure 2-3 shows management of usage rates and operation information.

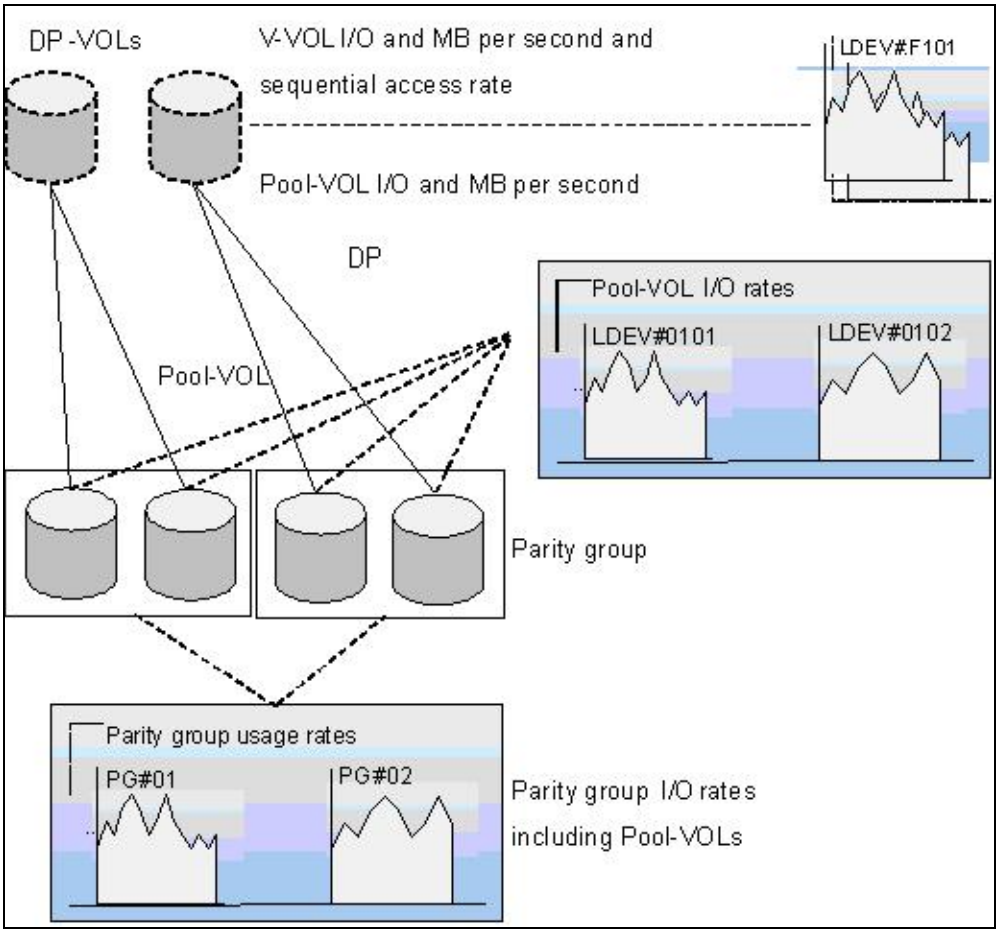

Figure 2-3 Managing Usage Rates and I/Os

- Use System Option Modes

  If SOM 734 is enabled, a SIM is reported when the pool threshold is exceeded. If the pool usage rate continues to exceed the pool threshold, the SIM is repeatedly reported every 8 hours. If the pool usage rate falls below the pool threshold, and then exceeds it again, the SIM is reported again.

  If SOM 734 is disabled (the default is off to prevent multiple SIMs), a SIM is reported when the pool threshold is exceeded. However, the SIM is not reported while the pool usage rate continues to exceed the pool threshold. If the pool usage rate falls below the pool threshold, and then exceeds it again, the SIM is reported again.

  If this SIM occurs frequently, other SIMS may not be reported. Do not enable SOM 734 if you consistently run with over "double" thresholds.

Warning: Although enabling SOM 734 provides warning SIMs, if a pool is not expanded in time the pool will become full resulting in serious file systems problems. Therefore, we recommend you enable SOM 729 to prevent file systems from being destroyed. See the following section for a description of SOM 729.

We also recommend enabling SOM 741, which provides a SIM report to users and service personnel.

Full Pool Handling

Full pool conditions can be managed in two ways. The difference between the two handling methods is how a V-VOL is treated if it requires new pool capacity when no capacity is available.

The default method used during a full pool condition is to fail some read and write operations to V-VOLs using the pool. Read and write operations are handled in the following way:

- Successfully read data that already exists in the V-VOL. Reads to pool pages already assigned to the V-VOL are successful.
- Successfully update (write) data that already exists in the V-VOL. Writes to pool pages already assigned to the V-VOL are successful.
- Fail a read operation that specifies an LBA address that is not assigned to a page. This read would be for an area that has never been written to the V-VOL.
- Fail a write operation that species an LBA address that is not assigned to a page. This write operation requires free pool capacity, however the capacity is not available and therefore it must fail.

The second method used during a full pool condition is enabled using SOM 729. Call the Hitachi Data Systems Technical Support Center to inquire how to enable this option (see Calling the Hitachi Data Systems Technical Support Center). This method uses the Data Retention Utility to manage V-VOLs impacted by the full pool condition. Only V-VOLs that have required free pool capacity during a full pool condition are impacted. All V-VOLs that have not requested free capacity continue to operate without any read or write problems imposed by the full pool condition.

Using the second method, a V-VOL requesting a free page from the pool to support a write to an LBA address that is not mapped to an existing allocated page to the V-VOL is immediately changed to Protect status using the Data Retention Utility. In this case, the V-VOL becomes read and write protected when a write fails due to the full pool condition. This protection status preserves the integrity of the V-VOL by making it inaccessible.

If a V-VOL is set to Protect status, then the Storage Navigator Data Retention window indicates that the Protection attribute was added to the V-VOL, the **S-VOL** column displays **Enable**, and the **Retention Term** column displays **0 days**. However, if the Protect attribute is added to a V-VOL with the S-VOL Disable attribute, the **S-VOL** column remains **Disable**.

If you want to make settings so that the pool capacity is not insufficient when the hosts write to the V-VOL, call the Hitachi Data Systems Technical Support Center. You can make such settings if the pool is not associated with V-VOLs exceeding the pool capacity. If the total V-VOL capacity exceeds the pool capacity after you perform such settings, you cannot associate V-VOLs with the pool, and you cannot increase the V-VOL capacity.

Once capacity has been added to the pool then the administrator should use the Storage Navigator Data Retention window to display the V-VOLs impacted by the previous full pool condition and also to reset the protection status of the V-VOL. Once the protection status is reset, normal operations can be returned to the hosts.

Thresholds

Dynamic Provisioning monitors V-VOLs capacity and pools capacity using two types of thresholds: V-VOL thresholds and pool thresholds.

- **Pool thresholds:** A pool threshold is the proportion (%) of used capacity of the pool to the total pool capacity. Each pool has its own pool threshold values that are divided into a variable threshold and a fixed threshold, for example:
  - Threshold 1: You can set it between 5% and 95%, in 5% increments. The default value is 70%.
  - Threshold 2: Fixed at 80%.

  Pool usage over either threshold will cause a warning to be issued via a SIM and an SNMP trap.

  Example: When the total pool capacity is 1 TB and the threshold 1 is 50%

  Figure 2-4 shows the pool capacity (when pool threshold 1 is 50%). If the used capacity of the pool is larger than 50% (500 GB) of the total pool capacity, a SIM and an SNMP trap are reported. If the used capacity of the pool increases and it exceeds the threshold 2 (80%), a SIM and an SNMP trap are reported again.

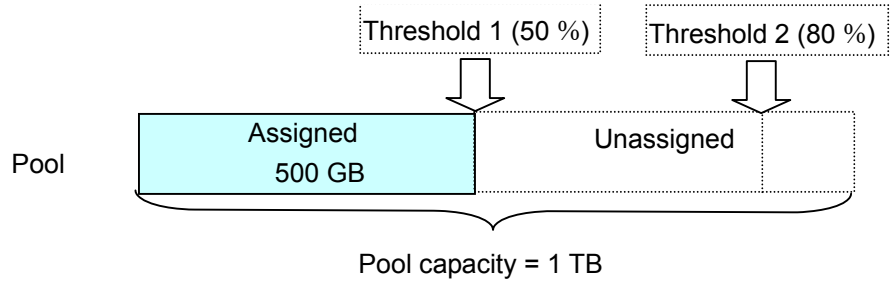

Figure 2-4 Pool Capacity (When pool threshold 1 is 50%)

- **V-VOL thresholds:** The V-VOL threshold is the ratio (%) of the unassigned pool capacity to the unassigned V-VOL capacity. The threshold can be specified from 5% to 300%.

  If the following formula is true, a SIM and an SNMP trap are reported.

  Unassigned V-VOL capacity × threshold > unassigned pool capacity

  Example 1: When the V-VOL threshold is 300 %

  Figure 2-5 shows the V-VOL capacity and the pool capacity (when the V-VOL threshold is 300 %). When a V-VOL capacity is 1 TB and the assigned capacity is 500 GB, the unassigned capacity of the V-VOL is 500 GB. Therefore, if free space of the pool is smaller than 1.5 TB (500 GB × 300%) of the unassigned capacity of the pool, a SIM and an SNMP trap are reported.

  Because a pool sometimes is used by multiple V-VOLs, the pool sometimes requires free space larger than the unassigned capacity of the V-VOL. So, you can specify the V-VOL threshold to a value more than 100%.

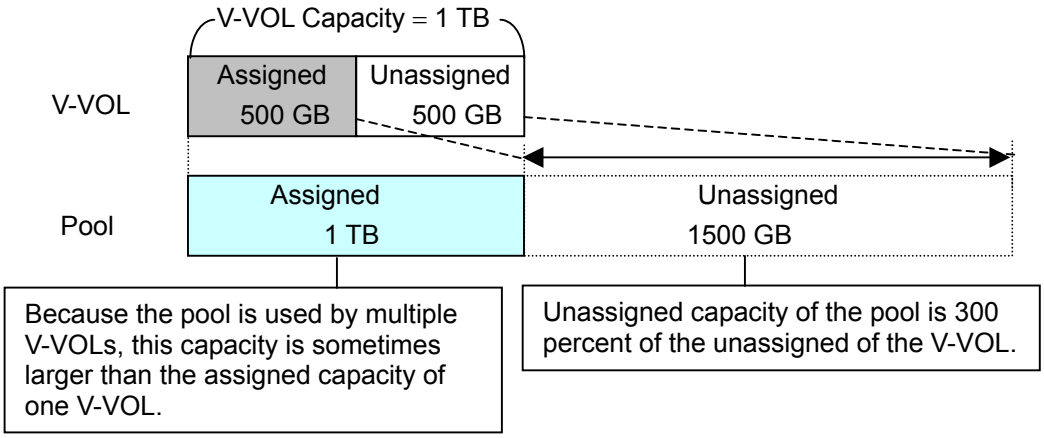

Figure 2-5 V-VOL Capacity and pool Capacity (When V-VOL threshold is 300 %)

Example 2: When the V-VOL threshold is 90 %

Figure 2-6 shows the V-VOL capacity and the pool capacity (when the V-VOL threshold is 90 %). If free space of the pool is smaller than 450 GB (500 GB × 90%) of the unassigned capacity of the pool, a SIM and an SNMP trap are reported.

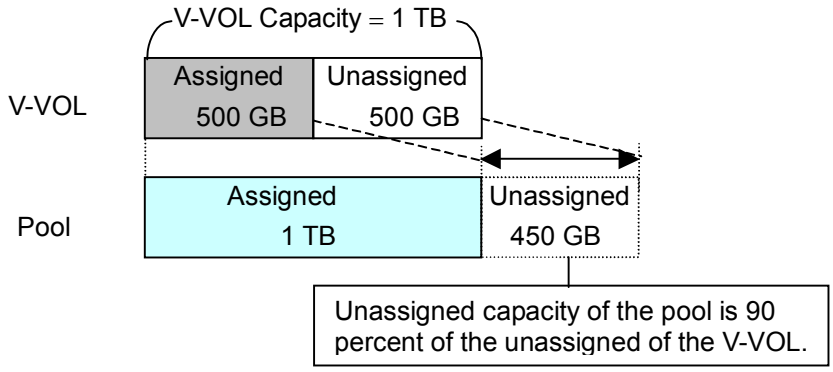

Figure 2-6 V-VOL Capacity and pool Capacity (When V-VOL threshold is 90 %)

SIM Reference Codes

The following table lists the SIM reference codes pertaining to Dynamic Provisioning. For more information on completing SIMs, see Managing Pool-Related SIMs.

Table 2-3 SIM Reference Codes

Codes (XXX is pool ID)	Events	Thresholds or Values	Various Types of Reports
620XXX	Pool usage level exceeded pool threshold 1.	5% to 95%, in 5% increments. Default: 70%.	Report to the host: Yes. If SOM 734 is enabled, repeats every 8 hours until the pool usage level is reduced to not exceed the threshold. Completion report to Storage Navigator: Yes. Information to the operator: No.
621XXX	Pool usage level exceeded pool threshold 2.	80% fixed.	Report to the host: Yes. If SOM 734 is enabled, repeats every 8 hours until the pool usage level is reduced to not exceed the threshold. Completion report to Storage Navigator: Yes. Information to the operator: No.
622XXX	Pool is full.	100%	Report to the host: Yes. Completion report to Storage Navigator: Yes. Information to the operator: No.
623XXX	Error occurred in the pool.	Not applicable.	Report to the host: Yes. Completion report to Storage Navigator: No. Information to the operator: Yes.
624XXX	No space in the shared memory.	Not applicable.	Report to the host: Yes. Completion report to Storage Navigator: Yes. Information to the operator: Yes.
625000	Pool usage level continues to exceed the highest pool threshold.	Highest pool threshold (80% to 95%).	Report to the host: Yes. Repeats every 8 hours if SOM 734 is enabled. Completion report to Storage Navigator: Yes. Information to the operator: Yes with SOM 741 enabled.
630XXX	Level of free pool capacity to free V-VOL capacity exceeded V-VOL threshold.	5% to 300% in 5% increments. Default: 5%. If pool IDs are the same, only one SIM is reported even if the V-VOLs are different.	Report to the host: Yes. Completion report to Storage Navigator: Yes. Information to the operator: No.
640XXX	V-VOL management area cannot be saved to a pool.	Not applicable.	Report to the host: No. Completion report to Storage Navigator: No. Information to the operator: Yes.

Pool Status

Table 2-4 lists the pool status definitions.

Table 2-4 Pool Status

Status	Definition	SIM Codes
Normal	Normal status. The pool usage level may exceed the variable or fixed pool threshold.	If the pool usage level exceeds either the variable or the fixed pool threshold, the following SIM occurs. 620XXX or 621XXX (XXX is pool ID)
Warning	Pool-VOL in the pool is blocked or being formatted.	None
Blocked	The pool is full or an error occurred in the pool, therefore the pool is blocked.	If the pool is full or an error occurs in the pool, the following SIM occurs. 622XXX or 623XXX (XXX is pool ID)

Balancing I/O Load Across the Pool

When defining a pool, dedicate as many array groups as needed to support the I/O load of the planned DP-VOLs.

When adding capacity to a Dynamic Provisioning pool defined using firmware 60-05-0X and higher, the DP rebalancing function moves some existing data for DP-VOLs from the older pool volumes to the newest pool volumes. The DP rebalance function rebalances each DP-VOL's data (pages assigned) evenly across each pool volume in the pool.

When adding capacity to the pool defined using firmware prior to 60-05-0X, then typically add about the same amount of space as defined originally.

Interoperability with Other Products and Functions

In certain cases, Dynamic Provisioning DP-VOLs and pool-VOLs can be used in conjunction with other Hitachi software products. Table 2-5 lists the operations that are permitted and not permitted. Note that Dynamic Provisioning supports only OPEN-V volumes.

Table 2-5 Using Dynamic Provisioning with Other Options

Product Name	Permitted	Not Permitted
Cache Residency Manager For more information, see the *Cache Residency Manager User's Guide*.	None	
Copy-on-Write Snapshot For more information, see the *Copy-on-Write Snapshot User's Guide*.	Using a DP-VOL as a Copy-on-Write Snapshot P-VOL. The maximum total number of Dynamic Provisioning pools per storage system is 128. Copy-on-Write Snapshot pool limits are reduced by the number of Dynamic Provisioning pools.	Using a DP-VOL as a Copy-on-Write Snapshot S-VOL or pool-VOL. Using a Dynamic Provisioning pool-VOL as a Copy-on-Write Snapshot P-VOL, S-VOL, or pool-VOL. Increasing the capacity of DP-VOL used by this program product. Discarding zero data, and running Copy-on-Write Snapshot on the same DP-VOL (This operation will be prohibited by the microcode).
Data Retention Utility For more information, see the *Data Retention Utility User's Guide*.	Performing operations on DP-VOLs.	Use on Dynamic Provisioning pool-VOLs.
Database Validator	Performing operations on DP-VOLs.	Use on Dynamic Provisioning Pool-VOLs.
LUN Expansion (LUSE) For more information, see the *LUN Expansion User's Guide*.	None.	Use on Dynamic Provisioning pool-VOLs or DP-VOLs.
LUN Manager, LUN Security For more information, see the *LUN Manager User's Guide*.	Performing operations on DP-VOLs.	Use on Dynamic Provisioning Pool-VOLs.
Server Priority Manager For more information, see the *Performance Manager User's Guide*.	Performing operations on DP-VOLs.	Use on Dynamic Provisioning pool-VOLs.

Product Name	Permitted	Not Permitted
ShadowImage For more information, see the *ShadowImage User's Guide*.	Using a DP-VOL as a ShadowImage P-VOL or S-VOL. See ShadowImage for more information.	Using a Dynamic Provisioning pool-VOL as ShadowImage P-VOL or S-VOL. Increasing the capacity of DP-VOL used by this program product. Discarding zero data, and running ShadowImage on the same DP-VOL (This operation will be prohibited by the microcode).
TrueCopy For more information, see the *TrueCopy User and Reference Guide*.	Using a DP-VOL as a TrueCopy P-VOL or a S-VOL.	Using a Dynamic Provisioning pool-VOL as a TrueCopy P-VOL or an S-VOL. Increasing the capacity of DP-VOL used by this program product.
TrueCopy Asynchronous For more information, see the *TrueCopy User and Reference Guide*.	None	Use on Dynamic Provisioning pool-VOLs or DP-VOLs. Increasing the capacity of DP-VOL used by this program product.
Universal Replicator For more information, see the *Universal Replicator User's Guide*.	Using a DP-VOL as a Universal Replicator P-VOL or a S-VOL.	Using a DP-VOL as a Universal Replicator journal volume. Use on Dynamic Provisioning Pool-VOLs. Increasing the capacity of DP-VOL used by this program product.
Universal Volume Manager	Enabling volumes created by Universal Volume Manager to be used as pool-VOLs.	Increasing the capacity of DP-VOL mapped to another storage system. If you try to increase the capacity of the external volume, the capacity of the volume will be the same capacity as the former capacity. If you want to increase the capacity, release the mapping to the DP-VOL from the mapping device.
Virtual LUN For more information, see the *Virtual LVI/LUN and Volume Shredder User's Guide*.	Registering Virtual LUN volumes in Dynamic Provisioning pools.	Performing Virtual LUN operations on volumes that are already registered in a Dynamic Provisioning pool.
Virtual Partition Manager For more information, see the *Virtual Partition Manager User's Guide*.	Performing operations on Dynamic Provisioning DP-VOLs and pool-VOLs. See Virtual Partition Manager for more information.	
Volume Migration For more information about volume migration, contact Hitachi Data Systems Support Center (see Calling the Hitachi Data Systems Technical Support Center).	Using a DP-VOL as a migration source or a migration target.	Use on Dynamic Provisioning pool-VOLs. Increasing the capacity of DP-VOL used by this program product. Discarding zero data, and running Volume Migration on the same DP-VOL (This operation will be prohibited by the microcode).

Product Name	Permitted	Not Permitted
Volume Shredder For more information, see the *Virtual LVI/LUN and Volume Shredder User's Guide*.	Use on DP-VOLs.	Use on Dynamic Provisioning Pool-VOLs. Increasing the capacity of DP-VOL used by this program product. Discarding zero data, and running Volume Shredder on the same DP-VOL (This operation will be prohibited by the microcode).

TrueCopy

You can use Dynamic Provisioning in combination with TrueCopy to replicate DP-VOLs. You can also use TrueCopy as a tool to move the data of the DP-VOL for I/O load reasons. The recommended movement is between the P-VOL in pool A and S-VOL in pool B. Figure 2-7 illustrates the interaction when the TrueCopy P-VOL and S-VOL are also Dynamic Provisioning DP-VOLs. Table 2-6 lists the specifics.

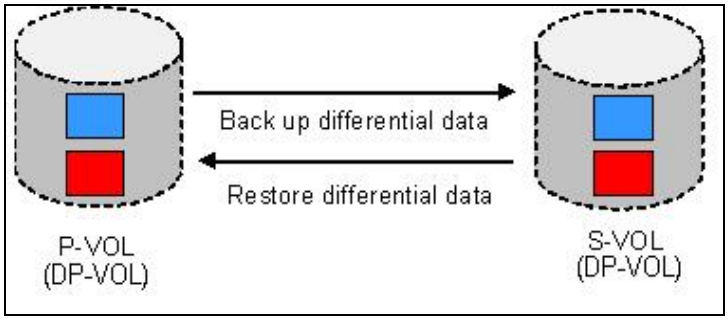

Figure 2–7 Using Dynamic Provisioning and TrueCopy

Table 2-6 Supported TrueCopy and Dynamic Provisioning Combinations

TrueCopy P-VOL	TrueCopy S-VOL	Explanation
Dynamic Provisioning DP-VOLs	Dynamic Provisioning DP–VOLs	Supported. At initial PAIR create time pages in the S-VOL are freed if not needed for replicating the P-VOL.
Dynamic Provisioning DP-VOLs	Normal volumes	Supported.
Normal volumes	Dynamic Provisioning DP-VOLs	Supported. This combination consumes the same amount of pool capacity as the original normal volume (P-VOL).
Notes: ▪ You cannot specify a Dynamic Provisioning pool-VOL as a TrueCopy P-VOL or S-VOL. ▪ If the cache write pending rate exceeds 55%, the copy process stops temporarily.		

Universal Replicator

You can use Dynamic Provisioning in combination with Universal Replicator to replicate DP-VOLs. You can also use Universal Replicator as a tool to move the data of the DP-VOL for I/O load reasons. The recommended movement is between the P-VOL in pool A and S-VOL in pool B. Figure 2-8 illustrates the interaction when the Universal Replicator P-VOL and S-VOL are also Dynamic Provisioning DP-VOLs. Table 2-7 lists the specifics.

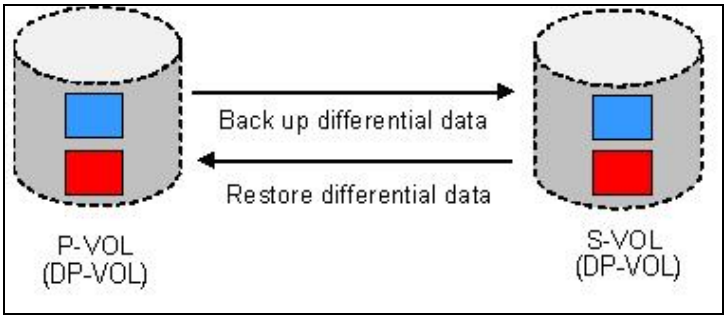

Figure 2–8 Using Dynamic Provisioning and Universal Replicator

Table 2-7 Supported Universal Replicator and Dynamic Provisioning Combinations

Universal Replicator P-VOL	Universal Replicator S-VOL	Explanation
Dynamic Provisioning DP-VOLs	Dynamic Provisioning DP–VOLs	Supported. At initial PAIR create time pages in the S-VOL are freed if not needed for replicating the P-VOL.
Dynamic Provisioning DP-VOLs	Normal volumes	Supported.
Normal volumes	Dynamic Provisioning DP-VOLs	Supported. This combination consumes the same amount of pool capacity as the original normal volume (P-VOL).
Notes: ▪ You cannot specify a Dynamic Provisioning pool-VOL as a Universal Replicator P-VOL or S-VOL. ▪ If the cache write pending rate exceeds 55%, the copy process stops temporarily.		

