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Hitachi Unified Storage
Provisioning Configuration Guide

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MK-91DF8277-14

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Contents

Preface

Welcome to the Hitachi Unified Storage Provisioning Configuration Guide.

This document describes the Hitachi Dynamic Provisioning and Hitachi Dynamic Tiering software.

Hitachi Dynamic Provisioning provides virtual storage capacity capabilities. When an application requires more storage capacity, Hitachi Dynamic Provisioning allows the Hitachi Unified Storage system to allocate the necessary storage automatically by drawing from a central virtual pool, without requiring physical disks to be added.

Hitachi Dynamic Tiering optimizes the use of tiered storage by eliminating the need for manual data classification and data movement. Working with Hitachi Dynamic Provisioning, Hitachi Dynamic Tiering moves data among tiers automatically, according to workload, to the most appropriate media.

Hitachi Dynamic Provisioning and Hitachi Dynamic Tiering operations can be performed using a graphical user interface (GUI) and a command-line interface (CLI).

- GUI activities are performed using Hitachi Storage Navigator Modular 2 and are described in this document.
- CLI activities are described in the *Hitachi Unified Storage Command Line Interface Reference Guide*.

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

This preface includes the following information:

Intended audience

This document is intended for system administrators, Hitachi Data Systems representatives, and authorized service providers who install, configure, and operate Hitachi Unified Storage systems.

Product version

This document applies to Hitachi Unified Storage firmware version 0981/D or later.

Changes in this revision

- Under Relocation operation conditions (page 10-15), added situations when tier relocation cannot be performed.
- Under Buffer space for tier relocation (page 10-13), added description about when target DP pool tier relocation does not operate.

Related documents

This Hitachi Unified Storage documentation set consists of the following documents.

Hitachi Unified Storage Firmware Release Notes, RN-91DF8304

Contains late-breaking information about the storage system firmware.

Hitachi Storage Navigator Modular 2 Release Notes, RN-91DF8305

Contains late-breaking information about the Storage Navigator Modular 2 software.

Read the release notes before installing and using this product. They may contain requirements and restrictions not fully described in this document, along with updates and corrections to this document.

Hitachi Unified Storage Getting Started Guide, MK-91DF8303

Describes how to get Hitachi Unified Storage systems up and running in the shortest period of time. For detailed installation and configuration information, refer to the Hitachi Unified Storage Hardware Installation and Configuration Guide.

Hitachi Unified Storage Hardware Installation and Configuration Guide, MK-91DF8273

Contains initial site planning and pre-installation information, along with step-by-step procedures for installing and configuring Hitachi Unified Storage systems.

Hitachi Unified Storage Operations Guide, MK-91DF8275

Describes the following topics:

- Adopting virtualization with Hitachi Unified Storage systems
- Enforcing security with Account Authentication and Audit Logging
- Creating DP-Vols, standard volumes, Host Groups, provisioning storage, and utilizing spares
- Tuning storage systems by monitoring performance and using cache partitioning
- Monitoring storage systems using email notifications and Hi-Track
- Using SNMP Agent and advanced functions such as data retention and power savings
- Using functions such as data migration, volume expansion and volume shrink, RAID Group expansion, DP pool expansion, and mega VOLs

Hitachi Unified Storage Replication User Guide, MK-91DF8274

Describes how to use the four types of Hitachi replication software to meet your needs for data recovery:

- ShadowImage In-system replication
- Copy-on-Write Snapshot replication
- TrueCopy Remote replication
- TrueCopy Extended replication

Hitachi Unified Storage Provisioning Configuration Guide, MK-91DF8277 — **this document**

Describes how to use virtual storage capabilities to simplify storage additions and administration.

Hitachi Unified Storage Hardware Service Guide, MK-91DF8302

Provides removal and replacement procedures for the components in Hitachi Unified Storage systems.

Hitachi Unified Storage Command Line Interface Reference Guide, MK-91DF8276

Describes how to perform management and replication activities from a command line.

Document organization

The first part of this document describes Hitachi Dynamic Provisioning, while the second part describes Hitachi Dynamic Tiering. Thumbnail descriptions of the chapters are provided in the following table. Click the chapter title in the first column to go to that chapter. The first page of every chapter contains links to the contents.

Chapter/Appendix Title	Description
Chapters 1 through 8 — Hitachi Dynamic Provisioning	
Chapter 1, Hitachi Dynamic Provisioning overview	Describes the general features, functions, and benefits of using Hitachi Dynamic Provisioning.
Chapter 2, About Hitachi Dynamic Provisioning operations	Explains DP pools and DP-VOLs used by Hitachi Dynamic Provisioning, and Dynamic Provisioning functions.
Chapter 3, Preparing for Hitachi Dynamic Provisioning operations	Explains the requirements and restrictions to use Dynamic Provisioning, and how to install, uninstall, disable, and enable the application.
Chapter 4, Using the Hitachi Dynamic Provisioning GUI	Describes features of the Hitachi Dynamic Provisioning graphical user interface (GUI).
Chapter 5, Performing Hitachi Dynamic Provisioning operations	Provides procedures for performing Hitachi Dynamic Provisioning operations using the Hitachi Storage Navigator Modular 2 GUI.
Chapter 6, Hitachi Dynamic Provisioning Troubleshooting	Contains troubleshooting suggestions for Hitachi Dynamic Provisioning.
Chapter 7, Installing Hitachi Dynamic Provisioning when Cache Partition Manager is used	Describes how to install Dynamic Provisioning when Cache Partition Manager is used.
Chapter 8, Capacity of Hitachi Dynamic Provisioning RAID Group	Shows the actual capacities of Hitachi Dynamic Provisioning RAID groups.
Chapters 9 through 14 — Hitachi Dynamic Tiering	
Chapter 9, Hitachi Dynamic Tiering overview	Describes the general features, functions, and benefits of using Hitachi Dynamic Tiering.
Chapter 10, About Hitachi Dynamic Tiering operations	Explains DP pools, DP RAID groups, DP-VOLs, and tiers used by Dynamic Tiering, and Dynamic Tiering functions.
Chapter 11, Preparing for Hitachi Dynamic Tiering operations	Explains the requirements and restrictions to use Hitachi Dynamic Tiering, and how to install, uninstall, disable, and enable the application.

Chapter / Appendix Title	Description
Chapter 12, Using the Hitachi Dynamic Tiering GUI	Describes features of the Hitachi Dynamic Tiering GUI.
Chapter 13, Performing Hitachi Dynamic Tiering operations	Provides procedures for performing Hitachi Dynamic Tiering operations using the Hitachi Storage Navigator Modular 2 GUI.
Chapter 14, Hitachi Dynamic Tiering Troubleshooting	Contains troubleshooting suggestions for Hitachi Dynamic Tiering.
Chapter 15, Installing Hitachi Dynamic Tiering when Cache Partition Manager is used	Describes how to install Dynamic Tiering when Cache Partition Manager is used.
Chapter 16, Capacity of Hitachi Dynamic Tiering RAID Group	Shows the actual capacities of Hitachi Dynamic Tiering RAID groups.

Dynamic Provisioning and Dynamic Tiering also provide a command-line interface that lets you perform operations by typing commands from a command line. For information, refer to the *Hitachi Unified Storage Command Line Interface Reference Guide*.

Document conventions

The following typographic conventions are used in this document.

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 you or the system. Example: copy *source-file target-file* Angled brackets (< >) are also used to indicate variables.
screen or code	Indicates text that is displayed on screen or entered by you. Example: `# pairdisplay -g oradb`
< > angled brackets	Indicates a variable, which is a placeholder for actual text provided by you or the 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 symbols to draw attention to important safety and operational information.

Symbol	Meaning	Description
	Tip	Tips provide helpful information, guidelines, or suggestions for performing tasks more effectively.
	Note	Notes emphasize or supplement important points of the main text.
	Caution	Cautions indicate that failure to take a specified action could result in damage to the software or hardware.
	WARNING	Warns that failure to take or avoid a specified action could result in severe conditions or consequences (for example, loss of data).

Convention for storage capacity values

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

Physical capacity unit	Value
1 KB	1,000 bytes
1 MB	1,000 KB or $1{,}000^2$ bytes
1 GB	1,000 MB or $1{,}000^3$ bytes
1 TB	1,000 GB or $1{,}000^4$ bytes
1 PB	1,000 TB or $1{,}000^5$ bytes
1 EB	1,000 PB or $1{,}000^6$ bytes

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

Logical capacity unit	Value
1 block	512 bytes
1 KB	1,024 (2^{10}) bytes
1 MB	1,024 KB or 1024^2 bytes
1 GB	1,024 MB or 1024^3 bytes
1 TB	1,024 GB or 1024^4 bytes
1 PB	1,024 TB or 1024^5 bytes
1 EB	1,024 PB or 1024^6 bytes

Accessing product documentation

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

Getting help

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

Comments

Please send us your comments on this document: doc.comments@hds.com. Include the document title and number, including the revision level (for example, -07), and refer to specific sections and paragraphs whenever possible. All comments become the property of Hitachi Data Systems.

Thank you!

1

Hitachi Dynamic Provisioning overview

This chapter describes the general features, functions, and benefits of using Hitachi Dynamic Provisioning.

The following topics are covered in this chapter:

- Hitachi Dynamic Provisioning features
- Hitachi Dynamic Provisioning benefits

Hitachi Dynamic Provisioning features

Hitachi Dynamic Provisioning is an advanced thin-provisioning software product that provides Virtual Storage Capacity to simplify administration and addition of storage, improve volume efficiency, eliminate application service interruptions, and reduce costs.

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

Hitachi 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 in the storage system. It also decouples the provisioning of storage to an application from the physical addition of storage capacity to the storage system.

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

Hitachi Dynamic Provisioning software also simplifies performance optimization by transparently spreading application data across many physical drives, thereby reducing performance management concerns and optimizing performance and throughput.

With Hitachi Dynamic Provisioning, overall storage utilization rates improve and the entire storage system is tuned for greater efficiency. Hitachi Dynamic Provisioning is also compatible with delivering benefits to a tiered storage environment.

Coupled with the advanced features and reliability of the Hitachi Unified Storage systems, implementing Hitachi Dynamic Provisioning can reduce your capital and management expenses, resulting in an improved return on your storage investment.

Hitachi Dynamic Provisioning benefits

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

With Hitachi Dynamic Provisioning, the storage administrator defines a virtual volume that is assigned to a DP Pool consisting of physical drives. The customer's application only interacts with the virtual volume.

Table 1-1 shows the benefits of Hitachi Dynamic Provisioning.

Table 1-1: Hitachi Dynamic Provisioning benefits

Benefits	Using Hitachi Dynamic Provisioning	Not Using Hitachi Dynamic Provisioning
Reduced system cost	A DP-VOL's total capacity can be larger than the actual drive capacity. You can purchase drive capacity to match the written data size near-term requirement while defining a larger capacity (volume size) to accommodate future long-term requirements. As a result, the initial system cost can be reduced. Effective capacity reduction depends on the operating system, file system, application, and projected near-term growth requirement.	Initial purchase capacity must accommodate predicted future growth, even if this growth is delayed or never materializes. The cost of the Hitachi Unified Storage system is higher due to larger purchased capacity.
Reduced operation management cost	When the actual drive capacity is insufficient to accommodate near-term growth, drives can be added without having to stop the system. Operation management costs are reduced by eliminating outages to increase volume capacity and drive capacity.	It is required to stop the system to add capacity.
Improved drive operation efficiency	A DP pool can consist of two or more RAID groups that stripes data across multiple disk drives to improve responsiveness.	Normally, volumes are defined to a single RAID group, and other RAID groups that are prepared in advance for future use remain non-operational. In this way, the load from an application or collection of applications is concentrated on the operating RAID group only.

Non-disruptive addition of physical drives

A Hitachi Dynamic Provisioning volume appears as a Virtual LVI or LUN volume that has no actual storage capacity. Actual storage capacity from the Hitachi 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 drive capacity can be installed transparently when needed, without interrupting application services.

Improved performance

Hitachi Dynamic Provisioning software effectively combines many application I/O patterns and spreads the I/O activity across all available physical resources. Before Hitachi Dynamic Provisioning software was available, optimizing to use all drives was a complex manual task requiring considerable expertise. Avoiding drive ‘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 drives may generate I/O patterns that cause contention and performance bottlenecks.

Hitachi Dynamic Provisioning software automatically distributes hundreds of users' I/O patterns evenly over all available drives and optimizes aggregate throughput to deliver the best performance without requiring individual application balancing and manually matching up drives.

Reduced storage acquisition costs

Defining a volume larger than the physical drive allows you to plan for additional future storage needs during initial installation and then adding physical storage capacity incrementally over time. This approach provides savings in space, power, and cooling requirements.

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

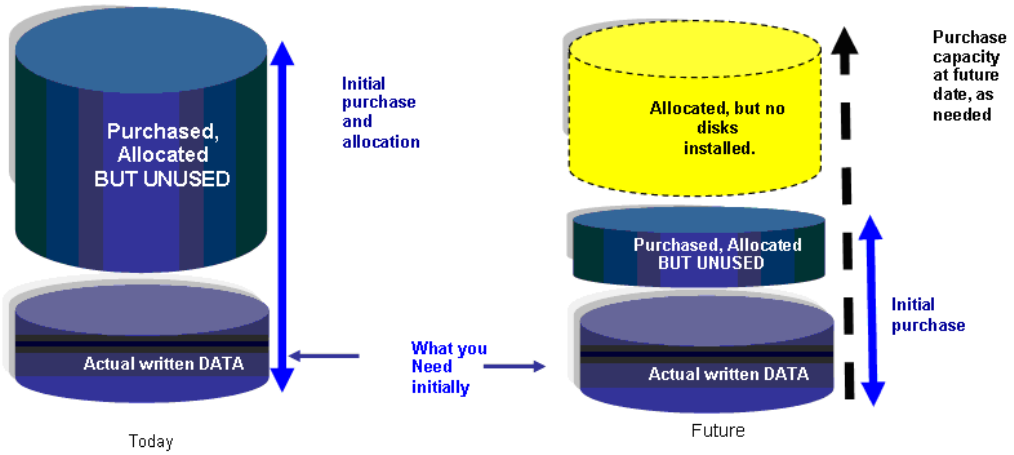


Figure 1-1: Benefits of Hitachi Dynamic Provisioning

2

About Hitachi Dynamic Provisioning operations

This chapter provides an overview of Hitachi Dynamic Provisioning. The following topics are covered in this chapter:

- Hitachi Dynamic Provisioning components
- Supported configurations
- Interoperability with other Hitachi software features
- Monitoring resources and tuning

Hitachi Dynamic Provisioning components

Hitachi Dynamic Provisioning comprises the following components:

- Hitachi Dynamic Provisioning
- DP pools
- DP RAID groups dedicated to a DP pool
- DP-VOLs

Hitachi Dynamic Provisioning software feature

The Hitachi Dynamic Provisioning software feature operates from the Hitachi Storage Navigator Modular 2 management console (PC) connected to a Hitachi Unified Storage system using a TCP/IP local area network (LAN). When logging in to a Hitachi Unified Storage system from the Storage Navigator Modular 2 PC, you can obtain information on the configuration and status of the array and send commands to the array.

Relationship between DP pool, RAID group, and DP-VOL

In Hitachi Dynamic Provisioning, the data in the DP pool is accessed using the DP-VOL. The DP-VOL is managed in the DP-VOL management area, which manages the mapping information between the virtual volume and the actual volume in the DP pool. Therefore, at least one DP-VOL and one DP pool are required for using Hitachi Dynamic Provisioning. A DP pool consists of one or more dedicated RAID groups.

Figure 2-1 shows the relationship between DP pools and the DP-VOL.

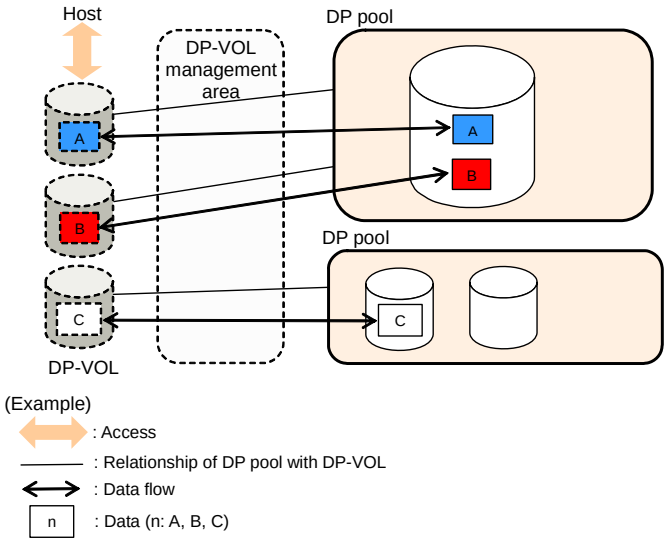


Figure 2-1: Relationship between DP pools and DP-VOL

DP pools and DP RAID groups

Hitachi Dynamic Provisioning requires DP pools. A DP pool consists of one or more dedicated RAID groups. A RAID group created for a DP pool is a DP RAID group. The rules for constructing a DP RAID group are the same as standard RAID groups.

A Hitachi Unified Storage 150 or Hitachi Unified Storage 130 can register up to 4,096 DP-VOLs for one DP pool. The maximum number of DP pools that can be created in one Hitachi Unified Storage 150 or Hitachi Unified Storage 130 is 64.

A Hitachi Unified Storage 110 array can register up to 2,048 DP-VOLs for one DP pool. The maximum number of DP pools that can be created in one Hitachi Unified Storage 110 is 50.

DP pools are created using Storage Navigator Modular 2. See Chapter 5, Performing Hitachi Dynamic Provisioning operations for graphical user interface (GUI) operations and the *Hitachi Unified Storage Command Line Interface Reference Guide* for command-line interface (CLI) operations. When deleting a DP pool, all the data in the DP pool is deleted. When deleting a DP pool, you must first delete the DP-VOLs belonging to the DP pool.

DP-VOLs

The DP-VOL is a virtual volume that consumes and maps physical storage space only for areas of the volume where data is written. In Hitachi Dynamic Provisioning, a DP-VOL is associated with a DP pool.

The DP-VOL needs to specify a DP pool number, DP-VOL logical capacity, and DP-VOL number. Many DP-VOLs can be defined for one DP pool. A DP-VOL cannot be defined in multiple DP pools.

- Hitachi Unified Storage 150 and Hitachi Unified Storage 130 can register up to 4,096 DP-VOLs.
- Hitachi Unified Storage 110 can register up to 2,048 DP-VOLs.

The maximum number of DP-VOLs is reduced by the number of system-wide RAID groups.

A DP-VOL is created using Storage Navigator Modular 2. See Chapter 5, Performing Hitachi Dynamic Provisioning operations for GUI operations and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operations.

Increasing DP pool capacity

The total amount of capacity of the DP RAID groups registered in the DP pool is the capacity of that DP pool. You can increase DP pool capacity by adding DP RAID groups to the DP pool. Each DP RAID group is used in sequence as chunks (a chunk is a 1GB allocation unit within the DP pool) are needed to satisfy data writes.

When increasing DP pool capacity, be sure you add Hitachi Dynamic Provisioning RAID group units that have the same RAID type as the existing DP RAID groups. The drives used to create a new DP RAID group while adding to an existing DP pool should be the same type and size, or nearly the same, as those already configured to the DP pool. This limitation does not apply to firmware versions 0945/A and later, which let you increase DP pool capacity by adding a DP RAID group using any supported RAID type and supported drive type.

The upper limit is defined by the Unified Storage array you are using:

- Hitachi Unified Storage 110: upper limit is approximately 650 TB
- Hitachi Unified Storage 130: upper limit is approximately 980 TB
- Hitachi Unified Storage 150: upper limit is approximately 2,600 TB

If the pool is completely used or the pool capacity depletion alert threshold value is exceeded and you cannot increase DP pool capacity, then increase the free capacity by migrating some data to another Unified Storage system or delete unnecessary DP-VOLs.

Use Storage Navigator Modular 2 to monitor the free capacity of the DP pool, and grow the DP pool as needed. See Chapter 5, Performing Hitachi Dynamic Provisioning operations for GUI operations and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operations.

The consumed capacity in the DP pool can be balanced across the DP RAID groups after adding DP pool capacity (see Optimizing a DP pool and Changing DP-VOL capacity). The balancing of consumed capacity effectively balances each DP-VOL's utilization across all the DP pool's RAID groups.

NOTE: For Hitachi Unified Storage 130 and 150 systems with firmware version 0950/A or later, the upper limit can be changed by setting the DP Capacity Mode to the maximum capacity of 2,600 TB (approx.) for the Hitachi Unified Storage 130 and 5,200 TB (approx.) for the Hitachi Unified Storage 150. For more information, see DP Capacity Mode on page 2-7.

Shrinking DP pool capacity

Deleting the DP RAID group from the DP pool can shrink DP pool capacity. When shrinking DP pool capacity, the total DP pool capacity is shrunk. See Shrinking the DP pool capacity on page 5-10, and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operations.

DP pool capacity cannot be shrunk when the:

- Pool status to which the DP RAID group of a shrinking target belongs is exceeding the Depletion Alert threshold value.
- Pool capacity after shrinking exceeded the depletion threshold value.
- Pool to which the DP RAID group of a shrinking target belongs is blocked.
- DP-VOL in the pool to which the DP RAID group of a shrinking target belongs is blocked.
- DP-VOL in the pool to which the DP RAID group of a shrinking target belongs is unformatted.
- DP-VOL in the pool to which the DP RAID group of a shrinking target belongs is during online parity correction.
- DP RAID group of a shrinking target occurs during drive restoration. When a DP RAID group other than a shrinking target occurs during drive restoration, the instruction is received. However, DP pool

shrinking fails if the RAID group during drive restoration is selected as a migration destination.

- DP-VOL status in the pool to which the DP RAID group of a shrinking target belongs is during deletion or formatting.
- Drive firmware is being replaced while array power is turned on.
- Pool to which the DP RAID group of a shrinking target belongs is exceeding Limit Threshold of Over Provisioning. If the Limit Enforcement is enabled, the DP pool can be shrunk.
- Pool to which the DP RAID group of a shrinking target belongs exceeds Limit Threshold of Over Provisioning after shrinking. If the Limit Enforcement is enabled, the DP pool can be shrunk.
- Memory is being reconstructed.
- Pool is changing background configuration.
- Shrinking target DP RAID group is the last DP RAID group in pool.
- DMLU exists in the pool to which the shrinking target DP RAID group belongs when the firmware version is less than 0970/A.
- Replication or management area capacity exists in pool to which the shrinking target DP RAID group belongs. If replication or management area capacity exists in the DP pool, capacity shrinking may be possible. The DP RAID group added to the DP pool or as part of the DP RAID groups when the replication or management area capacity must be less than the number of DP RAID groups Í 1GB is a target.
- DP RAID group of a shrinking target exceeds Replication Data Released Threshold in the pool in which the group belongs after shrinking.

Shrinking reduces the total DP pool capacity, so be extremely careful not to deplete the capacity. When executing host I/O, shrinking takes more time than when the host I/O is not occurring. Shrink times depend on factors such as the RAID range of the DP RAID group and the stripe range of the DP pool or drive types, even when shrinking the same capacity.

Canceling DP pool capacity shrinking

DP pool shrinking can be canceled. If DP pool shrinking is canceled on the way, the data migrated in accordance with shrinking does not return to the original DP RAID group. Optimize the DP as needed. See Canceling DP pool capacity shrinking on page 5-11 for GUI operations and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operations.

Growing or shrinking the DP-VOL capacity

DP-VOL capacity can grow or shrink. When the DP-VOL capacity is shrunk, the DP pool area used for the part that shrunk is released and the free capacity of the DP pool increases. You grow or shrink the DP-VOL using Storage Navigator Modular 2. See Chapter 5, Performing Hitachi Dynamic Provisioning operations for GUI operations and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operations. The consumed capacity in the DP pool can be rebalanced by selecting Optimize when shrinking DP pool capacity. For more information, see Accelerated Wide Striping Mode on page 2-10.

Deleting a DP pool

When you delete a DP pool, first delete all the DP-VOLs defined to the DP pool. When all DP-VOLs have been deleted, then delete the DP pool. See Chapter 5, Performing Hitachi Dynamic Provisioning operations for GUI operations and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operations.

Optimizing a DP pool

The DP pool can be optimized by rebalancing each DP-VOL's allocated pool capacity evenly across each of the DP RAID groups. This is particularly effective after adding a DP RAID group to a DP pool.

After adding a DP RAID group to the DP pool, the usage between DP RAID groups will not be balanced. When optimizing the DP pool, the unbalanced consumed capacity between DP RAID groups can be redistributed. Optimizing can also eliminate capacity taken by binary zero data patterns and combine partially used chunks assigned to a DP-VOL so capacity can be released from DP-VOLs. The released capacity will increase the free capacity in the DP pool.

While optimizing the DP pool, the I/O performance of the host for the DP-VOLs may be slightly affected. Setting **Priority** to **Host Access** in the Change Priority dialog box minimizes this impact (see Changing optimization priority on page 5-18). In addition, optimization will slightly increase the capacity consumed in the pool temporarily while DP-VOL data is being relocated between DP RAID groups. The throughput of the optimization process depends on many factors. When there is no host I/O, throughput of optimization is approximately 60 MB/s.

See Chapter 5, Performing Hitachi Dynamic Provisioning operations for GUI operations and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operations.

If reclaiming zero data while optimizing the DP pool, a page (which is a 32 Mb segment of a 1 Gb chunk) consisting solely of binary zeroes will be unmapped.

There are some advantages to reclaiming zero data while optimizing the DP pool:

- When restoring a volume's data from backup such as a tape, areas consisting of zero data are reclaimed and capacity can be reduced.
- After Volume Migration from a normal volume to a DP-VOL, the parts of the normal volume that had been binary zeroes can be reclaimed and capacity can be reduced.
- A ShadowImage pair between a normal volume and a DP-VOL can reclaim capacity from areas of zero data.
- When unused areas increase in the file system, reducing the capacity of the file system becomes simplified.

Auto DP optimization mode

Auto DP optimization mode monitors unused capacity in a DP volume and performs DP optimization automatically.

In the DP volume where auto DP optimization mode is set, the unused capacity is monitored at midnight every day and DP optimization starts when the unused capacity equals or exceeds the auto DP optimization threshold value.

If the pool usage rate equals or exceeds the depletion alert threshold value, DP optimization mode starts if the unused capacity of the target DP volumes equals or exceeds 1 GB. Table 2-1 shows the conditions when auto DP optimization is performed.

Table 2-1: Conditions when auto DP optimization is performed

DP pool usage rate	Conditions for performing auto DP optimization
Less than depletion alert threshold value	Unused equals or exceeds the auto DP optimization threshold value
Equals or exceeds the depletion alert threshold value	Unused capacity equals or exceeds 1 GB

This mode can be changed in units of DP volumes in the Change Attributes window at any time. By default, it is disabled. For more information, see Changing provisioning attributes on page 5-22.