ShadowImage

You can use Dynamic Provisioning in combination with ShadowImage to replicate DP-VOLs. You can also use ShadowImage as a tool to move the data of the DP-VOL for I/O load reasons. The recommended movement is between the P-VOL in pool A and S-VOL in pool B. Figure 2-9 illustrates the interaction when the ShadowImage P-VOL and S-VOL are also Dynamic Provisioning DP-VOLs. Table 2-8 lists the specifics.

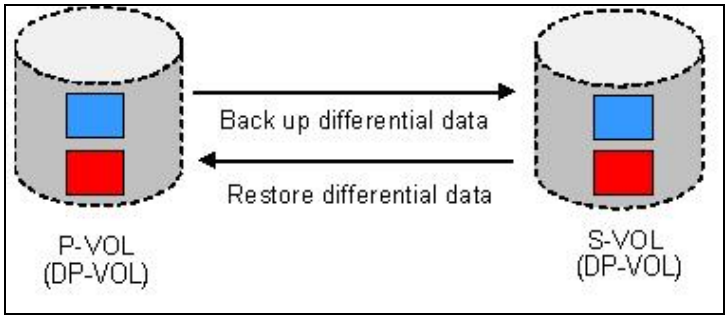

Figure 2–9 Using Dynamic Provisioning and ShadowImage

Table 2-8 Supported ShadowImage and Dynamic Provisioning Combinations

ShadowImage P-VOL	ShadowImage S-VOL	Explanation
Dynamic Provisioning DP-VOLs	Dynamic Provisioning DP–VOLs	Supported.
Dynamic Provisioning DP-VOLs	Normal volumes	Supported, but the Quick Restore function is not available.
Normal volumes	Dynamic Provisioning DP-VOLs	Supported, but the Quick Restore function is not available. This combination consumes the same amount of pool capacity as the normal volume (P-VOL).
Notes: ▪ You cannot specify a Dynamic Provisioning pool-VOL as a ShadowImage P-VOL or S-VOL. ▪ Zero Page Reclaim (zero page discard) will not operate on a DP-VOL being used as a P-VOL or S-VOL. Also you cannot make a P-VOL or S-VOL from a volume currently undergoing Zero Page Reclaim.		

If you retry Quick Restore or Volume Migration on DP-VOLs where Quick Restore has already been performed, error 5208 65714 may occur. If the error occurs, use the following equation to calculate how long to wait before retrying Quick Restore or Volume Migration:

(Pool Capacity in terabytes × 3 seconds) + 40 minutes

If the workload on the storage system is heavy, add additional time to the wait period. If **Operation** on **DP-VOL** list remains **Processing**, wait until it changes to **Ready** before attempting to perform Quick Restore or Volume Migration.

Virtual Partition Manager

You can assign DP-VOLs and pool-VOLs to Virtual Partition Manager SLPRs and CLPRs, with the following restrictions:

- All pool-VOLs in the same pool must belong to the same CLPR.
- We recommend that DP-VOLs and the associated pool are allocated to the same CLPR.

For more information, see *Virtual Partition Manager User's Guide*.

Volume Migration

Consider the following when you move DP-VOLs using Volume Migration: and Hitachi Tiered Storage Manager

- DP-VOLs have two emulation types, OPEN-0V and OPEN-V. You can check the emulation type of DP-VOLs in the LDEV window of the Basic Information window of Storage Navigator. For more information about the LDEV window, see the *Storage Navigator User's Guide*.
- You cannot move OPEN-0V DP-VOLs to OPEN-V normal volumes. Conversely, you cannot move OPEN-V normal volumes to OPEN-0V DP-VOLs. If you need to move volumes in this way, please change the emulation type from OPEN-0V to OPEN-V. For more information about changing an emulation type, see V-VOL Window.

  However, when both the migration source volume and the migration destination volume are DP-VOLs, they can be moved regardless of emulation types such as OPEN-0V or OPEN-V.
- If you retry Volume Migration or Quick Restore on DP-VOLs where Volume Migration has already been performed, error 5208 65714 may occur. If the error occurs, use the following equation to calculate how long to wait before retrying Volume Migration or Quick Restore:

  (Pool Capacity in terabytes × 3 seconds) + 40 minutes

  If the workload on the storage system is heavy, add additional time to the wait period. If **Operation** on **DP-VOL** list remains **Processing**, wait until it changes to **Ready** before attempting to perform Volume Migration or Quick Restore of ShadowImage.

For more information about volume migration, contact Hitachi Data Systems Support Center. See Calling the Hitachi Data Systems Technical Support Center.

System Option Modes

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

To set and manage the SOMs

1. Review the SOMs for your storage system. The SOMs are described in detail in the *User and Reference Guide*.
2. Work with your Hitachi Data Systems team to make sure the appropriate SOMs are set on your storage system.
3. Check each new revision of the *User and Reference Guide* to see if there are any SOM changes that may apply to your operational environment. If so, contact your Hitachi Data Systems team.

The following table lists and describes SOMs applicable to Dynamic Provisioning. For a complete list of all SOMs for the USP V/VM, see the *User and Reference Guide*. This SOM information may have changed since this document was published. Contact your Hitachi Data Systems team for the latest SOM information.

Mode	Description
460	When turning off PS, the control information for Dynamic Provisioning stored in shared memory will be backed up in the SVP. After that, when performing volatile PS ON, the control information will be restored into shared memory from the SVP. Mode 460 = OFF (default) Mode 460 = ON: Enables the function. Notes: 1. With mode 460 set to ON, the completion time of PS-OFF for SM backup or the completion time of volatile PS-ON after SM recovery takes up to 30 minutes. 2. When using power monitoring devices (PCI, etc.), the monitoring time for PS-OFF/ON must be set to the maximum of 30 minutes. 3. When the storage system is powered off automatically at power outage while destage mode is ON, SM is not backed up to the SVP even though mode 460 is set to ON. 4. In the case of using Dynamic Provisioning: With DKCMAIN version 60-02-04-00/00 and later, the DP management information is stored in a dedicated area in the pool in case data is lost from the SM. However, restoring the data from the dedicated area in the pool may take more time than restoring the data from the SVP. Therefore, setting mode 460 to ON is recommended to enable the data backup and recovery function from the SVP.

Mode	Description
726	Prevents a virtual group from having more than one Dynamic Provisioning (DP) volume created at a time. Mode 726 = ON: In the window for DP volume creation, a virtual group is prevented from having more than one DP volume created. Also, the Virtual LVI/LUN operation of the DP volume is prevented. Mode 726 = OFF (default): A virtual group can have multiple DP volumes created (the same operation as before). Note: When set to ON, only up to 63,232 DP volumes can be created per storage system.
727	Controls whether the local copy of control information residing in shared memory is saved and recovered to a system disk when power to the storage system is turned OFF and then ON. **ON:** The control information in shared memory is automatically saved to a system disk for use after power off. A system disk is required to use this setting. If shared memory is volatilized and recovery of the control information from the service processor fails when power comes on following power off, recovery of the control information from the system disk to shared memory is implemented. **OFF (default):** Automatic save and recovery of control information using a system disk is not available. ***Notes:*** 1. Set this SOM to ON when SI, SIz, FC v1, FC v2, Volume Migration, COW Snapshot, or Dynamic Provisioning are used if you want to save and recover control information for these products. 2. Set this SOM to ON after preparing a normal system disk that has more than 7.744 MB available capacity (9,082 cylinders for 3390 format). If Define Configuration & Install is performed, set this SOM to ON after formatting the system disk. 3. Review the timeout settings on connected systems when this SOM is ON, because power ON/OFF can take up to 15 minutes longer than when this SOM is OFF. 4. You can also set this SOM to ON or OFF using Virtual LVI/LUN (**Additional Configuration Back Up** setting on the **System Disk Options** dialog box).
729	Sets the Protect attribute to control read/write access on the DP-VOL that is using Data Retention Utility (DRU). This is required when a write operation is requested to an area where page allocation is not provided when the DP pool is full. **ON:** Sets the Protect, disabling read/write operations on the DP-VOL that is using DRU. **OFF (default):** Does not set the Protect attribute for the DP-VOL that is using DRU. ***Notes:*** 1. This SOM should be set to ON when; ▪ The pool threshold is high (e.g., 95%) and the pool may be full. ▪ File system is used. ▪ Data Retention Utility is installed. 2. The read operation is not allowed, because the Protect attribute is set for the V-VOL. 3. When DRU is not installed, the desired effect is not achieved. 4. After releasing the Full status of the pool by adding a pool-VOL, you can release the Protect attribute using the Data Retention window of Storage Navigator.

Mode	Description
734	Controls the repetition of service information message (SIM) reporting when the pool usage range exceeds the pool threshold. When exceeding the pool threshold, the SIM is reported as follows: **ON:** A SIM is reported when the pool threshold is exceeded. If the SIM is completed, and if the pool usage rate continues to exceed the pool threshold, the SIM is repeatedly reported every 8 hours. When the pool usage rate falls below the pool threshold, and then exceeds again, the SIM is reported again. **OFF (default):** A SIM is reported when the pool threshold is exceeded. If the SIM is completed, then the SIM is not reported again while the pool usage rate continues to exceed the pool threshold. When the pool usage rate falls below the pool threshold and then exceeds it again, the SIM is reported again. ***Notes:*** 1. Set this SOM to ON to prevent the write I/O operation from being unavailable due to pool full. 2. If the exceeding pool threshold SIM occurs frequently, other SIMs may not be reported. 3. Though setting this SOM to ON can increase the warning effect, if measures such as adding a pool fail to be done in time so that the pool becomes full, SOM 729 can be used to prevent file systems from being destroyed. 4. Setting SOM 741 to ON can provide the SIM report to users and service personnel.
741	Controls whether to report SIM-RC 625000 (DP pool usage rate continues to exceed the threshold) to service personnel. **ON:** SIMs are reported to service personnel. **OFF (default):** SIMs are not reported to service personnel. ***Notes:*** 1. Set this SOM to ON to have SIMs reported to service personnel: ▪ When SNMP and E-mail notification are not set. ▪ When Storage Navigator is not used and monitored regularly. 2. When SOM 734 is OFF, SIM-RC625000 is not reported, even if this SOM is ON.

Mode	Description
748	Controls pool allocation of Dynamic Provisioning. The page for DP host write operation is sequentially allocated from the top of the data drive. Additionally, with multiple pool volumes, the load of pool volume is dispersed by equalizing the usage rate of pages among pool volumes. **ON:** Page allocation is random. **OFF (default):** Page allocation is sequential. ***Notes:*** 1. Achieving load dispersal among pool volumes by equalizing the usage rate of pages used by DP volumes among pool volumes may change the performance characteristics. Set this SOM to ON when such a change is not desired. 2. SOM 749 is not available when this SOM is ON. 3. When this SOM is ON, performance equivalent to that of microcode 60-04-1*x* and earlier is achieved. Equalizing capacity for pool allocation becomes unavailable. 4. Availability: Even when this SOM is ON, a pool (a) that was created, (b) to which a pool volume was added as Add Pool VOL operation, or (c) for which zero data discarding was performed, while this SOM was OFF, would work based on the new logic (that is to allocate in a sequential manner from the top of HDD). 5. Impact without setting: When there is a pool (a) that was created, (b) to which a pool volume was added as Add Pool VOL operation, or (c) for which zero data discarding was performed, while this SOM was OFF, the microcode cannot be downgraded to 60-04-1*x* or earlier. Even when this SOM is ON, the pool (a) that was created, (b) to which a pool volume was added as Add Pool VOL operation, or (c) for which zero data discarding was performed, while this SOM was OFF, would work based on the new logic (that is, to allocate in sequential order from the top of the HDD).
749	Controls the Dynamic Provisioning Rebalance function that allows the drives of all ECC Groups in the pool to share the load. **ON:** Disables the Dynamic Provisioning Rebalance function. **OFF (default):** Enables the Dynamic Provisioning Rebalance function. ***Notes:*** 1. Apply this SOM when you do not need to change the performance characteristics. 2. This SOM is based on SOM 748. A pool created when SOM 748 is OFF can be subject to the Dynamic Provisioning Rebalance function. 3. When a new pool is installed, the load may be concentrated on the installed pool volumes. 4. When zero-data discarding is executed, load may be unbalanced among pool volumes. 5. This SOM does not work for the pool installed while SOM 748 is ON. Only pools installed when SOM 748 is OFF can be subject to the Dynamic Provisioning Rebalance function.

Mode	Description
763	Controls whether V-VOL usage rate is applied to all DP pools. **ON:** Association or expansion of DP-VOL exceeding DP pool capacity cannot be done for all pools. **OFF (default):** Association or expansion of DP-VOL exceeding DP pool capacity can be done for any pool. ***Notes:*** 1. You should set this SOM to ON when the pool usage rate is high and the pool is likely to be full. 2. Association or expansion of DP-VOL exceeding DP pool capacity is disabled, and the operation fails. 3. V-VOL usage rate is supported after this SOM is set to ON. If the capacity of a DP pool with which DP-VOLs are associated exceeds the maximum pool capacity before setting this SOM to ON, no report is issued for the pool. However, for association/expansion of DP-VOL for a pool with which DP-VOLs exceeding DP pool capacity have been associated before this SOM was ON, guard logic can be applied if any additional association/expansion of DP-VOL is performed. 4. When this SOM is ON, the V-VOL usage rate is applied to all DP pools regardless of whether SOM 764 is ON. If V-VOL usage rate is applied only to a specified pool by setting SOM 764 to ON, then this SOM must be set to OFF.
764	Enforces no over subscription on specific HDP pools **OFF (default):** Association or expansion of DP-VOL exceeding DP pool capacity can be done for any pool even the pool threshold is set to 95%. **ON:** ▪ Will not allow the aggregate DP-VOL's provisioned capacity to exceed the capacity of certain HDP pools. The HDP pools impacted by an ON setting are those pools with a utilization threshold setting of 95%. ▪ HDP pools with a user-defined utilization threshold of 5 to 90% are not under the control of Mode 764. Subscription is defined as the total sum of DP-VOL capacities divided by the associated pool capacity. Pools with a subscription level of less than 1 (or less than 100%) cannot possibly generate a pool full failure. If the association of a V-VOL to a HDP pool or the expansion of an existing DP-VOL would cause the total DP-VOL provisioned capacity to exceed the associated HDP pool capacity, then the association or DP-VOL expand is not allowed. ▪ A user who wants to construct a configuration where some HDP pools cannot fail due to a pool full condition and does not expect to realize any capacity savings due to thin provisioning for those pools can use this option. HDP pools that cannot be oversubscribed are pools with a utilization threshold of 95% and Mode 764 set to ON. Each HDP pool's subscription level is handled separately. ▪ Mode 763 overrides Mode 764. **Notes:** 1. Mode 764 can be turned ON or OFF at any time. The setting becomes immediately active. 2. If the subscription level for a pool is over 100%, the pools threshold setting is 95% and the option is changed from OFF to ON then the pool will continue to operate normally, however no new V-VOL associations will be allowed to that pool. 3. If Mode 764 is ON and the HDP pool utilization threshold is set from 5-90% to 95%, then the pool will continue to operate normally, however no new V-VOL associations will be allowed to that pool. 4. If Mode 764 is ON and the HDP pool utilization threshold is set from 95% to 5-90%, then the pool's subscription level will no longer be enforced.

Mode	Description
783	Minimizes impact of DP zero-clear processing on host I/O performance. This SOM is used to slow down the zero-clear processing to minimize the effect on the I/O performance of external VOL, because the workload of external pool (external VOL) is increased when zero-clear processing is performed. Set this SOM to ON when a DP pool is built using external storage (UVM). It provides a pacing scheme for deleting pages to prevent the overloading of the external storage. **ON:** Zero-clear processing is executed more slowly than usual when I/O processing of external pool (external VOL) is executed. **OFF (default):** Zero-clear processing is executed at the usual speed. ***Notes:*** 1. Apply this SOM to mitigate the effect on host I/O performance when workload of the external pool (external VOL) increases due to zero-clear processing executed when releasing a DP-VOL association, rebalancing, or executing initial copy of RCU in TC/UR. When this SOM is ON, the effect on host performance can be kept to about 15%, and zero-clear processing takes about seven times longer than with this SOM OFF. 2. Zero-clear processing (zero out the data area) and TC/UR initial copy take time. 3. For V06 version: When this SOM is set to ON/OFF, a onetime password is required. Apply this SOM according to factory (RSD) instruction. 4. For V07+2 version: When this SOM is set to ON/OFF, a one time password is not required. Apply this SOM according to Technical Support instruction.

3

Preparing for Dynamic Provisioning Operations

This chapter describes the necessary environment for Dynamic Provisioning.

- ☐ Preparing the Storage System and Storage Navigator Computer(s)
- ☐ Installing and Uninstalling Dynamic Provisioning

Preparing the Storage System and Storage Navigator Computer(s)

Hardware and Software Requirements

Before launching Dynamic Provisioning, you must take several preliminary steps. These include the following:

- Install the USP V/VM V storage system.
- Install the Storage Navigator computer(s), and connect them to the USP V/VM internal LAN.
- Enable Dynamic Provisioning on each storage system where you intend to use the option.
- If you intend to use Dynamic Provisioning DP-VOLs as ShadowImage P-VOLs or S-VOLs, you must also install ShadowImage. For detailed instructions on enabling Storage Navigator options, see the *User and Reference Guide* and the *Storage Navigator User's Guide*.
- If you intend to increase the capacity of DP-VOL, the Command Control Interface must be installed on your host server.

License Requirements

You will need a Dynamic Provisioning license for the total pool capacity. Licensed capacity for Dynamic Provisioning is priced on a per subsystem basis, so if you are using Virtual Partition Manager, you will not be charged for license capacity per storage logical partition (SLPR).

If you are using ShadowImage, TrueCopy, or Universal Replicator, you will need a license for the total consumed pool capacity in use by the P-VOLs and S-VOLs. If the total used pool capacity exceeds the licensed capacity, the additional capacity will be treated as a temporary license. You will be able to use the additional capacity for 30 days. After 30 days, you will not be able to perform ShadowImage operations except for deleting pairs. After 30 days, you will not be able to perform TrueCopy and Universal Replicator operations except for suspending copy operations or deleting pairs. For more information about temporary license capacity, see the *Storage Navigator User's Guide*.

Shared Memory Requirements

Dynamic Provisioning requires its own dedicated shared memory for the V-VOL management area, which is separate from the shared memory for Copy on Write Snapshot. The required shared memory will be installed by your Hitachi Data Systems representative.

Operating System and File System Capacity

When initializing a P-VOL, operating systems and file systems will consume some dynamic provisioning pool space. Some combinations will initially take up little pool space, while other combinations will take pool space as much as the virtual capacity of the DP-VOL. Table 3-2 shows the effects of those combinations. For more information, contact your Hitachi Data Systems representative.

Table 3-1 Operating System and File System Capacity

Operating System	File System	Metadata Writing	Pool Capacity Consumed
AIX®	JFS	Writes metadata in 8-MB intervals.	Size of DP-VOL If you change the Allocation Group Size settings when you create the file system, the metadata can be written to a maximum interval of 64 MB. Approximately 65% of the pool is used.
	JFS2	Writes metadata to first block.	Small (one page)
	VxFS	Writes metadata to first block.	Small (one page)
HP-UX®	JFS (VxFS)	Writes metadata to first block.	Small (one page)
	HFS	Writes metadata in 10-MB intervals.	Size of DP-VOL.
Linux®	XFS	Writes metadata in Allocation Group Size intervals.	Depends upon allocation group size. The amount of pool space consumed will be approximately [DP-VOL Size]*[42MB/Allocation Group Size]
	Ext2 Ext3	Writes the metadata in 128-MB intervals.	About 33% of the size of the DP-VOL. The default block size for these file systems is 4KB. This results in 33% of the DP-VOL acquiring HDP pool pages. If the file system block size is changed to 2 KB or less then the DP-VOL Page consumption becomes 100%.
Solaris®	UFS	Writes the metadata in 52-MB intervals.	Size of DP-VOL.
	VxFS	Writes metadata to first block.	Small (one page)

Operating System	File System	Metadata Writing	Pool Capacity Consumed
Windows Server 2003	NTFS	Writes metadata to first block.	Small (one page) The allocated capacity increases if the update of the file is repeated, and the effectiveness of reducing the pool capacity consumption decreases.
Windows Server 2008	NTFS	Writes metadata to first block.	Small (one page) If you perform the standard format operation when creating the file system, the size of the pool capacity the same as the file system capacity is consumed. In this case, we recommend using the Quick Format function. The allocated capacity increases if the update of the file is repeated, and the effectiveness of reducing the pool capacity consumption decreases.

Volume and Pool Requirements

Pool-VOL requirements are described in Table 3-2. Pool requirements are described in Table 3-3. DP-VOL requirements are described in

Table 3-4.

Table 3-2 Pool-VOL Requirements

Item	Requirement
Volume type	Logical volume (LDEV). Separating pool-VOLs from other volumes into different parity groups is recommended for best performance. You cannot specify the following volumes as Dynamic Provisioning pool-VOLs: ▪ Volumes used by ShadowImage, Volume Migration, TrueCopy, TrueCopy Asynchronous, or Universal Replicator ▪ LUSE volumes ▪ Volumes defined by Cache Residency Manager ▪ Volumes already registered in Copy-on-Write Snapshot or Dynamic Provisioning pools. ▪ Volumes used as Copy-on-Write Snapshot P-VOLs or S-VOLs. ▪ Data Retention Utility volumes with a Protect, Read Only, or S-VOL Disable attribute. ▪ Volumes whose LDEV status is other than Normal or Normal (Quick Format). You cannot specify volumes in blocked status or volumes in copying process. ▪ System disks ▪ Command devices ▪ Quorum disks You cannot store any pool-VOLs in a pool, including external volumes with a cache mode attribute.
Emulation type	OPEN-V
RAID level	Any RAID levels. ▪ Volumes with different RAID levels in a pool is not recommended. ▪ RAID-6 is recommended for large pools and where recovery time due to drive failure may be unacceptable.
Drive type	FC, SATA, and flash drive can be used as drive type. ▪ Internal Volume Pool-VOLs: Cannot be intermixed in the same pool if drive types are different. ▪ External Volume Pool-VOLs: Cannot be intermixed in the same pool if drive types are different; however, this configuration is not recommended for performance reasons.
Volume capacity	8 GB to 4 TB.
LDEV format	You must perform LDEV formatting before the volume is registered in a pool. You cannot format pool-VOLs.
Deleting pool-VOLs	You cannot remove pool-VOLs that are registered in pools. You need to delete the pool and then the pool-VOL(s) can be deleted.
Path definition	You cannot specify a volume with a path definition as a pool-VOL.

Table 3-3 Pool Requirements

Item	Requirement
Pool capacity	Please see Pools where a formula for calculating capacity is provided. However, the upper limit of total capacity of all pools is 1.1 PB.
Max Number of pool-VOLs	Up to 1024 per pool.
Max Number of pools	Up to 128 total pools per subsystem for Dynamic Provisioning. Pool IDs (0 to 127) are assigned as pool identifiers. The number of Dynamic Provisioning pools reduces the total availability of Copy-on-Write pools.
Increasing capacity	You can increase pool-VOL capacity dynamically increasing capacity by one or more parity groups is recommended.
Reducing capacity	You cannot reduce pool capacity. You must delete and then reconfigure the pool.
Deleting	You can delete pools that are not associated with any DP-VOLs.
Thresholds	Pool threshold 1: Default value is 70%. You can set it between 5% and 95%, in 5% increments. Pool threshold 2: Fixed at 80% Pool usage over either threshold will cause a warning to be issued via a SIM and an SNMP trap.
Data allocation unit	42 MB

Table 3-4 DP-VOL Requirements

Item	Requirement
Volume type	V-VOL. The LDEV number is handled in the same as for normal volumes.
Emulation type	Servers (including Command Control Interface) will show emulation types as follows: - OPEN-0V for V-VOLs created with microcode version 60-02-06 or lower. - OPEN-V for V-VOLs created with microcode version 60-02-25 or higher.
Maximum number of DP-VOLs	Up to 8192 volumes per pool Up to 1024 volumes per volume group Up to 63232 volume groups per system
Volume capacity	46 MB to 4 TB per volume Total maximum volume capacity of 1.1 PB per storage system.
Threshold	The DP-VOL threshold is the proportion of the potential demand a DP-VOL can consume of the pool capacity. The default value is 5% of the potential capacity. You can set it between 5% and 300%, in 5% increments. The default value is recommended,
Path definition	Available. However, you cannot define paths unless you first associate the DP-VOL with a pool.
LDEV format	Available. When you format an LDEV on the DP-VOLs, the storage system initializes data only in the consumed pool pages of the DP-VOLs. However, after you format an LDEV, the free space in the pool does not increase because the pages are not released.

Installing and Uninstalling Dynamic Provisioning

General installation instructions are contained in the *Storage Navigator User's Guide*. This section contains an outline of the additional instructions that are specific to Dynamic Provisioning.

Installing Dynamic Provisioning

4. Your Hitachi Data Systems representative will install the additional shared memory for the DP-VOL management area. This is separate from the shared memory for Copy-on-Write Snapshot.
5. Make sure that you have sufficient license capacity for the pool and any near term pool growth. For specific instructions on installing license capacity, see the Storage Navigator User's Guide.
6. Add parity groups, and define the volumes that will be used as pool-VOLs. You can use volumes in existing unused parity groups, in which case you would delete the path definition and perform LDEV format. For specific instructions on LDEV formatting see the Virtual LVI/LUN and Volume Shredder User's Guide.
7. Create the pools. For specific instructions, see Viewing Pool Information.
8. Create V-VOLs. For specific instructions, see Creating a V-VOL Group. After creation, at this point, they are DP-VOLs
9. Associate DP-VOLs to the pools. For specific instructions, see Changing the V-VOL Settings.
10. Define the paths for the DP-VOLs. For specific instructions, see the *LUN Manager User's Guide*.

Uninstalling Dynamic Provisioning

1. Delete the path definition for the DP-VOLs. For specific instructions, see the LUN Manager *User's Guide*.
2. Perform LDEV formatting on the DP-VOLs. For specific instructions on LDEV formatting see the Virtual LVI/LUN and Volume Shredder *User's Guide*.
3. Release the association between the DP-VOLs and the pools. For specific instructions, see Associating a V-VOL with a Pool.
4. Delete all DP-VOLs. For specific instructions, see Deleting a V-VOL Group.
5. Delete all pools. For specific instructions, see Deleting Pools.
6. Uninstall the Dynamic Provisioning license. For specific instructions on uninstalling license capacity, see the *Storage Navigator User's Guide*.

4

Using the Dynamic Provisioning GUI

This chapter describes the Dynamic Provisioning windows and dialog boxes.

Pool Window

Access the Pool window by selecting **Go** → **LUN Expansion/VLL** → **Pool**. The Pool window (see Figure 4-1) provides information about both Dynamic Provisioning pools and Copy-on-Write Snapshot pools.

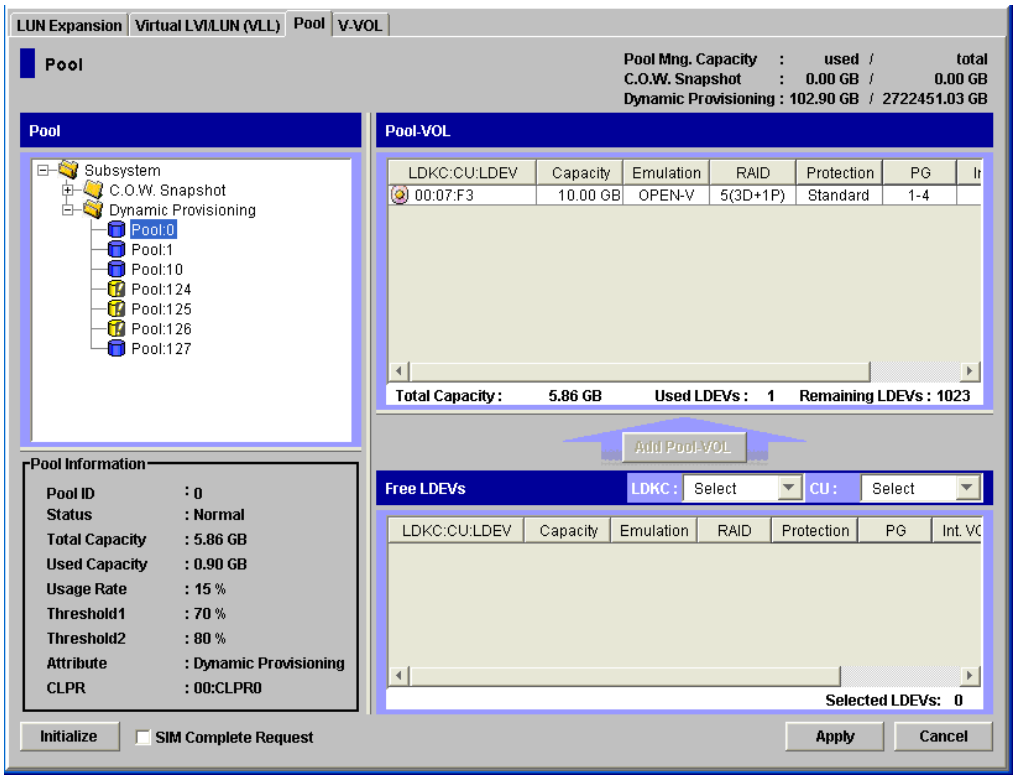

Figure 4-1 Pool Window

Item	Description
Pool tree	Shows the Dynamic Provisioning and Copy on Write Snapshot pools. The Pool tree contains one or more of the following icons:  : A folder is used to indicate the storage system, the group of Dynamic Provisioning pools or the group of Copy-on-Write Snapshot pools.  Pool X: A pool in normal status (X indicates the pool ID).  Pool X: A pool whose usage level exceeds the threshold (X indicates the pool ID).  Pool X: A blocked pool or a pool where a pool-VOL is blocked or being formatted (X indicates the pool ID).  : A normal pool in the process of being deleted.  : A blocked pool or a pool where a pool-VOL is blocked or being formatted, which is in the process of being deleted.  : A pool with a usage level that exceeds a threshold and is in the process of being deleted. Table 4-1 lists the pop-up menu commands available in the tree.
Pool Mng. Capacity (Pool Management Capacity)	Capacity for both Copy-on-Write Snapshot and Dynamic Provisioning pools. ***Caution:*** The total capacity and used capacity value are changed, when you add or delete pool-VOLS, after you click **Apply**. ▪ **Used:** Capacity, in GB, of the pools that are in use. ▪ **Total:** Total capacity, in GB, of the pools that are in use plus those that can be created. The capacity of the pools that can be created is derived from the available shared memory capacity. Available pool capacity decreases when a V-VOL is added, and increases when a V-VOL is deleted. ***Warning:*** Do not exceed the total capacity for pool management blocks in use.

Item	Description
Pool-VOL table	The Pool-VOL table contains one or more of following icons:  : Pool-VOLs having the V-VOL management area.  : Pool-VOLs not having the V-VOL management area. The Pool-VOL table, on the upper right of the Pool window, provides the following information about the selected pool-VOL(s): ▪ **LDKC:CU:LDEV:** Unique address consisting of the LDKC (logical DKC) number, CU number and LDEV number ▪ **Capacity:** LDEV capacity. ▪ **Emulation:** Emulation type. ▪ **RAID:** RAID level. As a best practice, always specify the same RAID level for all pool-VOLs registered to the same pool. RAID-6 is recommended for large pools and where recovery time due to drive failure may be unacceptable. ▪ **Protection**: SATA protection level. Internal SATA storage can have one of two types of write verification. The values reported are: o **SATA-W/V:** Write & Verify method on internal SATA drives o **SATA-E:** Enhancing method on internal SATA drives o **Standard:** All other storage (FC drives, flash drives, external volumes, or V-VOLs) It is recommended that the data protection level of the pool-VOLs in the same pool be the same. ▪ **PG:** Parity group. ▪ **Int. VOL Info:** Drive type of internal volumes. o Nothing will be displayed for FC drives. o An asterisk (*) will be displayed for a SATA drive. o A dollar mark ($) will be displayed for a flash drive. o Three consecutive hyphens (---) will be displayed for an external volume. ⚠ ***Caution:*** Pool-VOLs with different drive types cannot be intermixed in the same pool. ▪ **Ext. VOL Info:** Drive type of external volumes. Best practice is to specify the same drive type for all pool-VOLs registered in the same pool. o Nothing will be displayed for FC drives. o An asterisk (*) will be displayed for a SATA or BD drive. o A dollar mark ($) will be displayed for a flash drive. Three consecutive hyphens (---) will be displayed for an internal volume. ▪ **Cache Mode:** If the volume is an external volume, cache mode appears. This cache mode is specified automatically when the external volume is mapped. ⚠ ***Caution:*** Pool-VOLs with different cache modes cannot be intermixed in the same pool. ▪ **Total Capacity:** Total capacity of the pool-VOLs in the pool. ▪ **Used LDEVs:** Total number of the pool-VOLs. ▪ **Remaining LDEVs:** Total number of the pool-VOLs that you can add to the pool

Item	Description

Pool Information box	Details about the pool.
	▪ **Pool ID:** Pool identifying number.
	▪ **Status:** Pool status
	  ○ **Normal:** Normal status. The pool usage level may exceed the variable or fixed pool threshold.
	  ○ **Warning:** Pool-VOL in the pool is blocked or being formatted.
	  ○ **Blocked:** The pool is full or an error occurs in the pool, therefore the pool is blocked. If the pool is in both **Warning** and **Blocked** statuses, only **Warning** is displayed.
	▪ **Total Capacity:** Total pool capacity. **Total Capacity** is calculated from the number of pages (42 MB per page).
	▪ **Used Capacity:** Used pool capacity. **Used Capacity** is calculated from the number of pages (42 MB per page).
	▪ **Usage Rate:** The pool usage level as a percentage of the current used pool capacity to the total pool capacity.
	▪ **Threshold1:** Variable threshold compared to usage level. The default setting is 70%. You can set it from 5% to 95% in 5% increments.
	▪ **Threshold2:** Fixed threshold compared to usage level. Threshold2 is always fixed at 80%.
	  ○ **Warning:** Usage level exceeds a threshold.
	  ○ **Error:** Usage level has reached 100%.
	▪ **Threshold:** Pool usage threshold (%).
	▪ **Attribute:** Program product that uses the pool.
	  ○ **Dynamic Provisioning**
	  ○ **C.O.W. Snapshot**
	▪ **CLPR:** CLPR number of the pool volume.

Initialize or **Optimize** button	If there is no pool in the storage system, click **Initialize** to initialize the entire V-VOL management area. Click **Optimize** under the following conditions: ▪ For pools created using any microcode version before V05 or microcode version V05 and later with SOM 748 set to the non-default setting of ON, click **Optimize** after adding all pool volumes to the pool when creating a new pool and when adding additional capacity to the pool. This balances the assignment of future storage requests across all the pool volumes. If **Optimize** is not used at this time, free pages are reordered over the next half hour (or more). ▪ Optimize is ignored for pools created using microcode version v05 or later; creating a new pool or adding capacity to a pool is not enhanced by using **Optimize**. Processing time depends on pool capacity. Processing normally takes 1 minute for each 10 TB of the pool, and could take up to 30 minutes. ***Warning***: Clicking this button cancels any other pending operations in this window.
SIM Complete Request check box	Completes the pool-related SIMs, including threshold warnings and blocked pool warnings. For more information, see Managing Pool-Related SIMs. All outstanding SIMs will be marked completed after clicking **Apply**. Before using the **SIM Complete Request** check box, ensure that all outstanding SIM conditions are cleared. For instance, pool space has been added to lower the usage level below all defined threshold settings.

Item	Description
Add Pool VOL button	Adds the volumes you selected in the **Free LDEVs** list (below) to the pool-VOL table. ▪ The **LDKC** list limits the display to CUs in the selected LDKC. ▪ The **CU** list limits the free LDEVs display to volumes in the selected CU.
Free LDEVs table	Lists the volumes that can be specified as pool-VOLs. The following information is displayed for each volume: ▪ **LDKC:CU:LDEV:** Logical DKC (LDKC) number, CU number and LDEV number. An LDEV number ending in # (e.g., 00:00:01#) indicates an external volume. ▪ **Capacity:** LDEV capacity. ▪ **Emulation:** Emulation type. ▪ **RAID:** RAID level. It is recommended that you specify the same RAID level for pool-VOLs registered in the same pool for best performance. RAID-6 is recommended for large pools and where recovery time due to drive failure may be unacceptable. ▪ **Protection**: SATA protection level. Internal SATA storage can have one of two types of write verification. The values reported are: o **SATA-W/V:** Write and verify method on internal SATA drives o **SATA-E:** Enhancing method on internal SATA drives o **Standard:** All other storage (FC drives, flash drives, external volumes, or V-VOLs) It is recommended that the data protection level of the pool-VOLs in the same pool be the same. ▪ **PG:** Parity group. ▪ **Int. VOL Info:** Drive type of internal volumes. o Nothing appears for FC drives. o An asterisk (*) indicates a SATA drive. o A dollar mark ($) indicates a flash drive. o Three consecutive hyphens (---) will be displayed for an external volume. ⚠***Caution:*** Pool-VOLs with different drive types cannot be intermixed in the same pool. ▪ **Ext. VOL Info:** Drive type of external volumes. Best practice is to specify the same drive type for all pool-VOLs registered in the same pool. o Nothing appears for FC drives. o An asterisk (*) indicates a SATA or BD drive. o A dollar mark ($) indicates a flash drive. o Three consecutive hyphens (---) indicate for an internal volume. ▪ **Cache Mode:** If the volume is an external volume, cache mode appears. ⚠***Caution:*** This cache mode is specified automatically when the external volume is mapped. Pool-VOLs with different cache modes cannot be intermixed in the same pool. ▪ **CLPR: CLPR** number. ▪ **Selected LDEVs:** Total number of selected volumes.
Apply	Implements all pending operations.
Cancel	Cancels all pending operations.

Table 4-1 Pop-Up Menu Commands

Command Menu		Function
When you right-click the **Dynamic Provisioning** icon:	New Pool	Opens the New Pool dialog box (see Figure 5-4).
	Delete Pool(s)	Deletes one or more pools. This command is only available when there are pools that can be deleted.
	Restore Pool(s)	Returns one or more blocked pools to normal status. This command is only available when blocked pools exist. If the pool usage level is 100% (POOL FULL) or a pool-VOL in the pool is blocked or being formatted, this command is not available.
When you right-click a **Pool** icon:	Change Pool Information	Opens the Change Pool Information dialog box (see Figure 5-5.
	Delete Pool	Deletes the selected pool.
	Restore Pool	Returns blocked pool to normal status. This command is only available when blocked pools exist. If the pool usage level is 100% (POOL FULL) or a pool-VOL in the pool is blocked or being formatted, this command is not available.

V-VOL Window

Access the V-VOL window by selecting the **Go** → **LUN Expansion/VLL** → **V-VOL**. This window displays both Dynamic Provisioning and Copy on Write Snapshot V-VOLS.

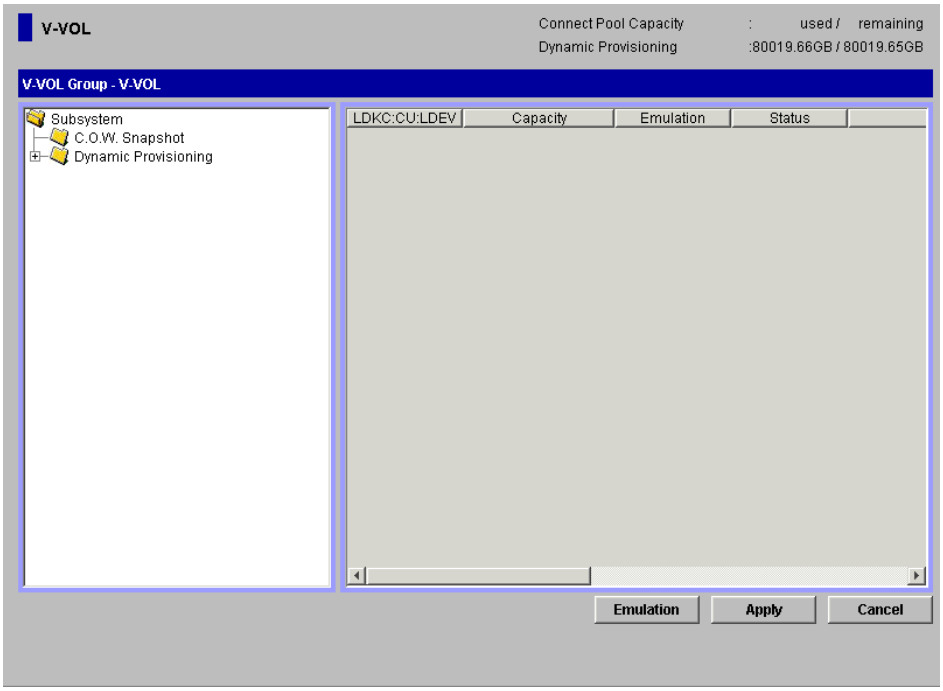

Figure 4-2 V-VOL Window

Item	Description
Connect Pool Capacity	Provides the following information about V-VOLs of Dynamic Provisioning: ▪ **used:** total capacity (GB) of V-VOLs associated with pools. ▪ **remaining:** Total capacity (GB) of V-VOLs that can be associated with pools. This capacity is calculated based on the assumption that V-VOLs of 1024 GB are associated with pools. If V-VOLs of another size are associated with pools, please calculate the total capacity of V-VOLs that can be associated with pools from the **remaining** value by the following formulas. X1 = ↓ (**remaining** (GB) ÷ 1024) ↓ S1 = (X1 × 14 + (**remaining** (GB) - (X1 × 1024)) ÷ 84) S2 = (↑ (Capacity of one V-VOL (GB) ÷ 84) ↑ + 1) Total capacity of V-VOLs that can be associated with pools = (S1 ÷ S2) × Capacity of one V-VOL ○ ↓ ↓ indicates that the number enclosed by two downward arrows should be rounded down to the nearest whole number. ○ ↑ ↑ indicates that the number enclosed by two upward arrows should be rounded up to the nearest whole number. ⚠***Caution:*** The values of **used** and **remaining** are not reflected in the window until you click **Apply**.

Item	Description
V-VOL Group - V-VOL tree	Shows the V-VOL groups in the storage system. The following icons can appear:  : The folder for a storage system or a program product  : V-VOL Group ○ A V-VOL Group icon followed by a V indicates a Copy-on-Write Snapshot V-VOL, which cannot be used for Dynamic Provisioning operations. ○ A V-VOL Group icon followed by an X indicates a Dynamic Provisioning V-VOL, also referred to as a DP-VOL (because Copy-on-Write uses V-VOL).  : V-VOL group (in the process of being deleted).  : VDEV Table 4-2 lists the commands available from the pop-up menu.
V-VOL list	Provides the following information about the selected V-VOL: ▪ **LDKC:CU:LDEV:** Logical DKC (LDKC) number, CU number, and LDEV number. ○ A number followed by an X indicates a Dynamic Provisioning DP-VOL. ○ A number followed by a V indicates a Copy-on-Write Snapshot V-VOL. ▪ **Capacity:** Volume capacity. ▪ **Emulation:** Emulation type. "**CVS**" indicates a Virtual LVI/LUN volume. For more information, see the *Virtual LVI/LUN and Volume Shredder User's Guide*. ▪ **Status**: DP-VOL status ○ **Normal** ○ **Blocked** ▪ **CLPR**: CLPR number. ▪ **Access Attribute:** Access attribute of the DP-VOL. If the Data Retention Utility is installed, the Access attribute is set in Storage Navigator using the Data Retention window. Values include: ○ Read/Write ○ Read only ○ Protect ▪ **Path:** DP -VOL LU path. ▪ **Threshold**: Potential demand capacity warning threshold. ▪ **Pool ID**: Pool identifying number. ▪ **Usage Rate**: The pool usage level as a percentage of the consumed DP-VOL capacity to the total DP-VOL capacity. ▪ **Used Page Num**: Number of pages used in DP-VOL. ▪ **Page Status**: Current page status of DP-VOL. ○ **Discarding Zero Data**: Zero data are being discarded and the pages are being released. ○ **Discard Zero Data**: Dynamic Provisioning is ready to discard zero data and release pages. This status appears in blue bold italics until **Apply** is clicked. ○ **Stop Discarding Zero Data**: Dynamic Provisioning is ready to stop discarding zero data and releasing pages. This status appears in blue bold italics until **Apply** is clicked. ○ **Releasing**: Disassociation of the V-VOL from the pool is applied, and the page is being released. ○ A hyphen (-) appears when the page status is other than listed above.

Item	Description
Emulation	Changes the emulation type OPEN-0V to OPEN-V. Only the emulation value settings for the DP-VOL are changed using this control. Also, when initiated, the contents that have appeared in blue bold italics in the V-VOL group tree or V-VOL list are cancelled. Clicking **Emulation** opens a window (see Figure 4-3) on which **Normal** mode and **Force** mode are selectable. These two options (**Normal** and **Force**) further restrict which DP-VOLs change. Selecting **Normal** mode or **Force** mode determines the scope of the emulation change process, as follows: ▪ **Normal** mode: In **Normal** mode, Dynamic Provisioning V-VOLs that do not have a defined LU path change. All OPEN-0V DP-VOLs without a path assigned change to OPEN-V. ▪ **Force** mode: In **Force** mode, all Dynamic Provisioning V-VOLs, regardless of whether an LU path is defined, change. All OPEN-0V DP-VOLs change to OPEN-V. Because the **Force** mode also changes Dynamic Provisioning V-VOLs on which a LU path is defined, the emulation type recognized by the server changes suddenly for these volumes. Therefore it remains possible that the LU cannot be recognized by the host and that I/O stops. While the host is online and I/O occurs, it is strongly recommended you avoid using the **Force** mode. If you use the **Force** mode and change the emulation type already recognized by the host, reconfigure the LU from the host so that the LU is recognized by the host. These modes and the execution of the emulation process are not restricted by any selection or highlighting of V-VOL entries in the list. All DP-VOLs are considered for an OPEN-V change during the emulation process. Volume migration cannot be performed between volumes with different emulation types. For example, volume migration is not available between a Dynamic Provisioning V-VOL recognized as OPEN-0V and a normal volume.
Apply	Implements all pending operations.
Cancel	Cancels all pending operations.

Table 4-2 V-VOL Window Pop-up Menu Commands

Command Menu		Function
When you right-click the Dynamic Provisioning folder	New V-VOL Group	Opens the New V-VOL Group dialog box (see Figure 4-8).
	Associate V-VOL Groups with Pool	Opens the Associate V-VOL Groups with Pool dialog box (see Figure 4-15). Associates V-VOLs in multiple V-VOL groups with a pool at the same time.
	Release V-VOL Groups from Pool	Opens the Release V-VOL Groups from Pool dialog box (see Figure 4-16). Releases V-VOLs in multiple V-VOL groups from a pool at the same time.
	Delete V-VOL Groups	Opens the Delete V VOL Groups dialog box (see Figure 4-17). Deletes multiple V-VOL groups and the V-VOLs that are in that V-VOL group at the same time.
When you right-click the V-VOL Group icon	Delete V-VOL Group	Deletes the V-VOL group and associated V-VOLs.
When you right-click a Dynamic Provisioning V-VOL	Associate V-VOL with Pool	Opens the Connect Pool dialog box (see Figure 4-13).
	Release V-VOL from Pool	Releases the V-VOL from the Dynamic Provisioning pool.
	Change Threshold	Opens the Change Threshold dialog box (see Figure 4-14)
	Discard Zero Data	Releases pages if all the data in the pages of the V-VOL are zero.
	Stop Discarding Zero Data	Stops discarding zero data and releasing the pages.

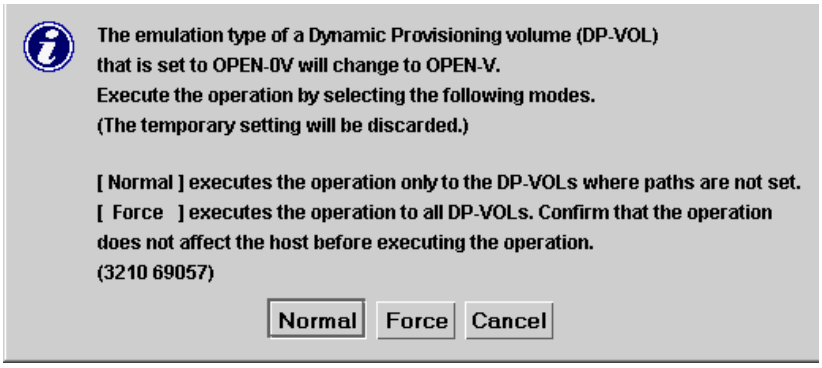

Figure 4-3 Storage Navigator Window Showing Two Modes

Dynamic Provisioning Window

Access the Dynamic Provisioning window by selecting **File → Basic Information → Dynamic Provisioning**. The Dynamic Provisioning window allows you to display and manage DP -VOLs, pools, and the V-VOL management area.