Auto DP optimization does not use the option to reclaim the zero data page. To reclaim zero data page, perform DP optimization manually.

Before DP optimization is performed, auto DP optimization is checked (the same way manual DP optimization is checked prior to executing the DP optimization). During this time, unnecessary capacity accumulates. As a result, if the conditions for executing auto DP optimization are met, when the conditions for executing the DP optimization are not met, DP optimization is not executed.

DP Capacity Mode

When the firmware version for a Hitachi Unified Storage 130 or 150 system is 0950/A or later, you can change the upper limit of the DP pool capacity. Table 2-2 on page 2-8 shows the upper limit in case the mode is changed. The DP Capacity Mode changes to the maximum capacity when creating a DP pool exceeding the regular capacity or creating/expanding a DP-VOL where the total capacity of the DP-VOL defined in the array exceeds the regular capacity.

See Chapter 5, Performing Hitachi Dynamic Provisioning operations for GUI operations and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operations.

Table 2-2: Maximum DP pool capacity value by DP Capacity Mode

Hitachi Unified Storage System	DP Capacity Mode	
	Regular capacity	Maximum capacity
130	Approximately 980 TB	Approximately 2,600 TB
150	Approximately 2,600 TB	Approximately 5,200 TB

If at least one instance of **Maximum Capacity** appears in the DP Optimization screen (see DP Optimization window on page 4-19), the firmware version for the Hitachi Unified Storage 130 or 150 system must be 0950/A or later. DP Capacity Mode is not supported by the Hitachi Unified Storage 110.

For Hitachi Unified Storage 150 systems with 8 GB of cache per controller, the DP Capacity Mode cannot be changed to the maximum capacity. To use the maximum capacity, set the installed cache memory capacity per controller to 16 GB.

Changing the DP Capacity mode might require the storage system to be restarted. If you do not restart the storage system or reconfigure memory after changing the DP Capacity Mode, DP operations may be limited. When using Cache Partition Manager, reconfiguring the memory does not change the DP Capacity Mode; the storage system must be restarted for the changes to take effect. Changing to maximum capacity mode resets Cache Partition Manager to default settings after system reboots (restarts).

If the volume size cannot be set after the memory reconfiguration, the DP Capacity Mode cannot be changed using memory reconfiguration. Cancel the resident volume or make the resident volume capacity small, and then restart the storage system. When restarting the storage system, the set resident volume is cancelled.

When using the maximum capacity mode, user data area is reduced from the regular capacity mode because part of the cache memory becomes the management area for the DP. Table 2-3 on page 2-9 shows the cache memory reduction when changing from regular capacity to maximum capacity mode. The reduction is approximately 1,000 MB in Hitachi Unified Storage 130 systems and 1,654 MB in Hitachi Unified Storage 150 systems (see Table 2-3 on page 2-9 and Table 2-4 on page 2-9).

When changing from the maximum capacity mode to the regular capacity mode, DP pools should not exist.

If a Hitachi Unified Storage 130 system will be upgraded to a Hitachi Unified Storage 150 system, the maximum cache supported increases from 8 GB per controller to 16 GB per controller.

Table 2-3: Supported capacity in Regular Capacity mode

Hitachi Unified Storage System	Cache memory capacity per controller	Management information capacity (Dynamic Provisioning)	Management information capacity (Dynamic Tiering)	User data area		
				Dynamic Provisioning is disabled	Only Dynamic Provisioning is used	Dynamic Provisioning and Dynamic Tiering are used
130	8 GB	640 MB	200 MB	4,660 MB	4,020 MB	3,820 MB
	16 GB			11,280 MB	10,640 MB	10,440 MB
150	8 GB	1,640 MB	200 MB	4,540 MB	2,900 MB	2,700 MB
	16 GB			11,160 MB	9,520 MB	9,320 MB

Table 2-4: Supported capacity in Maximum Capacity mode

Hitachi Unified Storage System	Cache memory capacity per controller	Management information capacity (Dynamic Provisioning)	Management information capacity (Dynamic Tiering)	User data area		
				Dynamic Provisioning is disabled	Only Dynamic Provisioning is used	Dynamic Provisioning and Dynamic Tiering are used
130	8 GB	1,640 MB	200 MB	4,660 MB	3,000 MB	2,800 MB
	16 GB			11,280 MB	9,620 MB	9,420 MB
150	8 GB	3,300 MB	200 MB	4,540 MB	Not supported	
	16 GB			11,160 MB	7,860 MB	7,660 MB

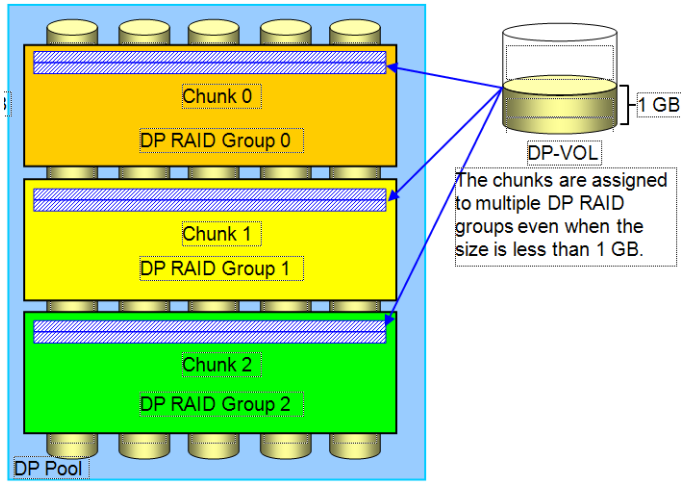
Accelerated Wide Striping Mode

Accelerated Wide Striping Mode is a mode that can improve random-access performance for small-sized volumes. The default value is disabled.

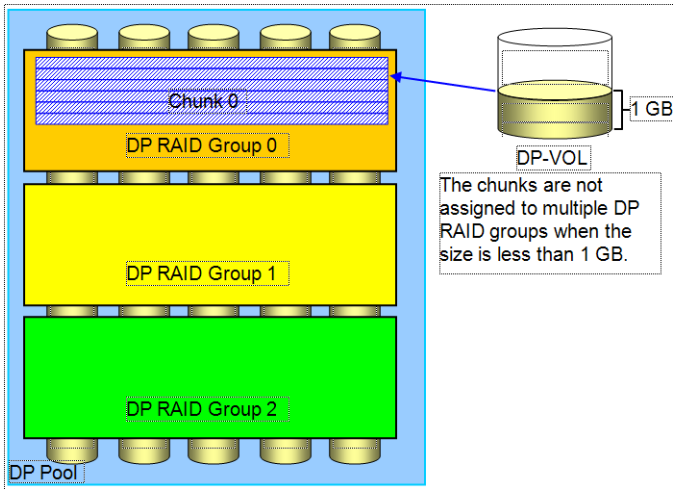
Accelerated Wide Striping Mode is particularly useful when the used volume size (in GBs) is smaller than the number of DP RAID groups in the Hitachi Dynamic Provisioning pool. Accelerated Wide Striping Mode can potentially improve performance for randomly accessed volumes with a relatively small amount of data.

If Accelerated Wide Striping Mode is expected to be used, set Accelerated Wide Striping when creating the DP-VOL (see Changing provisioning attributes on page 5-22). Since the page assignment method changes in Accelerated Wide Striping Mode, the chunks to be reserved will increase. Therefore, all the capacity displayed in the reclaimed capacity may not be recovered (DP Optimization window). For the pages in chunks that are already assigned, the location will not change even if the mode is changed.

When enabled, Accelerated Wide Striping Mode assigns more pool capacity to a DP-VOL. A chunk is acquired dynamically for each DP RAID Group in the pool. The DP-VOL pages will be associated randomly across the acquired chunks.



When Accelerated Wide Striping is disabled, the DP-VOL will acquire just one chunk at a time. The pages will be allocated as needed until the chunk is fully allocated.



On average, every DP-VOL has spare capacity available for new page requests. The average amount of spare capacity per DP-VOL is 50% of a chunk (.5 GB). When Accelerated Wide Striping has been enabled from DP-VOL at create time, the average amount of spare capacity per DP-VOL is .5 GB times the number of DP RAID Groups. Spare capacity can be reclaimed using DP optimization after changing the setting from Enabled to Disabled.

- The number of chunks will not increase, even if it is changed from Disabled to Enabled.
- The number of chunks will not decrease, even if it is changed from Enabled to Disabled. DP optimization can be used to reclaim the spare capacity.
- Accelerated Wide Striping Mode might not improve performance.

Full Capacity Mode

Full Capacity Mode assigns all the physical capacity in advance for the DP-VOL.

A DP-VOL should be set to Full Capacity Mode to avoid pool depletion status. The mode can be set per DP-VOLs in the DP Optimization screen under Change Attribute at time of the DP-VOL creation or later. The default value of **Disabled** assigns physical capacity as needed at the time of Write I/O.

When using **Enabled** mode, DP pool capacity is consumed. Therefore, use Full Capacity Mode only when DP pool capacity is acquired.

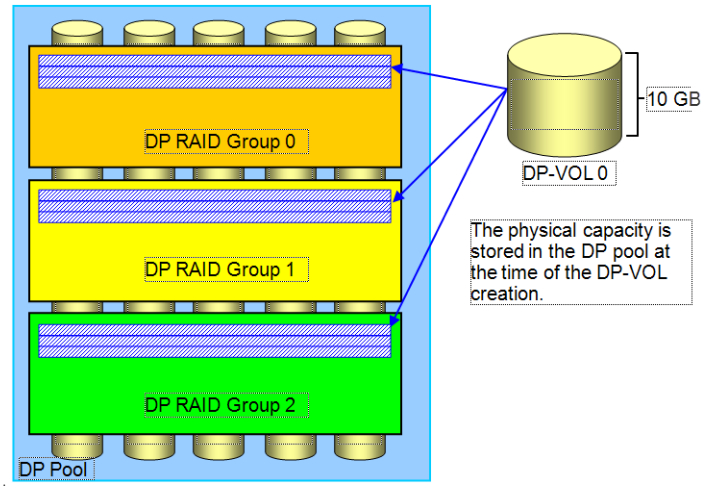


Figure 2-2: Full Capacity Mode enabled

If the total used pool capacity, including the DP-VOLs with the mode being enabled, is more than the pool's Depletion Alert threshold value, the Full Capacity Mode setting cannot be changed. Add DP pool capacity or change the Depletion Alert threshold value to continue changing the mode.

When using all the capacity of the DP pool by DP-VOLs in Full Capacity Mode, set the Depletion Alert threshold value to the maximum value (99%). Do not to mix DP-VOLs whose Full Capacity Mode is disabled in the same DP pool.

If the formatted area in the DP pool is not large enough, the mode cannot be enabled. Enter the mode after the DP pool formatting has completed.

If the mode is changed to **Enabled**, capacity is not assigned to the DP-VOL immediately. The typical assignment time is approximately 30 seconds for each TB.

When the mode is changed to **Disabled**, the previously assigned capacity is not released. Therefore, if there is any unnecessary capacity assigned to the DP-VOL, select **Reclaim zero pages before optimizing DP** and perform the operation in the DP Optimization window.

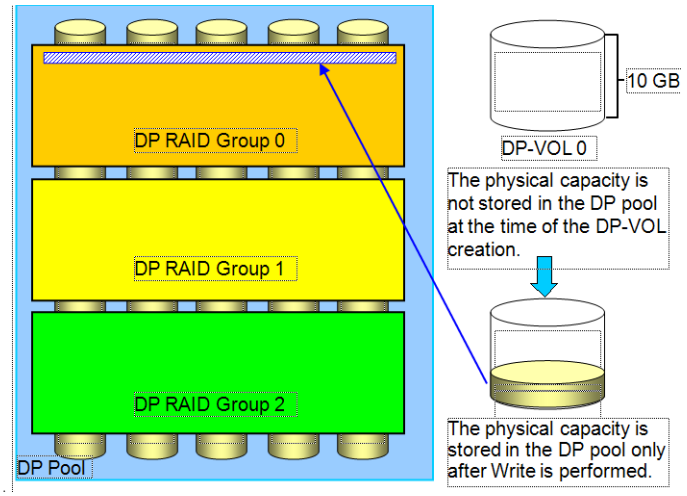


Figure 2-3: Full Capacity Mode disabled

Full Capacity Mode cannot be set to “Enabled” for the DMLU. Furthermore, a DP-VOL whose Full Capacity Mode is “Enabled” cannot be set as a DMLU.

Changing the Full Capacity Mode setting is inhibited for the following cases:

- DMLU
- DP pool is blocked
- DP-VOL is formatting
- DP-VOL is blocked
- Volumes during pair creation of ShadowImage, Copy on Write Snapshot, TrueCopy, TrueCopy Extended Distance, or Volume Migration

The following operations are inhibited for DP-VOLs whose Full Capacity Mode is **Enabled**:

- Setting the DMLU
- DP pool optimization with the **Reclaim zero pages before optimizing DP** option

The following operations are inhibited for DP-VOL whose Full Capacity Mode was set to “Enabled” but whose use rate has not reached 100%:

- DP pool optimization
- Deleting the DP-VOL
- Growing the DP-VOL
- Shrinking the DP-VOL
- Formatting the DP-VOL

Supported configurations

Table 2-5 shows the supported Hitachi Dynamic Provisioning configurations for Hitachi Unified Storage systems.

Table 2-5: Supported Hitachi Dynamic Provisioning configurations

Item	Hitachi Unified Storage 110	Hitachi Unified Storage 130	Hitachi Unified Storage 150
Maximum number of DP-VOLs (The number of volumes is reduced by the number of RAID groups.)	2,048	4,096	4,096
DP-VOL capacity	32 MB to 128 TB	32 MB to 128 TB	32 MB to 128 TB
Maximum number of DP pools	50	64	64
DP pool capacity	650 TB	980 - 2600 TB If capacity exceeds 980 TB, change DP Capacity Mode to Maximum Capacity.	2,600 - 5200 TB If capacity exceeds 2,600 TB, change DP Capacity Mode to Maximum Capacity.

Table 2-6 shows the supported Hitachi Dynamic Provisioning capacities for Hitachi Unified Storage systems. For more information, see DP Capacity Mode on page 2-7.

Table 2-6: Supported Hitachi Dynamic Provisioning capacities

Hitachi Unified Storage	Cache memory capacity per controller	DP Capacity mode	Management information capacity		User data area		
			Hitachi Dynamic Provisioning	Hitachi Dynamic Tiering	Hitachi Dynamic Provisioning enabled	Hitachi Dynamic Provisioning and Dynamic Tiering enabled	Hitachi Dynamic Provisioning and Dynamic Tiering disabled
110	4 GB	Not supported	420 MB	50 MB	1,000 MB	960 MB	1,420 MB
130	8 GB	Regular Capacity	640 MB	200 MB	4,020 MB	3,820 MB	4,660 MB
		Maximum Capacity	1,640 MB	200 MB	3,000 MB	2,800 MB	4,660 MB
	16 GB	Regular Capacity	640 MB	200 MB	10,640 MB	10,440 MB	11,280 MB
		Maximum Capacity	1,640 MB	200 MB	9,620 MB	9,420 MB	11,280 MB
150	8 GB	Regular Capacity	1,640 MB	200 MB	2,900 MB	2,700 MB	4,540 MB
	16 GB	Regular Capacity	1,640 MB	200 MB	9,520 MB	9,320 MB	11,640 MB
		Maximum Capacity	3,300 MB	200 MB	7,860 MB	7,660 MB	11,160 MB

Interoperability with other Hitachi software features

In a Hitachi Unified Storage system, where the normal volume and the DP-VOL are mixed, the Hitachi software features can be used with the normal volume. The DP-VOL has restrictions on which Hitachi software features can be used. Table 2-7 shows the conditions of using Hitachi Dynamic Provisioning with other Hitachi software features.

Table 2-7: Permitted use of Hitachi software features with Hitachi Dynamic Provisioning DP VOLs and DP pools

Software feature	Conditions
ShadowImage	• The DP-VOL can be used for both P-VOL and S-VOL. For details, see ShadowImage on page 2-16. • The DP-VOL used by ShadowImage cannot grow or shrink its capacity. • Pairs can be created for the DP-VOLs during the DP pool optimization. • When using P-VOLs and S-VOLs with Full Capacity Mode, both P-VOL and S-VOL should have the same Full Capacity Mode setting; that is, Full Capacity Mode should be enabled or disabled for both P-VOL and S-VOL.
Copy on Write Snapshot	• The DP-VOL can be used for P-VOL and S-VOL.
TrueCopy or TrueCopy Extended Distance	• The DP-VOL can be used for both P-VOL and S-VOL. • When Full Capacity Mode is enabled, set both P-VOL and S-VOL to the same mode status.
LUN Manager and Cache Partition Manager	• The DP-VOL can be assigned as well as the normal volume. • The Hitachi Dynamic Provisioning DP pool cannot be set. • DP Capacity Mode cannot be changed by reconfiguring the memory while using Cache Partition Manager. When changing to maximum capacity mode by restarting the array, the partition setting returns to the default. • If you do not restart the array or reconfigure the memory after changing the DP Capacity Mode, Cache Partition Manager cannot be installed or validated.
Volume Migration	• Volume Migration cannot be created for DP-VOLs during the DP pool optimization. • DP pool optimization will not be performed for DP-VOLs used by Volume Migration. • When using P-VOLs and S-VOLs with Full Capacity Mode, both P-VOL and S-VOL should have the same Full Capacity Mode setting (Full Capacity Mode should be enabled or disabled for both P-VOL and S-VOL).
Cache Residency Manager	• The DP-VOL cannot be used. • The DP pool and DP RAID group cannot be set.
Power Saving/ Power Saving Plus	• The power saving function cannot be used for the DP RAID group belonging to the DP pool.

ShadowImage

Hitachi Dynamic Provisioning can be used concurrently with ShadowImage. Table 2-4 shows an example.

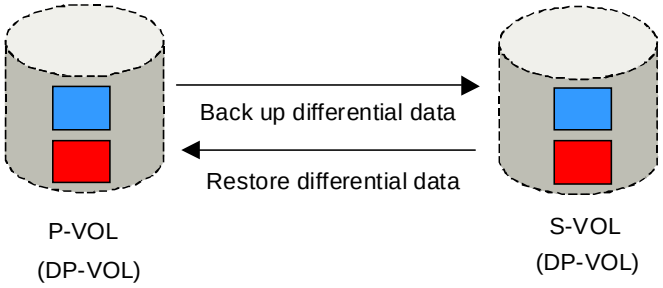


Figure 2-4: Using Hitachi Dynamic Provisioning with ShadowImage Example

When using Hitachi Dynamic Provisioning and ShadowImage together, the DP-VOL can be copied.

Table 2-8 shows the combination of the volumes that can be shared when using Hitachi Dynamic Provisioning and ShadowImage together.

Table 2-8: Shared volumes using Hitachi Dynamic Provisioning and ShadowImage together

ShadowImage P-VOL	ShadowImage S-VOL	Conditions
DP-VOL	DP-VOL	Can be used. If Full Capacity Mode is enabled, set both P-VOL and S-VOL to the same mode status.
DP-VOL	Normal volume	Can be used.
Normal volume	DP-VOL	Can be used; however, the DP pool of the same capacity as the normal volume (P-VOL) is used. Therefore, this combination is not recommended.

When using the used DP-VOL as an S-VOL at pair creation, the DP-VOL can also be created; however, the initial copy time may be long. Therefore, initialize the DP-VOL first, and then create a pair.

Copy on Write Snapshot

When using both Hitachi Dynamic Provisioning and Copy on Write Snapshot in an Unified Storage system and enabling Full Capacity Mode, set both P-VOL and S-VOL to the same mode status.

Monitoring resources and tuning

This section explains the functions to accumulate the DP pool trend information and the statistical information displayed on Performance Monitor. These functions support the management of Hitachi Dynamic Provisioning.

Managing DP pool capacity

When using a DP-VOL of Hitachi Dynamic Provisioning, you can monitor DP pool utilization, as well as the total DP-VOL capacity provisioned against the DP pool capacity. If free capacity of the DP pool is exhausted, disruption to host access can result.

NOTE: If a DP pool has no free capacity, host access to DP-VOLs can be disrupted.

Write data to DP-VOLs that cannot be supported with available DP pool capacity will result in the write I/O failing and those DP-VOLs becoming protected volumes. Host access will not be permitted to those DP-VOLs until DP pool free capacity is restored to a level of at least 5% of the total pool capacity. Once DP pool free capacity is restored, the protected DP-VOLs will automatically be unprotected.

DP-VOLs other than those that had a write fail due to the full DP pool condition are not affected and their access is not disrupted.

NOTE: The DP-VOLs with protected status cannot be migrated.

Defining threshold alerts on the Edit DP Pool Attributes window helps monitor consumption of DP pool capacity. If consumption of the DP pool capacity exceeds the Early Alert threshold value defined when the pool was created, a trap is reported to the Simple Network Management Protocol (SNMP). If the consumption of the DP pool continues to increase and exceed the Depletion Alert threshold value, a second trap is reported to SNMP.

If the total logical capacity for all DP-VOLs defined exceeds the user-defined DP-VOL Over-provisioning Warning and Limit thresholds on the Edit DP Pool Attribute window, traps are reported to SNMP. These thresholds help monitor the ratio of provisioned application capacity relative to physical pool capacity. For more information about SNMP traps, refer to the *Hitachi Unified Storage Operations Guide*.

If the e-mail alert is turned on in Storage Navigator Modular 2 in the DP Pool Property window, Advanced tab, the system sends an e-mail alert warning that capacity exceeded a threshold value. You can also turn on e-mail reports in Storage Navigator Modular 2 by enabling **E-mail Alert Report** in E-mail Alert located under [Array Name] > **Settings**.

See Chapter 4, Using the Hitachi Dynamic Provisioning GUI for information about monitoring DP pool capacity using the DP Pool Trend window.

You can monitor system performance using Performance Monitor and information on the DP-VOL using Storage Navigator Modular 2. For information about Performance Monitor, see the *Hitachi Unified Storage Operations Guide*.

DP pool usage capacity threshold alerts

Hitachi Dynamic Provisioning monitors DP pool capacity usage using two thresholds. The value of each threshold can be set as shown below. It is important to set these thresholds according to usage conditions (Edit DP Pool Attributes).

- Early Alert threshold value: A threshold value to warn that the capacity is nearing depletion. This can be set in units of 1% in the 1% to 99% range. The default value is 40%. Set this threshold to give administrators time to react to low available pool space.
- Depletion Alert threshold value: A threshold value to warn that adding capacity is required. This can be set in units of 1% in the 1% to 99% range. The default value is 50%. This value must be larger than the Early Alert threshold value.

You can select one or more methods shown in Table 2-9 as methods of being notified.

Table 2-9: Alert threshold notification methods for DP pool usage capacity

Notification method	Notification timing (Note 1)	Contents	Storage Navigator Modular 2 setting
E-mail	Over the threshold value (Note 2)	Using email alert function	Enable the e-mail alert function
SNMP Trap		Using SNMP Agent Support Function	Install and configure SNMP Agent Support Function
Windows Event Viewer	Interval time	Logging out to Windows Event Viewer (Note 3)	Set the **auerroralert** command-line option (Note 4)

Note 1: Notifications for exceeding a threshold are provided. There is no notification when the level drops below the threshold.

Note 2: The Depletion Alert threshold value is reported every six hours until the DP pool available capacity improves.

Note 3: The DP pool status is output during command execution.

Note 4: Storage Navigator Modular 2 GUI is not supported.

For more information, refer to the Storage Navigator Modular 2 online help for GUI operations or the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operations.

Figure 2-5 shows the alert threshold monitoring for DP pool usage capacity.

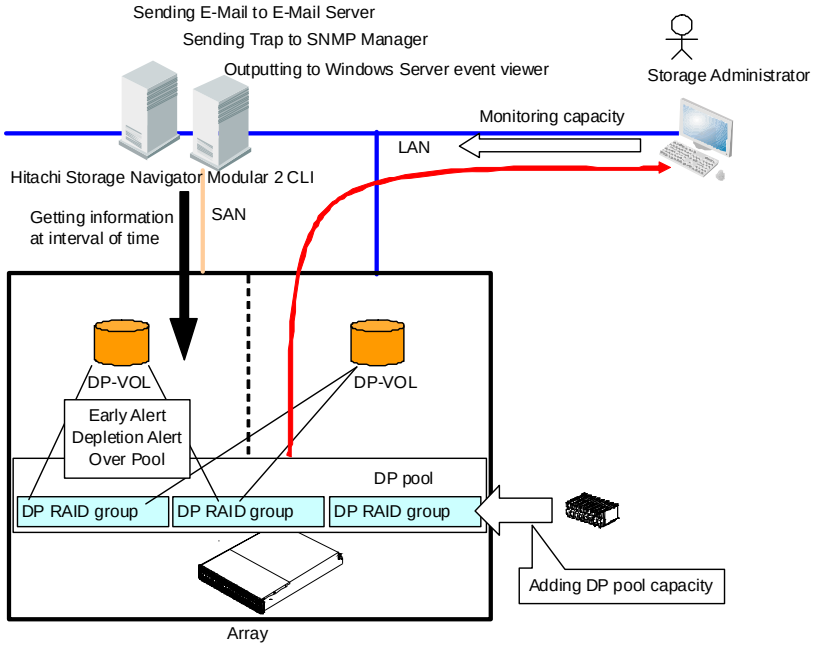


Figure 2-5: Monitoring the DP pool usage capacity alert threshold

Example

If the entire capacity of the DP pool is 1 TB and the Early Alert threshold value is 40%

Figure 2-6 on page 2-20 shows the DP pool total capacity of 1 TB and the Early Alert threshold value of 40%. If the DP pool consumed capacity exceeds 40% (400 GB) of the DP pool, it is reported by an e-mail alert and/or SNMP trap. Furthermore, if the DP pool consumed capacity increases and exceeds the Depletion Alert threshold value (e.g., 50%), it is reported again by an e-mail alert and/or SNMP trap. The Depletion Alert threshold value is reported every 6 hours unless the DP pool available capacity is increased.

Arrays can remain operational, although a warning message appears when defining or increasing DP-VOLs, DP Optimization, or volume mapping to a host group or iSCSI target group at the time of depletion or Depletion Alert status. If this occurs, we recommend you increase capacity immediately.

.