Figure 4-4 shows the default view, which is with the **LDKC:CU** button selected.

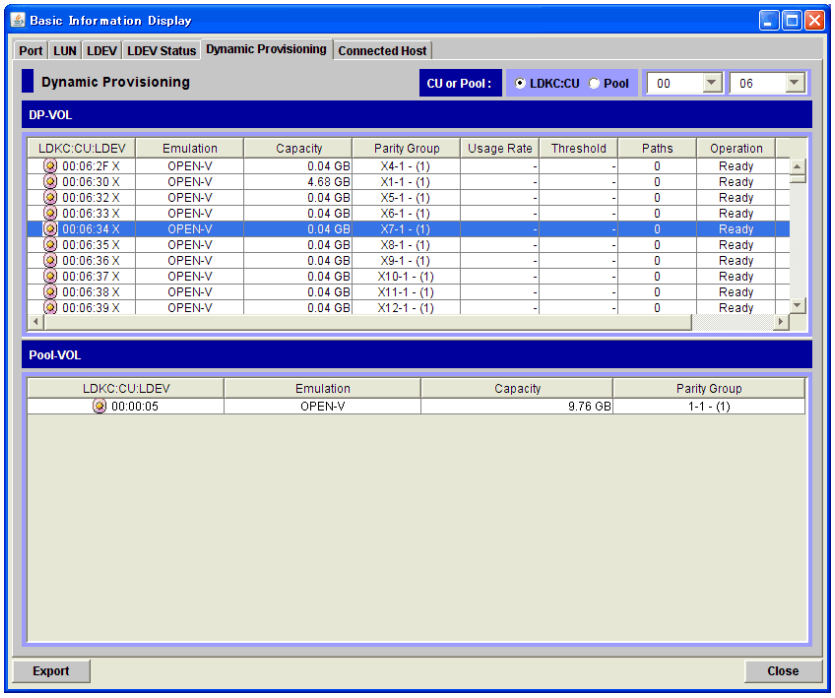

Figure 4-4 Dynamic Provisioning Window (LDKC View)

Figure 4-5 shows the Dynamic Provisioning window with the **Pool** button selected.

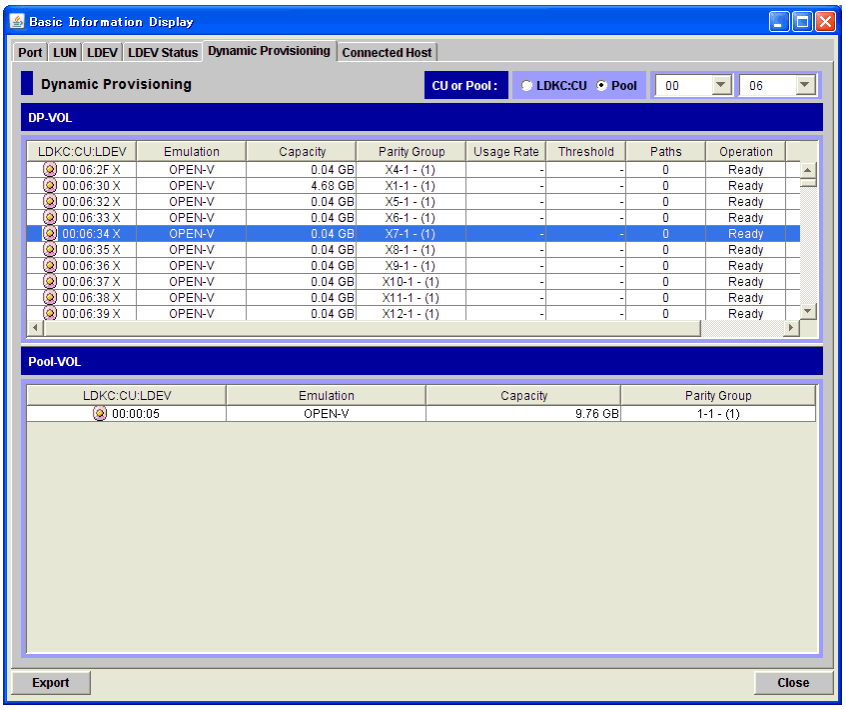

Figure 4-5 Dynamic Provisioning Window (Pool View)

Item	Description
LDKC:CU or **Pool**	Use these options to filter the data to be displayed to view either LDKC:CU information or pool information.
DP-VOL list	Provides information about the selected DP-VOL: ▪ **LDKC:CU:LDEV:** Logical DKC (LDKC) number, CU number and LDEV number. The icons can include the following: indicates a normal LDEV. indicates a secured volume. indicates a remote command device. indicates a command device. indicates a secured command device. ○ If the number is followed by X, it indicates a Dynamic Provisioning DP-VOL. ○ If the number is followed by V, it indicates a Copy-on-Write Snapshot V-VOL. ▪ **Emulation:** Emulation type. OPEN-V is the only supported emulation type. "**CVS**" indicates a Virtual LVI/LUN volume. For more information, see the *Virtual LVI/LUN and Volume Shredder User's Guide*. ▪ **Capacity:** DP-VOL capacity, in GB. ▪ **Parity Group:** Parity group number. ▪ **Usage rate:** The pool usage level as a percentage of the used capacity compared to the total capacity. ▪ **Threshold:** Potential demand capacity consumed percentage at which a warning will be issued. Available values are from 5% to 300%, in 5% increments.

Item	Description
	▪ **Paths:** Number of LU paths to the volume, from 0 to 65280. ▪ **Operation:** Indicates whether you can perform an operation on the DP-VOL. ○ **Ready:** You can perform an operation on the DP-VOL. ○ **Processing:** You cannot perform any operation on the DP-VOL because another operation is being performed on the DP-VOL. ○ **Discarding Zero Data:** You cannot start a new operation for discarding zero data because discarding of zero data is currently taking place. ○ **Releasing**: You cannot perform any operation on the DP-VOL because another operation is being performed on the DP-VOL. ▪ **Pool ID**: Pool identifier. ▪ **Used Page Num**: Number of pages used in DP-VOL.
Pool VOL list	Provides the following information about the selected pool-VOL: ▪ **LDKC:CU:LDEV:** Logical DKC (LDKC) number, CU number, and LDEV number. The icon that will be one of the following:  A normal LDEV.  A secured volume.  A remote command device.  A command device.  A secured command device. ▪ **Emulation:** Emulation type. OPEN-V is the only supported emulation type. ▪ **Capacity:** Pool-VOL capacity, in GB. ▪ **Parity Group:** Parity group number.
Apply	Implements all pending operations.
Cancel	Cancels all pending operations.

New Pool Dialog Box

The **New Pool** dialog box opens after you right-click the **Dynamic Provisioning** icon in the Pool window and select **New Pool**.

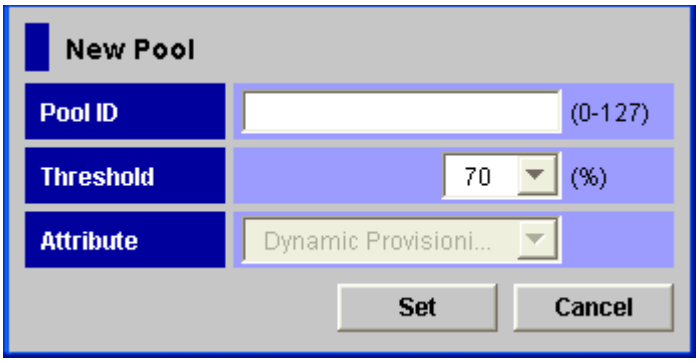

Figure 4-6 New Pool Dialog Box

Item	Description
Pool ID	Enter the pool ID number using numbers from 0 to 127. Do not use a number that is already in use.
Threshold	Select the pool usage warning threshold, which is specified as a percentage. The range can be between 5 and 95. The default value is 70. If the pool usage level exceeds the threshold, the pool status changes to **Warning** when the pool is in Warning Status then additional pool volume should be added to the pool.
Attribute	Dynamic Provisioning should already be selected.
Set	Creates the new pool and closes the dialog box. The setting will not be implemented until you click **Apply** on the **Pool** window.
Cancel	Cancels the settings and closes the dialog box. No pool will be created.

Change Pool Information Dialog Box

Access the Change Pool Information dialog box by right-clicking the selected pool, then selecting **Change Pool Information**.

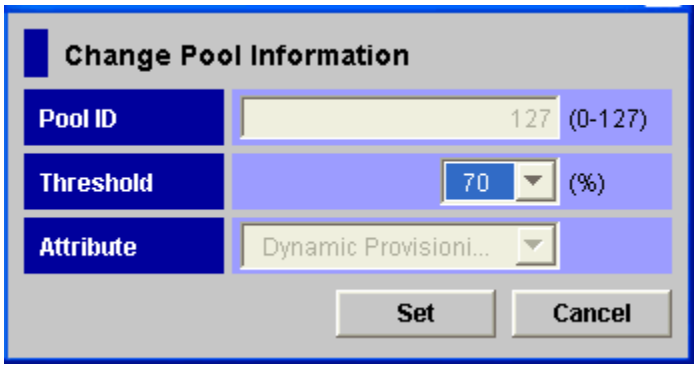

Figure 4-7 Change Pool Information Dialog Box

The features of the Change Pool Information dialog box are the same as for the New Pool Dialog box, except that only the **Threshold** field is available.

New V-VOL Group Dialog Box

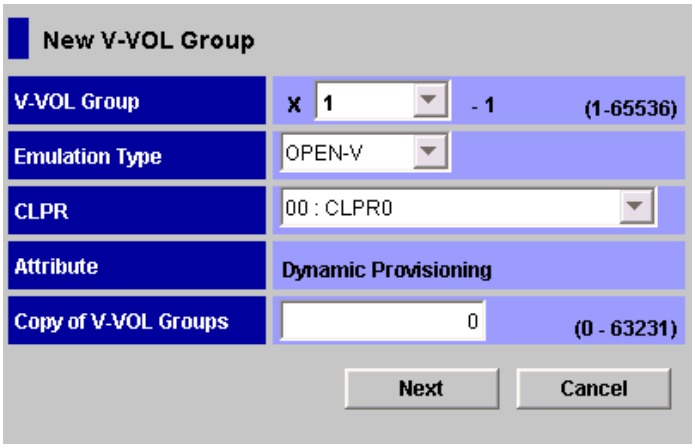

Figure 4-8 New V-VOL Group Dialog Box

Item	Description
V-VOL Group	Select the V-VOL Group ID using numbers from 1 to 65535. Do not use a number that is already in use as a V-VOL Group ID.
Emulation Type	Select the emulation type. Open-V is the only type that is supported.
CLPR	Select the cache logical partition. For more information on cache logical partitions, see the *Virtual Partition Manager User's Guide*. The CLPR value should be the same as the pool that will be assigned to the DP-VOLs.
Attribute	Shows either Copy-on-Write Snapshot or Dynamic Provisioning.
Copy of V-VOL Groups	Enter the number of V-VOL groups to be created. You can enter numbers from 0 to 63231. This is the maximum per subsystem. If you have any external volumes or any Copy-on-Write Snapshot volumes, this maximum is decreased accordingly. If you enter 0, no V-VOL group will be created.
Next	Implements the setting in the **New V-VOL Group** dialog box and opens the **Create V-VOL** dialog box (1).
Cancel	Cancels the settings and closes the dialog box. No group will be created.

Create V-VOL Dialog Box (1)

Access this dialog box by clicking **Next** on the New V-VOL Group dialog box (see New V-VOL Group Dialog Box).

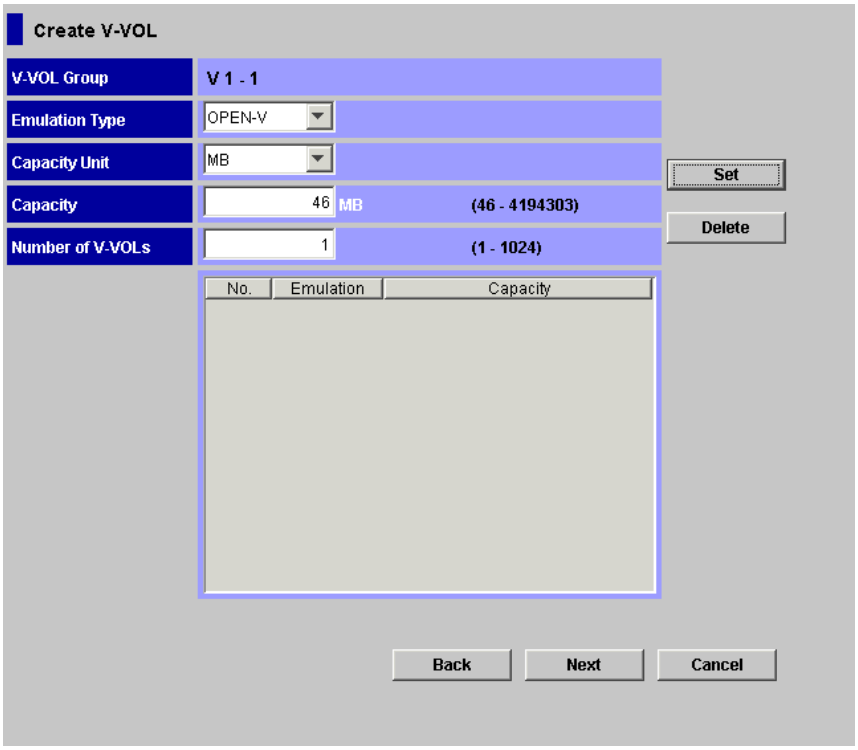

Figure 4-9 Create V-VOL Dialog Box (1)

Item	Description
V-VOL Group	Shows the V-VOL group ID set in the New V-VOL Group dialog box.
Emulation Type	Select the emulation type. OPEN-V is the only type that is supported.
Capacity Unit	Select the capacity unit: ▪ **MB** (megabyte) ▪ **Block** ▪ **Cyl** (cylinder)
Capacity	Enter the DP-VOL capacity. ▪ If you selected **MB** in the **Capacity Unit** list, enter numbers from 46 to 4194303. ▪ If you selected **block** in the list, enter numbers from 96000 to 8589934592. ▪ If you selected **Cyl** in the **Capacity Unit** list, enter numbers from 50 to 4473924. When you specify the **Capacity Unit** as MB or Cyl, the storage system optimally corrects the **Capacity**. Therefore, to set **Capacity** accurately to the largest value of the VDEV capacity, specify the **Capacity Unit** as block.

Item	Description
Number of V-VOL	Enter the number of DP-VOLs that you want to add, from 1 to 1024. See SOM 726 explained in DP-VOLs. The number of DP-VOLs that you can enter in this dialog box can vary, depending on the number of V-VOL groups specified in New V-VOL Group dialog box (see Figure 4-8). For example, if you specified 100 V-VOL Groups, in this dialog box you can specify 10 V-VOLs per V-VOL Group, because the maximum total is 1024. In this case, the displayed range would be 1 - 10.
Set	Adds the V-VOLs to the list.
Delete	Deletes the V-VOLs from the list.
V-VOL information setting list	Shows the following information about the selected V-VOL(s): ▪ **No.:** Number. ▪ **Emulation:** Emulation type. ▪ **Capacity:** Capacity.
Back	Keeps the settings in this dialog box, but returns you to the New V-VOL Group dialog box (see Figure 4-8).
Next	Opens the Create V-VOL dialog box (2) (see Figure 4-10).
Cancel	Cancels the operation and closes the dialog box. No V-VOL will be created.

Create V-VOL Dialog Box (2)

Access the Create V-VOL dialog box (2) by selecting **Next** on the Create V-VOL dialog box (1) (see Figure 4-9).

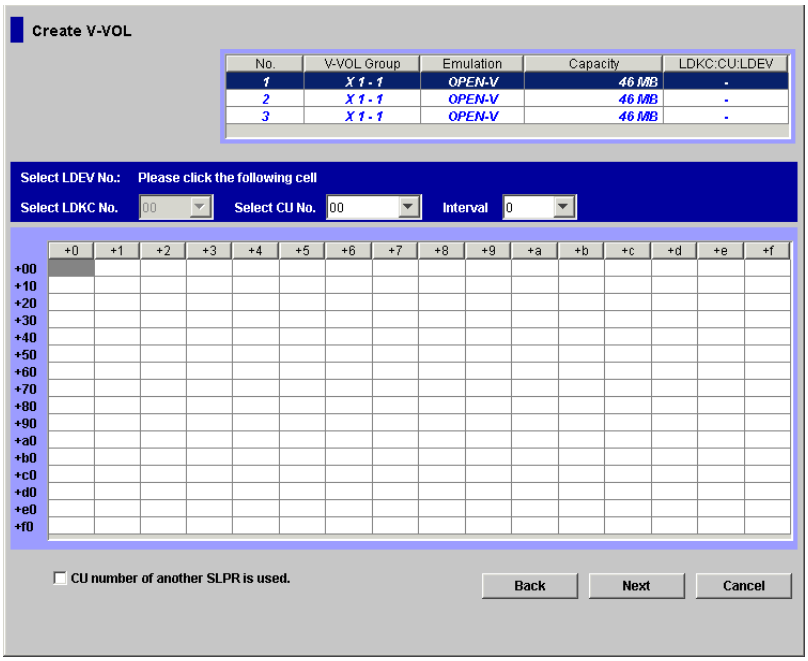

Figure 4-10 Create V-VOL Dialog Box (2)

Item	Description
V-VOL list	Information about each V-VOL in the list: ▪ **No.:** Number. ▪ **V-VOL Group:** Group ID. ▪ **Emulation:** Emulation type. ▪ **Capacity:** Capacity. ▪ **LDKC:CU:LDEV:** LDKC number, CU number and LDEV number. Dynamic Provisioning LDEV numbers are followed by an **X**. Copy-on-Write Snapshot LDEV numbers are followed by a **V**.
Select LDKC No.	Select the LDKC.
Select CU No.	Select the CU.
Interval	Select the interval between the LDEV numbers that will be assigned to the newly-created V-VOLs. If you select **0**, the LDEV numbers will be sequential. The value you specify as the interval between LDEV numbers counts only the available LDEV numbers and skips those that are not selectable. Even when you use the multiple CUs, LDEV numbers will be assigned according to the **Interval** list.

Item	Description
Select LDEV No.	The LDEV number grid. The location on the grid indicates the LDEV number. The numbers across the top (CU number) combined with the numbers on the left side indicate the LDEV number. For example, the LDEV number of the cell with a CU number of **+2** and an LDEV number of **+10** is 12. ▪ Gray cells indicate LDEVs that are already in use. ▪ White cells indicate unused LDEV numbers. ▪ Blue cells indicate LDEVs that have been selected for V-VOLs in this procedure.
CU number of another SLPR is used	If checked, allows you to select CU numbers from another SLPR.
Back	Maintains the settings in this dialog box while returning you to the **Create V-VOL dialog box (1)** (see Figure 4-9).
Next	Implements the settings in this dialog box and opens the Create V-VOL Confirmation dialog box (see Figure 4-12). The **Create V-VOL dialog box (3)** appears only when SSID is not assigned to the boundary area that contains LDEV numbers you set in this dialog box. The **Create V-VOL dialog box (4)** appears when SSID is assigned.
Cancel	Cancels the operation and closes the dialog box. No V-VOL will be created.

Create V-VOL Dialog Box (3)

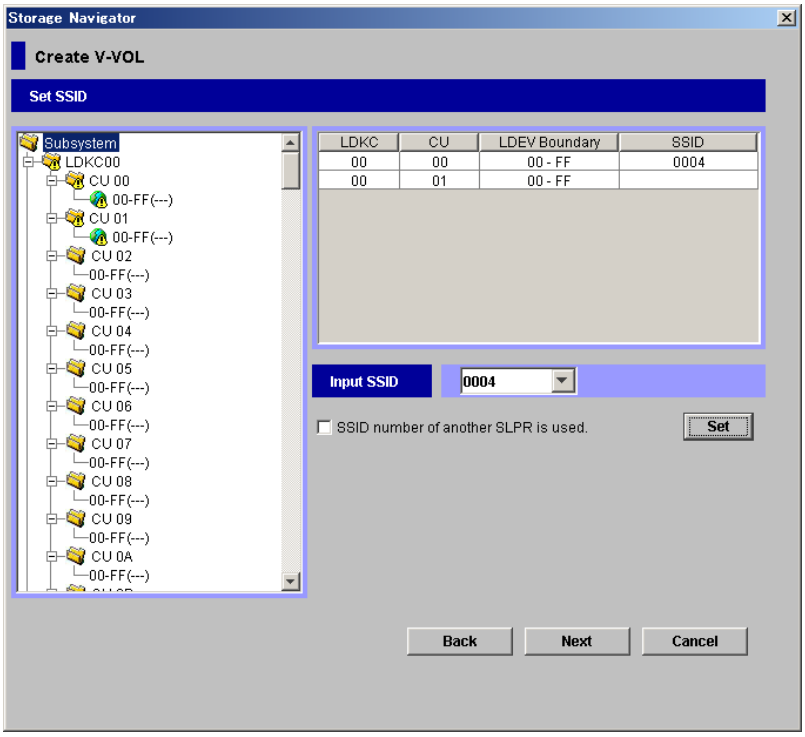

Figure 4-11 Create V-VOL Dialog Box (3)

Item	Description
Set SSID tree	A hierarchical structure of LDKC numbers (for example, LDKC00), CU numbers (for example, CU 00), SSID boundary areas (for example, 00-FF), and SSID (for example, 0004). The boundary area is a collection of LDEV numbers to which that SSID is assigned. For example, if a boundary area is 00-FF, an SSID must be assigned to a group of LDEV numbers from 00 to FF. A CU contains one or four boundary areas, which are fixed per CU by the factory settings. An SSID appears to the right of a boundary area and is enclosed in parentheses. If no SSID is assigned to a boundary area, hyphens (----)appear to the right of the boundary area, and an exclamation mark (!) appears on the LDKC icon, the CU icon, and the boundary area icon.
Set SSID icons	The icons indicate the SSID boundary area assignments:  : An LDKC number or a CU number. SSIDs are assigned to all the boundary areas.  : An LDKC number or a CU number. SSIDs are not assigned to all the boundary areas.  : No SSID is assigned to this boundary area.
Set SSID table	Use this table to set the SSID boundary area. ▪ **LDKC:** LDKC number for the CU number that contains and LDEV boundary with no SSID. ▪ **CU:** CU number that contains an LDEV boundary with no SSID. ▪ **LDEV boundary:** Boundary area of the LDEV number with no SSID. ▪ **SSID:** Assigned SSID. The default is blank.
Input SSID list	Select or enter the desired SSID. You can enter SSID only when you are logged in as a storage administrator.
SSID number of another SLPR is used	When checked, you may select the SSID number that does not exist in the SLPR to which the parity group does not belong. When the check box is cleared, you can select only the SSID in the SLPR to which the parity group belongs. The check box is available only when logged in as a storage administrator, and when there are two or more SLPRs. You cannot enter the number in this list when this check box is cleared.
Set	▪ **Input SSID:** Sets the SSID selected or input from **Input SSID** list. ▪ **Set SSID:** Updates the SSID selected or input from **Input SSID** list.
Back	Maintains the settings in this dialog box and returns to the **Create V-VOL dialog box (2)** (see Figure 4-10).
Next	Implements the settings in this dialog box and opens the **Create V-VOL confirmation dialog box** (see Figure 4-12).
Cancel	Cancels the operation and closes the dialog box.

Create V-VOL Confirmation Dialog Box

Use this dialog box to confirm settings. Open the V-VOL Confirmation dialog box by selecting **Next** on the Create V-VOL dialog box (2) (see Figure 4-10).