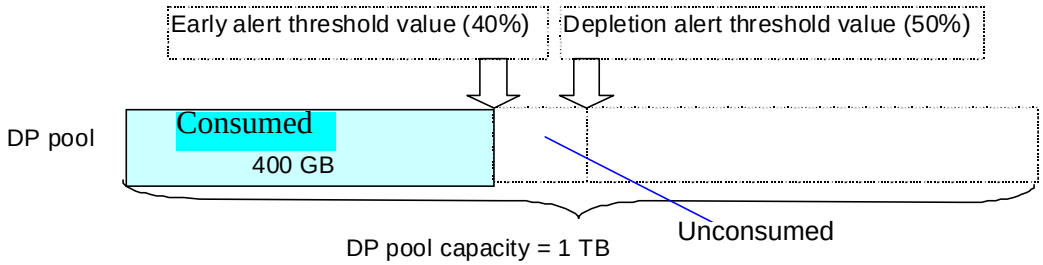


Figure 2-6: DP pool capacity if early alert threshold value is 40%

During normal operation, the DP pool is not totally depleted; therefore, do not allow the DP pool to be completely consumed. If the DP pool is totally depleted, DP-VOLs can be assigned protected status to inhibit reads and writes. As a result, applications might end abnormally, or system failures might occur.

The threshold alert can be selected as an option, and alerts occur only if the check box is checked. The threshold alert provides advance notice that the DP pool is approaching full capacity. In the normal operation, be sure to use it with the check box checked. If the check box is not checked, the application may terminate abnormally without noticing the depletion status or a system shutdown failure may occur.

NOTE: To monitor the DP pool usage capacity alert threshold using Windows Event Viewer, specify an interval time using the **`auerroralert`** command of the Storage Navigator Modular 2 CLI. If an interval time is set too high, the time required to output the DP pool depletion message is long and the depletion message might not be output.

Example

Relationship among the failure monitoring time for E-Mail, SNMP trap, and Windows Event Viewer when the DP pool consumed capacity changes over time as shown in Figure 2-7 on page 2-21.

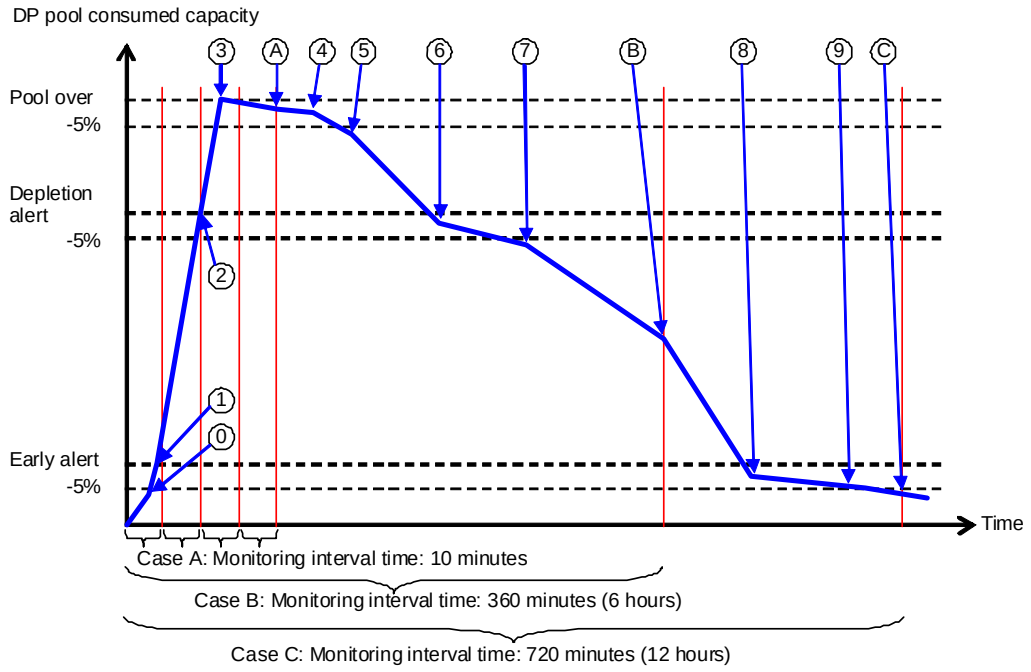


Figure 2-7: Relationship between DP pool consumed capacity and threshold value report

Table 2-10: Status notification

Items	Figure Number in Figure 2-7									
	0	1	2	3	4	5	6	7	8	9
Storage Navigator Modular 2 status	Normal	Early alert	Depletion alert	Capacity over	Capacity over	Depletion alert	Depletion alert	Early alert	Early alert	Early alert
E-mail (Note)	No	Yes	Yes	Yes	No	No	No	No	No	No
SNMP (Note)	No	Yes	Yes	Yes	No	No	No	No	No	No
Windows Event Viewer	No	Yes	Yes	Yes	No	No	No	No	No	No

Case A: In Figure 2-7, ?, ?, and ?are output. At point A, since the capacity deletion is already output, it is not output again. The next time it is output, the capacity must be less than 5% of the threshold value.

Case B: The early alert log in the current status is output.

Case C: Since the current status is Normal, nothing is output in the log.

NOTE: The Deletion Alert threshold value is reported every six hours unless the DP pool unconsumed capacity is improved.

DP-VOL over-provisioning thresholds

The setting capacity of the DP-VOL in the DP pool is monitored by two over-provisioning threshold values: Warning and Limit (Edit DP Pool Attributes). The value of each over-provisioning threshold can be set as follows.

- Warning Alert threshold value: This can be set in units of 1% in the 50% to 1000% range. The default value is 100%.
- Limit threshold value: This can be set in units of 1% in the 50% to 1000% range. The default value is 130%. This value must be larger than the Warning Alert threshold value.

If the total logical capacity associated with a pool compared to the physical pool capacity exceeds the above-mentioned values, you can select one or more shown in Table 2-11. Since the threshold value is optional, it applies only when the check box is checked.

Table 2-11: Notification methods for the DP-VOL over provisioning threshold

Notification method	Notification timing	Contents	Storage Navigator Modular 2 setting
E-mail	Over the threshold value	Using email alert function	Enable the e-mail alert function
SNMP Trap		Using SNMP Agent Support Function	Install SNMP Agent Support Function and set the appropriate parameter

Example

When the entire DP pool capacity is 1 TB and the Warning Alert threshold value is 100%.

If the total logical capacity associated with a pool compared to the physical pool capacity exceeds the above-mentioned values, and the e-mail alert is turned on in Storage Navigator Modular 2 in the DP Pool Property window, Advanced tab, the systems sends an e-mail alert warning and reports the SNMP trap.

Figure 2-8 on page 2-23 shows the DP pool capacity of 40 TB and an over-provisioning Warning alert threshold value of 100%. When total DP-VOL capacity of 40 TB is defined, it matches the Warning alert of 100% of Pool capacity and sends the warning report by e-mail and SNMP trap. If the Limit threshold value is set to 130% and DP-VOLs are created or extended to cause the total DP-Vol capacity to reach 52 TB, the limit is reported by e-mail and SNMP trap. If the Limit threshold value is exceeded, creation and extension of DP-VOLs and the enabling of Accelerated Wide Striping Mode are not allowed for the pool until the DP pool capacity is increased.

If the version of the firmware is 0935/A or later, you can add or expand a volume and enable Accelerated Wide Striping Mode when the limit threshold is exceeded by enabling the **Limit Enforcement** option. Exercise care because adding a volume that exceeds the limit threshold increases the risk of pool capacity depletion.

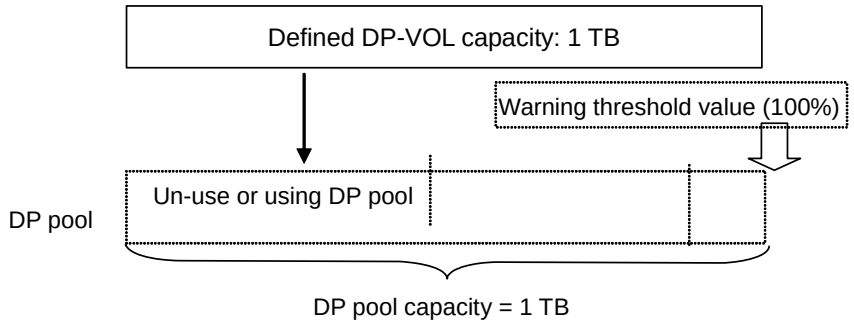


Figure 2-8: DP pool capacity when warning alert threshold value is 100%

The ways that the Over Provisioning threshold is calculated depends on whether Accelerated Wide Striping Mode for the DP volumes is enabled or disabled.

- If Accelerated Wide Striping Mode is disabled, the Over Provisioning Threshold =Total Capacity of DP Volumes in DP Pool / DP Pool Capacity
- If Accelerated Wide Striping Mode is enabled, the Over Provisioning Threshold = (SUM (ceiling (STDlun)) + SUM (ceilingRG (AWSlun))) / DP Pool Capacity
  - **SUM**: Total.
  - **STDlun**: Size of the normal DP volume in units of GB.
  - **ceiling (STDlun)**: Size of the DP volume rounded up to the nearest GB.
  - **AWSlun**: Size of each DP volume whose AWS (Accelerated Wide Striping) is enabled in units of GB.
  - **ceilingRG (AWSlun)**: Size of the DP volume rounded up to the nearest value that is an integer multiple of the number of RAID groups in the pool. If the pool has four RAID groups, AWSlun should be 4, 8, 12, 16 ... GB. However, if there is a page of a fraction within the number of RAID groups, do not round it up.

NOTE: If Tier Mode is enabled and the SSD/FMD drives are in the pool, use the same calculation method as when Accelerated Wide Spring Mode is disabled, even if the mode is enabled.

Example: Assume the DP pool capacity is 100 GB, the number of DPRAID groups is 20, and the number of DP volumes is four (128 MB, 100 GB, 4 GB and 10 GB).

- If Accelerated Wide Striping Mode is disabled, the Over Provisioning Threshold = (1 + 100 + 4 + 10) / 100 Í 100 = 115.0%.
- If Accelerated Wide Striping Mode is enabled:

- Over Provisioning Threshold = (4 + 100 + 20 + 20) / 100 Í 100 =144.0%.
- AWSlun = 1 GB, 100 GB, 4 GB and 10 GB.
- ceilingRG (AWSlun) = 4 GB (Note), 100 GB, 20 GB, and 20 GB.

NOTE: Convert 20 GB to 4 GB for the page of any fraction within the number of RAID groups.

Monitoring DP pool usage rates

A DP pool's consumed capacity and a DP-VOL's consumed capacity can be viewed in the DP pool window and the Volume property window, respectively. Using the DP pool window lets you monitor the free capacity of the DP pool and estimate the need to increase capacity in the DP pool. The Volume property window provides information about how much DP pool capacity is occupied by a DP-VOL.

Table 2-12: Viewing method of the DP pool usage

Viewing items	Viewing method
Consumed Capacity of DP-VOL	The amount of pool capacity assigned to a DP-VOL can be displayed for each DP-VOL.
Consumed Capacity of DP pool	The DP pool consumed capacity can be displayed for each DP pool.

Figure 2-9 shows an example of the change in DP pool usage rates.

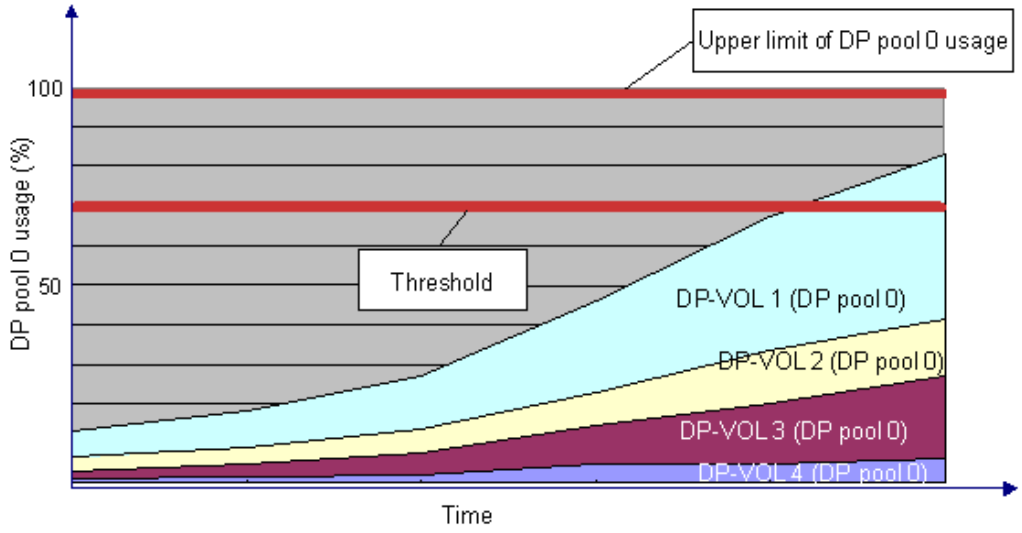


Figure 2-9: Time change in DP pool usage rate example

DP pool depletion host notification

Hosts may manage their user and application access to DP-VOLs based on DP pool capacity depletion state. If the host has this ability, set Enable Depletion Detail Reply Mode to Yes (see the Edit Host Group options). This setting creates a check condition for temporary resource shortage and DP

pool depletion. Use this option only when the host requires that its provisioning space shortage create check conditions for space allocation in progress and space allocation failed write protect.

Performance management

Performance management for the DP-VOL can be performed by collecting monitoring information. Analyzing monitoring information helps you understand the load of the DP pool (access frequency, trend of DP pool usage growth rate, and access load of drives) and the load of the DP-VOL (access frequency, trend of the DP pool assignment rate) and use them for tuning the appropriate pool capacity and assignment of DP-VOLs to DP pools.

Monitoring information includes:

- Access frequency of DP-VOL, Read Hit rate, and Write Hit rate (Performance Monitor statistics)
- Usage rate of RAID group of the DP pool
- DP-VOL usage (ratio of data stored) and time passage of DP pool usage

Figure 2-10 shows the I/O usage rate. Dynamic Provision does not report overall DP Pool usage. It reports individual RAID group usage information. Therefore, you need to consider DP Pool usage as the sum of the RAID group usage values.

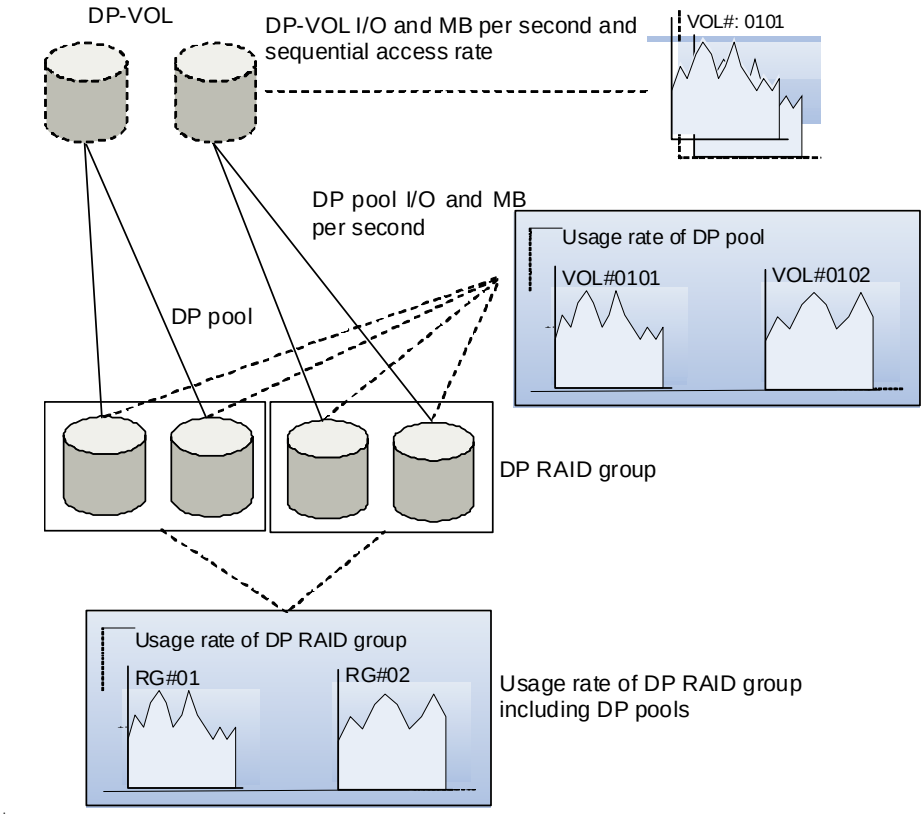


Figure 2-10: Managing usage rates and I/O

DP pool status

Table 2-13 shows the DP pool status displayed on Storage Navigator Modular 2.

Table 2-13: DP pool status

Status	Meaning
Normal	There are no problems reported by the DP RAID groups.
Check Component	The DP pool contains one or more unformatted volumes or hard drive units (HDUs) that are performing copy back operations.
Regression	At least one DP RAID group has regressed. It is necessary to replace the blocked drive.
Detached	At least one DP RAID group is detached. It is necessary to reconfigure the DP pool.

DP pool formatting status

The DP pool formatting progress level is displayed in the form of **Formatting (nn%)**, where n is 1 to 99. The capacity of the displayed progress level is usable. See DP pool capacity shrink status conditions on page 2-28 for information about the DP pool capacity shrinking status.

DP pool optimization status

Table 2-14 shows the DP pool optimization status displayed on Storage Navigator Modular 2.

Table 2-14: DP pool optimization status

Status	Meaning
Normal	Optimization processing is not currently active.
Accepting	Accepts optimization process request.
Pending (n)	Waiting for optimization to start, where (n) indicates the order.
Optimizing (nn%)	Optimizing Hitachi Dynamic Provisioning, where (nn%) indicates optimization completion percent.
Suspended (nn%)	Optimization process suspended due to a change in the status of the array. Optimization resumes automatically when the status changes.
Canceling	User canceled optimization.
Failed (Code-nn: error message)	Optimization failed due to errors on the array. Follow the instructions below and optimize again. If optimization fails again, contact customer support. • Failed(Code-01:DP Pool Detachment): Optimization failed because the DP pool with the optimized DP volume is detached. Optimize again after recovering the DP pool. • Failed(Code-02:DP Pool Depletion): Optimization failed because not enough capacity is available to optimize. Optimize again after adding the required DP pool capacity. • Failed(Code-03:Destage Time-out):Optimization failed because the host I/O load for optimizing DP volumes and the DP pool to which it belongs is too high. Optimize again while the host I/O load is low. If it fails again, stop the array and then restart it.

If the DP optimization status is Suspended(50%) or does not change from Pending(n), the internal processing might be running. Check the progress of the internal processing in the next screen, and wait for DP optimization to start.

- The capacity of Needing Preparation in the DP Optimization Screen is not zero (0).
- When the recoverable capacity in the DP Optimization screen increases or decreases.

DP RAID Group status conditions

Table 2-15 on page 2-28 shows the DP RAID Group status conditions displayed in Hitachi Storage Navigator Modular 2.

Table 2-15: DP RAID Group status conditions

Status condition	Description
Normal	DP RAID group is normal.
Check Component	Drive (HDU) that configures the DP RAID group is during copy back or the unformatted volume is included.
Regression	DP RAID group is regressed. Replace the blocked drive.
Detached	DP RAID group is detached. Reconfigure the DP pool.

DP pool capacity shrink status conditions

Table 2-16 shows the DP pool capacity shrink status conditions displayed in Hitachi Storage Navigator Modular 2.

Table 2-16: DP RAID Group status conditions

Status condition	Description
Shrinking(Relocating(nn%))	The DP pool capacity shrinking data is moving. The number in parentheses shows the progress level.
Shrinking(Reconfiguring(nn%))	The DP pool capacity shrinking data moved and is changing the configuration. The number in parentheses shows the progress level. DP pool shrinking cannot be canceled.
Shrinking(Pending)	Waiting for DP pool capacity shrinking to start.
Shrinking(Suspended)	DP pool capacity shrinking is interrupted due to changes of the array status. This operation automatically restarts while the array status changes.
Shrinking(Canceling)	A user request to cancel DP pool capacity shrinking has been accepted.

Table 2-16: DP RAID Group status conditions (Continued)

Status condition	Description
Shrinking(Failed(Code-nn: error message))	Shrinking failed because problems occurred in the array. Follow the direction of the error codes and messages below to the status. If it fails again, contact your Hitachi representative. • Failed (Code-01) Error contents: DP Pool was blocked. Processing failed because the status of the DP pool to which the DP RAID group number (RAID group number) displayed as an error belongs is not normal. Cancel the pool capacity shrinking of the DP RAID group number (RAID group number) displayed as an error and execute it again after the recovery and see A DP pool is blocked. You cannot make pool modifications. on page 6-4. • Failed (Code-02) Error contents: DP-VOL was blocked. • Processing failed because the status of the DP-VOL to which the DP RAID group number (RAID group number) displayed as an error belongs is not normal. Cancel the pool capacity shrinking of the DP RAID group number (RAID group number) displayed as an error and execute it again after the recovery and see A DP-VOL is blocked. on page 6-4. • Failed (Code-03) Error contents: DP pool was depleted. Processing failed because the DP pool to which the DP RAID group number (RAID group number) displayed as an error belongs is depleted. Cancel the pool capacity shrinking of the DP RAID group number (RAID group number) displayed as an error and execute it again after the recovery and see DP pool capacity is depleted (DP pool status is Capacity Deplete). on page 6-2.

Shrinking(Failed(Code-nn: error message)) — continued	• Failed (Code-04) Error contents: The array is abnormal. Processing failed because an “abnormal” array is detected in the DP RAID group number (RAID group number) displayed as an error. Cancel the pool capacity shrinking of the DP RAID group number (RAID group number) and recover the PIN. • Failed (Code-05) Error contents: The array is abnormal. Processing failed because an “abnormal” array is detected in the DP RAID group number (RAID group number) displayed as an error. Cancel the pool capacity shrinking of the DP RAID group number (RAID group number) and recover the PIN. • Failed (Code-06) Error contents: DP management information destage timed out. Processing failed because the management information destage timed out in the DP pool to which the DP RAID group number (RAID group number) displayed as an error belongs. Cancel the pool capacity shrinking of the DP RAID group number (RAID group number) displayed as an error, stop the array and then restart it. • Failed (Code-07) Error contents: Invalid DP pool was detected. Processing failed because invalid management information was detected in the DP pool to which the DP RAID group number (RAID group number) displayed as an error belongs. Cancel the pool capacity shrinking of the DP RAID group number (RAID group number) displayed as an error, stop the array and then restart it. • Failed (Code-08) Error contents: Online forced parity recovery is executed. Processing failed because the online forced parity correction executed for the DP-VOL to which the DP RAID group number (RAID group number) displayed as an error belongs. Cancel the pool capacity shrinking of the DP RAID group number (RAID group number) displayed as an error and execute it again after completing the online forced parity correction of the DP-VOL. • Failed (Code-09) Error contents: Drive is restored. Processing failed because the drive is being restored in the DP pool to which the DP RAID group number (RAID group number) displayed as an error belongs. Cancel the pool capacity shrinking of the DP RAID group number (RAID group number) displayed as an error and execute it again after completing the drive restoration.

3

Preparing for Hitachi Dynamic Provisioning operations

This chapter describes the requirements and restrictions for using Hitachi Dynamic Provisioning. It also describes how to install, uninstall, disable, and enable Hitachi Dynamic Provisioning.

The following topics are covered in this chapter:

Requirements and restrictions

A license key or license file for the Hitachi Unified Storage dual-controller array, including drives and the Hitachi Dynamic Provisioning software feature used on a Hitachi Storage Navigator Modular 2 PC, is required for operating Hitachi Dynamic Provisioning. The system requirements for using Hitachi Dynamic Provisioning are listed in the following tables.

DP-VOL and DP pool requirements

Table 3-1 shows DP-VOL requirements. Table 3-2 on page 3-3 shows DP pool requirements.

CAUTION! You can shrink the capacity of the DP-VOL online. Reducing the logical capacity of a DP-VOL will permanently lose any data present in the capacity trimmed away. Many operating systems, file systems, and volume managers do not support the shrinking of a DP-VOLN. For example, you cannot use shrink with a DP-VOL that is a Windows 2008 Dynamic Disk.

Table 3-1: DP-VOL requirements

Item	Requirements

Volume type	DP-VOL. The following restrictions apply to DP-VOLs:
	• A DP-VOL cannot be created in the RAID group.
	• You cannot specify the following volume as DP-VOL:
	  • Unified volume.
	  • Volume defined by Cache Residency Manager.
	• You cannot set a DP-VOL in blocked status.
	• A new DP-VOL cannot be set if it exceeds if it exceeds the maximum value of the DP pool capacity (see Table 2-5 on page 2-13), the depletion threshold value, or the limit over provisioning threshold value. Arrays remain operational, although a warning message appears when defining or increasing DP-VOLs, DP Optimization, or LU mapping to a host group or iSCSI target group at the time of depletion or Depletion Alert status. If this occurs, we recommend you increase capacity immediately.

Data allocation unit	Maps 32 MB of capacity at a time to a DP-VOL. Allocates at least 1 GB area at a time in the DP pool for writing from the host. Thirty-two uniquely mapped areas of 32 MB each are formed from the 1 GB allocated DP pool capacity.
Volume capacity	32 MB to 128 TB
Volume initialization	It is already formatted at the time of the DP pool creation. Therefore, a special operation is not necessary for creating the DP-VOL. Use this if recovering failures by the DP-VOL.

Table 3-1: DP-VOL requirements (Continued)

Item	Requirements
Maximum volume number	For each one DP pool: • Hitachi Unified Storage 150 and Hitachi Unified Storage 130: Maximum 4,096 • Hitachi Unified Storage 110: Maximum 2,048 For one array: • Hitachi Unified Storage 150 and Hitachi Unified Storage 130: Maximum 4,096 • Hitachi Unified Storage 110: Maximum 2,048
Growth capacity	You can grow the capacity of the DP-VOL online.
Shrink capacity	You can shrink the capacity of the DP-VOL online. Reducing the logical capacity of a DP-VOL will permanently lose any data present in the capacity trimmed away. Consumed DP pool capacity can be reclaimed and rebalanced after reducing (shrinking) DP-VOL logical capacity (see Changing DP-VOL capacity on page 5-14). To average the DP-VOL usage rate, select **Optimize after reducing capacity** when shrinking DP pool capacity.
Deleting	You can delete a DP-VOL.

Table 3-2: DP pool requirements

Item	Requirements
RAID level of DP RAID group	RAID 0 is not supported. Only the DP RAID group of the same RAID level can be registered in the same DP pool. When the firmware version is 0945/A or later, the DP RAID group in different RAID levels can be registered in the DP pool. Performance can vary, so exercise care when mixing the different RAID levels.
Number of DP RAID groups	• Hitachi Unified Storage 110: Maximum 50. Assign a DP RAID group number from 0 to 49 as an identifier of the DP RAID group. • Hitachi Unified Storage 130: Maximum 75. Assign a DP RAID group number from 0 to 74 as an identifier of the DP RAID group. • Hitachi Unified Storage 150: Maximum 200. Assign a DP RAID group number from 0 to 199 as an identifier of the DP RAID group.
Drive type	If the drive types are supported by the array, they can be used for the drive type. 2.5-inch drives and 3.5-inch drives are treated as different drives. The DP RAID group consisting of different types of drives cannot be mixed in the same DP pool. When the firmware version is 0945/A or later, DP RAID groups with different drive types can be mixed in the DP pool. Performance can vary, so exercise care when mixing the different RAID levels.
DP pool deletion	When the DP-VOL is defined, all DP-VOLs must be deleted to delete the DP pool.
DP pool capacity	Up to the total array capacity (see Table 2-5 on page 2-13).

Table 3-2: DP pool requirements (Continued)

Item	Requirements
DP pool number	Maximum: • Hitachi Unified Storage 150 and Hitachi Unified Storage 130: 64 • Hitachi Unified Storage 110: 50 DP pool IDs are assigned as DP pool identifiers: • Hitachi Unified Storage 150 and Hitachi Unified Storage 130: 0 to 63 • Hitachi Unified Storage 110: 0 to 49
Usable threshold	The DP pool usage is monitored by two threshold values: • Early Alert: Set in units of 1% in the 1% to 99% range. The default is 40%. • Depletion Alert: Set in units of 1% in the 1% to 99% range. The default is 50%. This value must be larger than the Early Alert threshold value. If the DP pool usage exceeds the above-mentioned value, output the E-mail, warn the user, and report the SNMP trap. The Deletion Alert threshold value is reported once in six hours unless the DP pool unconsumed capacity is improved. This threshold notice is optional. Therefore, you can change it to operate only when the check box is checked. We recommend you check this check box. Arrays remain operational, although a warning message appears when defining or increasing DP-VOLs, DP Optimization, or LU mapping to a host group or iSCSI target group at the time of depletion or Depletion Alert status. If this occurs, we recommend you increase capacity immediately
Over-provisioning threshold	The total logical capacity of all DP-VOLs assigned to the DP pool is managed by two over-provisioning threshold values. The total logical capacity as a percent of total pool capacity is monitored by the thresholds: • Warning: Set in units of 1% in the 50% to 1000% range. The default is 100%. • Limit: Set in units of 1% in the 50% to 1000% range. The default is 130%. This value must be larger than the Warning Alert threshold value. If the over-provisioning level exceeds the above-mentioned values, the system sends an e-mail alert to warn users and reports the SNMP trap if the optional email reporting function and SNMP trap report are enabled in Hitachi Storage Navigator Modular 2. Adding DP-VOLs is restricted until DP pool capacity is added.
Growth capacity	You can grow the capacity of the DP pool online. A DP RAID can be added when adding drives. To average the DP-VOL usage rate, select **Optimize after reducing capacity** when adding DP pool capacity. For Hitachi Unified Storage systems with firmware version 0950/A or later, the upper limit of the DP pool capacity can be changed by changing the DP Capacity Mode.
Capacity shrinking	DP pool capacity can be shrunk online.

Requirements for using Hitachi Dynamic Provisioning

To use Hitachi Dynamic Provisioning, the firmware necessary for Hitachi Dynamic Provisioning must be installed. In addition, the hardware necessary for defining DP pools must be available.

License requirements

All Hitachi Unified Storage family arrays purchased following the initial release of Hitachi Dynamic Provisioning include a license key that can be installed to enable product functionality.

For Hitachi Unified Storage systems purchased prior to the initial release of Hitachi Dynamic Provisioning, the software feature must be purchased to obtain the license key.

Operating system and file system capacity

The capacity reduction benefits achieved by using Hitachi Dynamic Provisioning depend on the operating system and file system in use.

Table 3-3 is a representative list of operating systems and file systems that have the capacity reduction benefit. For more information, contact HDS Support at portal.hds.com.

Table 3-3: Operating system and file system capacity

Operating system	File system	Metadata writing	DP pool capacity consumed
Windows Server 2003	NTFS	Writes metadata to first block.	Space savings can be realized. This is basic drive only. If the dynamic drive is used, writes metadata to another first block.
Windows Server 2008	NTFS	Writes metadata to first block.	Space savings can be realized. This is basic drive only. If the dynamic drive is used, writes metadata to another first block.
Linux	XFS	Writes metadata in Allocation Group Size intervals.	Space savings can be realized. Depends upon allocation group size. The amount of pool space consumed will be approximately: (DP-VOL size) * (32 MB / Allocation Group Size) rounded up to the next GB level.
	Ext2 Ext3	Writes the metadata in 128-MB intervals.	Space savings can be realized. About 33% of the size of the DP-VOL. The default block size for these file systems is 4 KB. This results in 33% of the DP-VOL acquiring DP 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.	No space savings.
	VxFS	Writes metadata to first block.	Space savings can be realized.

Table 3-3: Operating system and file system capacity (Continued)

Operating system	File system	Metadata writing	DP pool capacity consumed
AIX	JFS	Writes metadata in 8-MB intervals.	No space savings. 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 in this case.
	JFS2	Writes metadata to first block.	Space savings can be realized.
	VxFS	Writes metadata to first block.	Space savings can be realized.
HP-UX	JFS (VxFS)	Writes metadata to first block.	Space savings can be realized.
	HFS	Writes metadata in 10-MB intervals.	No space savings.

VMware VMFS needs the **zeroedthick** option (default) to provide optimum space saving.

If the DP-VOL is extremely small, the capacity reduction benefit decreases, even in the above-mentioned file systems that have reduction benefits. For example, if the DP-VOL capacity is 100 MB in Windows 2003 or NTFS, the assignment of the first page (32 MB) occurs from an allocation of 1 GB. Therefore, DP-VOL minimum logical capacity is recommend to be 1 GB.

Precautions

Observe the precautions in Table 3-4 when using Hitachi Dynamic Provisioning.

CAUTION! You can shrink the capacity of the DP-VOL online. Reducing the logical capacity of a DP-VOL will permanently lose any data present in the capacity trimmed away. Many operating systems, file systems, and volume managers do not support the shrinking of a DP-VOL. For example, you cannot use shrink with a DP-VOL that is a Windows 2008 Dynamic Disk.

Table 3-4: Hitachi Dynamic Provisioning precautions

Situation	Precaution
Deleting DP pool capacity	When the firmware version is less than 0945/A, a RAID group, once registered in the DP pool, cannot be released from the DP pool. To reduce DP pool capacity, create a second, smaller DP pool, and copy the DP-VOLs between the pools.

Table 3-4: Hitachi Dynamic Provisioning precautions

Situation	Precaution
Adding capacity to the DP pool	Host I/O performance deteriorates while an added RAID group is formatted after adding capacity. Check formatting progress in the Status column of the DP pool.
Shrinking DP pool capacity	Host I/O performance may deteriorate due to the data moving processing at capacity shrinking to the DP pool. Check shrinking progress in the Status columns of the DP pool and DP RAID group.
Shrinking DP-VOL capacity	When DP-VOL capacity is shrunk, the free capacity may be reserved as the consumed capacity for the shrunk DP-VOLs instead of being assigned to other DP-VOLs, depending on the I/O pattern. When the DP-VOL is shrink, host I/O performance deteriorates because the shrunk area is formatted after the shrink operation. Check the progress rate of the format in the Status column of the DP pool for the appropriate DP-VOL.
Decreasing DP-VOL consumed capacity	Depending on the I/O pattern, the free capacity may not be reclaimed but continues to be reserved for future capacity needs of the DP-VOL. When reclaiming the consumed capacity of a DP-VOL, host I/O performance deteriorates because the reclaimed area is formatted after decreasing. Check formatting progress in the Status column of the DP pool where the DP-VOL belongs. If a Windows 2008 dynamic drive is used by the master boot record, you cannot shrink capacity of a DP-VOL.
Deleting a DP-VOL	Host I/O performance deteriorates because the deleted area is formatted after deleting. Check the formatting progress in the Status column of the DP pool where the DP-VOL concerned belongs.
Creating a DP pool, adding the DP pool capacity, shrinking the DP pool capacity, deleting the DP pool capacity, or initializing the DP pool	When a DP pool is created or capacity is added, formatting occurs for the DP pool. If host I/O is performed during the formatting, the usable capacity may become depleted. Since the formatting progress is displayed when checking the Status column of the DP pool, check whether the sufficient usable capacity is secured according to the formatting progress, and then start the operation. While the DP pool capacity is being deleted, other DP pool operations such as creating, adding capacity, and reinitializing cannot be performed. Wait 10 minutes before performing these tasks. While shrinking DP pool capacity (status is Reconfiguring), the operation processing in the same DP pool (creation, capacity addition, capacity shrinking, re-initialization) cannot be executed. Wait 10 minutes and then repeat. Check the progress of the reconfiguring progress in the Status columns of DP pool and DP RAID group.

Table 3-4: Hitachi Dynamic Provisioning precautions

Situation	Precaution
Mixed drive types	When SAS and SAS7.2K drives are mixed in the array, format times may be extended. Therefore, avoid mixing types of drives that are formatted when DP Pools are created or operational. When the firmware version is 0945/A or later, performance may deteriorate if drive types are mixed in the DP pool due to slow drives.
Optimizing a DP pool	DP pool optimization does not start until the DP pool formatting status is complete. Because rebalancing of the page may fail when competing with the host I/O, the DP-VOLs whose host I/O is highly -loaded may not be equal. Optimizing the DP pool is time consuming and may take one week if actual allocation of capacity is 10 TB. When there is no host I/O in conflict with optimization, throughput is approximately 60 MB/s. Because the DP pool is used for page migration, the consumed capacity and reclaimed capacity of the DP pool temporarily increase during page migration. As a result: • The sum total value of the total capacity of DP pools and the used amount of DP-VOLs in the pool may not be matched. • Reclaimable capacity may remain for a while after the optimization completes, but it will be reclaimed as time goes by. • Optimization temporarily increases pool utilization; therefore, it should not be tried if there is only a small amount of available capacity. Instead, add pool capacity before trying to perform an Optimization operation. When the firmware version is less than 0937/A, the array firmware cannot be updated while optimizing the DP pool. Therefore, stop optimizing the DP pool to update the firmware. If the current firmware version is 0937/A or later, it cannot be updated when changing to a firmware version earlier than 0937/A. When updating the firmware, stop the DP pool optimization once and then update the firmware. If zero data does not exist, even if zero data is deleted, the free capacity of the DP pool may not be reduced. The default optimization priority mode is Standard mode. If you change optimization priority mode when optimization is being performed, DP optimization processing is given priority and host I/O performance deteriorates. When changing to host access priority mode, host I/O is given priority and optimization time becomes longer than Standard mode.
Windows 2008 Precautions	For Windows 2008 connections that use dynamic disk, the DP-VOL capacity cannot be shrunk for use as a dynamic disk.
Using path-switching software	When path-switching software checks the path, the consumed capacity of the DP pool may temporarily increase or decrease by 1 GB for each volume and the DP pool may be depleted temporarily, depending on its free capacity. Check the free capacity of the DP pool in advance.

Table 3-4: Hitachi Dynamic Provisioning precautions

Situation	Precaution
Powering on the array with data in cache	Powering on the array with data in cache may start DP pool formatting. If this occurs, go to Storage Navigator 2 and check the DP pool Status column for format progress. If progress is displayed, I/O performance may deteriorate or usable capability may be depleted. Start the operation after confirming there is sufficient capacity based on the format progress.

Reconfiguring memory

Observe the following memory reconfiguration guidelines when installing, uninstalling, invalidating, validating memory, or changing DP Capacity Mode.

I/O processing performance

I/O performance for sequential write pattern decreases approximately 20% to 30% by releasing a part of the user data area in the cache memory and performing the memory reconfiguration of the management information storage area for Hitachi Dynamic Provisioning. In other patterns, the I/O performance decreases less than 10%.

Time-out for memory reconfiguration processing

If the I/O inflow is large, saving cache data to the drives takes time and may time out in 10-to-15 minutes (internal processing time is 10 minutes). In this case, the processing can be continued by executing it again when I/O inflow is small.

Inhibiting memory reconfiguration

Memory reconfiguration is inhibited under the following conditions to increase the data amount to the cache. Perform memory reconfiguration processing after completing other functions or recovering the failure.

- Cache partition other than master cache partition (partition 0 and partition 1) in use
- Cache partition being changed
- DP pool in optimization
- RAID group is growing
- LU ownership is changing
- Cache Residency volume is operating
- Remote path and/or pair of TrueCopy or TrueCopy Extended Distance is operating
- Copy on Write Snapshot volumes is operating
- DMLU is operating
- Volume is being formatted
- Volume is performing parity correction
- IP address for maintenance or management in operation
- SSL information in operation
- Array firmware is updating
- Power OFF of array is being performed
- Spin-down or spin-up by Power Saving/Power Saving Plus feature in operation

- Inhibiting the operation of other functions during memory reconfiguration
  - When the memory reconfiguration processing fails due to the factors other then the time-out
  - RAID group grown operation
  - Replication Pair operation
  - Hitachi Dynamic Provisioning operation
  - Cache Residency Manager setting operation
  - Volume formatting operation
  - Volume parity correction operation
  - Cache Partition Manager operation
  - Modular Volume Migration operation
  - Array firmware updating operation
  - Installing, uninstalling, enabling, or disabling of extra-cost option
  - Volume operation
  - Volume unifying operation
  - DP pool shrinking operation

If memory reconfiguration fails when uninstalling, and DP Capacity Mode is set to maximum capacity mode, you might not be able to downgrade firmware, depending on when the failure occurred. Follow the recovery procedure when memory reconfiguration status is **Failed (Code-nn: Error Message)** in Table 3-5 to complete the memory reconfiguration and execute the downgrade again.

Table 3-5: Memory reconfiguration status

Status	Meaning
Normal	Memory reconfiguration processing is completed normally. The memory reconfiguration status in the DP Capacity Mode is displayed as **Normal** even if the memory reconfiguration is unnecessary.
Pending	Waiting for the memory reconfiguration. Even if the memory reconfiguration instruction is executed and the message indicating the inoperable status is output, it changes to this status because the instruction is received. See the Note on next page.
Reconfiguring(nn%)	Memory reconfiguration is operating. (nn%) shows reconfiguring as a percent.
N/A	Out of memory reconfiguration target.

Table 3-5: Memory reconfiguration status

Status	Meaning
Failed(Code-nn: error message)	This indicates the status that the memory reconfiguration failed because failures and others have occurred inside the array. Recover the status according to the following troubleshooting for each error code and each error message. If it still fails, contact HDS Support at portal.hds.com. • Failed(Code-01: Time out) Code-01 occurs when the access from the host is frequent or the amount of the unwritten data in the cache memory is large. Execute the memory reconfiguration operation again when the access from the host decreases. • Failed(Code-02: Failure of Reconfigure Memory) Code-02 occurs when the drive restoration processing starts in the background. Execute the memory reconfiguration operation again after the drive restoration processing is completed. • Failed(Code-03: Failure of Reconfigure Memory) Code-03 occurs when the copy of the management information in the cache memory fails. The controller replacement is required. Contact contact HDS Support at portal.hds.com. • Failed(Code-04: Failure of Reconfigure Memory) Code-04 occurs when the unwritten data in the cache memory cannot be saved to the drive. The array must be restarted.

NOTE: Dynamic Provisioning license, Dynamic Tiering license, and DP capacity mode affect the status of memory reconfiguration. If the memory reconfiguration of the other function is executed while one function is in the **Pending** status, the memory reconfiguration of the function in the **Pending** status starts as well. The following example describes the behavior of the **Pending** status:

1. After installing the Dynamic Provisioning license, change the status of memory reconfiguration to **Pending** without reconfiguring the memory or restarting the storage system.

2. Change Dynamic Tiering to the **Pending** status in the same way.

3. Change the DP Capacity Mode to the **Maximum Capacity** mode, and either start memory reconfiguration or restart the storage system.

Three memory reconfigurations or array restarts are required if performed separately. However, the above steps allow only one memory reconfiguration or array restart. Memory reconfiguration can be canceled only when the rate of progress of the memory reconfiguration is less than 50 percent.

Installing Hitachi Dynamic Provisioning

Because Hitachi Dynamic Provisioning requires a separate license key, Hitachi Dynamic Provisioning cannot usually be selected (locked) when first using the array. To make Hitachi Dynamic Provisioning available, you must install Hitachi Dynamic Provisioning and make its function selectable (unlocked).

Hitachi Dynamic Provisioning can be installed with or without requiring the array to be rebooted. You perform the installation using either the Hitachi Storage Navigator Modular 2 graphical user interface (GUI) or command-line interface (CLI). The following sections describe how to use the GUI. For installation procedures using the CLI, refer to the *Hitachi Unified Storage Command Line Interface Reference Guide*.

Before installing or uninstalling Hitachi Dynamic Provisioning, observe the following guidelines:

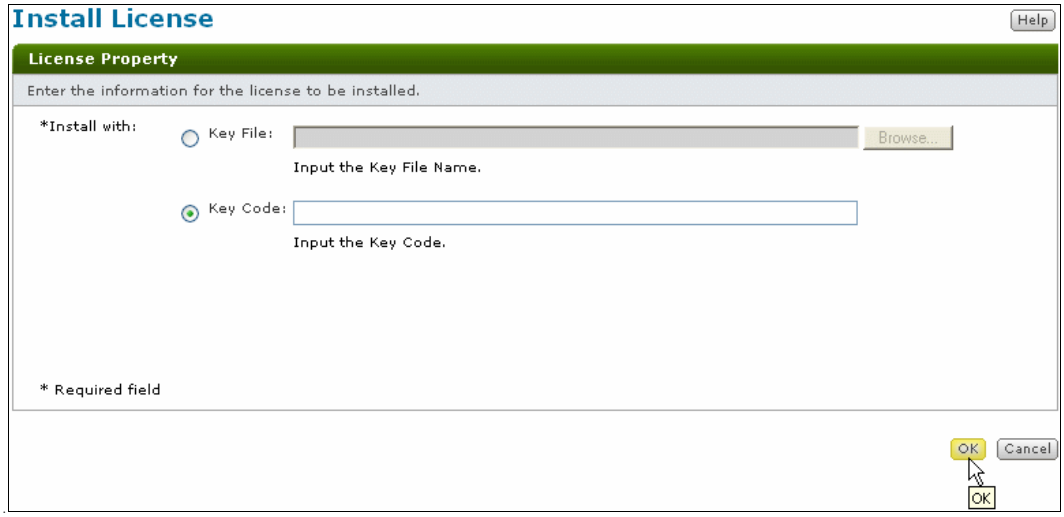
- Verify that the Hitachi Unified Storage system is operating in a normal state. If a failure such as a controller blockade has occurred, installation or uninstallation cannot be performed.
- Exercise care that the cache partition information is initialized as described under Using Cache Partition Manager on page 3-18 when Hitachi Dynamic Provisioning is installed with Cache Partition Manager already in use.
- The key code or key file is required.

Installing without rebooting

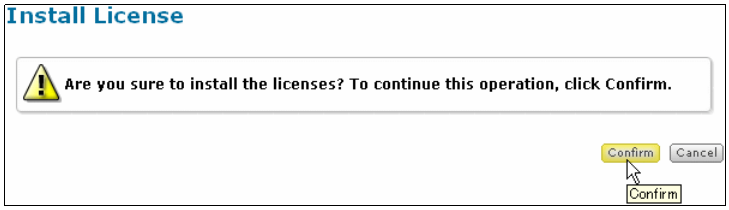
To install Hitachi Dynamic Provisioning without requiring the array to be rebooted:

1. Start Storage Navigator Modular 2.
2. Log in as a registered user to Storage Navigator Modular 2.
3. Select the array in which you will install Hitachi Dynamic Provisioning.
4. Click **Show & Configure Array**.
5. Select **Install License** in the **Common Array Task**.

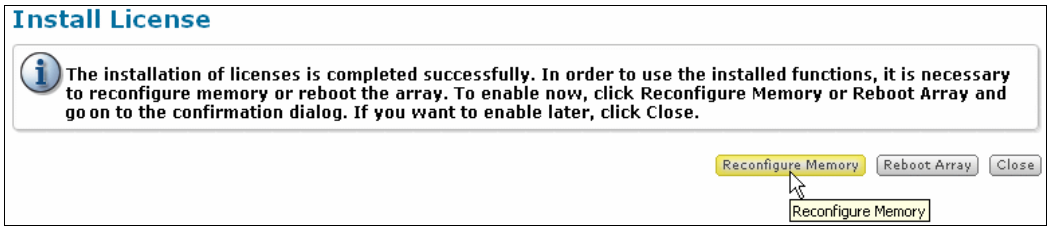
6. In the Install License window:
   - To install the option using the key file, select **Key File** and click the **Browse** button to specify the path for the key file name.
   - To install the option using the key code, select **Key Code** and then type the key code.



7. Click **OK**.
8. In the Install License message, click **Confirm**.



9. When the next screen appears, click **Reconfigure Memory**.



10. At the next Reconfigure Memory page, click **Confirm**.
11. At the next page, click **Close**.
12. When the Licenses list appears, confirm the **Reconfigure Memory Status** is **Reconfiguring(nn%)** or **Normal**.
13. If the **Reconfigure Memory Status** is **Reconfiguring(nn%)**, wait a few minutes and then click **Refresh Information**. Confirm the **Reconfigure Memory Status** changed to **Normal**.
14. If the **Reconfigure Memory Status** is **Failed(Code-01:Timeout)**, click **Install License** and repeat steps step 6 through 11.

    Code-01 occurs when the access from the host is frequent or the amount of the unwritten data in the cache memory is large.
15. If the **Reconfigure Memory Status** is **Failed(Code-02: Failure of Reconfigure Memory)**, check the **D_PROVISIONING** check box in the **Installed Storage Features** list, and then click **Reconfigure Memory**. Repeat steps 8 through 12.

16. If the **Reconfigure Memory Status** is **Failed(Code-04: Failure of Reconfigure Memory)**, click **Resource** on the **Explorer** menu and return to the Arrays screen.

Code-04 occurs when the unwritten data in the cache memory cannot be saved to the drive.

17. Select the array in which you will install Hitachi Dynamic Provisioning and click **Reboot Array**.
18. If the **Reconfigure Memory Status** is **Failed(Code-03: Failure of Reconfigure Memory)**, contact HDS Support at portal.hds.com.

    Code-03 occurs when the copy of the management information in the cache memory fails.

Installation of Hitachi Dynamic Provisioning is now complete.

Installation and rebooting

The following procedure installs Hitachi Dynamic Provisioning and requires the array to be rebooted.

If a power saving instruction is executed on a link that is not experiencing I/O along with the Power Saving or Power Saving Plus option, installing, uninstalling, or changing Hitachi Dynamic Provisioning while the power saving status is **Normal (Command Monitoring)** changes the status to **Normal (Spin Down Failure: PS OFF/ON)** and may cause spin down to fail. If spin-down fails, execute spin-down again. Check that the spin-down instruction has not been issued and that there is no RAID group whose power saving status is **Normal (Command Monitoring)** resulting from a power saving instruction on a non-I/O link before installing, uninstalling, or changing Hitachi Dynamic Provisioning.

When you install, uninstall, enable, or disable Hitachi Dynamic Provisioning when a drive array is used on the remote side of TrueCopy or TrueCopy Extended Distance, the following conditions occur with the restart of the drive array.

- Both paths of TrueCopy or TrueCopy Extended Distance are blocked. When a path is blocked, a TRAP occurs that notifies the SNMP Agent Support Function. The TrueCopy or TrueCopy Extended Distance path recovers from the blockade automatically after the drive array restarts.
- If the pair status of TrueCopy or TrueCopy Extended Distance is **Paired** or **Synchronizing**, it changes to **Failure**.
- When you restart the drive array, install, uninstall, enable, or disable Hitachi Dynamic Provisioning after changing the pair status of TrueCopy or TrueCopy Extended Distance to **Split**.
- If the NAS unit is connected to the drive array, have the drive array administrator check whether the NAS unit is connected and NAS service is operational.

  Ask the NAS unit administrator to check whether a failure has occurred by checking the NAS administration software. In case of a failure, execute the maintenance operation together with the NAS maintenance personal.

  If the NAS unit is connected, contact the NAS unit administrator for termination of NAS OS and shutdown of the NAS unit. After completing this operation, contact the NAS unit administrator to reboot the NAS unit.

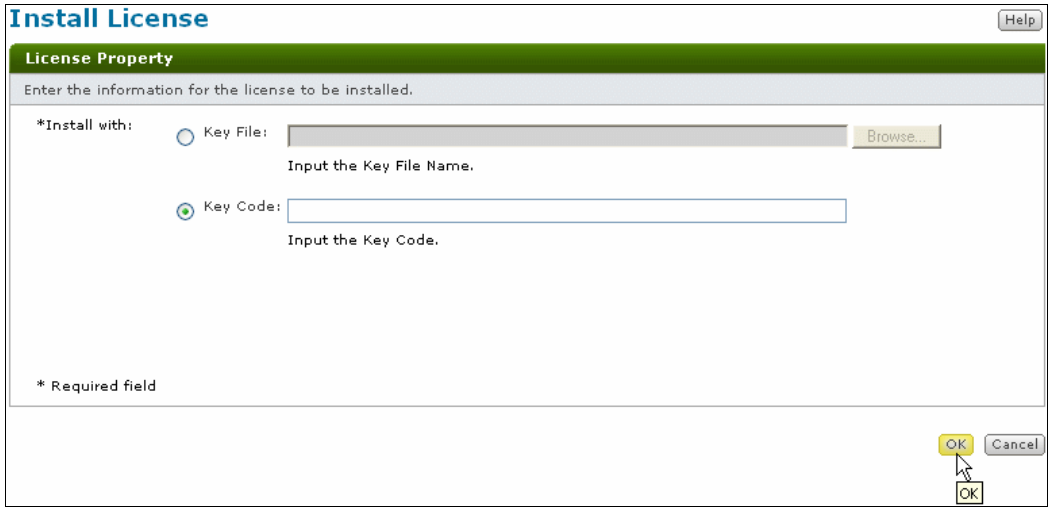
  After rebooting, have the NAS unit administrator refer to “Recovering from FC path errors” in the *Hitachi NAS Manager User's Guide* and check the status of the Fibre Channel (FC) path and to recover the FC path if it is in a failure status.

  If there are personnel for the NAS unit maintenance, contact the NAS unit maintenance personnel to reboot the NAS unit.