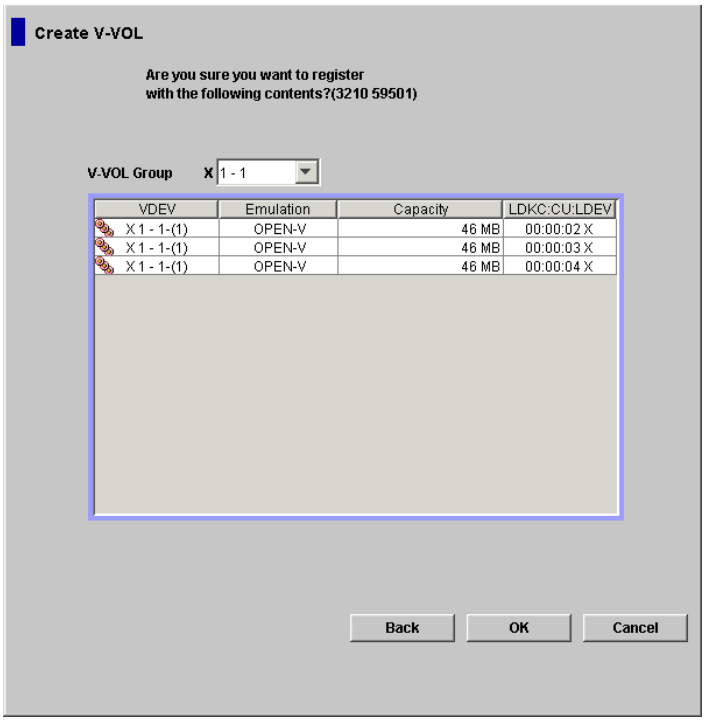

Figure 4-12 Create V-VOL Confirmation Dialog Box

Item	Description
V-VOL Group	V-VOL group ID.
V-VOL information	Information about each V-VOL in the group that you are creating: ▪ **VDEV:** V-VOL group ID and VDEV number. ▪ **Emulation:** Emulation type. ▪ **Capacity:** Capacity. ▪ **LDKC:CU:LDEV:** LDKC number, CU number and LDEV number.
Back	Maintains the settings in this dialog box and returns to the **Create V-VOL Dialog box (2)** (see Figure 4-10).
OK	Implements the settings and closes the dialog box. The settings are not applied to the subsystem until you click **Apply** in the V-VOL window.
Cancel	Cancels the operation and closes the dialog box.

Connect Pool Dialog Box

Access the Connect Pool dialog box by opening the **V-VOL window** (see Figure 4-2), then right-clicking on the V-VOL group that you want to associate with the pool, and then selecting **Associate V-VOL with Pool**.

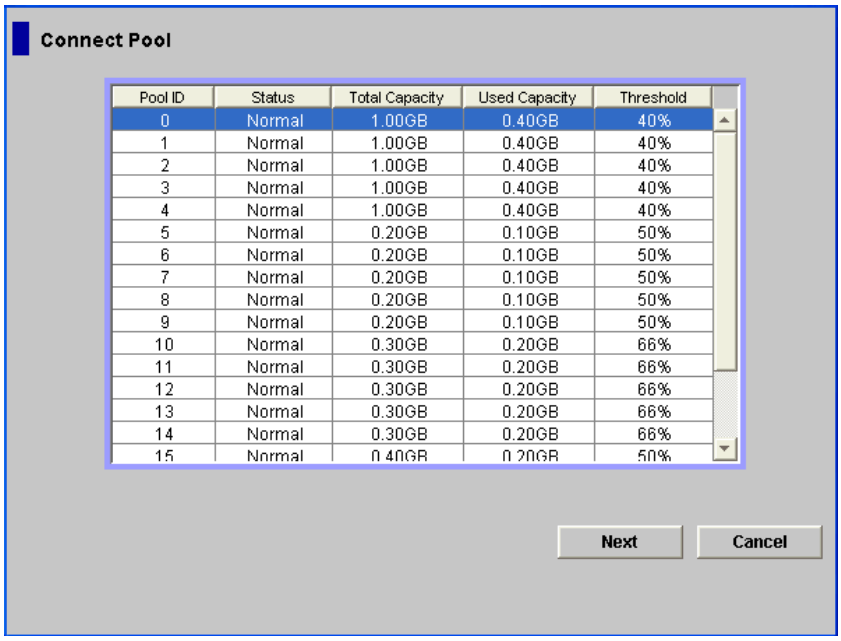

Figure 4-13 Connect Pool Dialog Box

Item	Description
Pool ID	Pool ID.
Status	Pool status (**Normal** or **Blocked**).
Total Capacity	The total pool capacity (value is truncated to 2 decimal places).
Used Capacity	Used pool capacity (value is truncated to 2 decimal places).
Threshold	Pool usage level threshold.
Next	Opens the Change Threshold dialog box, provided that you have selected a row.
Cancel	Cancels the operation and closes the dialog box. No pool will be connected.

Change Threshold Dialog Box

Access the Change Threshold dialog box by selecting **Next** on the Connect Pool dialog box.

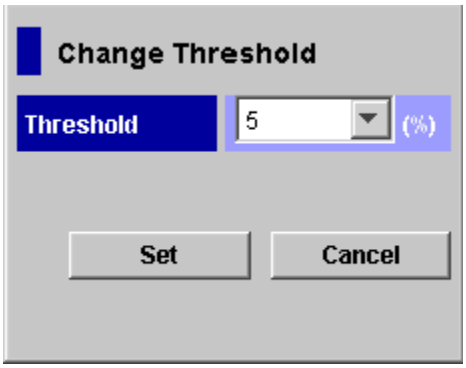

Figure 4-14 Change Threshold Dialog Box

Item	Description
Threshold	Select the DP-VOL potential demand capacity threshold. Select values from 5% to 300%, in 5% increments. The default is 5%.
Set	Implements the threshold setting for that V-VOL.
Cancel	Cancels the operation and closes the dialog box.

Associate V-VOL Groups with Pool Dialog Box

Access the Associate V-VOL Groups with Pool dialog Box by opening the V-VOL window (see Figure 4-2), right-clicking on the **Dynamic Provisioning** icon, and then selecting **Associate V-VOL Groups with Pool**.

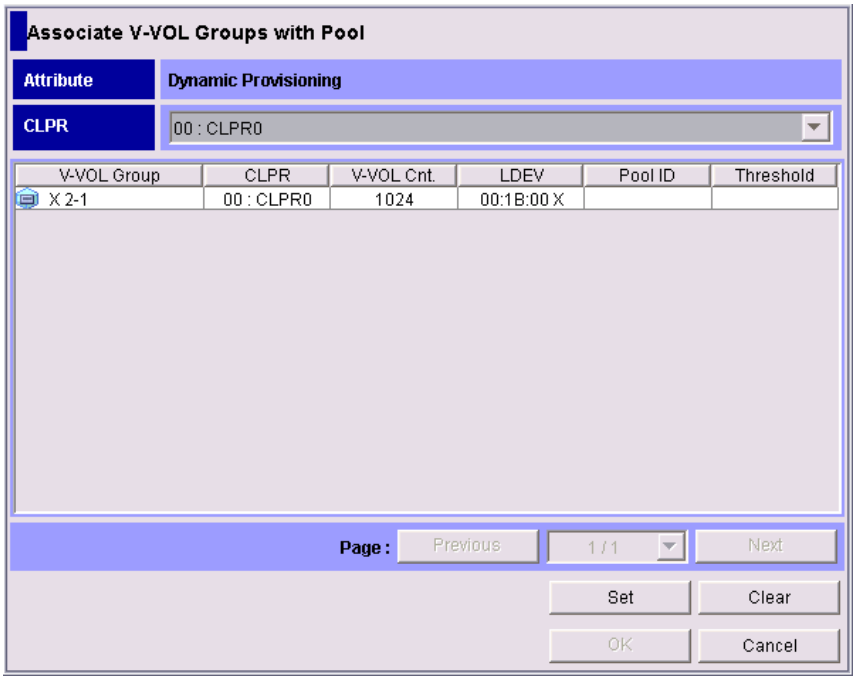

Figure 4-15 Associate V-VOL Groups with Pool Dialog Box

Item	Description
Attribute	The name of the program product that is going to use the V-VOL groups. This is the name of the program product whose icon you right-clicked in order to display the Associate V-VOL Groups with Pool dialog box.
CLPR	Select the CLPR of the V-VOL group that you want to associate with a pool.

Item	Description
V-VOL information	Information about the V-VOL groups. ▪ **V-VOL Group.:** V-VOL group ID. ▪ **CLPR:** CLPR number. ▪ **V-VOL Cnt.:** Number of the V-VOLs in the V-VOL groups. ▪ **LDEV:** LDKC number, CU number and LDEV number of the first LDEV in the V-VOL group. These numbers are separated by colons. ▪ **Pool ID:** Pool ID of the first LDEV in the V-VOL group. The following symbols are used to display status: ○ If a V-VOL group is associated with a pool, a **Pool ID** appears in blue bold italics. ○ If a V-VOL group is released from a pool, a hyphen (-) is shown. ○ If the V-VOL group is not associated with a pool, a space [ ] is shown. ▪ **Threshold:** Threshold (5% to 300%) applies to the first LDEV in the V-VOL group. The following symbols are used to display status: ○ If the V-VOL group is associated with pool, the Threshold appears in blue bold italics. ○ If the V-VOL group is released from pool, a hyphen (-) is shown. ○ If the V-VOL group is not associated with a pool, a space [ ] is shown.
Icons	The following icon appears in the dialog box:  : V-VOL group.
Page	The number of the current page. Use the buttons to change pages. ▪ **Previous** displays the previous 4,096 V-VOL groups. ▪ ***N/M*** list: The ***N*** displays the number of the current page. The ***M*** displays the total number of pages. You can click the list, and choose the number of the page you want to display. ▪ **Next** displays the next 4,096 V-VOL groups.
Set	Specifies that the V-VOL groups selected in the V-VOL information setting list will be associated with a pool. The V-VOL groups to be associated with a pool appear in blue bold italics. The Connect Pool dialog box (Figure 4-13) opens.
Clear	Clears each setting in the V-VOL information setting list.
OK	Closes the dialog box and displays a confirmation message asking whether it is OK to apply the setting to the storage system.
Cancel	Cancels all the and closes the dialog box.

Release V-VOL Groups from Pool Dialog Box

Access the Release V-VOL Groups from Pool dialog box by opening the V-VOL window (see Figure 4-2), right-clicking on the **Dynamic Provisioning** icon, and then selecting **Release V-VOL Groups from Pool**.

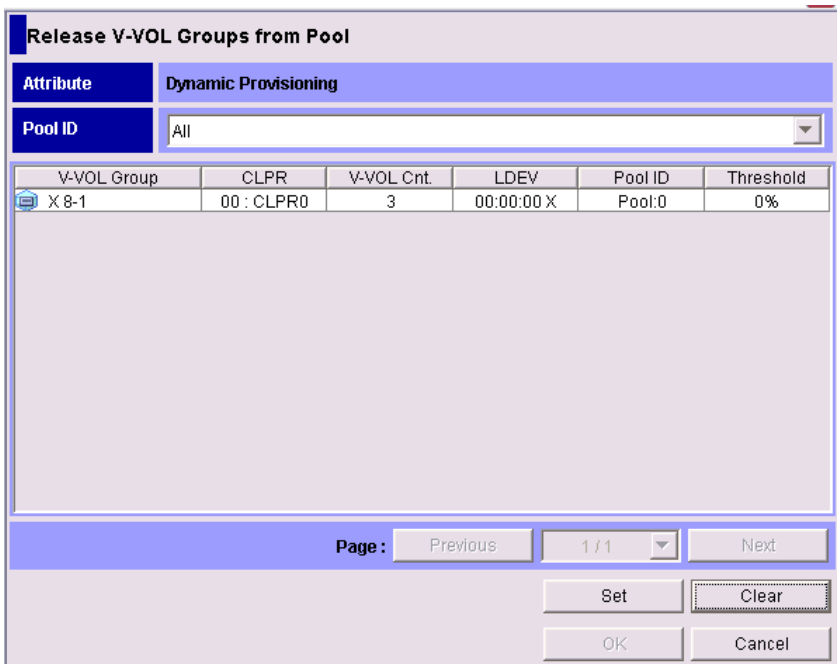

Figure 4-16 Release V-VOL Groups from Pool Dialog Box

Item	Description
Attribute	The name of the program product that is going to use the V-VOL groups is shown. This is the name of the program product whose icon you right-clicked in order to display the Release V-VOL Groups from Pool dialog box.
Pool ID	Select the CLPR of the V-VOL group that you want to release from a pool. If **All** is selected, all V-VOL groups associated with a pool are displayed.

Item	Description
V-VOL information	Information about the V-VOL groups. ▪ **V-VOL Group.:** V-VOL group ID. ▪ **CLPR:** the number of the CLPR. ▪ **V-VOL Cnt.:** the number of the V-VOLs in the V-VOL groups. ▪ **LDEV:** LDKC number, CU number and LDEV number of the first LDEV in the V-VOL group. These numbers are separated by colons. ▪ **Pool ID:** Pool ID of the first LDEV in the V-VOL group. The following symbols are used to display status: ○ If the V-VOL group is associated with pool, the **Pool ID** appears in blue bold italics. ○ If the V-VOL group is released from pool, a hyphen (-) is shown. ○ If the V-VOL group is not associated with a pool, a space [ ] is shown. ▪ **Threshold:** Threshold (5% to 300%) that applies to the first LDEV in the V-VOL group. The following symbols are used to display status: ○ If the V-VOL group is associated with pool, the Threshold appears in blue bold italics. ○ If the V-VOL group is released from pool, a hyphen (-) is shown. ○ If the V-VOL group is not associated with a pool, a space [ ] is shown.
Page	The number of the current page. Use the buttons to change pages. ▪ **Previous** displays the previous 4,096 V-VOL groups. ▪ **N/M** list: The ***N*** displays the number of the current page. The ***M*** displays the total number of pages. You can click the list, and choose the number of the page you want to display. ▪ **Next** displays the next 4,096 V-VOL groups.
Set	Specifies that the V-VOL groups selected in the V-VOL information setting list will be released from a pool. The V-VOL groups to be released from a pool appear in blue bold italics.
Clear	Clears each setting in the V.
OK	Closes the dialog box and displays a confirmation message asking whether it is OK to apply the setting to the storage system.
Cancel	Cancels all the settings and closes the dialog box.

Delete V-VOL Groups Dialog Box

Access the Delete V-VOL Groups dialog box by opening the V-VOL window (see Figure 4-2), right-clicking on the **Dynamic Provisioning** icon, and then selecting **Delete V-VOL Groups**.

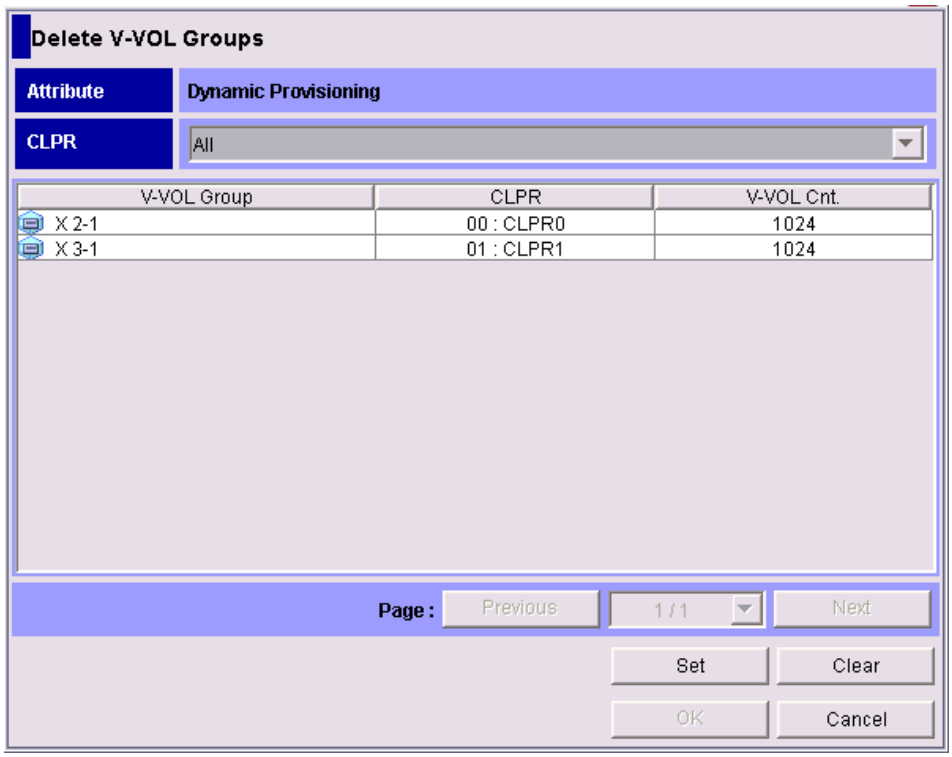

Figure 4-17 Delete V-VOL Groups Dialog Box

Item	Description
Attribute	The name of the program product that is going to use the V-VOL groups. This is the name of the program product whose icon you right-clicked in order to display the Delete V-VOL Groups dialog box.
CLPR	Select the CLPR of the V-VOL group. If **All** is selected, all V-VOL groups in all CLPRs are displayed.
V-VOL information	Information about the V-VOL groups that you are going to delete. ▪ **V-VOL Group.:** V-VOL group ID. ▪ **CLPR:** the number of the CLPR. ▪ **V-VOL Cnt.:** the number of the V-VOLs in the V-VOL groups.
Icons	The following icons are displayed in the dialog box: : V-VOL group. : V-VOL group (in the process of being deleted).

Item	Description
Page	The number of the current page. Use the buttons to change pages. ▪ **Previous** displays the previous 4,096 V-VOL groups. ▪ **N/M** list: The N indicates the number of the current page. The M indicates the total number of pages. You can click the list, and choose the number of the page you want to display. ▪ **Next** displays the next 4,096 V-VOL groups.
Set	Specifies that the V-VOL groups selected in the V-VOL information setting list will be deleted. The V-VOL groups to be deleted appear in blue bold italics.
Clear	Clears each setting in the V-VOL information setting list.
OK	Closes the Delete V-VOL Groups dialog box and a confirmation message appears asking whether it is OK to apply the setting to the storage system.
Cancel	Cancels all the settings and closes the dialog box.

5

Performing Dynamic Provisioning Operations

This chapter gives instructions for performing Dynamic Provisioning Operations.

Dynamic Provisioning Flow Chart

Only Storage Administrators can perform Dynamic Provisioning operations. Figure 5-1 illustrates the Dynamic Provisioning functions:

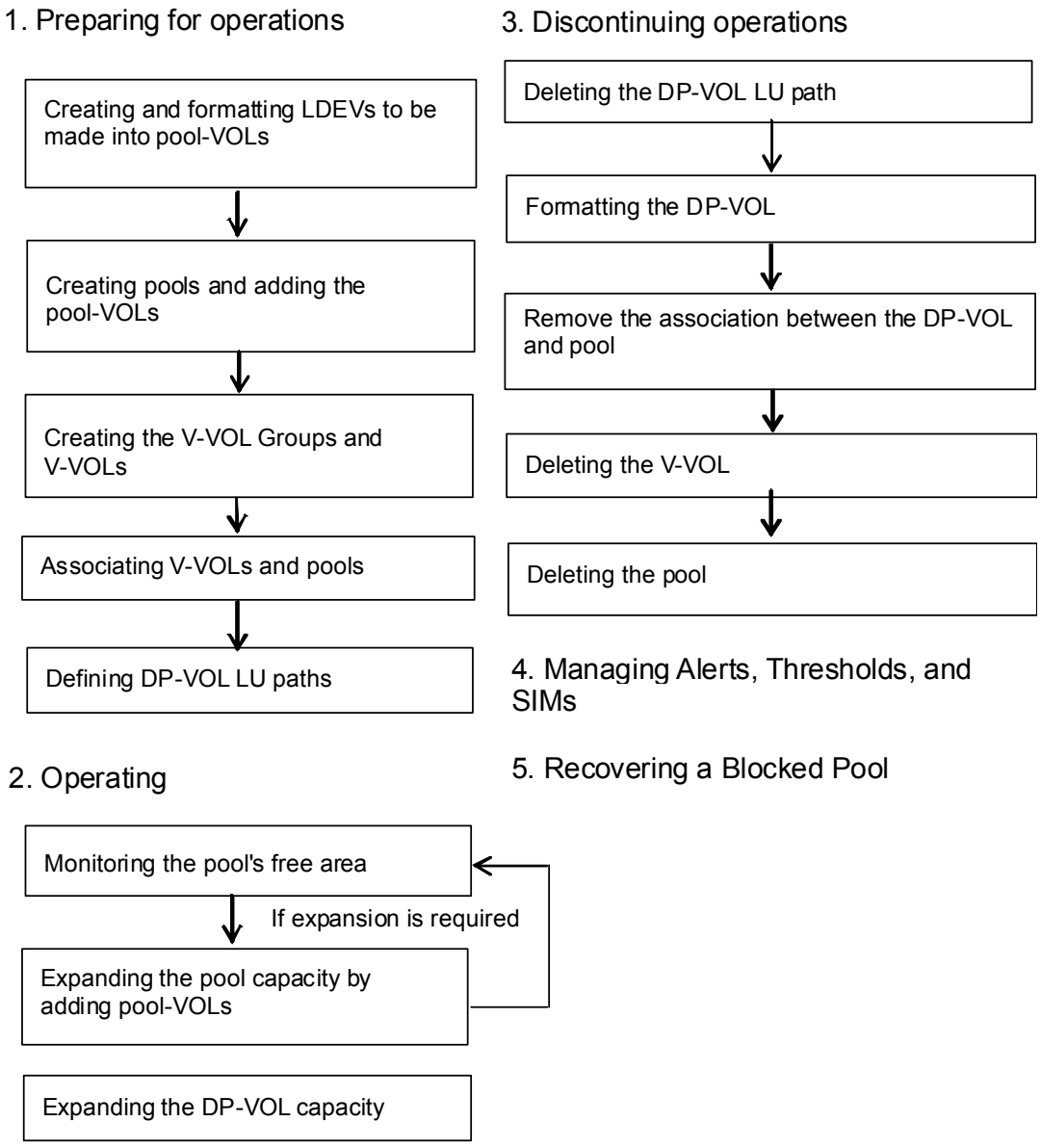

Figure 5-1 Dynamic Provisioning Flow Chart

Managing Pools

This section discusses the following topics:

- Viewing Pool Information
- Creating a Pool
- Associating a V-VOL with a Pool
- Changing the Pool Threshold
- Deleting Pools
- Recovering Pools in Blocked Status

Viewing Pool Information

To view the pool information:

1. From the **File** Menu, select **Basic Information**. The Basic Information Display window will open in a separate window. The **Port** tab is the default view.
2. Click the **Dynamic Provisioning** tab to display the **Dynamic Provisioning** window (see Figure 5-2). Click **LDKC:CU** to view information sorted by CU number. Click **Pool** to view information sorted by pool.

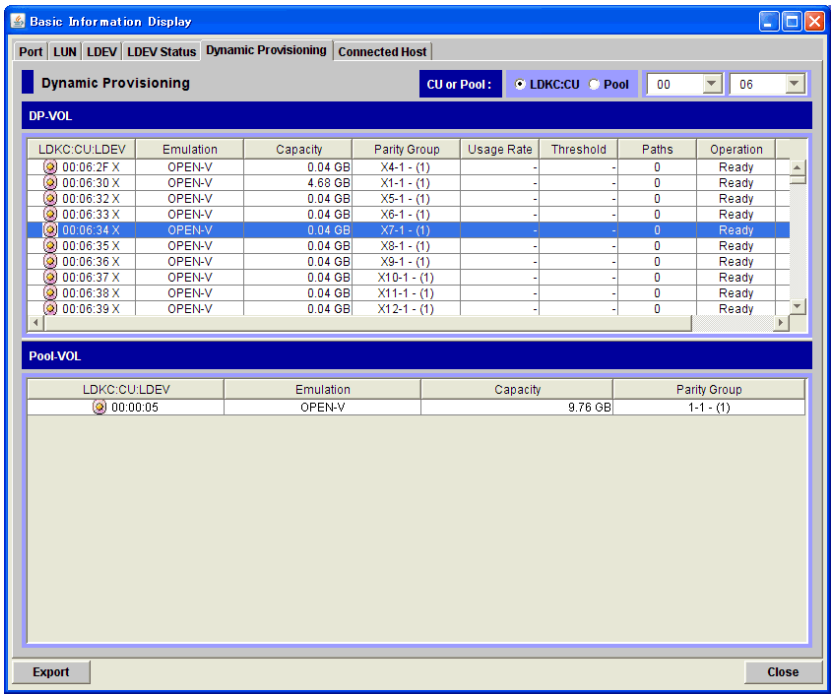

Figure 5-2 Viewing the Dynamic Provisioning Information

3. Additional Dynamic Provisioning information is available using Go > LUN Expansion/VLL > Pool (See Figure 5-3).

Creating a Pool

The first step in using Dynamic Provision is to create one or more pools.

Notes:

- Total capacity is the total pool storage capacity.
- The value for pool management blocks in use will increase if you add pool-VOLs.
- Warning: Make sure that the blocks-in-use capacity is less than the total capacity.

To create a pool:

1. Access the Pool window (see Figure 5-3) by selecting **Go → LUN Expansion/VLL → Pool**.
2. In the **Pool** tree, on the upper left of the Pool window, right-click the **Dynamic Provisioning** folder, then select **New Pool**.
3. In the **New Pool** dialog box (see Figure 5-4):
   - In the **Pool ID** text box, type the number for the pool ID. Use numbers from 0 to 127 and do not select a number that is already in use for any other pool (Dynamic Provisioning or Copy-on-Write).
   - In the **Threshold** list, select the pool usage level threshold. This is expressed as a percentage of pool usage over pool capacity.

Warning: If the usage level of the pool exceeds a threshold, you will go to warning status. Additional pool volumes should be added when the usage level is above a threshold.

   - In the **Attribute** list, select **Dynamic Provisioning**.
4. Verify that the settings are correct, then select **Set**.
5. The New Pool dialog box closes and the new pool appears in the **Pool** tree.
6. To create another pool, repeat the preceding steps.
7. Click **Apply** then **OK** to create the new pool or pools. This operation may take up to 20 minutes depending on the number and capacity of the pools and pool-VOLs.

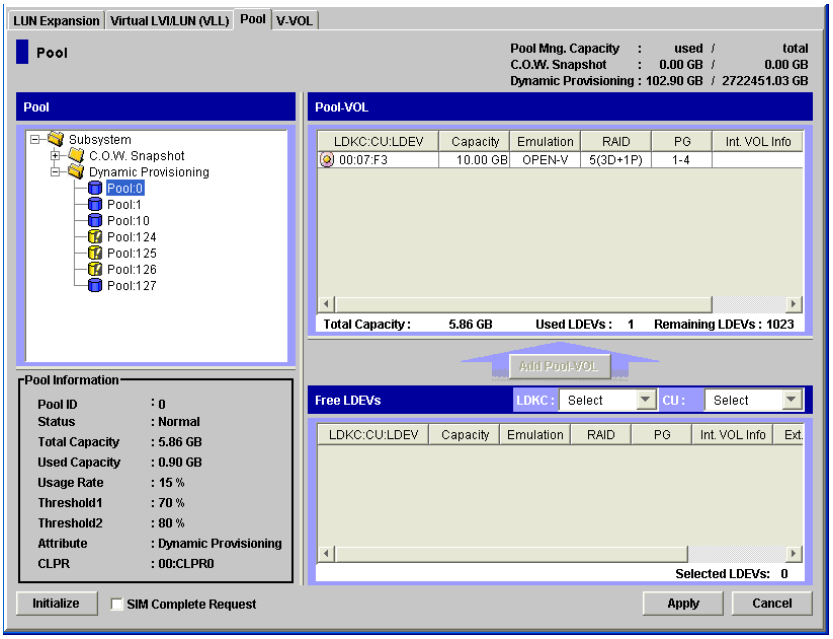

Figure 5-3 Pool Window

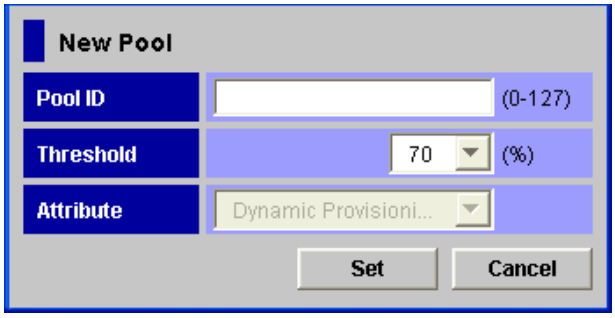

Figure 5-4 Defining a New Pool

Associating the Pool-VOLs with the Pool

To associate one or more pool-VOLs with a pool:

1. Access the **Pool** window (see Figure 5-3) by selecting **Go** → **LUN Expansion/VLL** → **Pool**.
2. In the Pool tree, on the upper left of the Pool window, select a pool.
3. In the **Free LDEVs** list, on the bottom right of the window, select the volume(s) that you want to register in the pool as the pool-VOLs.
   - If you select an LDKC number from the list, the **CU** list will contain only CUs within that LDKC.

- If you select a CU number from the **CU** list, the **Free LDEVs** list will contain only the LDEVs in that CU. Within the same CU, you can select multiple LDEVs at a time.

Caution: As a best practice, use the same drive type for all pool-VOLs in the same pool.

4. Right-click the selected volumes and select **Add Pool-VOL**.
5. Check the list of the volumes, then click **OK**. The dialog box closes and the selected volumes appear in the **Pool-VOL** list.

Caution: You cannot delete the pool-VOLs after you add them. Make sure to verify that the settings are correct.

6. To add more pool-VOLs, repeat the preceding steps.
7. Click **Optimize** based on the following conditions:
   - For pools created using any microcode version before V05 or microcode version V05 and later with SOM 748 set to the non-default setting of ON, click **Optimize** after adding all pool volumes to the pool when creating a new pool and when adding additional capacity to the pool. This balances the assignment of future storage requests across all the pool volumes. If **Optimize** is not used at this time, free pages are reordered over the next half hour (or more).
   - **Optimize** is ignored for pools created using microcode version v05 or later; creating a new pool or adding capacity to a pool is not enhanced by using **Optimize**.

   Processing time depends on pool capacity. Processing normally takes 1 minute for each 10 TB of the pool, and could take up to 30 minutes.

Warning: Clicking this button cancels any other pending operations in this window.

8. Click **Apply** then **OK** to associate the pool-VOL with the pool.

Changing the Pool Threshold

Once you have created a pool, the only setting you can change is the threshold.

To change the pool threshold:

1. Access the **Pool** window (see Figure 5-3) by selecting **Go** → **LUN Expansion/VLL** → **Pool**.

2. In the pool tree on the upper left of the window, right-click the selected pool, then select **Change Pool Information** to open the Change Pool Information dialog box (see Figure 5-5). If the pool usage level is 95% or higher, the pop-up menu will not be available.
3. Select the value for the threshold from the Threshold list.
4. Click **Set** to close the Change Pool Information dialog box.
5. Click **Apply** and then **OK** to change the pool threshold.

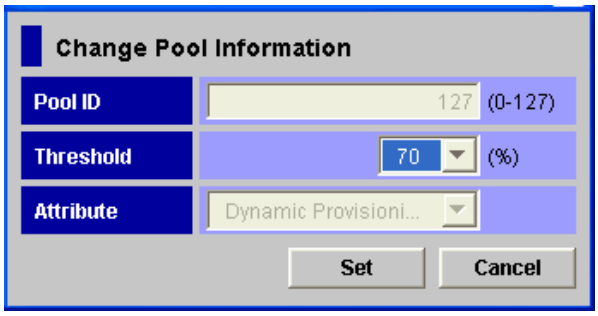

Figure 5-5 Change Pool Information Dialog Box

Deleting Pools

As a general rule you will specify and delete a single pool. If you choose to delete multiple pools, all pools that can be deleted will be deleted.

Deleting a Single Pool

A pool can be deleted only when there are not DP-VOLs associated with the pool. Confirm that the pool usage is 0 and the pool association with DP-VOL has been deleted, and then you can delete a single pool.

To delete a pool:

1. Access the Pool window (see Figure 5-3) by selecting **Go → LUN Expansion/VLL → Pool**.
2. If the pool is associated with any DP-VOL, disassociate it and confirm that the pool usage is 0 (see Releasing a V-VOL from a Pool.

   For details about how to dissociate the association, see Changing the V-VOL Settings.
3. In the pool tree, on the upper left of the window, right-click the selected pool, then select **Delete Pool**. If the pool is associated with DP-VOLs, the pop-up menu will not be available.
4. Click **OK** on the confirmation message. The icon of the selected pool changes to indicate that the pool will be deleted.
5. Click **Apply** and then **OK** to delete the pool.

Deleting Multiple Pools

Caution: This operation will delete all pools that can be deleted. If you want to delete just a single pool, see Deleting a Single Pool for instructions.

To delete multiple pools:

1. Access the Pool window (see Figure 5-3) by selecting **Go → LUN Expansion/VLL → Pool**.
2. If the pool is associated with any DP-VOL, disassociate it and confirm that the pool usage is 0 (see Releasing a V-VOL from a Pool.

   For details about how to disassociate the association, see Changing the V-VOL Settings.
3. In the pool tree, on the upper left of the window, right-click the selected pools, then select **Delete Pool(s)**.
4. Click **OK** on the confirmation message. The icon of the selected pools change to indicate that the pools will be deleted.
5. Click **Apply** and then **OK** to delete the pools.

Recovering Pools in Blocked Status

This operation is for failure recovery of a blocked pool. Ordinarily you should not need to perform this operation.

The recovery time for pools varies depending on pool usage or V-VOL usage. Calculate roughly 20 minutes of recovery time for every 100 TB of pool or V-VOL usage. Recovery time may vary depending on the workload of the storage system at the time of recovery.

Recovering a Single Blocked Pool

To recover a blocked pool:

1. Access the **Pool** window (see Figure 5-3) by selecting **Go** → **LUN Expansion/VLL** → **Pool**.
2. In the Pool tree, on the upper left of the window, select and right click the blocked pool you want to recover to display the **Restore Pool**.
3. Select **Restore Pool**, then select **OK** on the confirmation message. The pool icon will change to indicate a normal pool. Pool icons are described in the Pool Window.
4. Click **Apply** and then **OK** to restore the pool.

Recovering Multiple Blocked Pools

To recover multiple blocked pools:

1. Access the **Pool** window (see Figure 5-3) by selecting **Go** → **LUN Expansion/VLL** → **Pool**.
2. In the Pool tree, on the upper left of the window, select and right-click the **Dynamic Provisioning** icon, select **Restore Pools**, then select **OK** on the confirmation message. The pool icon will change to indicate a normal pool.
3. Click **Apply** and then **OK** to restore the pool.

Managing V-VOLs and V-VOL Groups

This section discusses the following topics

- Creating a V-VOL Group
- Changing the V-VOL Settings
- Changing the V-VOL Settings of Multiple V-VOL Groups
- Deleting V-VOL Groups
- Deleting V-VOLs

You will need to use Virtual LVI/LUN for the following V-VOL operations:

- Adding V-VOLs to an existing V-VOL group.
- Deleting V-VOLs from an existing V-VOL group.

For more information on Virtual LVI/LUN, see the *Virtual LVI/LUN and Volume Shredder User's Guide*.

Creating a V-VOL Group

When creating a V-VOL group, define the DP-VOLs for the group at the same time. Although multiple DP-VOLs can be defined to a V-VOL group, the recommendation is to define just one DP-VOL per V-VOL group. The number of V-VOL groups allowed is the same as the maximum number of DP-VOLs in the system.

If you plan to increase the capacity of a DP-VOL, free space is needed in the V-VOL group immediately adjacent to the DP-VOL. The recommendation to define a single DP-VOL per V-VOL group allows for any DP-VOL to be expanded to its maximum allowed capacity. For details about how to increase DP-VOL capacity, see Increasing V-VOL Capacity.

To create a V-VOL group:

1. Access the **V-VOL** window (see Figure 5-6) by selecting **Go** → **LUN Expansion/VLL** → **V-VOL**.
2. In the pool tree, on the upper left of the window, right-click the **Dynamic Provisioning** folder, then select **New V-VOL Group**.
3. In the **New V-VOL Group** dialog box (see Figure 5-7):
   - In **V-VOL Group**, select or enter the V-VOL group ID. Use numbers from 1 to 65535, and do not enter a number that is already in use.
   - In **Emulation Type**, select OPEN-V.
   - In **CLPR**, select the CLPR number.

- In **Copy of V-VOL Groups**, type the number of V-VOL groups to be created. You can use numbers from 0 to 63231. This is the maximum per subsystem. If you have any external volumes or any Copy-on-Write Snapshot volumes, this maximum is decreased accordingly. If you enter 0, no V-VOL group will be created.

4. Click **Next**.
5. In the Create V-VOL dialog box (2) (see Figure 5-8):
   - In **Emulation Type**, select OPEN-V.
   - In **Capacity Unit**, select one of the following:

     MB (megabyte)

     Block

     Cyl (cylinder)
   - In **Capacity**, enter the capacity:
     - If you selected **MB** in the **Capacity Unit** list, enter numbers from 46 to 4194303.
     - If you selected **block**, enter numbers from 96000 to 8589934592.
     - If you selected **Cyl**, enter numbers from 50 to 4473924.

     When you specify the **Capacity Unit** as MB or Cyl, the storage system optimally corrects the **Capacity**. Therefore, to set **Capacity** accurately to the largest value of the VDEV capacity, specify the **Capacity Unit** as block.
   - In **Number of V-VOL**, enter the number of the DP-VOLs you want to create, from 1 to 1024. Refer to SOM 726 explained in DP-VOLs.

     The number of DP-VOLs that you can enter in this dialog box can vary depending on the number of V-VOL groups specified in the New V-VOL Group dialog box (see Figure 4-8). For example, if you specified 100 V-VOL Groups, in this dialog box you can specify 10 V-VOLs per V-VOL Group, because the maximum total is 1024. In this case, the displayed range would be 1 to 10.
   - Click **Set** to add these DP-VOLs to the V-VOL list. If you want to add more DP-VOLs, repeat this step.
6. Click **Next**.
7. In the Create V-VOL dialog box (3) (see Figure 5-9):
   - In the Volume list on the upper part of the dialog box, select a volume.
   - In **Select LDKC No.**, select the LDKC number.
   - In **Select CU No.**, select the CU number. This will show the selected volume in the LDEV list, on the bottom part of the dialog box.
   - In **Interval**, select the interval between the LDEV numbers. If you select **0**, the LDEV numbers will be sequential.
   - If you want to select a CU that belongs to another SLPR, select the **CU number of another SLPR is used** check box.

- Only the areas displayed by the white cells are available for the DP-VOLs. Once the area is selected, it turns blue, and the CU and LDEV number are added to the V-VOL list on the top of the dialog box, in blue bold italics.
- To add another V-VOL, repeat this step.

8. Click **Next**.
9. In the Create V-VOL Group Confirmation dialog box (see Figure 5-10), verify that the settings are correct, then click **OK**. The new DP-VOLs appear in blue bold italics.
10. Click **Apply** and then **OK** to create the V-VOLs.

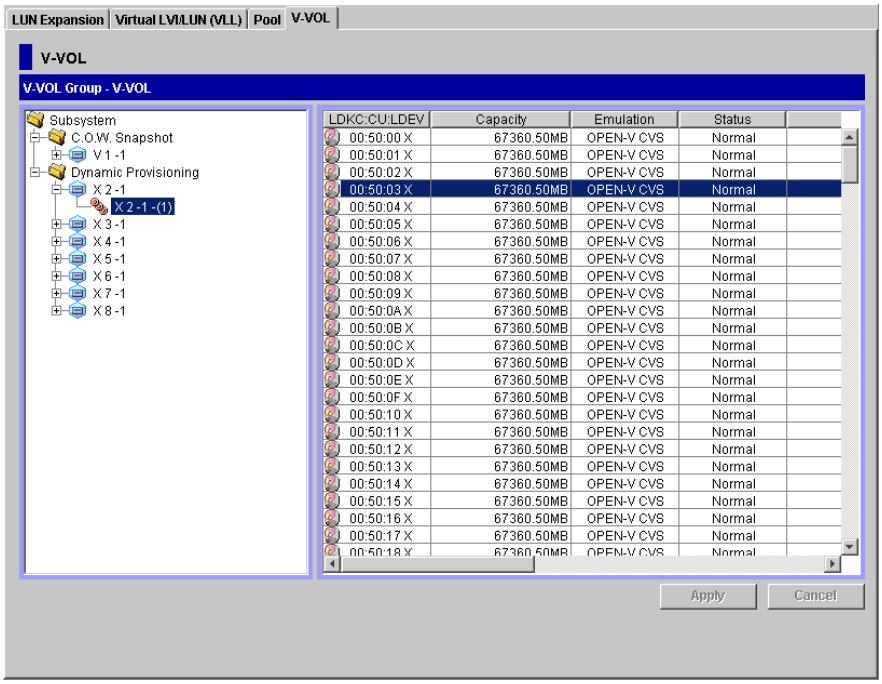

Figure 5-6 Selecting the V-VOL Group

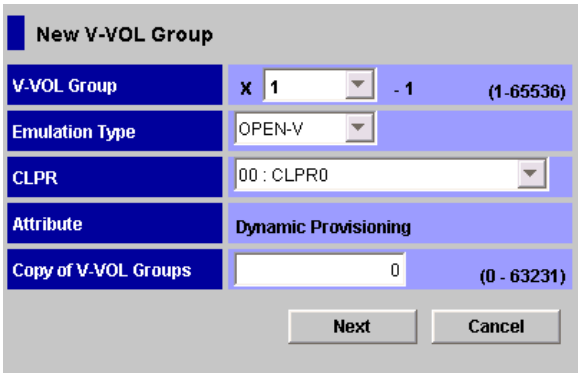

Figure 5-7 Creating a New V-VOL Group (1)

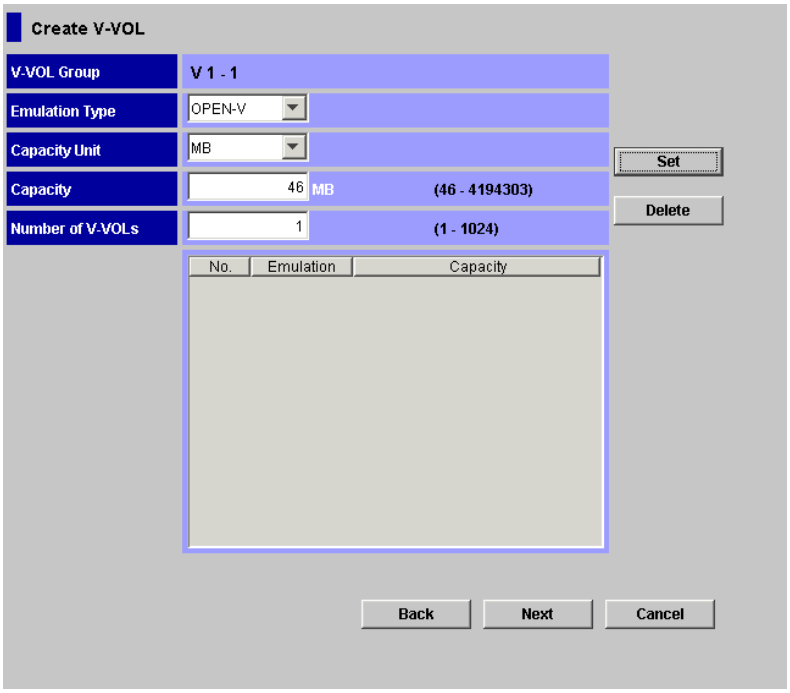

Figure 5-8 Creating a New V-VOL Group (2)

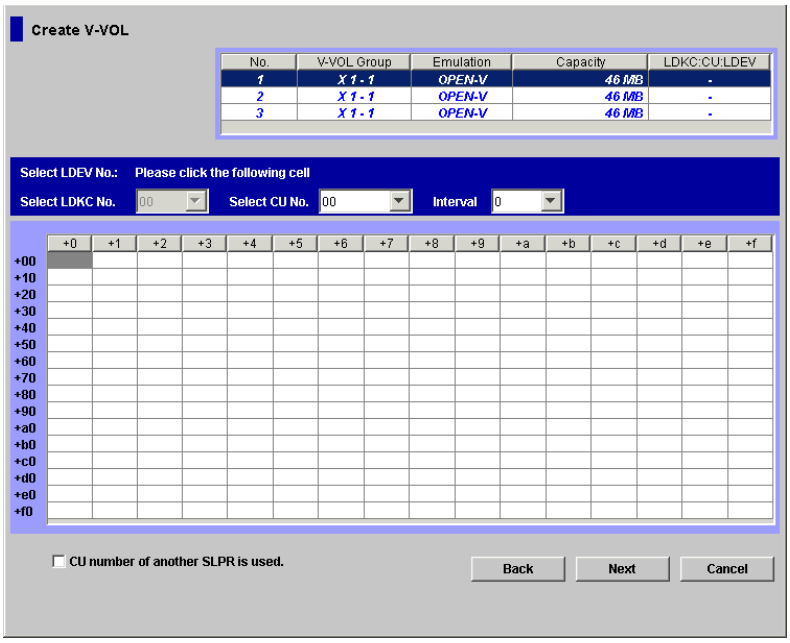

Figure 5-9 Creating a New V-VOL Group (3)

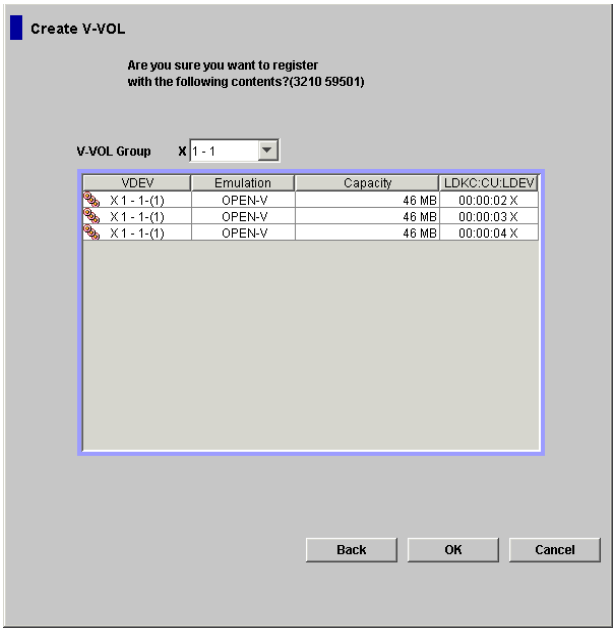

Figure 5-10 Confirming V-VOL Group Creation

Changing the V-VOL Settings

Associating a V-VOL with a Pool

To associate a V-VOL with a pool:

1. Access the **V-VOL** window (see Figure 5-6) by selecting **Go** → **LUN Expansion/VLL** → **V-VOL**.
2. In the **V-VOL Group - V-VOL** tree on the left side of window, select the V-VOL group that contains the V-VOLs that you want to associate with a pool. This will display the information for the individual V-VOLs on the right side of the window.
3. On the right side of the window, right-click one or more V-VOLs, and select **Associate V-VOL with Pool** to display the **Connect Pool** dialog box (see Figure 5-11). You can only select from rows with black font.
4. Select the pool ID with which you want to associate the V-VOL group, then select **Next** to display the **Change Threshold** dialog box (see Figure 5-12).
5. Select the threshold from the list, then click **Set** to implement the settings and return to the **V-VOL** window. You can set thresholds from 5 to 300%, in 5% increments.
6. Click **Apply** and then **OK** to associate the V-VOL with the pool.

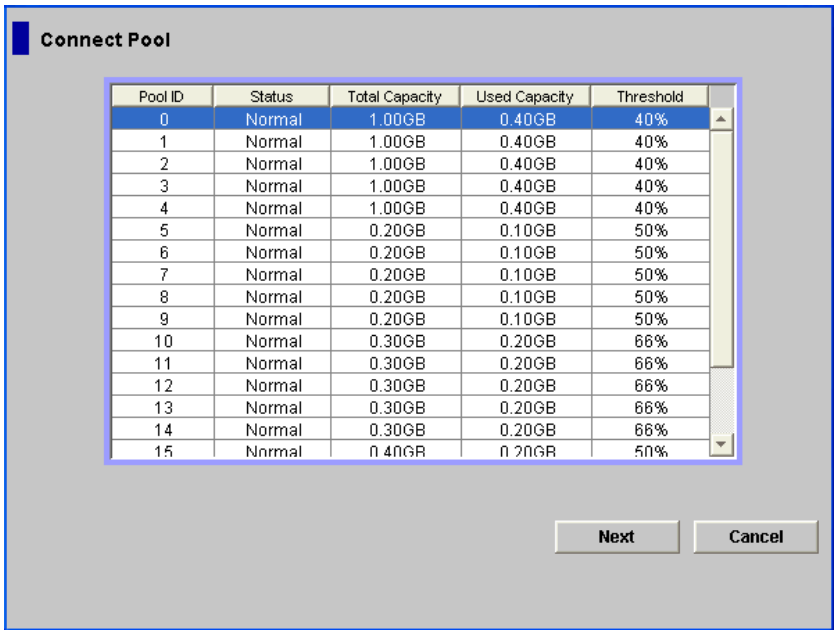

Figure 5-11 Selecting the Pool

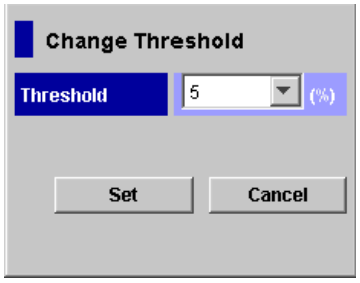

Figure 5-12 Changing the Threshold

Releasing a V-VOL from a Pool

When a DP-VOL is released from the pool, the space assigned to the DP-VOL is returned to the pool as free space. The pages assigned to the released DP-VOL go through a zero-scrub operation. The pages are written with zeros and then returned to the pool free page list. This effectively means that:

- There is added work in the pool writing zeros to those pages being freed.
- The pages being freed are not instantaneously placed on the free page list for the pool until the pages are overwritten with zeros.