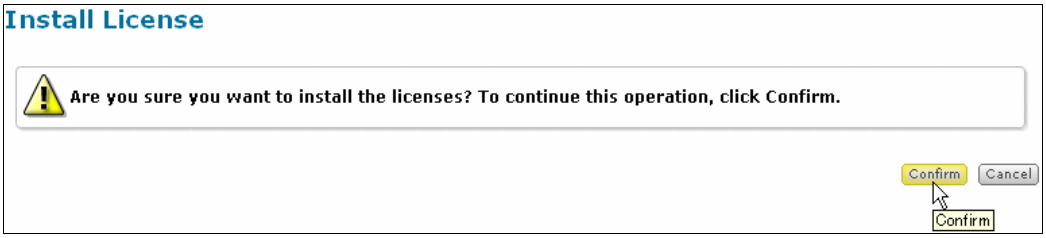
1. Start Storage Navigator Modular 2.

2. Log in as registered user to Storage Navigator Modular 2.
3. Select the array in which you will install Hitachi Dynamic Provisioning.
4. Click **Show & Configure Array**.
5. Select the **Install License** icon in the Common Array Task.

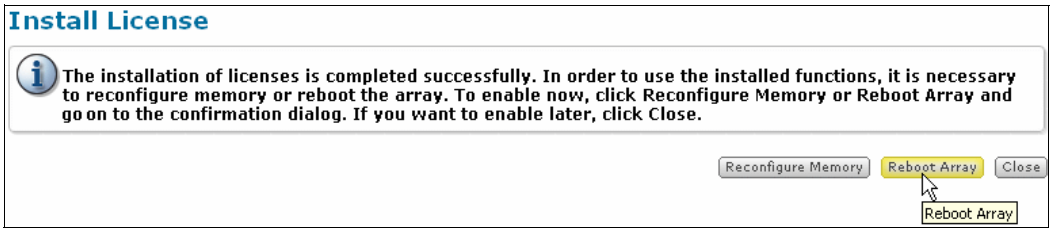
The Install License screen appears.



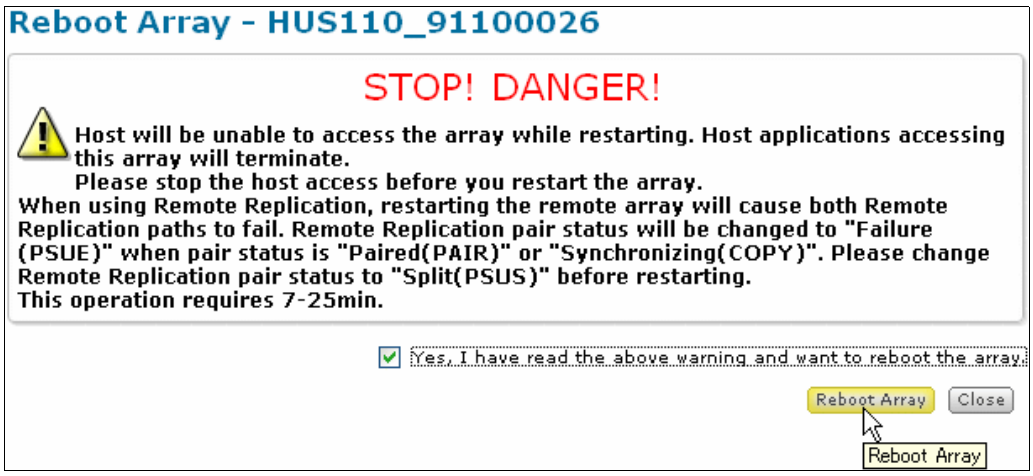
6. To install the option using the key code, click the **Key Code** radio button, and then enter the key code. To install the option using the key file, click the **Key File** radio button, and then use the **Browse** button to specify the path for the key file name. Click **OK**.
7. When a screen requests a confirmation to install Hitachi Dynamic Provisioning, click **Confirm**.



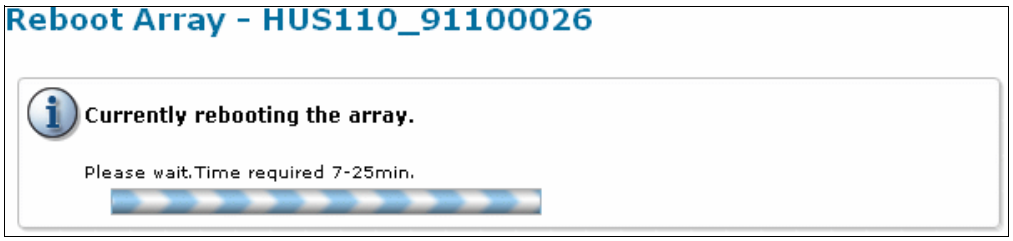
8. When the following screen appears, click **Reboot Array**.



9. When a message confirms that this optional feature is installed, check the check box and click **Reboot Array**.

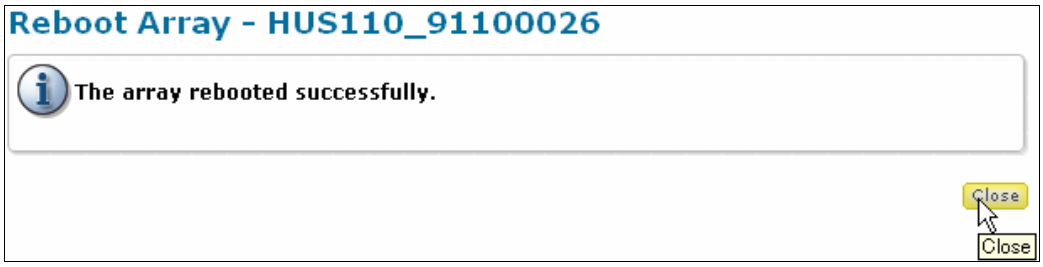


NOTE: To install the option, restart the array. The feature will close upon restarting the array. The array cannot access the host until the reboot is completed and the system restarts. Be sure the host has stopped accessing data before beginning the restart process. Restart usually takes from 7 to 25 minutes.



However, it may take time for the array to respond, depending upon the condition of the array. If it does not respond after 25 minutes or more, check the condition of the array.

10. When a message states that the restart is successful, click **Close**.



Installation of Hitachi Dynamic Provisioning is now complete.

Using Cache Partition Manager

Hitachi Dynamic Provisioning uses a part of the cache area to manage the internal resources. When this happens, the cache capacity that Cache Partition Manager can use therefore decreases.

Ensure that the cache partition information is initialized as shown in Figure 3-1 and Figure 3-2 on page 3-19 when Hitachi Dynamic Provisioning is installed and Cache Partition Manager is already in use.

- All the volumes are moved to the master partitions on the side of the default owner controller.
- All sub-partitions are deleted and the size of the each master partition is reduced to half of the user data area after the installing Hitachi Dynamic Provisioning.

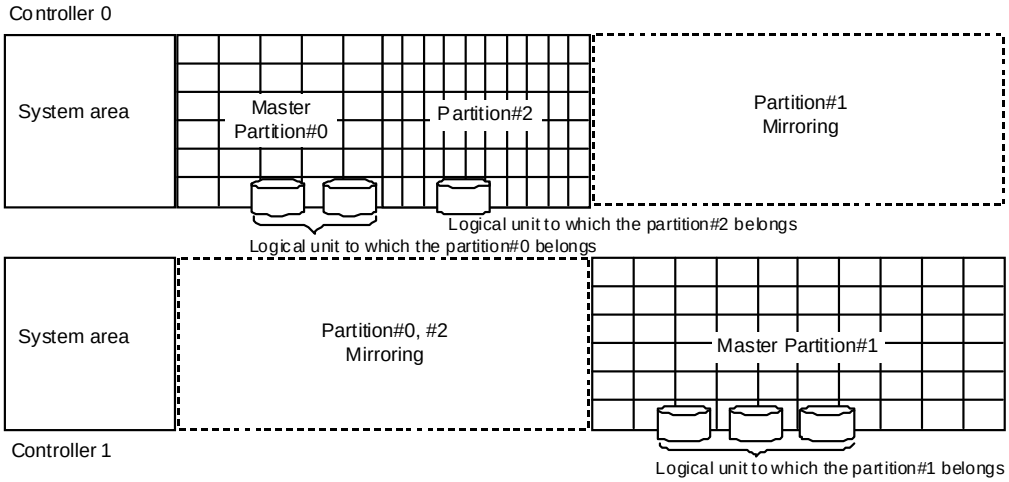


Figure 3-1: When Cache Partition Manager is used

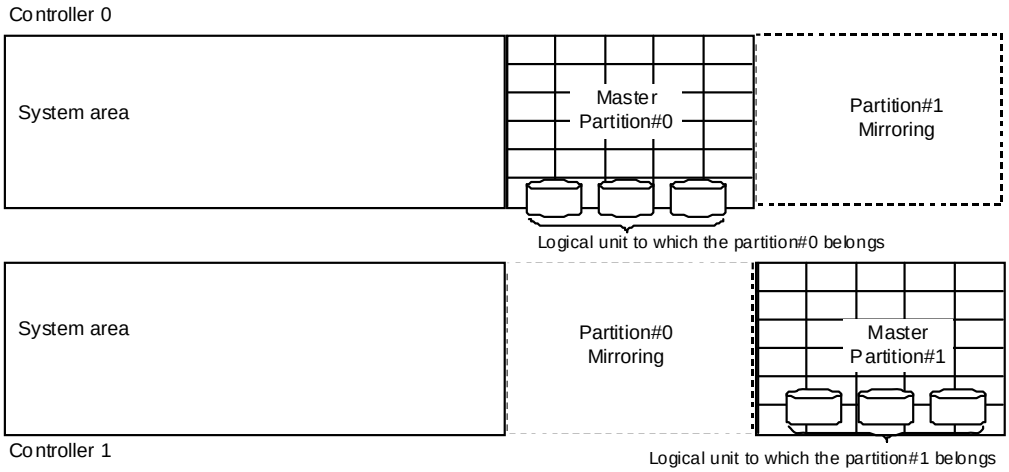


Figure 3-2: Where Hitachi Dynamic Provisioning is installed while Cache Partition Manager is used

Uninstalling Hitachi Dynamic Provisioning

To uninstall Hitachi Dynamic Provisioning, the key code or key file is required. Once uninstalled, Hitachi Dynamic Provisioning cannot be used (locked) until it is installed using the key code or key file.

Hitachi Dynamic Provisioning can be uninstalled with or without requiring the array to be rebooted. You perform the uninstallation using either the Hitachi Storage Navigator Modular 2 graphical user interface (GUI) or command-line interface (CLI). The following sections describe how to use the GUI. For installation procedures using the CLI, refer to the *Hitachi Unified Storage Command Line Interface Reference Guide*.

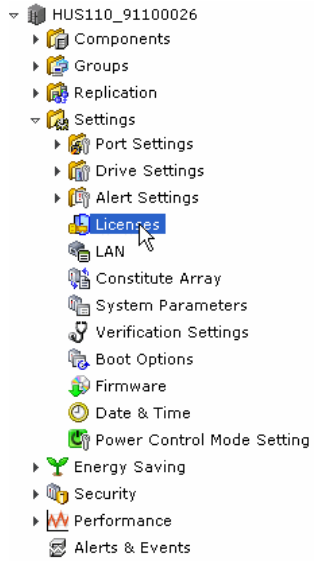
The following conditions must be satisfied to uninstall Hitachi Dynamic Provisioning:

- If the DP-VOL is mapped, release the mapping information.
- Delete all the DP-VOLs (see Deleting DP-VOLs from a DP pool on page 5-13).
- Delete all the DP pools for Hitachi Dynamic Provisioning (see Deleting a DP pool on page 5-7).

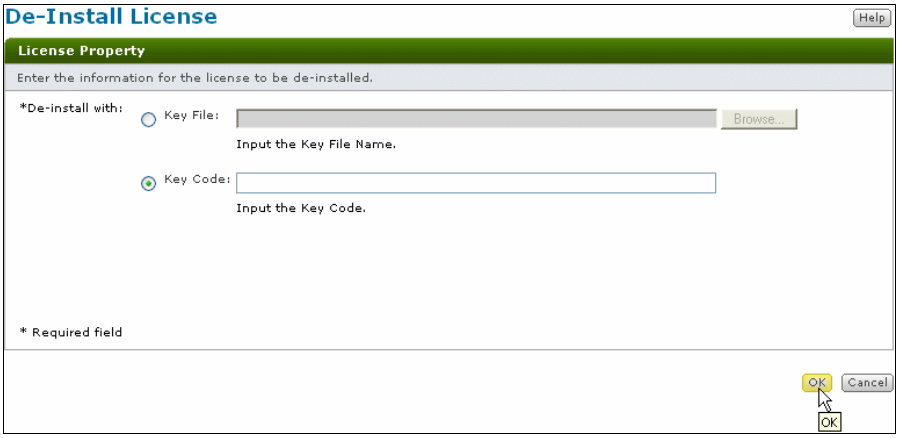
Uninstalling without rebooting

To uninstall Hitachi Dynamic Provisioning without requiring the array to be rebooted:

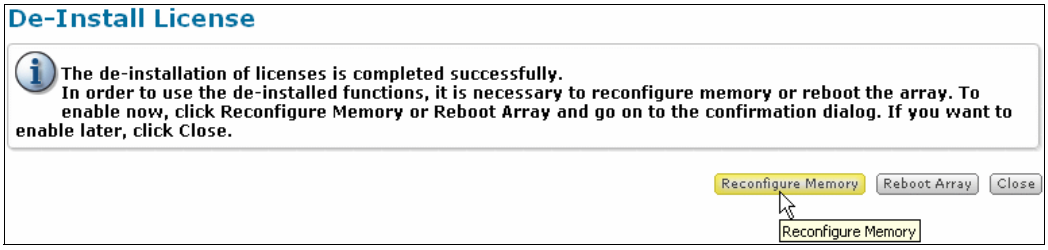
1. Start Storage Navigator Modular 2 and log in.
2. Select the array in which you will uninstall Hitachi Dynamic Provisioning.
3. Click **Show & Configure Array**.
4. Select **Licenses** in the **Settings** tree view.



5. In the **Licenses** list, click **De-install License**.
6. In the De-Install License window, enter the key code and click **OK**.



7. To uninstall Hitachi Dynamic Provisioning using the key code, click the **Key Code** radio button, and then enter the key code. To uninstall Hitachi Dynamic Provisioning using the key file, click the **Key File** radio button, and then use the **Browse** button to specify the path for the key file name. Click **OK**.
8. When a screen requests a confirmation to install Hitachi Dynamic Provisioning option, click **Reconfigure Memory**.



9. When the following message appears, click **Close**.

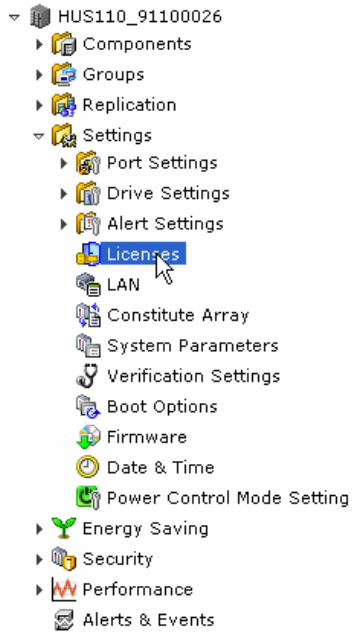
10. The Licenses list appears.

Uninstallation of Hitachi Dynamic Provisioning is now complete.

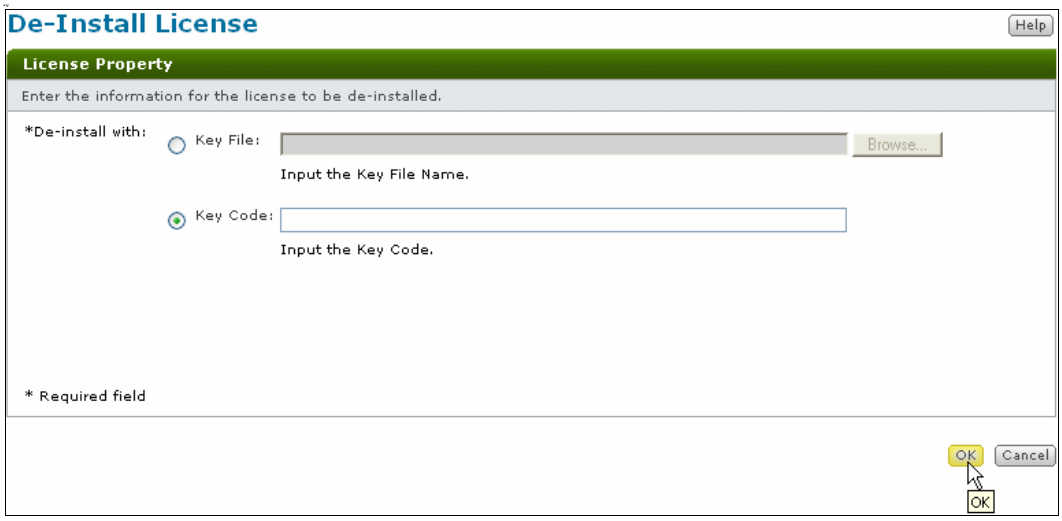
Uninstalling and rebooting

The following procedure uninstalls Hitachi Dynamic Provisioning and requires the array to be rebooted.

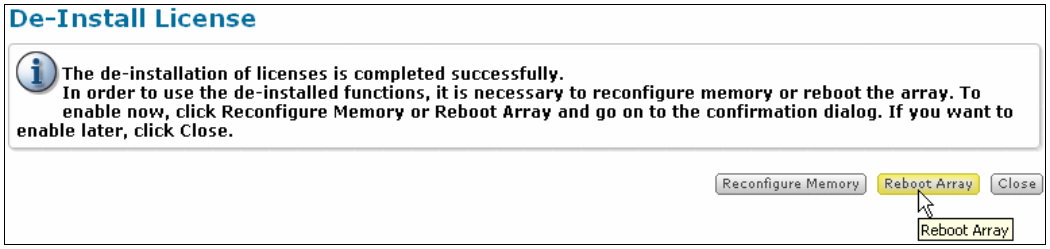
1. Start Storage Navigator Modular 2 and log in.
2. Select the array in which you will uninstall Hitachi Dynamic Provisioning.
3. Click **Show & Configure Array**.
4. Select **Licenses** in the **Settings** tree view.



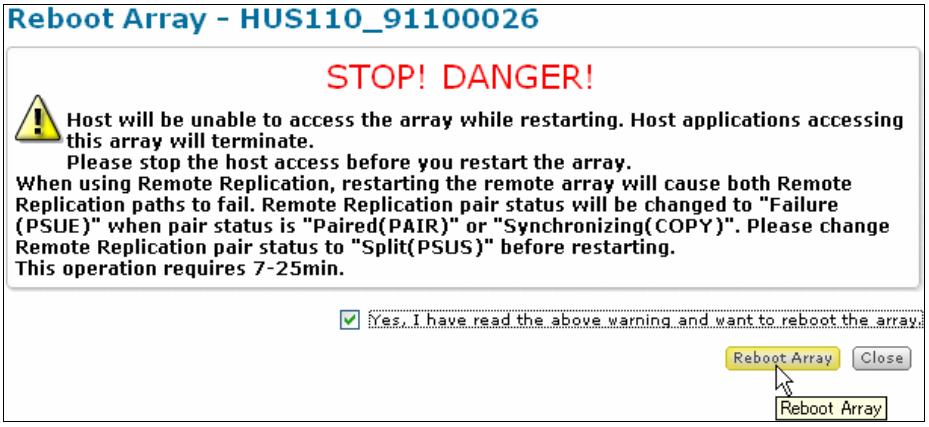
5. In the **Licenses** list, click **De-install License**. The De-Install License window appears.
6. To uninstall Hitachi Dynamic Provisioning using the key code, click the **Key Code** radio button, and then enter the key code. To uninstall Hitachi Dynamic Provisioning using the key file, click the **Key File** radio button, and then use the **Browse** button to specify the path for the key file name. Click **OK**.



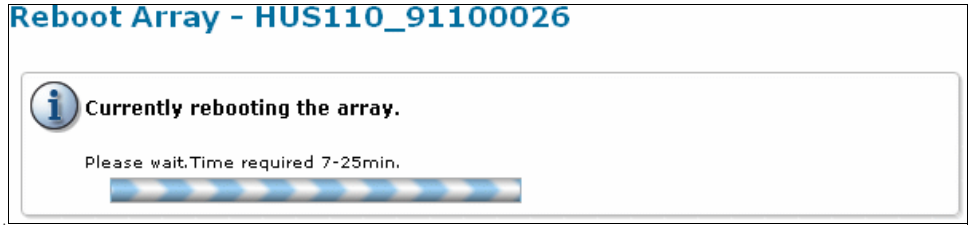
7. In the De-Install License confirmation message, click **Reboot Array**.



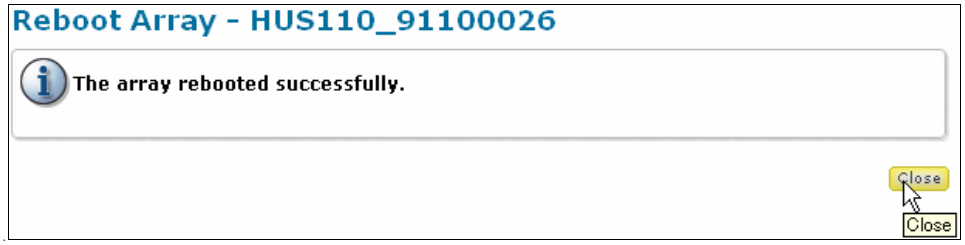
8. When the following message appears, check the check box and click **Reboot Array**.



NOTE: To install the option, reboot the array. The host or application cannot access the array until the reboot is complete and the system restarts. Be sure the host stops accessing data before restarting. It can take from 7 to 25 minutes for the array to restart, depending on the condition of the array. If it does not respond after 25 minutes or more, check the condition of the array.



9. When the message confirms that the restart is successful, click **Close**.



Uninstallation of Hitachi Dynamic Provisioning is now complete.

Enabling or disabling Hitachi Dynamic Provisioning

After Hitachi Dynamic Provisioning is installed, it can be enabled or disabled with or without requiring the array to reboot.

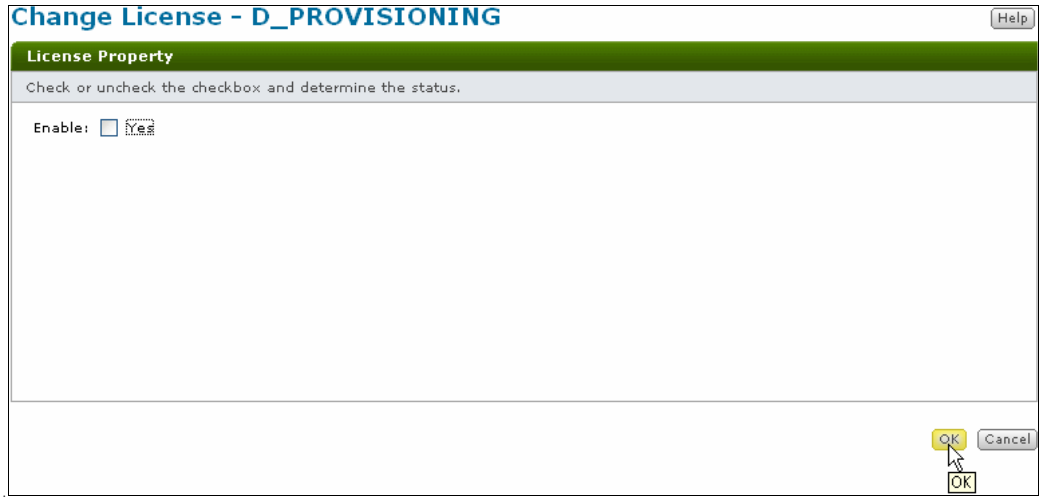
Before you disable Hitachi Dynamic Provisioning, observe the following guidelines:

- When the DP-VOL is mapped, release the mapping information.
- Delete all the DP-VOLs (see Deleting a DP-VOL from a DP Pool).
- Delete all the DP pools for Hitachi Dynamic Provisioning (see Deleting a DP pool on page 5-7).

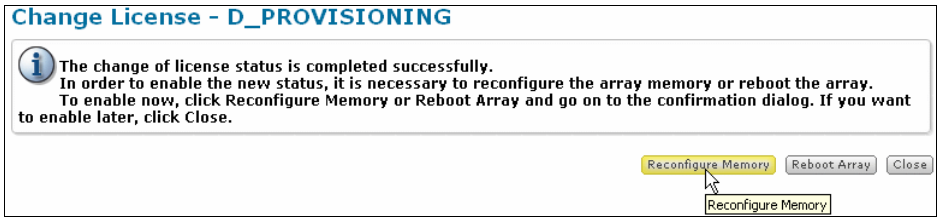
Enabling or disabling without rebooting

To enable or disable Hitachi Dynamic Provisioning without rebooting:

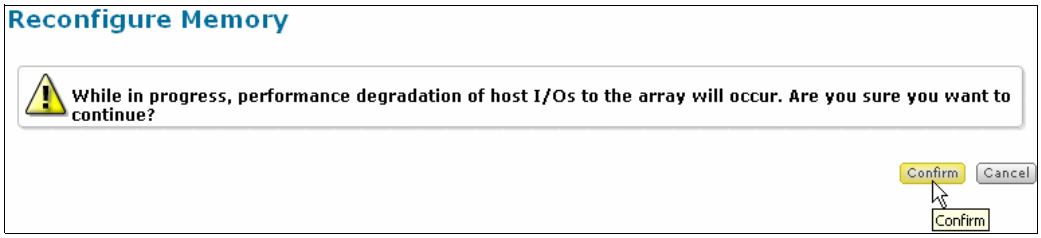
1. Start Storage Navigator Modular 2.
2. Log in as registered user to Storage Navigator Modular 2.
3. Select the array in which you will set Hitachi Dynamic Provisioning.
4. Click **Show & Configure Array**.
5. Select **Licenses** in the **Settings** tree view.
6. Select **D_PROVISIONING** in the **Licenses** list.
7. Click **Change Status**. The Change License window.



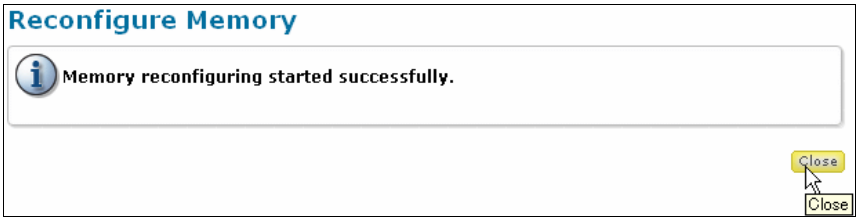
8. Perform the appropriate task:
   - To disable Hitachi Dynamic Provisioning, uncheck **Enable**.
   - To enable Hitachi Dynamic Provisioning, check **Enable**.
9. Click **OK**.
10. When the Change License message appears, click **Reconfigure Memory**.



11. When the Licenses list appears, confirm that **Pending** appears in the **Reconfigure Memory Status** column.
12. Check the check box **D_PROVISIONING** and click **Reconfigure Memory**.
13. When the following message appears, click **Confirm**.



14. When the following message appears, click **Close**.



15. When the license list appears, confirm the **Reconfigure Memory Status** is **Reconfiguring(nn%)** or **Normal**.
16. If the **Reconfigure Memory Status** is **Reconfiguring(nn%)**, wait a few minutes and then click **Refresh Information**. Confirm the **Reconfigure Memory Status** changes to **Normal**.
17. If the **Reconfigure Memory Status** is **Failed(Code-01:Timeout)**, click **Install License** and repeat steps 6 through 15.

    Code-01 occurs when the access from the host is frequent or the amount of the unwritten data in the cache memory is large.
18. If the **Reconfigure Memory Status** is **Failed(Code-02: Failure of Reconfigure Memory)**, check the **D_PROVISIONING** check box in the **Installed Storage Features** list, and then click **Reconfigure Memory**. Repeat steps 13 through15.

    Code-02 occurs when the drive restoration processing starts in the background.
19. If the **Reconfigure Memory Status** is **Failed(Code-04: Failure of Reconfigure Memory)**, click **Resource** on the **Explorer** menu to return to Arrays screen.

Code-04 occurs when the unwritten data in the cache memory cannot be saved to the drive.

20. Select the array in which you will install Dynamic Provisioning, and then click **Reboot Array**.
21. If the **Reconfigure Memory Status** is **Failed(Code-03: Failure of Reconfigure Memory)**, contact HDS Support at portal.hds.com.

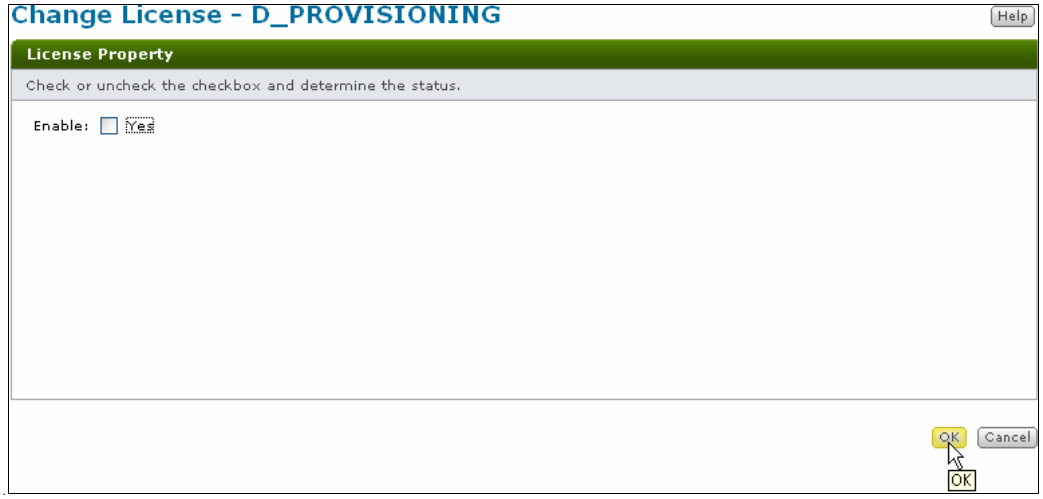
    Code-03 occurs when the copy of the management information in the cache memory fails.

Enabling or disabling of Hitachi Dynamic Provisioning is now complete.

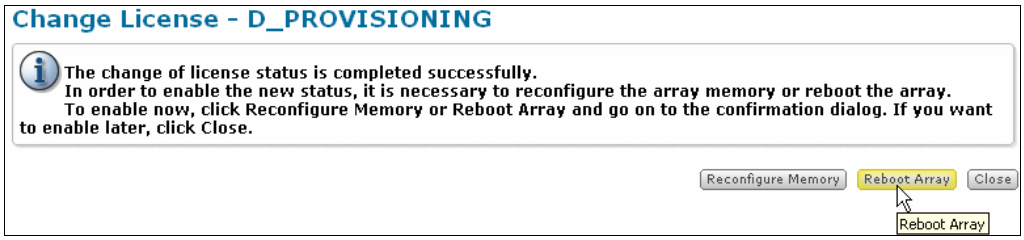
Enabling or disabling and rebooting

To enable or disable Hitachi Dynamic Provisioning and reboot the array:

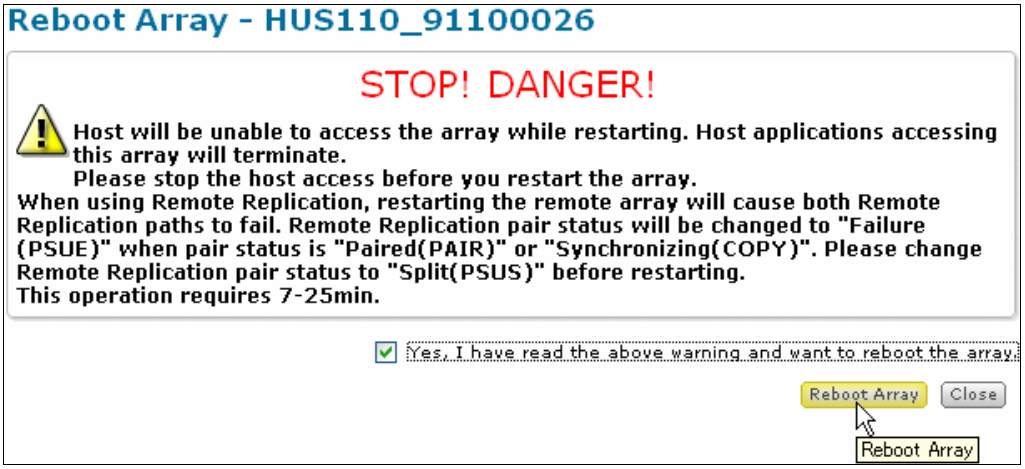
1. Start Storage Navigator Modular 2.
2. Log in as registered user to Storage Navigator Modular 2.
3. Select the array in which you will set Hitachi Dynamic Provisioning.
4. Click **Show & Configure Array**.
5. Select the **Licenses** icon in the **Settings** tree view.
6. Select the **D_PROVISIONING** in the **Licenses** list.
7. Click **Change Status**. The Change License screen appears.



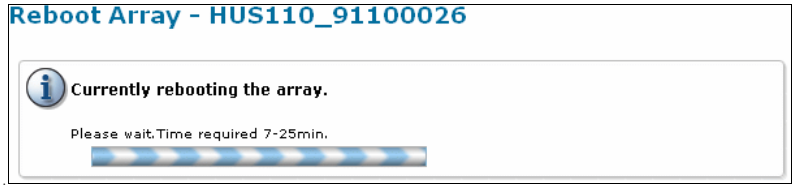
8. Perform the appropriate task:
   - To disable Hitachi Dynamic Provisioning, uncheck **Enable**.
   - To enable Hitachi Dynamic Provisioning, check **Enable**.
9. When the confirmation message appears, click **Reboot Array**.



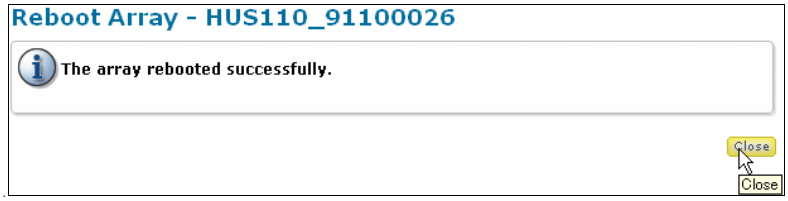
10. When a message confirms that this optional feature is set, check the check box and click **Reboot Array**.



NOTE: To install the option, reboot the array. The host or application cannot access the array until the reboot is complete and the system restarts. Be sure the host stops accessing data before restarting. It can take from 7 to 25 minutes for the array to restart, depending on the condition of the array. If it does not respond after 25 minutes or more, check the condition of the array.



11. In the Reboot Array message, click **Close**.



Enabling or disabling of Hitachi Dynamic Provisioning is now complete.

4

Using the Hitachi Dynamic Provisioning GUI

This chapter describes how to use the Hitachi Dynamic Provisioning graphical user interface (GUI) via Hitachi Storage Navigator Modular 2.

The following topics are covered in this chapter:

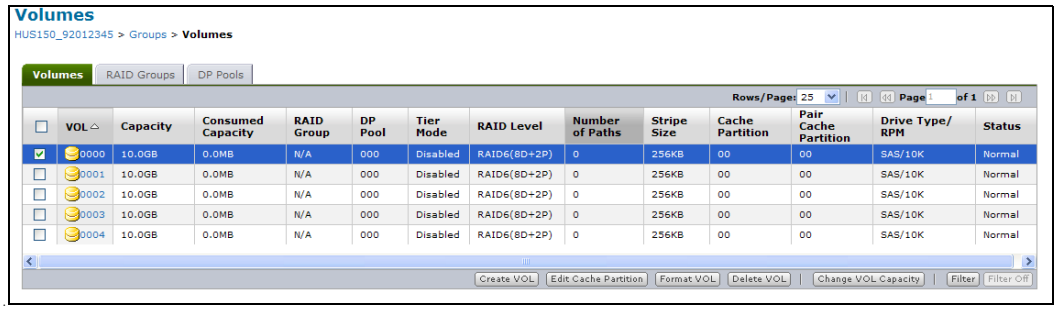
Volumes window

Use this window to view information about the volumes. This window uses these tabs:

- Volumes tab
- DP RAID Groups tab (property of DP Pool)
- DP Pools tab

Volumes tab

This tab shows information about the existing volumes in the RAID Group. Use this tab to create a volume, format a volume, delete a volume, or change a volume.

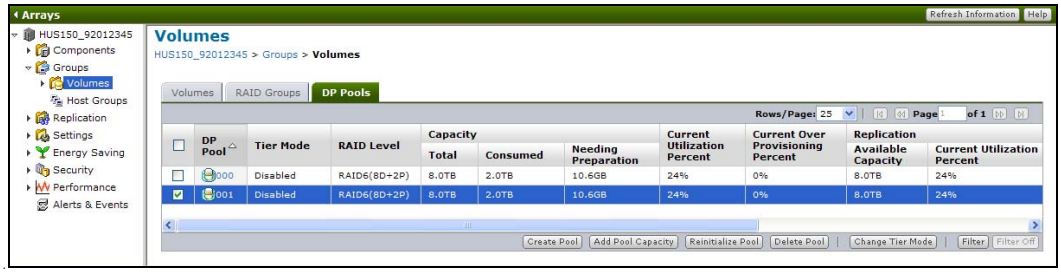


Item	Description
Rows/Pages	Use this list to select the number of items to display on this tab. The tab can display from 25 to 1000 rows on a page.
Forward and back buttons	Click to move back or forward a page, or to the first or last page.
Page x of 1	The page number of the current display.
VOL check box	Click to select a volume to edit properties.
VOL	Number of the created volume.
Capacity	Total capacity of the volume.
Consumed Capacity	Amount of total capacity already consumed in the DP-VOL. N/A for non-DP-VOLs.
RAID Group	RAID group number of the volume.
DP Pool	DP pool number. N/A for non-DP-VOLs.
Tier Mode	Shows when Tier Mode is enabled or disabled. When Hitachi Dynamic Tiering is disabled, N/A is shown.
RAID Level	RAID level (1 through 6) and drive combination assigned to the volume.
Number of Paths	Mapping information.
Stripe Size	Stripe size that is assigned to the volume.
Cache Partition	The number of the cache partition assigned to the volume. The range is 0 to nn.

Item	Description
Pair Cache Partition	The number of cache partition pairs assigned to the volume. • Auto (default). The volume is automatically assigned to the appropriate cached partition number. • 0 to nnn
Drive Type/ RPM	Type of drive and rotational speed.
Status	The status of the volume. • Normal • Unmounted • Detached • Detached (Unmounted) • Mounted
Create VOL	Click when creating a volume.
Format VOL	Click to format a selected volume.
Delete VOL	Click to delete a selected volume.
Change VOL Capacity	Click to change the volume.
Filter	Use to reduce the items displayed.
Filter Off	Turn off the filter.
VOL	Created DP-VOL number.
Capacity	Assigned capacity to the DP-VOL.
Consumed Capacity	Consumed capacity of the DP-VOL.
Number of Paths	Mapping information.
Stripe Size	Stripe size of the DP-VOL.
Cache Partition	Cache partition number using DP-VOL.
Pair Cache Partition	Paired cache partition number to be using the DP-VOL.
Status	Status of the DP-VOL.

DP Pools tab

This tab provides information about the DP pools in the volume. Use this tab to view DP pool information and to create a pool, delete a pool, or add pool capacity.



Item	Description
Rows/Pages	Use this list to select the number of items to display on this tab. The tab can display from 25 to 1000 items on a page.
Forward and back buttons	Click to move back or forward a page, or to the first or last page.
Page x of 1	Page number of the current display.
DP Pool check box	Select to perform a task on the selected DP pool.
DP Pool	Number identifier of the DP pools. Select a DP pool to view the DP pool properties, delete a pool, or add pool capacity. Click the DP Pool number to open the DP Pool Window that shows the properties of the selected DP pool.
Tier Mode	Shows when Tier Mode is enabled or disabled. When Hitachi Dynamic Tiering is disabled, N/A is shown.
RAID Level	RAID level (1 through 6) and drive combination assigned to the DP pool.
Capacity	Capacity information for this DP pool. • Total: Total capacity assigned to DP pool. • Consumed: Amount of capacity already consumed of the total capacity of the DP pool. • Needing Preparation: The unnecessary area is collected by the user's instruction such as shrinking the volume. Shows the remaining capacity during the collection.
Utilization Percent	Percentage of DP pool consumed capacity utilization.
Over Provisioning Percent	Total DP-VOL logical capacity as a percentage of DP pool capacity.
Replication	• Available Capacity: Shows the capacity available in the DP pool (the capacity subtracting the SSD/FMD Tier from the entire pool capacity). If SnapShot or TCE is disabled, N/A is shown. • Utilization Percent: Shows the rate of the capacity subtracting the SSD/FMD Tier use capacity from the replication use capacity in proportion to the replication usable capacity. When SnapShot or TCE is disabled, N/A is shown.

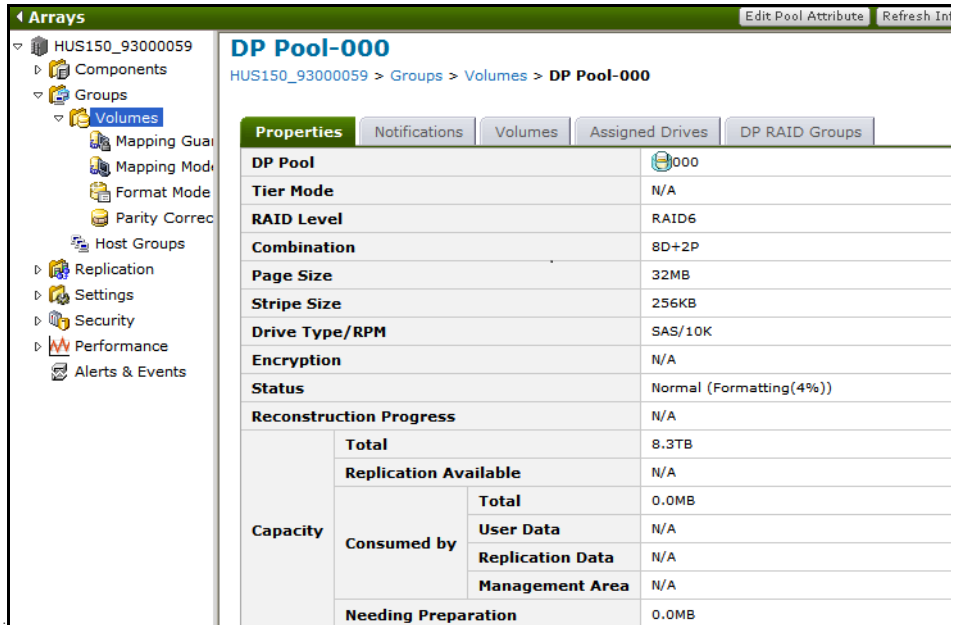
Item	Description
Stripe Size	Stripe size of the DP pool.
Drive Type/ RPM	Type of drive contained in the RAID group and rotational speed.
Encryption	Encryption status of the drives that configure the DP pool.

Status	Shows the **DP pool status** as a primary value, and **DP pool formatting progress** and **DP pool capacity status** as secondary values in parentheses.
	
	For example, if **DP pool status** is **Normal** and **DP pool capacity status** is **Depletion Alert over**, the Status shows Normal (Depletion Alert over).
	
	• **DP pool status** — one of the following:
	  • Normal: Indicates that this DP pool is normal.
	  • Check Component: Indicates that the drive (HDU) which configures the DP pool is during copy back or the unformatted volume is included.
	  • Regression: At least one DP RAID group is regressed. It is necessary to replace the blocked drive.
	  • Detached: At least one DP RAID group is detached. It is necessary to reconfigure the DP pool.
	• **DP pool formatting status** — displayed as Formatting (nn%) where n is 1 to 99. The capacity of the displayed progress level is usable.
	• **DP pool capacity status** — one of the following status indications for DP pool consumed capacity:
	  • Early Alert Over: The consumed capacity exceeds the Early Alert Threshold.
	  • Depletion Alert Over: The consumed capacity exceeds the Depletion Alert Threshold.
	  • Capacity Depleted: The DP pool capacity is depleted or exhausted. You cannot create or grow volumes to increase capacity under Dynamic Provisioning. The array is operable, although a warning message appears if the definition/growing of the DP-VOL, DP Optimization, or LU mapping to host group/iSCSI target group is performed during depletion or Depletion Alert status. We recommend you grow the capacity immediately.

Reconstruction Progress	DP pool reconstruction progress.
Create Pool	Click to open the Create DP Pool window to create a new DP pool.
Reinitialize Pool	Click when recovering a DP pool.
Delete Pool	Click to delete a selected DP pool.
Change Tier Mode	Click to change Tier Mode. This button is available only when Dynamic Tiering is enabled.
Add Pool Capacity	Opens the Add DP Pool Capacity window to add capacity to a DP pool.
Filter	Use to reduce the number of the items appearing in the window.
Filter Off	Turn off the filter and display all items in the window.

Properties tab (property of DP pool)

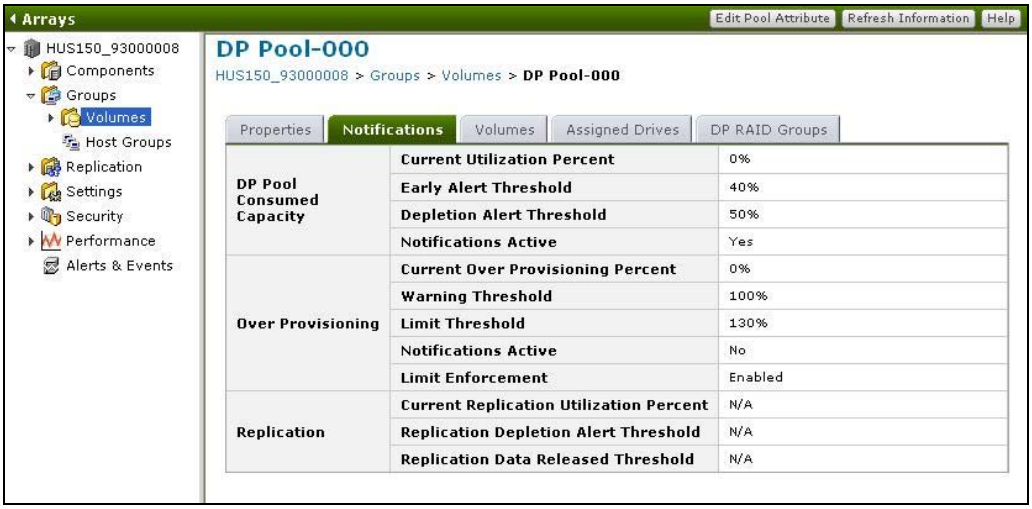
The following figure shows the DP pool property when a DP pool number is selected.



Item	Description
DP Pool	Type a number identifier from 0 to 49 (Hitachi Unified Storage 110) or from 0 to 63 (Hitachi Unified Storage 130 and Hitachi Unified Storage 150) for the DP pool. Do not use a number already in use.
Tier Mode	Shows when Tier Mode is enabled or disabled. When Hitachi Dynamic Tiering is disabled, N/A is shown.
RAID Level	Select a RAID level (1 through 6).
Combination	Select a RAID combination.
Page Size	Page size (fixed 32 MB).
Stripe Size	Stripe size of the DP pool.
Drive Type/ RPM	Type of drive contained in the RAID group and rotational speed.
Status	DP pool status.
Reconstruction Progress	DP pool reconstruction progress.
Capacity	Capacity information for this DP pool. • Total: Total capacity assigned to DP pool. • Replication Available: Shows the capacity available in the DP pool (the capacity subtracting the SSD/FMD Tier from the entire pool capacity). When SnapShot or TCE is disabled, N/A is shown. • Consumed: Amount of capacity already consumed of the total capacity of the DP pool, in units of 1024 MB. • Needing Preparation: The unnecessary area is collected by the user's instruction such as shrinking the volume. Shows the remaining capacity during the collection.

Notifications tab (property of DP pool)

The following figure shows the **Notifications** tab when a DP pool number is selected.



Item	Description
DP Pool Consumed Capacity	Capacity alerts for this DP pool: • Current Utilization Percent: Percentage of current utilization. • Early Alert Threshold: DP pool consumed capacity alert threshold value for an Early Alert for this pool. • Depletion Alert Threshold: DP pool consumed capacity alert threshold for a Depletion Alert for this DP pool. • Notifications Active: Shows the alert notice setting (Yes or No).
Over Provisioning	Over-provisioning thresholds for this DP pool: • Current Over Provisioning Percent: Percentage of current over provisioning level. • Warning Threshold: Over-provisioning threshold value for a Warning for this DP pool. • Limit Threshold: Over-provisioning threshold value for a Limit for this DP pool. • Notifications Active: Indicates whether an e-mail alert indicating an SNMP Agent trap is generated if any of the above threshold values are exceeded. This feature can be turned on and off in Storage Navigator Modular 2 in the DP Pool Property window, Advanced tab. • Limit Enforcement: Shows whether the operation is enabled or disabled.
Replication	• Current Replication Utilization Percent: Shows the capacity available in the DP pool (the capacity less the SSD/FMD Tier from the entire pool capacity). If Tier Mode is disabled, the Current Utilization Percent value is displayed. If Copy on Write SnapShot or TCE is disabled, N/A is shown. • Replication Depletion Alert Threshold: Shows the depletion alert threshold value. When Copy on Write Snapshot is disabled, N/A is shown. • Replication Data Released Threshold: Shows the depletion data released threshold value. When Copy on Write Snapshot is disabled, N/A is shown.

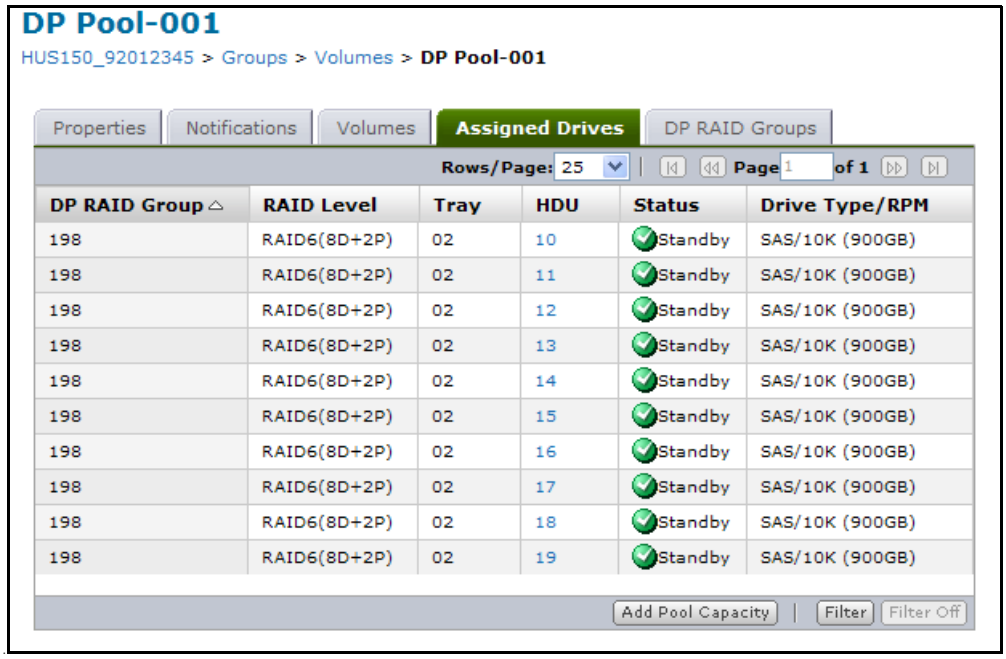
Volumes tab (property of DP pool)

The **Volumes** tab shows the following items when a DP pool number is selected.

Item	Description
Rows/Pages	Use this list to select the number of items to display on this tab. The tab can display from 25 to 1000 items on a page.
Forward and back buttons	Click to move back or forward a page, or to the first or last page.
Page x of 1	The page number of the current display.
VOL	Number of the DP-VOL
Capacity	Assigned capacity to the DP-VOL.
Consumed Capacity	Consumed capacity of the DP-VOL.
Number of Paths	Mapping information.
Stripe Size	Stripe size of the DP-VOL.
Cache Partition	Cache partition number using DP-VOL.
Pair Cache Partition	Paired cache partition number to be using the DP-VOL.
Drive Type/ ROM	Type of drive and rotational speed.
Encryption	Encryption status of the drives that configure the DP pool.
Status	Status of the DP-VOL.
Create VOL	Click when creating a volume.
Format VOL	Click to format a selected volume.
Delete VOL	Click to delete a selected volume.
Change VOL Capacity	Click to change the volume.
Filter	Use to reduce the items displayed.
Filter Off	Turn off the filter.

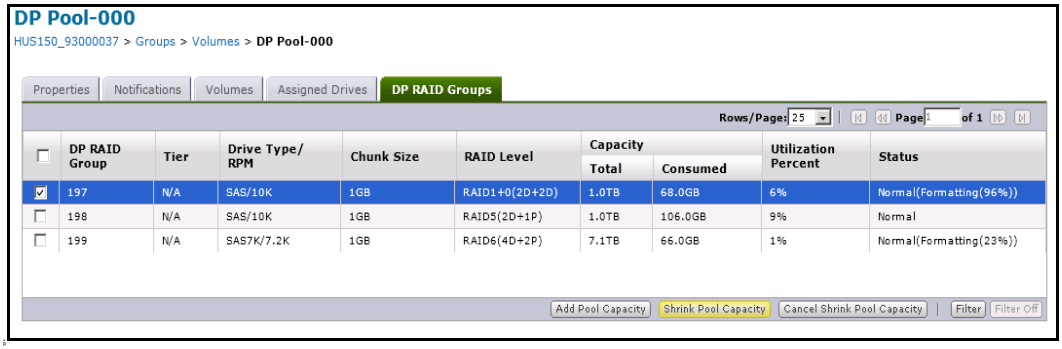
Assigned Drives tab (property of DP pool)

The **Assigned Drives** tab in the DP Pool window provides information about the drives assigned to the DP RAID groups in the DP pool.