If many pages are being released, performance can be impacted while the pages are being overwritten.

A DP-VOL cannot be released from a pool if the volume path is defined or if the volume is a reserved volume of Volume Migration.

To release a DP-VOL from a pool:

7. Release the path definitions to the DP-VOLs to be deleted. For instructions, see the LUN Manager User's Guide.
8. Access the V-VOL window by selecting Go → LUN Expansion/VLL → V-VOL (see Figure 5-6).
9. In the **V-VOL Group - V-VOL** tree on the left side of window, select the V-VOL group that contains the DP-VOLs that you want to release from a pool. This will display the information for the individual DP-VOLs on the right side of the window.
10. On the right side of the window, right-click one or more DP-VOLs, and select **Release V-VOL from Pool**.
11. Click **Apply** and then **OK** to release the DP-VOL from the pool. The space assigned to the DP-VOLs is returned to the pool as free space.

Changing the V-VOL Threshold

You can change the threshold of a V-VOL that is already associated with a pool.

To change the V-VOL threshold:

1. Access the **V-VOL** window by selecting **Go → LUN Expansion/VLL → V-VOL** (see Figure 5-6).
2. In the **V-VOL Group - V-VOL** tree on the left side of window, select the V-VOL group that contains the V-VOLs that you want to associate with a pool. This will display the information for the individual DP-VOLs on the right side of the window.
3. On the right side of the window, right-click one or more DP-VOLs, and select **Change Threshold** to display the Change Threshold dialog box (see Figure 5-12). Be sure to select V-VOLs that are already associated with a pool.
4. Select the threshold from the list, then click **Set** to implement the settings and return to the **V-VOL** window. You can set thresholds from 5 to 300%, in 5% increments. The default is 5%. You can only select from rows with black font.
5. Click **Apply** and then **OK** to change the V-VOL threshold.

Increasing V-VOL Capacity

If you increase the V-VOL capacity, use the raidvchkset command of the Command Control Interface (CCI). CCI version 01-22-03/06 supports the option for increasing capacity, but does not support the option for decreasing capacity.

You can increase the capacity of V-VOLs used online for the following operating systems (contact your Hitachi Data Systems account team for the latest information on platform support):

- Windows Server 2008
- Windows 2003
- AIX: Ver.5.3 and 6.1
- HP-UX 11.31
- Open VMS 8.3
- Red Hat Enterprise Linux 5.0
- Sun Solaris 10

Do not increase the capacity of V-VOLs used online to any other host. Any V-VOL's capacity can be increased if the V-VOL is offline to all hosts. Always check that the host operating system, volume manager, and file system accepts that a LUN's capacity can be increased before attempting to increase a V-VOL capacity. Also, review and test the proper procedure documented by the hosts's operating system concerning increasing a LUN's capacity.

If you want to notify the host that the V-VOL capacity has been increased, make sure the value of host mode option 40 is enabled.

Caution: Note that the processing differs as follows depending on the value of host mode option 40.

- When the value of host mode option 40 is not enabled, the host will not be notified that the V-VOL capacity has been increased. Therefore, the V-VOL data has to be read again by your storage system after the capacity is increased.
- When the value of host mode option 40 is enabled, the host will be notified that the V-VOL capacity has been increased. If the operating system cannot recognize the value of capacity that was increased, the V-VOL data has to be read again by your storage system.

In order to increase the V-VOL capacity, the following conditions must be satisfied:

- Free space exists immediately below the V-VOL in the [V-VOL] window. In the V-VOL capacity only the free space capacity can be increased. You can see the free space in the [V-VOL] window of Storage Navigator.

  Figure 5-13 illustrates an example of displaying free space.

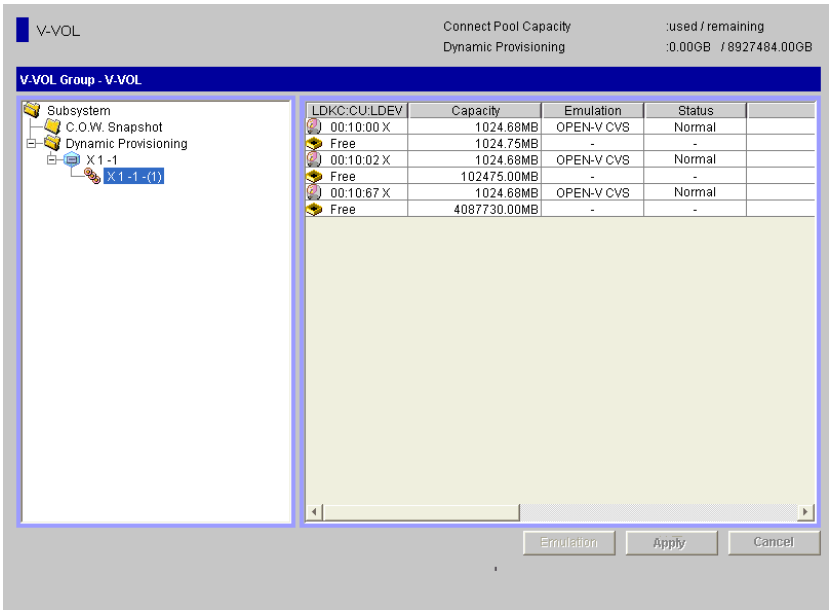

Figure 5-13 Example of Displaying Free Space

In this example you can increase the capacity of the LDEV shown as 00:10:00 by 1024.75 MB and the capacity of the LDEV shown as 00:10:67 by 4087730.00 MB. You can increase the V-VOL capacity while the free space exists.

Notes:

- If SOM 726 is enabled (the non-default setting), you can set only one V-VOL in one V-VOL group, thus, you can increase the size of a V-VOL without first migrating the V-VOL; however, you cannot use the V-VOL as a CV (custom-sized volume).
- If SOM 726 is disabled (the default setting), you can set more than one V-VOL in one V-VOL group.

- The DP-VOL to be increased is not shared with the program product that cannot increase the DP-VOL (See Table 2-5).
- The DP-VOL is not undergoing the LDEV format operation.
- The capacity to be added to the DP-VOL is smaller than the capacity displayed below the **remaining** label in the V-VOL window.
- If you increase the V-VOL capacity, the ratio of the free space capacity of the pool to the free space capacity of the V-VOL is equal to or more than the DP-VOL threshold.

  For details about the relation between increasing V-VOL capacity and the DP-VOL threshold, see Figure 5-14.

  Examples 1 and 2 illustrate whether the capacity of a V-VOL can be increased if the V-VOL threshold is 50 percent.

- In Example 1, the ratio of the free space capacity of the pool to the free space capacity of the V-VOL is 200 percent before the capacity increase and about 56% after the capacity increase. These percentages exceed the threshold (50 percent). Therefore, the capacity of the V-VOL can be increased.
- In Example 2, the ratio of the free space capacity of the pool to the free space capacity of the V-VOL is about 133 percent before the capacity increase and 40% after the capacity increase. Since the ratio goes below threshold (50 percent) after the capacity increase, the capacity of the V-VOL cannot be increased.

In Example 3, the ratio of the free space capacity of the pool to the free space capacity of the V-VOL is 200 percent, which is lower than the threshold (250 percent). Therefore, the capacity of the V-VOL cannot be increased.

For details about how to calculate the DP-VOL threshold, see

Table 3-4.

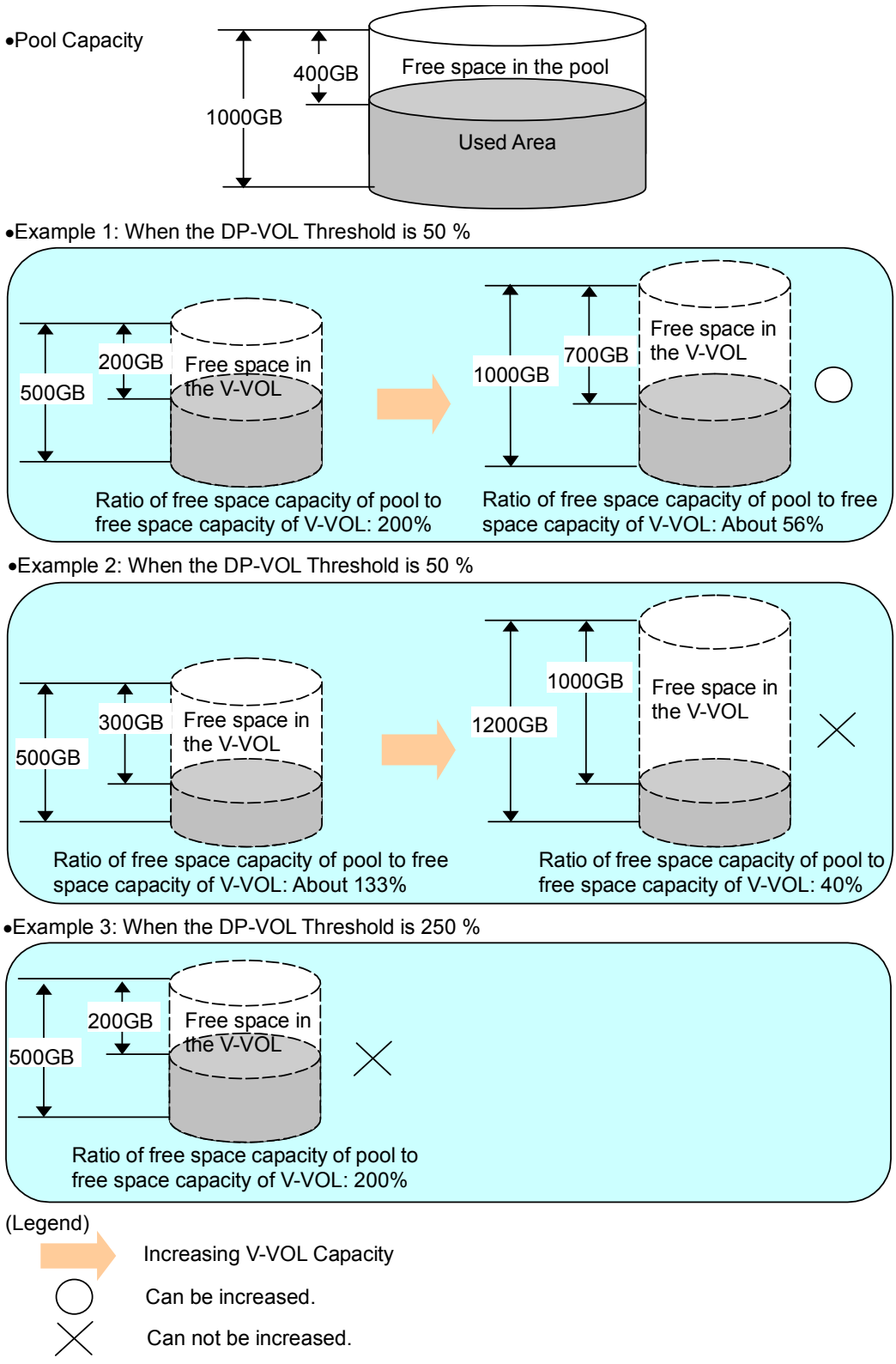
•Pool Capacity
400GB
1000GB
Free space in the pool
Used Area
•Example 1: When the DP-VOL Threshold is 50 %
200GB
500GB
Free space in the V-VOL
Ratio of free space capacity of pool to free space capacity of V-VOL: 200%
700GB
1000GB
Free space in the V-VOL
Ratio of free space capacity of pool to free space capacity of V-VOL: About 56%
•Example 2: When the DP-VOL Threshold is 50 %
300GB
500GB
Free space in the V-VOL
Ratio of free space capacity of pool to free space capacity of V-VOL: About 133%
1000GB
1200GB
Free space in the V-VOL
Ratio of free space capacity of pool to free space capacity of V-VOL: 40%
•Example 3: When the DP-VOL Threshold is 250 %
200GB
500GB
Free space in the V-VOL
Ratio of free space capacity of pool to free space capacity of V-VOL: 200%
(Legend)
Increasing V-VOL Capacity
Can be increased.
Can not be increased.

Figure 5-14 Relation Between Increasing V-VOL Capacity and DP-VOL Threshold

For more information on the raidvchkset command for increasing V-VOL capacity, see the *Command Control Interface User and Reference Guide*.

Warning: When increasing the V-VOL capacity, do not perform the following operations. And when performing the following operations, do not increase the V-VOL capacity.

- Operations using the Virtual LVI/LUN function
- Operations using the Cache Residency Manager function
- Creating V-VOLs
- Associating a V-VOL with a Pool
- Deleting association between a V-VOL and a Pool
- Restoring Pools
- Deleting V-VOLs
- Operations to increase the V-VOL capacity in another instance of CCI
- Maintenance of your storage system

Caution: After increasing the V-VOL capacity, click **Refresh** in Storage Navigator to make sure that the V-VOL is increased. If the V-VOL is not increased, wait a while, and then click **Refresh** again and make sure that the V-VOL is increased. If you perform a Storage Navigator operation without making sure that the V-VOL is increased, the operation from Storage Navigator can fail.

Caution: Using system option 733 deters simultaneous execution of the maintenance operation and one of the following operations:

- Volume Migration
- Quick Restore by ShadowImage

If this system option is in effect and Volume Migration or Quick Restore is being performed, you may fail to increase the V-VOL capacity. To confirm whether the V-VOL capacity is increased, click **Refresh** in Storage Navigator. If the V-VOL capacity is not increased, click **Refresh** again after Volume Migration or Quick Restore is finished to confirm the capacity.

Releasing Pages in a DP-VOL

If all the data written to a page assigned to a DP-VOL is binary zeroes, you can reclaim the page and return it to the pool's available capacity. See Reclaiming Pages from a DP-VOL for restrictions. You select the DP-VOLs that you suspect have a good amount of pages written with binary zeroes and use the discard zero data operation, which scans the selected DP-VOL's pages and finally frees up those with all binary zeros.

Zero data can be discarded if all the following conditions are satisfied:

- The page is completely written with only binary zeros.
- The DP-VOL is not used in conjunction with another program product that cannot perform discarding zero data.
- LDEV formatting is not being performed on the DP-VOL.
- The DP-VOL is not blocked.
- The V-VOL is associated with a pool.
- The pool associated with the DP-VOL is not blocked, or is full and blocked.

Zero data cannot be discarded if all the following conditions are satisfied:

- The DP-VOL status is not normal
- The V-VOL is not associated with a pool
- Zero data in the DP-VOL are already being discarded.

To release the pages in a DP-VOL:

1. In Storage Navigator, access the V-VOL window by selecting **Go** → **LUN Expansion/VLL** → **V-VOL** (see Figure 5-6).
2. In the **V-VOL Group - V-VOL** tree on the left side of window, select the V-VOL group containing the V-VOLs where the pages should be released. This will display the information about the individual V-VOLs on the right side of the window.
3. On the right side of the window, right-click one or more V-VOLs, and select **Discard Zero Data** from the pop-up menu. This may take some time as the software scans the entire V-VOL looking for pages with zero data, marking them for release when you later click **Apply**.
4. After selecting **Discard Zero Data** (and before clicking **Apply**), if you want to stop releasing pages, right-click one or more V-VOLs, and select **Stop Discarding Zero Data**. The discarding of zero data stops, but the already discarded zero data cannot be restored and the pages marked for release will be released when you click **Apply**.

   You cannot stop releasing pages if the page status for the V-VOL is not **Discarding Zero Data**.
5. Click **Apply** and then **OK** to release pages in the V-VOL in the background.

6. After discarding zero data and releasing pages in the V-VOL is complete, click **Refresh** in Storage Navigator to update the **Page Status**. If the **Page Status** is not immediately updated, wait a while, and then click **Refresh** again.

If you have started a discard zero data operation, and the storage system losses power, which then disrupts shared memory, the discard zero data operation will not automatically continue after the storage system restarts.

In any of the following cases, discarding of zero data will stop, and V-VOL pages will not be released.

- LDEV formatting was performed while discarding zero data.
- The pool-VOL that is being accessed by the target V-VOL was blocked.
- The pool associated with the target V-VOL was blocked while discarding zero data.
- The pool-VOL accessed by the target V-VOL cannot be used temporarily.
- Cache memory failure occurred while discarding zero data.
- The association between the target V-VOL and the pool was released when zero data was discarded.
- An attempt was made to perform TrueCopy or Universal Replicator initial copy operations on the V-VOL when zero data was discarded from the V-VOL.

Changing the V-VOL Settings of Multiple V-VOL Groups

You can change information about V-VOLs in the multiple V-VOL groups such as the pool association and the threshold.

Associating Multiple V-VOL Groups with a Pool

You can associate multiple V-VOL groups with a pool. The time required to associate changes between V-VOLs in multiple V-VOL groups with a pool can vary greatly depending on the V-VOL capacity and the quantity of V-VOLs being associated.

To associate multiple V-VOL groups with a pool:

1. Access the V-VOL window (see Figure 5-6) by selecting **Go** → **LUN Expansion/VLL** → **V-VOL**.
2. Right click **Dynamic Provisioning** in the V-VOL group tree of the V-VOL window, and then select **Associate V-VOL Groups with Pool**. Depending on your environment, it may take approximately 30 seconds to open the Associate V-VOL Groups with Pool dialog box (see Figure 5-15).
3. In the V-VOL groups information table, select the V-VOL groups you want to associate with a pool.

Display the list of V-VOL groups that are included in the CLPR by selecting a specific CLPR from the **CLPR** list. The groups will appear in the V-VOL groups list. Find V-VOL groups by clicking the button in the page area under the list. The page that includes the V-VOL groups will appear. The list shows a maximum of 4,096 V-VOL groups. Click **Previous** and **Next** to display the remaining V-VOL groups.

The following V-VOL groups will not appear in the Associate V-VOL Groups with Pool dialog box:

- A V-VOL group in which the first LDEV has been associated with a pool.
- A V-VOL group lacking any V-VOLs.

4. Click **Set**. The specified V-VOL groups appear in blue bold italics and the Connect Pool dialog box (see Figure 5-11) opens.
5. Click **Clear** to clear the specified V-VOL groups. To specify more V-VOL groups, repeat step 3 to step 4.
6. Select the Pool ID with which you want to associate the V-VOL groups in the Connect Pool dialog box, then select **Next** to open the Change Threshold dialog box (see Figure 5-12). If you clear the information and return to the **Associate V-VOL Groups with Pool** dialog box, click **Cancel**.
7. In the Change Threshold dialog box, select the threshold from the list, then click **Set** to implement the settings and return to the V-VOL window. If you clear the information and return to the Associate V-VOL Groups with Pool dialog box, click **Cancel**.

   The Pool ID and the threshold that have been set appear in blue bold italics. If you want to specify other V-VOL groups, go to step 3.
8. Click **OK**. The dialog box closes and a confirmation message appears asking whether it is **OK** to apply the setting to the storage system.
9. Click **OK**. The confirmation message closes and the V-VOL groups are associated with the pool. If you click **Cancel**, the Associate V-VOL Groups with Pool dialog box opens again. If the specified V-VOL groups cannot be associated with a pool, a message dialog box appears.

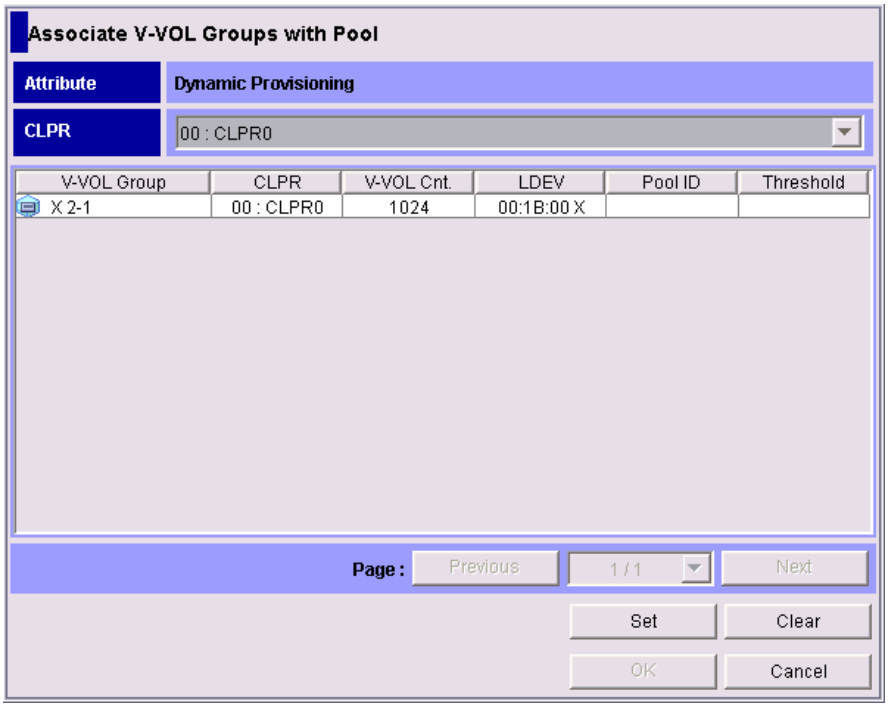

Figure 5-15 Associate V-VOL Groups with Pool Dialog Box

Releasing Multiple V-VOL Groups from a Pool

Before releasing V-VOL groups from a pool, confirm that the pool-VOLs added to the pool are not blocked. If the pool-VOLs are blocked, restore the volume status, then release the V-VOLs from a pool.

Also, if the cache write pending rate exceeds 55%, the pool usage may not be 0, because the V-VOL cannot be released from the pool.

After a V-VOL is released from a pool, performance of the initial copy may be lowered if the TrueCopy pair or the Universal Replicator pair is in the same pool as the V-VOL. You can prevent the performance from being lowered in one of the following ways:

- Do not release the V-VOL from the same pool where the initial copy of the TrueCopy pair V-VOL or the Universal Replicator pair V-VOL is performed.
- Before making an initial copy of the TrueCopy pair or the Universal Replicator pair, reserve enough pool capacity so that the threshold will not be reached during the initial copy.

If you attempt to release a V-VOL using the Quick Restore feature of ShadowImage or Volume Migration, error 3005 68727 may occur if the V-VOL had been previously used in a Quick Restore or Migration. If the error occurs, use the following equation to calculate how long to wait before attempting to release the V-VOL again:

(Pool Capacity in terabytes × 3 seconds) + 40 minutes.

If the workload on the storage system is heavy, add additional time to the wait period. If **Operation** on **DP-VOL** list remains **Processing**, wait until it changes to **Ready** before attempting to release a V-VOL using the Quick Restore feature of ShadowImage or Volume Migration.

To release multiple V-VOL groups from a pool:

1. Access the V-VOL window (see Figure 5-6) by selecting **Go → LUN Expansion/VLL → V-VOL**.
2. Right click **Dynamic Provisioning** in the V-VOL group tree of the V-VOL window, and select **Release V-VOL Groups from Pool**. The Release V-VOL Groups from Pool dialog box (see Figure 5-16) opens. Depending on your environment, it may take approximately 30 seconds to open the Release V-VOL Groups from Pool dialog box.
3. In the V-VOL groups information setting list in the Release V-VOL Groups from Pool dialog box, select the V-VOL groups you want to release from a pool.