Item	Description
Rows/Pages	Use this list to select the number of items to display on this tab. The tab can display from 25 to 1000 items on a page.
Forward and back buttons	Click to move back or forward a page, or to the first or last page.
Page x of 1	The page number of the current display.
DP RAID Group	This identifies the RAID group assigned to the DP pool.
RAID Level	RAID level that created the DP pool.
Tray	Tray number
HDU	Sequential hard drive unit number
Status	Drive status. • Standby • Normal • Unmounted • Detached • Detached (Unmounted) • Mounted
Drive Type/ RPM	Type of drive and rotational speed.
Add Pool Capacity	Click to add DP pool capacity.
Filter	Use to reduce the number of the items appearing in the window.
Filter Off	Turn off the filter and display all items in the window.

DP RAID Groups tab (property of DP Pool)

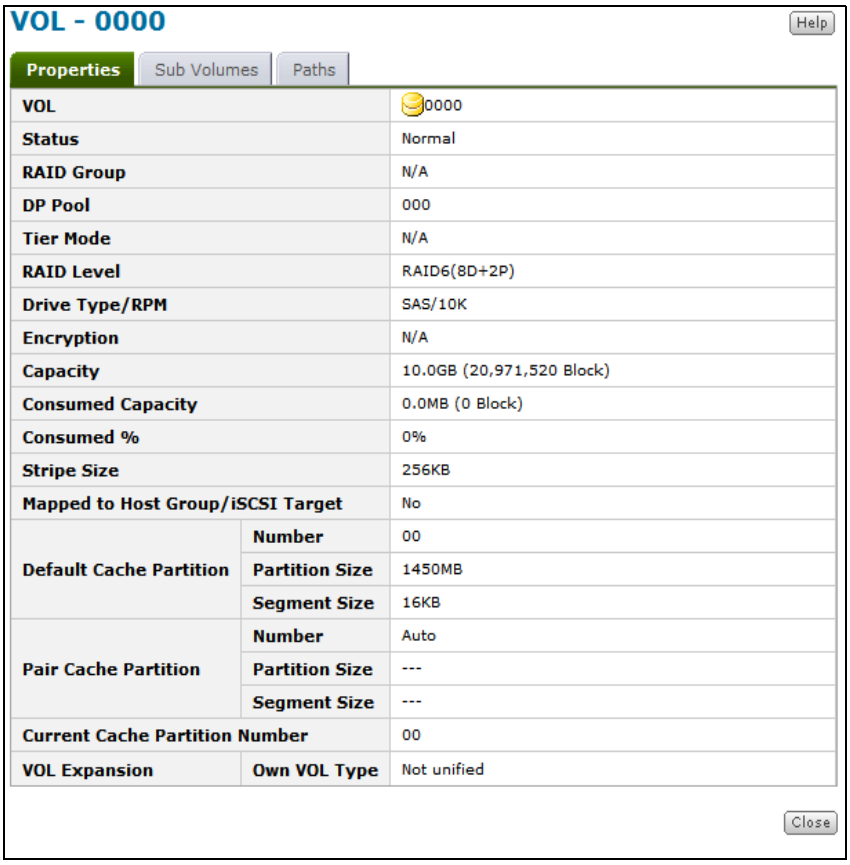


Item	Description
Rows/Pages	Use this list to select the number of items to display on this tab. The tab can display from 25 to 1000 items on a page.
Forward and back buttons	Click to move back or forward a page, or to the first or last page.
Page x of 1	The page number of the current display.
DP RAID Group	This identifies the RAID group assigned to the DP pool.
Tier	Shows the tier to which the DP RAID Group is assigned.
Drive Type/ RPM	Shows the drive type and the rotational speed.
Chunk Size	Shows the chunk size of the DP RAID group.
RAID Level	Shows the RAID level that created the DP pool.
Capacity	Total: Shows the DP pool capacity. Consumed: Shows the assigned capacity to the DP-VOL. The assigned capacity displays, in units of 1024 MB.
Utilization Percent	Current utilization percentage.
Add Pool Capacity	Click to add DP pool capacity.
Shrink Pool Capacity	Click to shrink DP pool capacity.
Cancel Shrink Pool Capacity	Click to cancel the DP pool shrink operation.

Volume Properties window

Volume Properties tab

This tab shows the properties of a selected volume.



Item	Description
VOL	Numerical identifier of the volume.
Status	Status of the volume.
RAID Group	RAID group number of the volume.
DP Pool	DP pool number.
RAID Level	RAID level (1 through 6) and drive combination assigned to the volume.
Drive Type/ RPM	Type of drive and rotational speed.
Encryption	Encryption status of the drives that configure the DP pool.
Capacity	Total capacity (in GB) of the volume.
Consumed Capacity	Amount of the total pool capacity already consumed.
Consumed %	Amount of pool capacity consumed as a percent of logical DP-VOL capacity.
Stripe Size	The size (in KB) of the data stripe assigned to the volume.

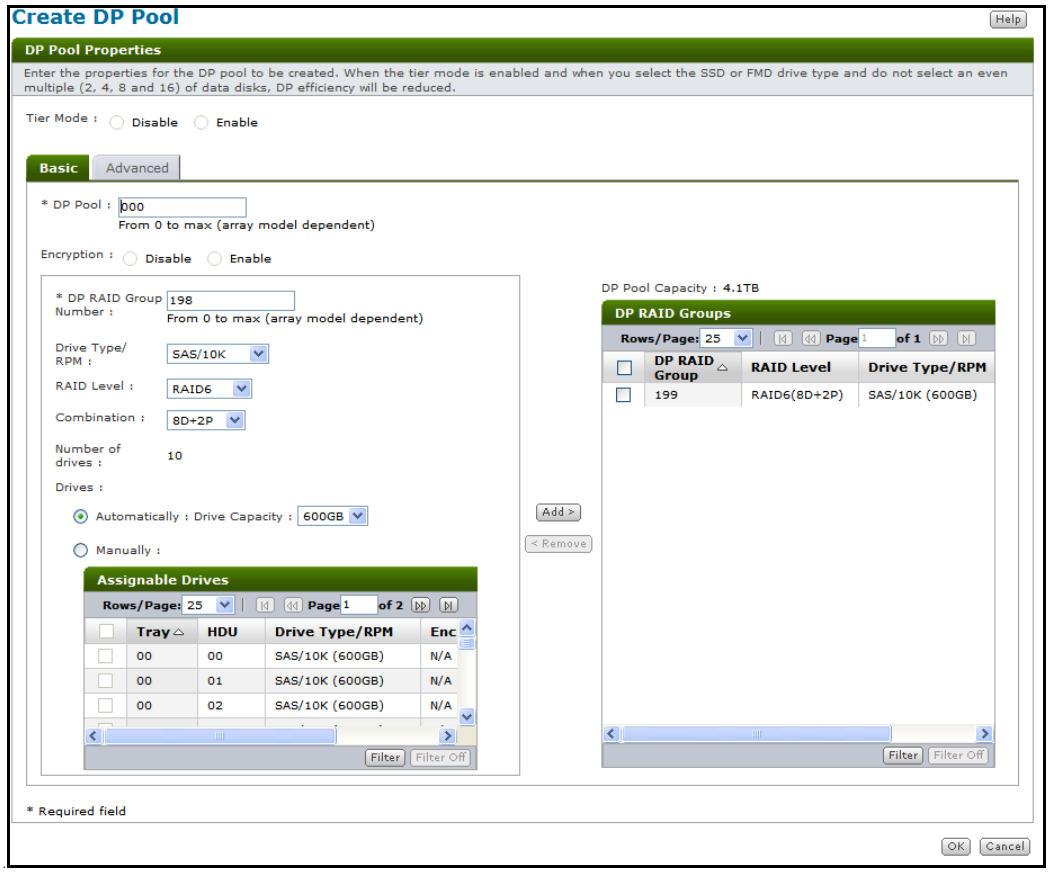
Item	Description
Mapped to Host Group/iSCSI Target	Shows mapping information.
Default Cache Partition	Information about the default cache partition. • Number: Numerical identifier of the default cache partition • Partition Size: Size (in MB) of the default cache partition. • Segment Size: Size (in KB) of the default cache partition segment.
Pair Cache Partition	Information about the pair cache partition. • Number: Numerical identifier of the pair cache partition • Partition Size: Size (in MB) of the pair cache partition. • Segment Size: Size (in KB) of the pair cache partition segment.
Current Cache Partition	Numerical identifier of the current cache partition.
VOL Expansion	Shows the unified volume attribute.
Own VOL Type	Unified volume attribute.
Close	Closes this tab.

Create DP Pool window

Use the tabs in this window to create a DP pool.

- Basic tab
- Advanced tab

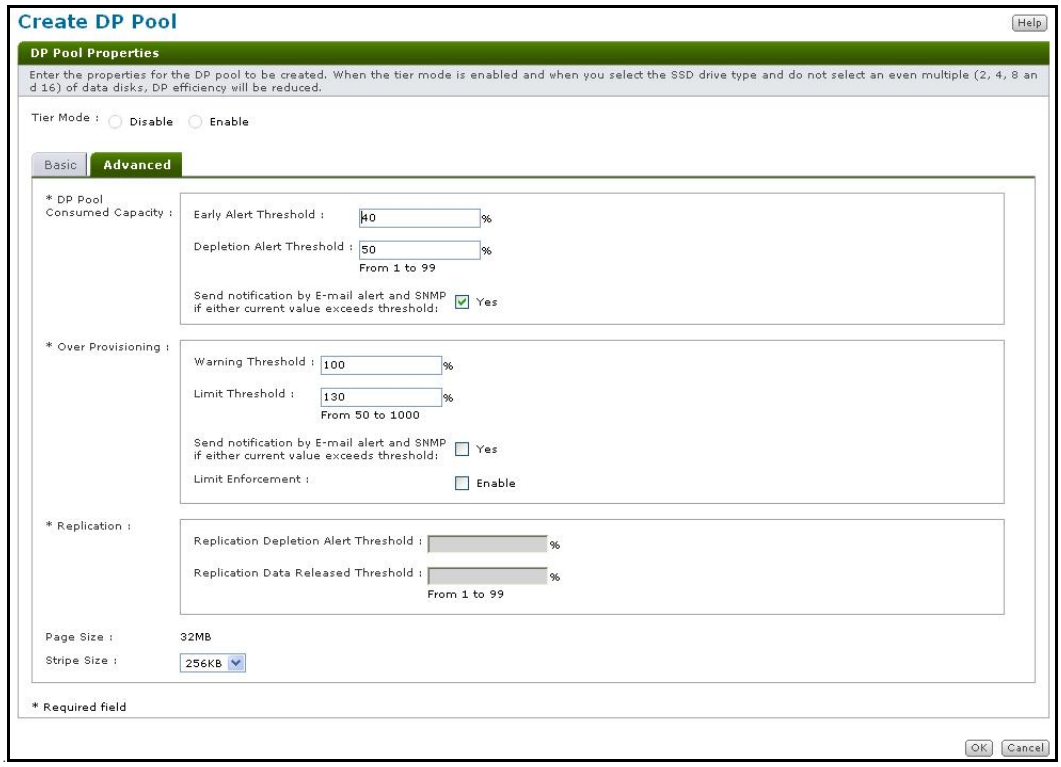
Basic tab



Item	Description
DP Pool	Type a number identifier, from 0 to 63, for the DP pool. Do not use a number already in use.
RAID Level	Select a RAID level (1 through 6).
Combination	Select a RAID combination.
Number of Drives	Type the number of drives to be added for this pool. Specify the number based on a single RAID Combination.
Automatic Selection	If you select this option, then also select a **Drive Type** and a **Drive Capacity**.
Manual Selection	If you select this option, then also specify a **Tray** and **HDU** combination from the **Assignable Drives** list.

Advanced tab

Use this tab to set the consumed capacity and over-provisioning thresholds, and to set up e-mail and SNMP alerts to warn if threshold values are reached.

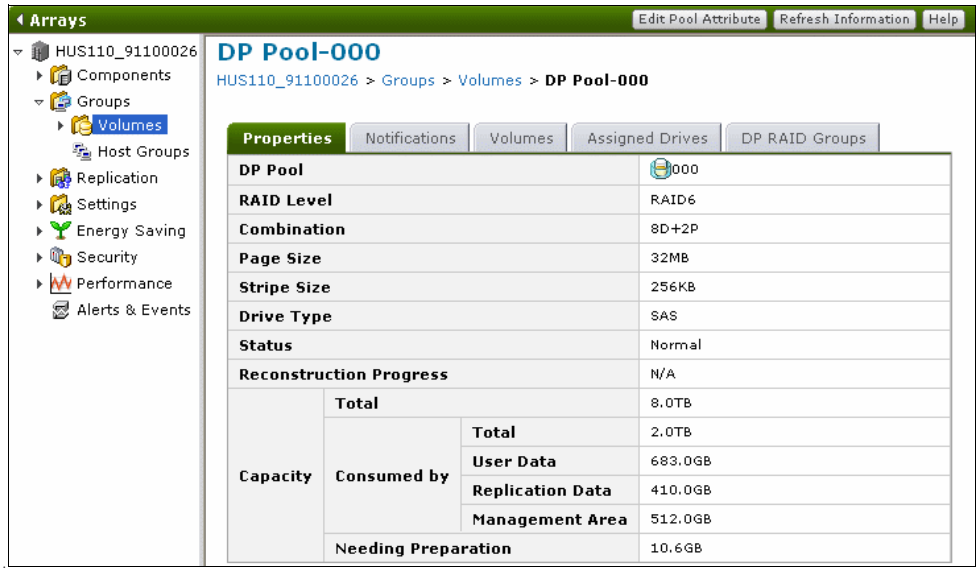


Item	Description
DP Pool Consumed Capacity Alert	Use the default values or set user-selected values. • Early Alert: Threshold value for an Early Alert for this DP pool. This is an initial warning and must be less than the Depletion Alert value. The range of values is from 1 to 99%; the default value is 40%. We recommend that you set this threshold based on the time it may require to order and set up additional drives before adding to the DP pool. • Depletion Alert: Threshold value for a Depletion Alert for this DP pool. This warning signals that available space in the DP pool is too low. The Unified Storage system provides warnings every 6 hours if this state continues. The range of values is from 1 to 99(%); the default is 50%. We recommend that you set this threshold based upon the rate that pool space is consumed and the administration reaction time to add additional pool capacity. A new DP-VOL cannot be created against the pool while the threshold is exceeded. • Notification: Shows the alert notice setting. (Yes or No)

Item	Description
Over Provisioning Threshold	Use the default values or set user-selected values. • Warning: Threshold value for an over-provisioning Warning for this DP pool. The range of values is from 50 to 1000%; the default is 100%. • Limit: Threshold value for the over-provisioning Limit for this DP pool. The Limit value must be greater than the Warning value. The range of values is from 50 to 1000%; the default is 130%. While the threshold is exceeded, a new DP-VOL cannot be created against the pool. We recommend you set the Limit value to a level that meets the administrator's judgment of good risk management. Initial values of near 100% are appropriate. After you reach a level of capacity savings expectations based on actual data, you can increase the Limit threshold.
Send notification by E-mail alert and SNMP if alert value is exceeded	Check Yes to enable e-mail alerts.
Page size	Size of a data unit to configure this DP pool (fixed at 32 MB)

DP Pool window

The DP Pool window summarizes information about the DP pools. Select a DP pool to view the summary information. You can also create a DP pool or change the properties of the selected DP pool.



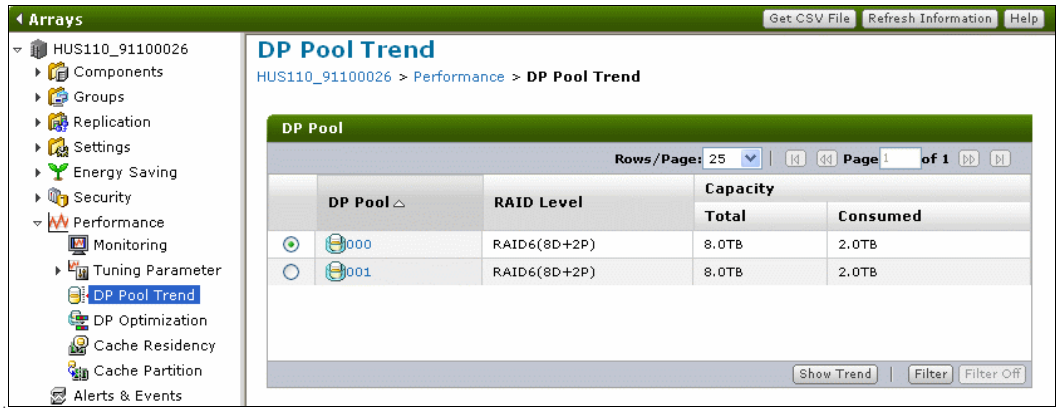
Summary table

This table in the DP Pool window provides summary information about the selected DP pool.

Item	Description
Edit Pool Attributes	Opens the Edit DP Pool Attribute window where you can change the DP pool attribute properties.
Refresh Information	Updates the display with any changes since the last refresh.
Help	Opens the online help system.
DP Pool	DP pool number. Click the icon to view or change the properties of this DP pool.
RAID Level	RAID level (1 through 6) assigned to the DP RAID group for this DP pool.
Combination	The RAID configuration, which is a RAID combination of drives configured for this DP pool. • D: Data • P: Parity
Page Size	Size of a data unit to configure this DP pool (fixed at 32 MB)
Stripe Size	Shows the stripe size of the DP pool.
Drive Type	Drive type of this DP pool.
Status	Status of this DP pool: • Normal: The standard (normal) status. • Regression: At least one drive in the RAID group of a DP pool has failed. • Detached: At least one RAID group in a DP pool has failed.

Item	Description
Reconstruction Progress	Shows the DP pool reconstruction progress.
Capacity	Capacity information for this DP pool: • Total: DP pool capacity. • Consumed: Assigned capacity to the DP-VOL. The assigned capacity displays by the unit of 1024 MB. • Needing Preparation: Unnecessary area is collected by the user's instruction such as shrinking the volume. Shows the remaining capacity during the collection.

DP Pool Trend window



Use this window to view trend information for the DP pools and their utilization rates in the selected Unified Storage system.

Item	Description
Rows/Pages	Use this list to select the number of items to display, from 25 to 1000 items on a page.
Forward and back buttons	Click to move back or forward a page, or to the first or last page.
Page x of 1	The page number of the current display.
DP Pool	A list of the DP pools in the Unified Storage system. You can sort the list by clicking the arrow in the heading.
RAID Level	RAID level (1 through 6) and drive combination assigned to the DP pool
Capacity	Capacity information for this DP pool. • Total: Total capacity assigned to this DP pool. • Consumed: Amount of capacity already consumed of the total capacity assigned to the DP pool.
Show Trend	Select a DP pool and click this button to view trend information about the selected DP pool.
Filter	Use to reduce the number of the items appearing in the window.
Filter Off	Turn off the filter and display all items in the window.

DP Optimization window

Use the following window to view Hitachi Dynamic Provisioning optimization information.

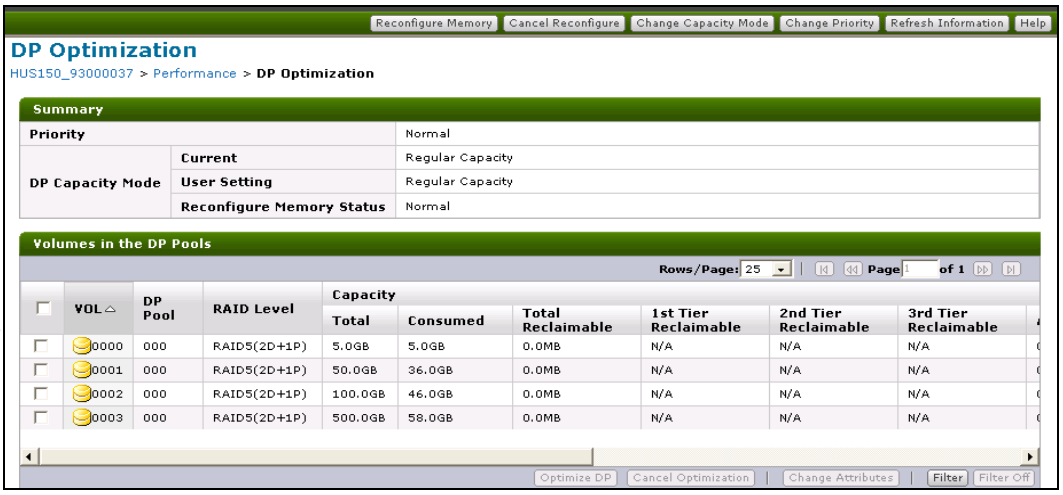


Figure 4-1: DP Optimization window (1 of 2)

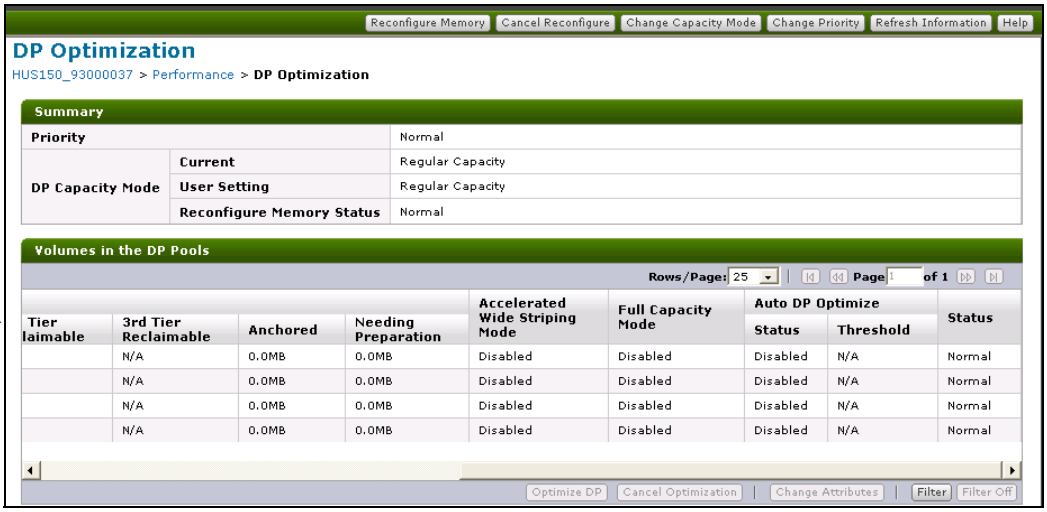


Figure 4-2: DP Optimization window (2 of 2)

Item	Description
Rows/Pages	Use this list to select the number of items to display, from 25 to 1000 items on a page.
Forward and back buttons	Click to move back or forward a page, or to the first or last page.
Page x of 1	The page number of the current display.
Items Under **Summary**	
Priority	Shows the priority of the DP optimization.

Item	Description
DP Capacity Mode	• Current: Current value of the DP Capacity Mode. • User Setting: Value specified by the user of the DP Capacity Mode. If the DP Capacity Mode is changed, this value is set and the Current value of the DP Capacity Mode is updated after restarting the array or reconfiguring the memory. • Reconfigure Memory Status: Memory reconfiguration status (see Table 3-5 on page 3-11).
Items on DP Optimization Window	
VOL	Numerical identifier of the volume.
DP Pool	DP pool number associated with the volume.
RAID Level	RAID level (1 through 6) that created the volume.
Capacity	Capacity information for the DP pool: • Total: Capacity assigned to the DP-VOL. • Consumed: Capacity used in the DP-VOL. • Reclaimed: Capacity reclaimed after optimization. Capacity may be recovered periodically after shrinking the DP-VOLs, when using Symantec Storage Foundation Suite, VMware, after the initial copy and other copies are made by ShadowImage, TrueCopy, and/or TrueCopy Extended Distance. • Anchored: Shows the capacity that is not actually used in the capacity secured as the chunk by the volume. When Accelerated Wide Striping Mode is enabled or the capacity of less than 1 GB exists, not all of the Anchored capacity can be used. • Needing Preparation: The unnecessary area is collected by the user's instruction such as shrinking the volume. Shows the remaining capacity during the collection.
Accelerated Wide Striping Mode	Shows whether Accelerated Wide Striping Mode is enabled or disabled. See Change Attributes.
Full Capacity Mode	Shows whether Full Capacity Mode is enabled or disabled. See Change Attributes.
Auto DP Optimize	Status: Shows whether Auto DP Optimize is enabled or disabled. Threshold: Shows the threshold value that determines when DP optimization is performed automatically when auto DP optimization mode is enabled. When the pool usage rate is less than the depletion alert threshold value, and the recoverable capacity is equals or exceeds this threshold value at midnight, the DP optimization is performed automatically. If the pool usage rate is equals or exceeds the depletion alert threshold value, and the recoverable capacity is 1 GB or more regardless of this value, DP optimization is performed automatically.
Status	DP-VOL status. • Normal • Optimizing • Waiting Optimization • Pending Optimization • Canceling Optimization • Failed
Optimize DP	Click to optimize the DP pool.

Item	Description
Cancel Optimization	Click to cancel DP optimization. If Optimization is cancelled, there will be some reclaimable capacity that has not been added back to the available pool capacity. Optimization must be run to completion, when convenient, to reclaim this capacity.
Change Attributes	Click this button to change the enabled or disabled status of Accelerated Wide Striping Mode, the Full Capacity Mode, and/or Auto DP Optimize.
Change Priority	Click to set or change the priority of DP optimization.
Change Capacity Mode	Click to change the upper limit of the maximum capacity of the DP pool.
Reconfigure Memory	Click to start the memory reconfiguration.
Cancel Reconfigure	Click to stop the memory reconfiguration.
Filter	Use to reduce the number of the items appearing in the window.
Filter Off	Turn off the filter and display all items in the window.

5

Performing Hitachi Dynamic Provisioning operations

This chapter provides procedures for performing Hitachi Dynamic Provisioning operations using the Hitachi Storage Navigator Modular 2 graphical user interface (GUI).

The following topics are covered in this chapter:

Hitachi Dynamic Provisioning workflow

Figure 5-1 shows the Hitachi Dynamic Provisioning workflow.