   In the **Pool ID** list, specify a Pool ID. The list of V-VOL groups associated with the selected Pool ID is available in the V-VOL groups information setting list. Find V-VOL groups by clicking the button in the page area under the list. The page that includes the V-VOL groups will display. The list displays V-VOL groups up to a maximum of 4,096 at a time. For lists that exceed that number, click **Previous** and **Next** to display the remaining V-VOL groups.

   The following V-VOL groups will not appear in the Release V-VOL Groups from Pool dialog box:

   - A V-VOL group in which the first LDEV has been associated with a pool.
   - A V-VOL group lacking any V-VOLs.
4. Click **Set**. The specified V-VOL groups appear in blue bold italics. Click **Clear** if you want to clear the specified V-VOL groups. If you want to specify more V-VOL groups, repeat step 3 to step 4.
5. Click **OK**. The Release V-VOL Groups from Pool dialog box closes and a confirmation message appears asking whether it is **OK** to apply the setting to the storage system.
6. Click **OK**. The confirmation message closes and the V-VOL groups are released from the pool. If you click **Cancel** in this message, the Release V-VOL Groups from Pool dialog box opens again. If the specified V-VOL groups cannot be released from a pool, a message dialog box appears.

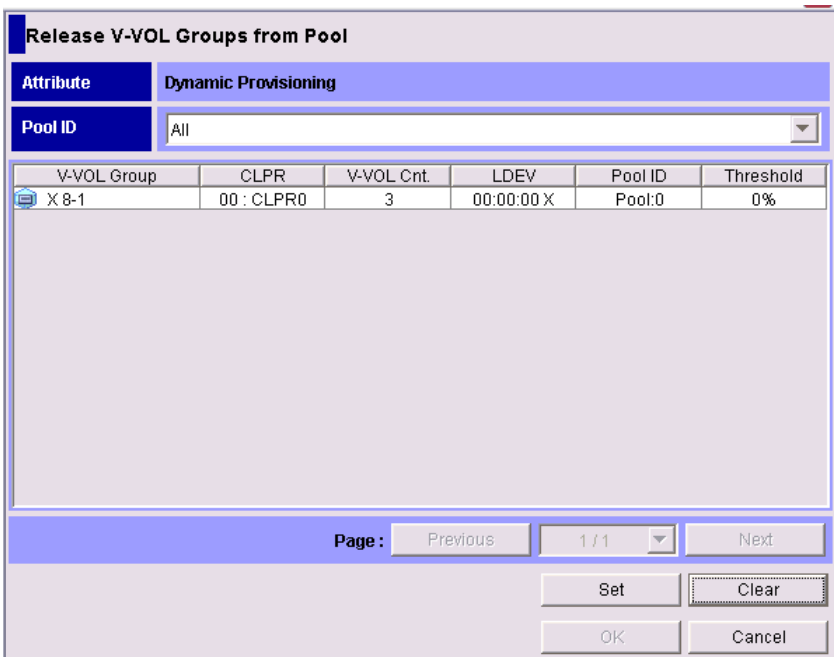

Figure 5-16 Release V-VOL Groups from Pool Dialog Box

Deleting V-VOL Groups

Usually you will specify and delete a single V-VOL group. If you choose to delete multiple V-VOL groups, all V-VOLs in the multiple V-VOL groups will be deleted.

Deleting a V-VOL Group

You can delete a V-VOL group and all V-VOLs in the V-VOL group.

V-VOL groups associated with a pool ID cannot be deleted. To delete such a group, first release the V-VOL group from a pool, then delete it.

To delete a V-VOL group:

1. Access the **V-VOL** window by selecting **Go** → **LUN Expansion/VLL** → **V-VOL** (see Figure 5-6).
2. In the **V-VOL Group - V-VOL** tree on the left side of window, right-click the V-VOL group that contains the V-VOL Group and DP-VOL(s) that you want to delete, then select **Delete V-VOL Group**.
3. Select **OK** on the confirmation message. The icon of the selected V-VOL group changes to indicate that deletion is in process.
4. Select **Apply** and then **OK** to delete the V-VOL group.

Deleting Multiple V-VOL Groups

You can delete multiple V-VOL groups and the V-VOLs in all the V-VOL groups.

V-VOL groups associated with a pool ID cannot be deleted. To delete such a group, first release the V-VOL groups from a pool, then delete it.

To delete selected multiple V-VOL groups:

1. Access the **V-VOL** window by selecting **Go** → **LUN Expansion/VLL** → **V-VOL** (see Figure 5-6).
2. Right-click **Dynamic Provisioning** in the V-VOL group tree of the V-VOL window, then select **Delete V-VOL Groups**. The Delete V-VOL Groups dialog box (see Figure 5-17) opens. Depending on your environment, it may take approximately 30 seconds to open the Delete V-VOL Groups dialog box.
3. Select the V-VOL groups you want to delete from the V-VOL groups information setting list in the Delete V-VOL Groups dialog box. In the CLPR list, select a CLPR and the list of V-VOL groups that are included in the CLPR is also displayed in the V-VOL groups information setting list. Find the V-VOL groups that you want to delete by clicking the button in the page area under the list. The page that includes the V-VOL groups that you want to delete appears. The list displays V-VOL groups up to a maximum of 4,096 at a time. For lists that exceed this maximum, click **Previous** and **Next** to display the remaining V-VOL groups.

   A V-VOL group in which the first LDEV has been associated with a pool will not be displayed in the Delete V-VOL Groups dialog box.
4. Click **Set**. The specified V-VOL groups appear in blue bold italics. Click **Clear** to clear the specified V-VOL groups. To specify more V-VOL groups, repeat step 3 to step 4.
5. Click **OK**. The Delete V-VOL Groups dialog box closes and a confirmation message appears asking whether it is **OK** to apply the setting to the storage system.
6. Click **OK**. The confirmation message closes and the deletion of the V-VOL groups is applied to the subsystem. If you click **Cancel** in this message, the Delete V-VOL Groups dialog box opens again. If the specified V-VOL groups are not deleted, a message appears.

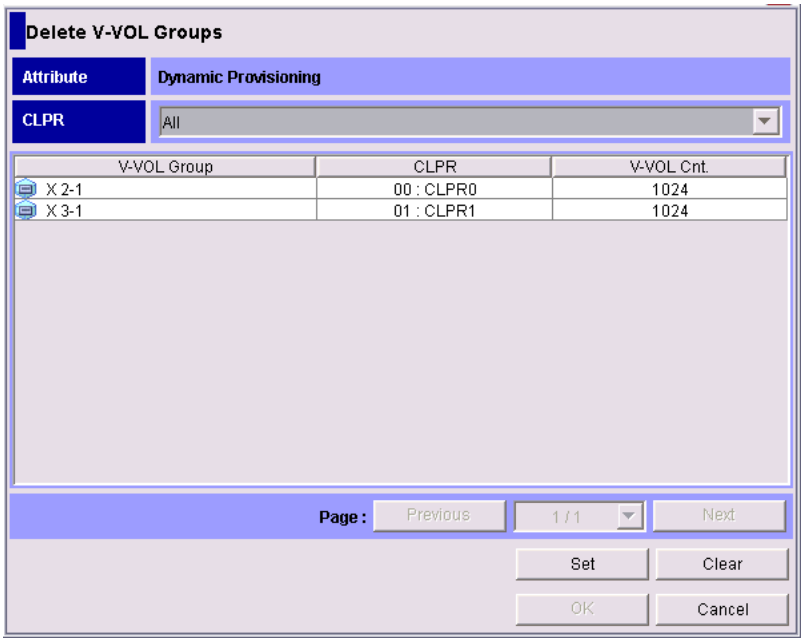

Figure 5-17 Delete V-VOL Groups Dialog Box

Deleting V-VOLs

This operation will delete selected V-VOLs in the V-VOL group.

To delete selected DP-VOL(s):

1. Delete the selected V-VOLs by using the Virtual LVI/LUN Volume to Space function. For more information, see the *Virtual LVI/LUN and Volume Shredder User's Guide*.
2. In the VLL window, in the VLL tree on the upper left, select the **Dynamic Provisioning** folder and then select the parity group.
3. From the DP-VOL list on the upper right, select the target V-VOL group from the list of the V-VOL group, then select the LDEV to be deleted from the V-VOL group.

6

Troubleshooting

This chapter describes how to troubleshoot Dynamic Provisioning problems.

Dynamic Provisioning Troubleshooting

Table 6-1 provides troubleshooting instructions for Dynamic Provisioning operations.

Table 6-1 Troubleshooting for Dynamic Provisioning

Problems	Causes and Solutions
Cannot install Dynamic Provisioning.	Cause: ▪ Shared memory for the V-VOL management area is not installed. Solution: ▪ Call the Technical Support Center and check if the shared memory for the V-VOL management area is installed.
Pool usage level exceeds the threshold.	Causes: ▪ Capacity of the pool is insufficient. ▪ The threshold of the pool is too low. Solutions: ▪ Add some pool-VOLs to increase the capacity of the pool. See Viewing Pool Information. Also consult the Technical Support Center for best practices on adding capacity. ▪ Set a larger value to the threshold of the pool. See Changing the Pool Threshold. After correcting the causes of SIMs 620XXX and 621XXX, you need to complete the SIMs. If you do not complete the SIMs, no new SIM will occur even if the usage level increases and again exceeds the threshold (Target SIM codes are 620XXX and 621XXX). SIMs 620XXX, 621XXX, and 625000 are automatically completed if you increase pool capacity by adding pool-VOLs because the condition that caused the SIM is removed. For details about how to complete the SIMs, see Managing Pool-Related SIMs. You need free volumes to add as pool-VOLs. If there are no free volumes, you need to create new volumes or ask the Technical Support Center to add the hard disks. Therefore, it may take time to solve the problem.
Cannot add Pool-VOLs.	Causes: ▪ 1024 pool-VOLs are already defined in the pool. ▪ There is no available free LDEV to add to the pool. ▪ Something in the storage system is blocked. Solutions: ▪ Add free LDEVs to another pool. See Viewing Pool Information. ▪ Confirm that the pool-VOL meets the pool requirements. See Volume and Pool Requirements. ▪ Ask the Technical Support Center to solve the problem.

Problems	Causes and Solutions
You cannot assign a DP-VOL to a pool.	Causes: ▪ The pool usage level is 100%. Also the maximum of DP-VOLs is currently associated with the pool. ▪ Something in the storage system is blocked. Solution: ▪ Add some pool-VOLs to increase the available capacity of the pool. See Viewing Pool Information. ▪ Define a new pool. ▪ Ask the Technical Support Center to solve the problem.
A Pool-VOL is blocked.	Cause: ▪ A failure occurred in two or more hard disk drives. Solution: ▪ Ask the Technical Support Center to solve the problem.
A pool is blocked.	Cause: ▪ The breaker has been turned off and the shared memory has been lost, and then the system has been started. Solution: ▪ Ask the Technical Support Center to solve the problem.
A pool cannot be restored.	Causes: ▪ Processing takes time, because something in the storage system is blocked. ▪ The pool-VOL is blocked. ▪ Although you increased the V-VOL capacity, the capacity has been reduced back to the previous V-VOL capacity. Solution: ▪ After waiting for a while, click **Refresh** or **Refresh All** from the **File** menu at the top left of the Storage Navigator window, and then check the pool status. ▪ If you increased the V-VOL capacity but the V-VOL capacity has been reduced back to the previous V-VOL capacity, follow the instructions in section Increasing V-VOL Capacity to make sure that the capacity is increased, and then restore the pool. ▪ Ask the Technical Support Center to solve the problem.
A pool cannot be deleted.	Causes: ▪ After the pool is disassociated from any DP-VOL, the pool usage is not 0. ▪ External volumes are removed from the pool before you delete the pool. Solutions: ▪ Confirm that the pool usage is 0, and then you can delete the pool. ▪ Ask the Technical Support Center to solve the problem.

Problems	Causes and Solutions
A pool usage cannot be 0.	Cause: ▪ Because the cache write pending rate exceeds 55%, the V-VOL cannot be dissociated from the pool. Solution: ▪ Decrease the cache write pending rate to less than 55% by reducing the host I/O.
I/O Errors on some writes occur to DP-VOLs	Causes: ▪ Free space of the pool is completely exhausted. The pool usage level is at 100%. ▪ Something in the storage system is blocked. Solutions: ▪ Check the free space of the pool and increase the capacity of the pool. ▪ Ask the Technical Support Center to solve the problem.
When you are operating Storage Navigator, time-out occurs frequently.	Causes: ▪ The load on the Storage Navigator computer is too heavy, so that the Storage Navigator computer cannot respond to the SVP. ▪ The period of time until when time-out occurs is set too short. Solutions: ▪ Wait for a while, then try the operation again. ▪ Verify the setting of the environment parameter of Storage Navigator RMI time-out period. ▪ For information about how to set RMI time-out period, see the *Storage Navigator User's Guide*.
When the host computer tries to access the port, error occurs and the host cannot access the port.	Causes: ▪ Free space of the pool is insufficient. ▪ Something in the storage system is blocked. Solutions: ▪ Check the free space of the pool and increase the capacity of the pool. ▪ Ask the Technical Support Center to solve the problem.
V-VOL capacity cannot be increased.	See Troubleshooting When Using Command Control Interface and identify the cause. Solutions: ▪ After you click the **Refresh** or **Refresh All** command on the **File** menu on the upper-left corner of the Storage Navigator window, make sure whether the processing for increasing V-VOL capacity meets conditions described in Increasing V-VOL Capacity. ▪ Retry the operation in 10 minutes or so. ▪ Ask the Technical Support Center to solve the problem.

Problems	Causes and Solutions
Cannot discard zero data in a V-VOL.	Cause: ▪ Zero data in the V-VOL cannot be discarded from Storage Navigator because the V-VOL does not meet conditions described in Releasing Pages in a DP-VOL. Solution: ▪ Make sure that the V-VOL meets the conditions described in Releasing Pages in a DP-VOL.
The V-VOL cannot not be released though zero data in the V-VOL is discarded.	Cause: ▪ Pages of the V-VOL are not released because the process of discarding zero data was interrupted. For details, see Releasing Pages in a DP-VOL. Solution: ▪ Make sure that the V-VOL meets the conditions described in Releasing Pages in a DP-VOL.
Cannot release the Protection attribute of the V-VOLs.	Causes: ▪ The pool is full. ▪ The pool-VOL is blocked. ▪ The pool-VOL of the external volume is blocked. ▪ Solutions: ▪ Add Pool-VOLs to the pool to increase the free space in the pool. For more information, see Creating a Pool. ▪ To restore the pool-VOL, contact the Hitachi Data Systems Technical Support Center. ▪ If the pool-VOL is an external volume, check the condition of the external storage system, for instance the path blockade. ▪ After performing the above-mentioned solutions, release the Protection attribute of the V-VOLs using the Data Retention window in Storage Navigator (if the Data Retention Utility is installed). For information about operating procedures, see the *Data Retention Utility User's Guide*.
SIM code such as 620XXX, 621XXX, 622XXX, or 625000 was issued.	Cause: ▪ Pool usage level exceeds the threshold. Solution: ▪ Add Pool-VOLs to the pool to increase the free space in the pool. For more information, see Creating a Pool.
Performance of the initial copy has been lowered.	Cause: ▪ You disassociated a V-VOL from a pool, and the V-VOL is in the same pool as the TrueCopy pair or the Universal Replicator pair is in. Solutions: ▪ Do not disassociate the V-VOL from the same pool where the Initial copy of the TrueCopy pair V-VOL or the Universal Replicator pair V-VOL is performed. ▪ Before you perform the Initial copy of the TrueCopy pair or the Universal Replicator pair, you reserve enough pool capacity so that the threshold will not be reached during the initial copy.

If you are unable to solve a problem using the above suggestions, or if you encounter a problem not listed, please contact the Hitachi Data Systems Technical Support Center.

If an error occurs during the operations, the error code and error message are displayed in the error message dialog box. For more information about error messages, see *Storage Navigator Messages*.

Managing Pool-Related SIMs

When the usage level of the pool exceeds the threshold, or when the potential demand of the DP-VOL exceeds the threshold, the following SIMs (Service Information Message) occur.

When the usage level of the pool exceeds pool threshold 1:	Reference code 620XXX
When the usage level of the pool exceeds pool threshold 2:	Reference code 621XXX
When pool usage level continues to exceed the highest pool threshold:	Reference code 625000
When the pool is full:	Reference code 622XXX
When an error occurs in the pool:	Reference code 623XXX
When the level of free pool capacity to the potential demand of a DP-VOL exceeds the DP-VOL threshold:	Reference code 630XXX
When the V-VOL management area can not be saved to pools:	Reference code 640XXX

To complete a SIM that occurs when the usage level of the pool exceeds the threshold or when the usage level of the V-VOL exceeds the threshold:

1. Change the status of the pool or the V-VOL whose usage level exceeds the threshold to normal. For information about the solutions when the pool usage level or the DP-VOL potential demand exceeds the threshold, see Table 6-1.
2. Change the mode of the Storage Navigator to **Modify**.
   For information about how to change the mode, see the *Storage Navigator User's Guide*.
3. Open the Pool window (see Figure 5-3).
4. Select the **SIM Complete Request** check box.
5. Click **Apply**. A confirmation message appears asking whether it is OK to apply the setting to the storage system.
6. Click **OK**. The confirmation message closes and the SIM complete process begins. It takes time if there are many SIMs to be completed.

If you complete a SIM, the status of the SIM changes to "completed". After the trouble that caused the SIM is solved, complete the SIM and change its status to "completed". If you complete the SIM before the underlying cause is solved, the SIM may reoccur.

After correcting the causes of SIMs 620XXX and 621XXX, you need to complete the SIMs. If you do not complete the SIMs, no new SIM will occur even if the usage level increases and again exceeds the threshold (Target SIM codes are 620XXX and 621XXX).

SIMs 620XXX, 621XXX, and 625000 are automatically completed if you increase pool capacity by adding pool-VOLs because the condition that caused the SIM removed.

You can check whether the SIMs complete successfully in the Storage Navigator window. For details, see the *Storage Navigator User's Guide*.

Troubleshooting When Using Command Control Interface

If an error occurs when increasing V-VOL capacity using CCI, you may be able to identify the cause of the error by referring to the log displayed on the CCI window or CCI operation log file. The CCI operation log file is stored in the following directory by default.

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

Where:

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

To identify the error code using the log file, follow the procedure below. For more information about CCI, please see the *Hitachi Command Control Interface (CCI) User and Reference Guide*.

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

   Example:

   ```
   09:06:18-82a22-10228- SSB  = 0xb96b,af2a
   ```

   Error codes appear on the right of the equal symbol (=). The left of the comma (,) indicates SSB1, and the right of the comma (,) indicates SSB2.

2. Refer to Table 6-2 and find the meaning of the error code.

   For details about the error codes that are not described in Table 6-2, contact the Hitachi Data Systems Technical Support Center (see Calling the Hitachi Data Systems Technical Support Center).

To identify the error code using the log displayed on the CCI window, follow the procedure below.

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

   Example:

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

   Error codes appear on the right of "SSB=". The left of the comma (,) indicates SSB1, and the right of the comma (,) indicates SSB2.

2. See Table 6-2 and find the meaning of the error code.

   For details about the error codes that are not described in Table 6-2, contact the Hitachi Data Systems Technical Support Center (see Calling the Hitachi Data Systems Technical Support Center).

Caution: Before increasing the V-VOL capacity, be sure to check the current V-VOL capacity. If you increase the V-VOL capacity specified with a group (i.e., with the -g option specified), some increased devices may exist in the group. Therefore, the capacity may be added to the device for which capacity has already been increased.

Table 6-2 Error Code and Error Contents When Operating CCI

Error Code (SSB1)	Error Code (SSB2)	Error Contents	Solution
0xb96b	0xb900/0xb901/ 0xaf28	Error occurred when increasing V-VOL capacity operation.	Ask the Technical Support Center to solve the problem.
	0xb902	The operation was rejected because the configuration was being changed by SVP or Storage Navigator, or because the V-VOL capacity was going to be increased by another instance of the CCI.	Increase the V-VOL capacity after finishing operations such as the Virtual LVI/LUN operation or the maintenance operation on your storage system. See the Caution in Increasing V-VOL Capacity.
	0xaf24	The operation was rejected because the total V-VOL capacity exceeds the pool capacity after the V-VOL capacity increases.	Make sure that the total V-VOL capacity does not exceed the pool capacity after the V-VOL capacity increases.
	0xaf25	The operation was rejected because releasing pages in the specified volume has not been completed.	Reexecute the operation after a brief interval.
	0xaf29	Because the specified volume was not a V-VOL, the operation was rejected.	Makes sure that the volume is a V-VOL.
	0xaf2a	Because the specified capacity exceeded the free space size immediately below the V-VOL, the operation was rejected.	When increasing capacity, specify that capacity does not exceed the free space capacity displayed in the V-VOL window. For details, see the conditions for increasing V-VOL capacity in Increasing V-VOL Capacity.
	0xaf2b	Because the specified volume operation was not finished, the operation was rejected.	Reexecute the operation after a brief interval.
	0xaf2c	Because the shared memory capacity is not enough to increase the specified capacity, the operation was rejected.	Make sure the value of the **remaining** in the V-VOL window is enough.
	0xaf2d	Because the ratio of the free space capacity of the pool to the free space capacity of the V-VOL was less than the DP-VOL threshold, the operation was rejected.	When increasing capacity, make sure that the ratio of free space in the pool to free space in the DP-VOL is not below the DP-VOL threshold. For details, see

Error Code (SSB1)	Error Code (SSB2)	Error Contents	Solution
			the conditions for increasing V-VOL capacity in Increasing V-VOL Capacity.

Calling the Hitachi Data Systems Technical Support Center

If you need to call the Hitachi Data Systems Technical Support Center, make sure you can provide as much information about the problem as possible. Include the circumstances surrounding the error or failure, the Storage Navigator configuration information saved in the floppy diskette(s) by the **FD Dump Tool**, the exact content of messages displayed on the Storage Navigator, and severity levels and reference codes displayed on the **Status** tab of the **Storage Navigator Main** window (see the *Storage Navigator Messages*).

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

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

Acronyms and Abbreviations

CCI	Command Control Interface
CLPR	cache logical partition
CTG	consistency group
CTRLID	controller ID
CU	control unit
DKC	disk controller
DKU	disk unit
DP-VOL	Dynamic Provisioning volume (a virtual volume with no memory space)
ECDS	Enterprise Content Delivery Service
ESCD	extended system configuration data
FD	floppy disk
GB	gigabyte (see Convention for Storage Capacity Values)
GID	group ID
HBA	host bus adapter
HRX	Hitachi RapidXchange
I/O	input/output
IBM	International Business Machines Corporation
JNL	journal
JNLG	journal group
KB	kilobyte (see Convention for Storage Capacity Values)
LAN	local-area network
LBA	logical block address
LCP	local control port
LDEV	logical device
LDLC	logical disc controller
LED	light-emitting diode
LU	logical unit
LUN	logical unit (also called device emulation or device type)
LUSE	LU size expansion

LVI	logical volume image (also called device emulation)
MB	megabyte (see Convention for Storage Capacity Values)
Mb/s	megabits per second
MCU	main control unit
MIH	missing interrupt handler
NSC	Hitachi TagmaStore Network Storage Controller
NVS	nonvolatile storage
PB	petabyte (see Convention for Storage Capacity Values)
PC	personal computer system
PCB	printed circuit board
PiT	Point-in-time
PSUE	pair suspended-error
PSUS	pair suspended-split
P-VOL	primary volume (for SI, TC, and UR)
RAID	redundant array of independent disks
RAID-1/-5/-6	specific RAID architectures
RCU	remote control unit
RIO	remote I/O
SI	Hitachi ShadowImage
SIM	service information message
SIz	Hitachi ShadowImage for IBM z/OS
SLPR	storage management logical partition
SOM	system option mode
SMPL	simplex
SVP	service processor
sync	synchronous
S-VOL	source volume (for SIz) or secondary volume (for SIz, TC, and UR)
S/N, s#	serial number
TB	terabyte (see Convention for Storage Capacity Values)
TC	Hitachi TrueCopy
TCz	Hitachi TrueCopy for IBM z/OS
UR	Hitachi Universal Replicator
URz	Hitachi Universal Replicator for IBM z/OS
USP	Hitachi TagmaStore Universal Storage Platform
USP V	Hitachi Universal Storage Platform V
USP VM	Hitachi Universal Storage Platform VM
VLL	Virtual LVI/LUN
VOL	volume
V-VOL	virtual volume

Index

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