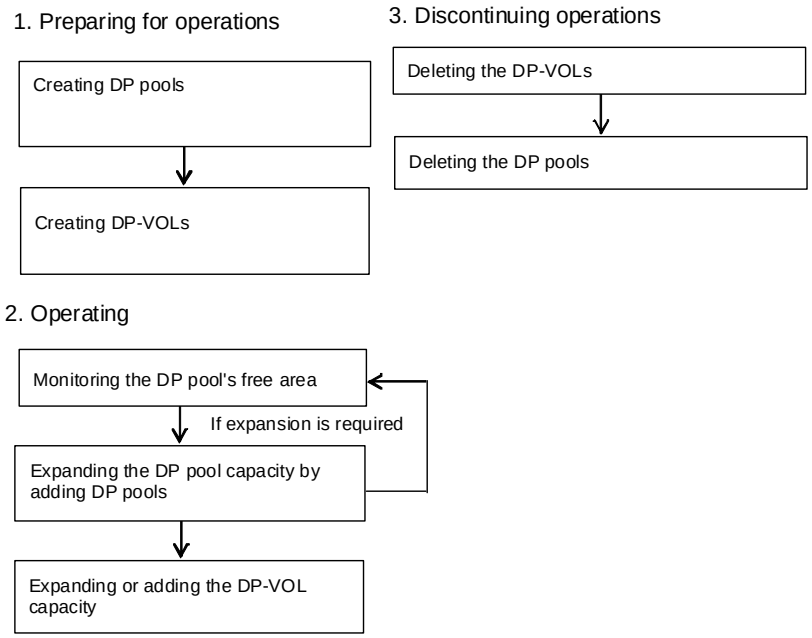


Figure 5-1: Hitachi Dynamic Provisioning workflow

Managing DP pools

This section describes the following topics:

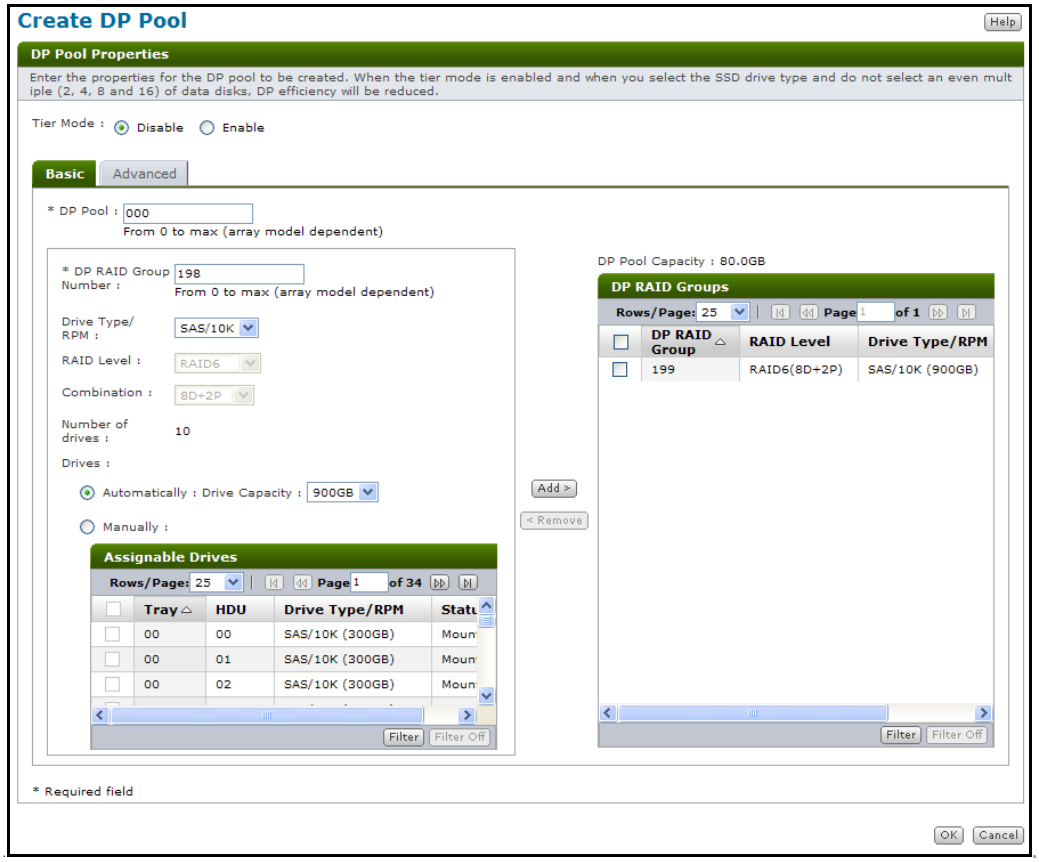
- Creating a New DP pool
- Changing DP pool thresholds
- Deleting a DP pool
- Reinitializing a DP pool
- Adding DP pool capacity
- Shrinking the DP pool capacity
- Canceling DP pool capacity shrinking

Creating a New DP pool

When creating many DP pools or adding hard drive units (HDUs) of large capacity to the DP pool, it may take a long time to complete processing. The time to create DP pools depends on the number and capacity of the DP pools to be created, the number and capacity of the HDUs to be added to the DP pool, etc.

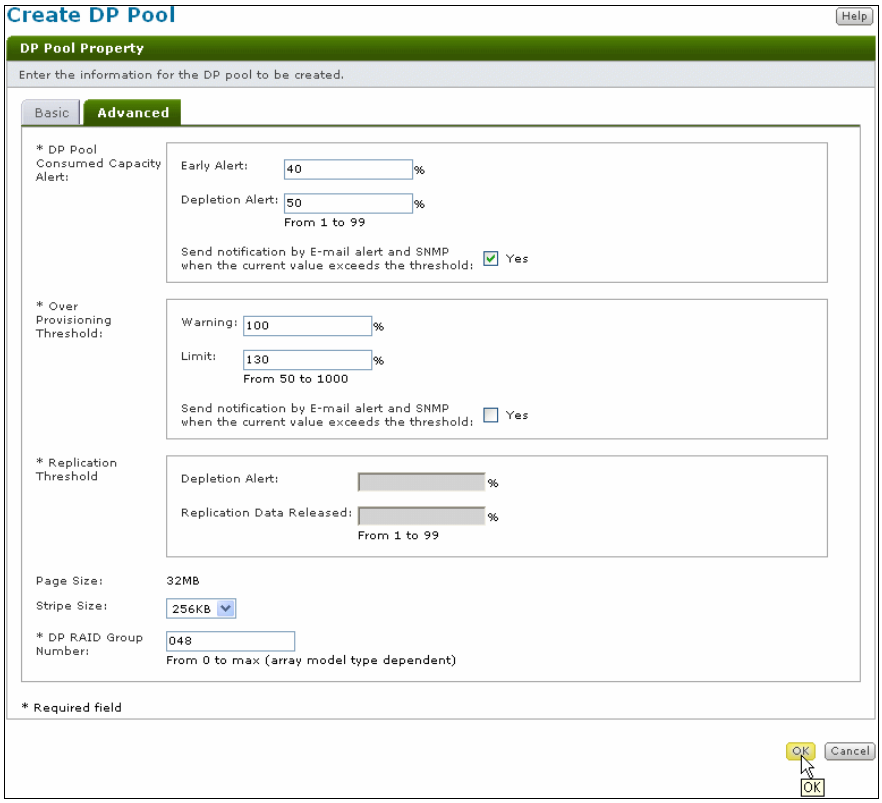
To create a new DP pool:

1. On the **DP Pools** tab, click **Create Pool**.



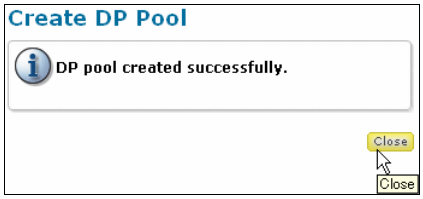
2. For **Tier Mode**, select **Enable** or **Disable**.

3. In **DP Pool**, type a DP pool number. Do not use a number that is already used.
   - Hitachi Unified Storage 150 and Hitachi Unified Storage 130: Enter values from 0 to 63.
   - Hitachi Unified Storage 110: Enter values from 0 to 49.
4. In **DP RAID Group Number**, enter a DP RAID group number.
   - Hitachi Unified Storage 150: Enter values from 0 to 63.
   - Hitachi Unified Storage 130: Enter values from 0 to 199.
   - Hitachi Unified Storage 110: Enter values from 0 to 49.
5. Select the drive type from the **Drive Type/RPM** drop-down list.
6. In **RAID Level**, select a RAID level. Be sure you have enough drives available to support the desired RAID level.
7. In **Combination**, select a RAID combination.
8. Select whether to set the drive automatically or manually:
   - **Automatically**: Select a **Drive Capacity** from the drop-down list.
   - **Manually**: Check the same number of HDU check boxes that match the number shown in **Number of drives**.
9. Click the **Add** button. A DP RAID group is added to the DP RAID Groups list. If you selected two or more DP RAID groups, repeat this procedure from step 6.
10. Click the **Advanced** tab.



11. Enter the **Early Alert Threshold** and **Depletion Alert Threshold** of the **DP Pool Consumed Capacity** if necessary.

12. Enter the **Warning Threshold** and **Limit Threshold** of the **Over Provisioning** if necessary.
13. To enable Over Provisioning e-mail alerts, check **Send notification by E-mail alert and SNMP when the current value exceeds the threshold**.
14. Check or uncheck **Limit Enforcement** if necessary
15. Enter **Replication Depletion Alert Threshold** and **Replication Data Released Threshold** of the **Replication** values if necessary.
16. Select a Stripe Size from the **Stripe Size** drop-down list if necessary.
17. Click **OK**.
18. When a message appears, click **Close**.



Creating a DP pool is now complete. You can create a DP-VOL.

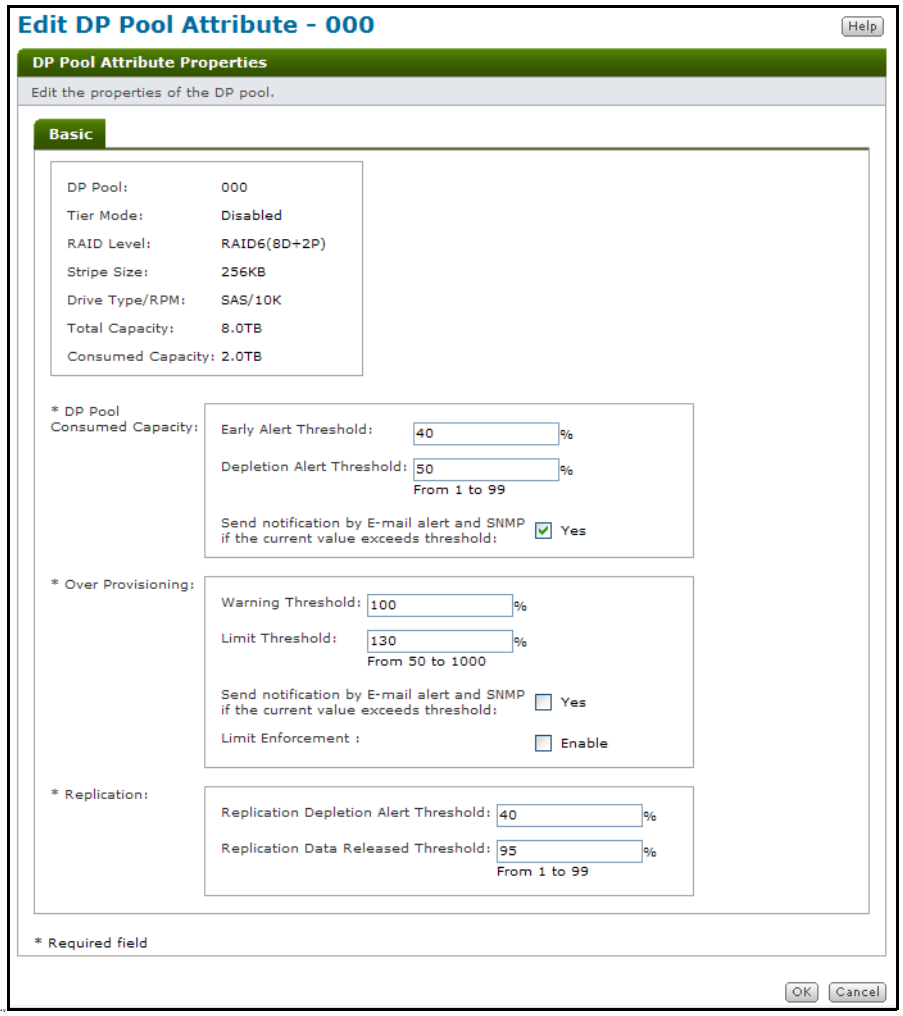
To turn off the DP Pool Consumed Capacity Alert, uncheck **Send notification by E-mail alert and SNMP when the current value exceeds the threshold** in the **SP Pool Consumed Capacity Alert** area.

Changing DP pool thresholds

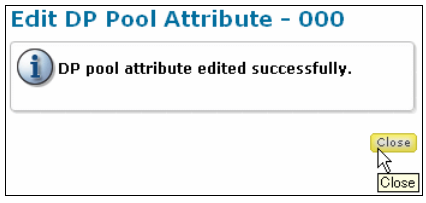
After creating a DP pool, the only DP pool settings that can be changed are the threshold values.

To change DP pool thresholds:

1. In the DP Pool Properties window, click **Edit Pool Attribute**. The Edit DP Pool Attribute window opens.



2. Enter the **Early Alert Threshold** and **Depletion Alert Threshold** of the **DP Pool Consumed Capacity** if necessary.
3. Enter the **Warning Threshold** and **Limit Threshold** of the **Over Provisioning** if necessary
4. To enable e-mail alerts for the over-provisioning threshold, check **Send notification by E-mail alert and SNMP if the current value exceeds threshold**.
5. Check or uncheck **Limit Enforcement** if necessary.
6. Enter the **Replication Depletion Alert Threshold** and **Replication Data Released Threshold** of the **Replication** values if necessary.
7. Click **OK**.
8. Click **Close** in the confirmation message.



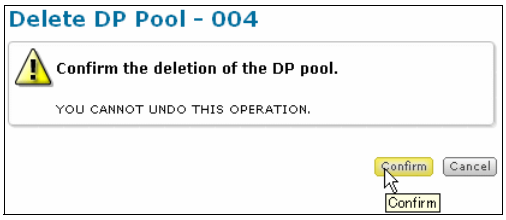
Deleting a DP pool

Usually only one DP pool is deleted at a time in normal practice. However, it is possible to delete multiple DP pools at the same time, if needed.

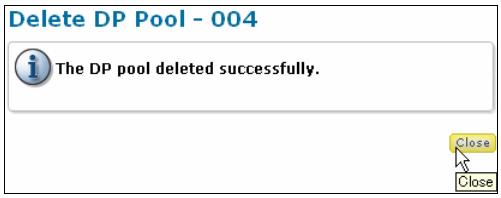
NOTE: Before deleting a DP pool, delete the DP-VOL defined using the DP pool (see Deleting DP-VOLs from a DP pool on page 5-13).

To delete a DP pool:

1. Select one or more **DP Pool** check boxes.
1. Click **Delete Pool**.
2. When the confirmation message appears, click **Confirm**.



3. Click **Close** in the confirmation message.



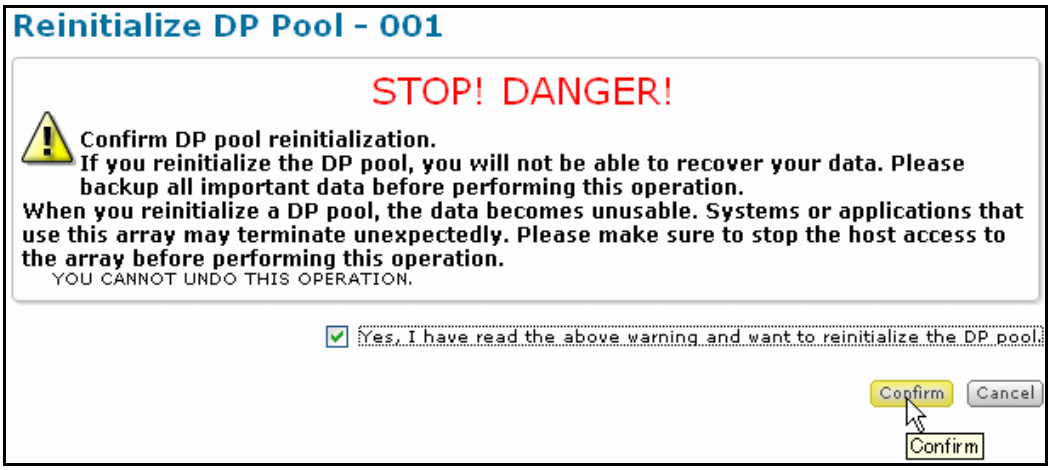
Reinitializing a DP pool

You can recover a DP pool to reset a pool after a failure. Before attempting to recover a DP pool, back up all important data and stop host access to the Hitachi Unified Storage system. All data stored in DP-VOLs using the pool will be lost if DP Pool recovery is performed. Therefore, DP pool recovery is appropriate only after a serious malfunction renders the pool inoperable.

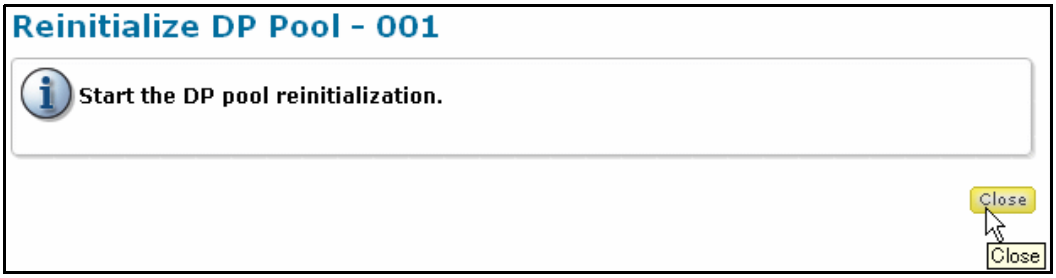
If the DP-VOL is blocked due to an HDU failure, recover the HDU in which the failure occurs. If the status of the DP-VOL is Unformat, format the volume.

To recover a DP pool:

1. Select the DP Pool you want to recover.
2. Click **Reinitialize Pool**.
3. Read the warning message, check the check box, and click **Confirm**. Otherwise, click **Cancel** if you need to first back up your data or stop host access to the Unified Storage system.



4. Click **Close** in the confirmation message.



Adding DP pool capacity

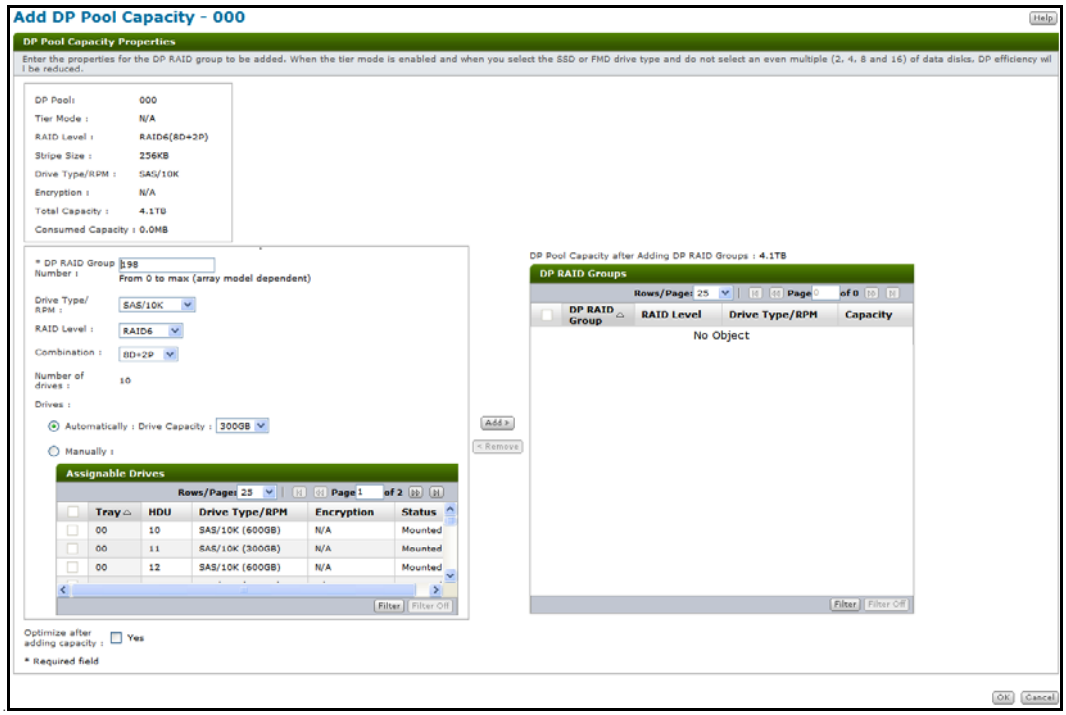
You can grow DP pool capacity by adding one or more DP RAID groups to the DP pool. The total amount of capacity of the DP RAID groups registered in the DP pool is the capacity of that DP pool. Monitor the free capacity of the usable DP pool, and then grow the DP pool as needed.

If you have just added a DP pool, you cannot add a DP RAID group to the DP pool while the DP pool is being formatted. Wait until formatting is complete before attempting to add another DP RAID group.

When adding capacity to a DP pool, the RAID level of the capacity that you are adding must match the RAID level and RAID combination of the existing DP pool (for example, add RAID1 to a RAID1 DP pool, add RAID 5 to a RAID5 DP pool).

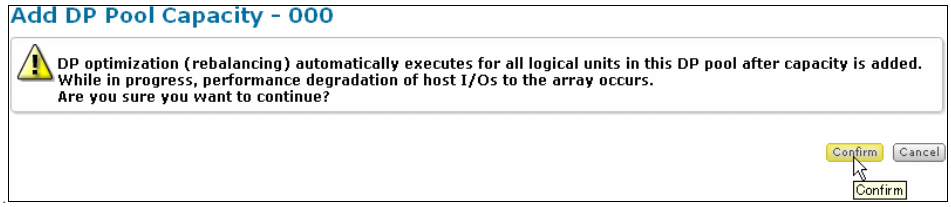
To add DP pool capacity:

1. In the **DP Pools** tab, select the DP pool that needs more capacity, and click **Add Pool Capacity**.

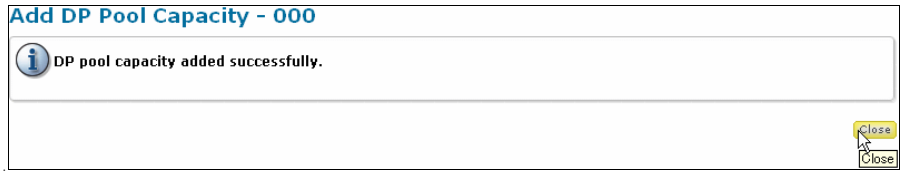


2. In the **Drives** section of the Add DP Pool Capacity Property window, select how you want to assign the drives:
   - If **Automatic Selection**: In **Number of drives**, type the number of drives to be added that match the combination shown in the RAID Level above. If 8D+2P is specified, for example, type **10**.
   - If **Manual Selection**: Specify a **Tray** and an **HDU** from the **Assignable Drives** list. This should be the same as the RAID combination of the pool.

3. To optimize automatically after adding DP pool capacity, select **Optimize after adding capacity**. When checked, the storage system performs DP optimization automatically after adding DP pool capacity.
4. Enter the **DP RAID Group Number** if necessary.
5. Click **OK**.
6. Read the warning message and click **Confirm**.



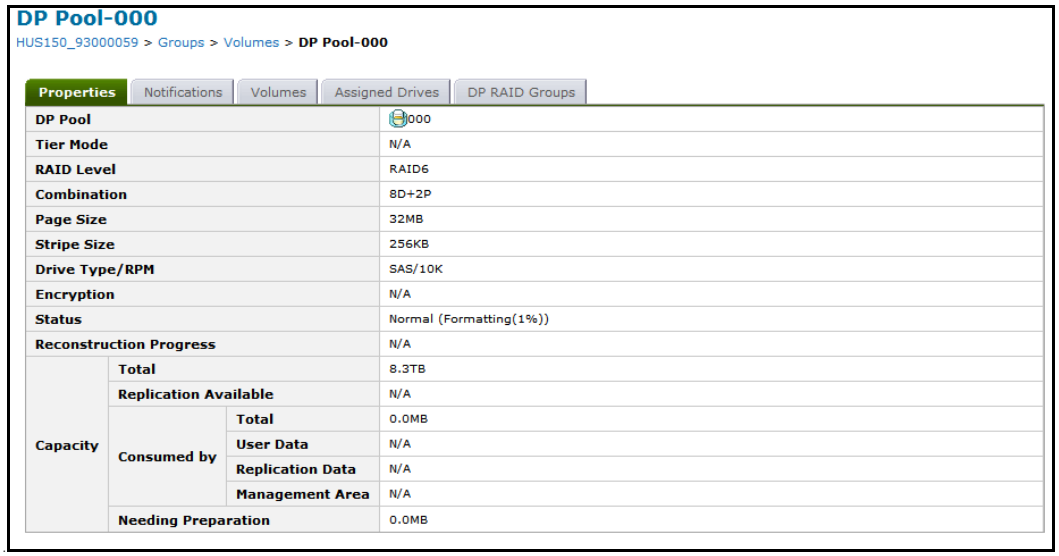
7. In the confirmation message, click **Close**.



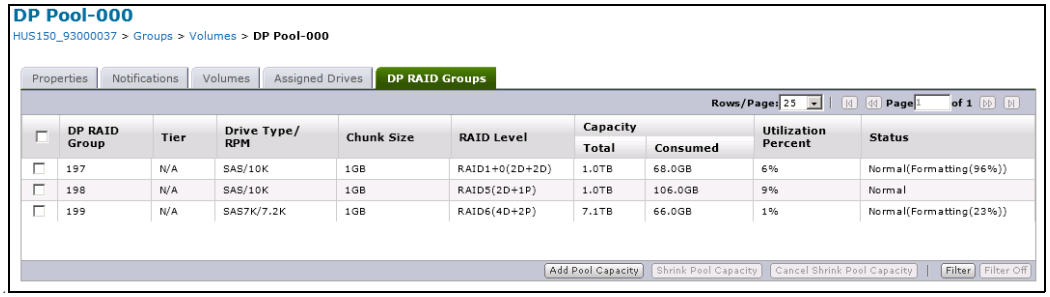
Shrinking the DP pool capacity

To shrink the DP pool capacity:

1. In the **DP Pools** tab, select the DP pool number you want to change the capacity. The DP Pool advanced screen appears.



2. Click the **DP RAID Groups** tab.

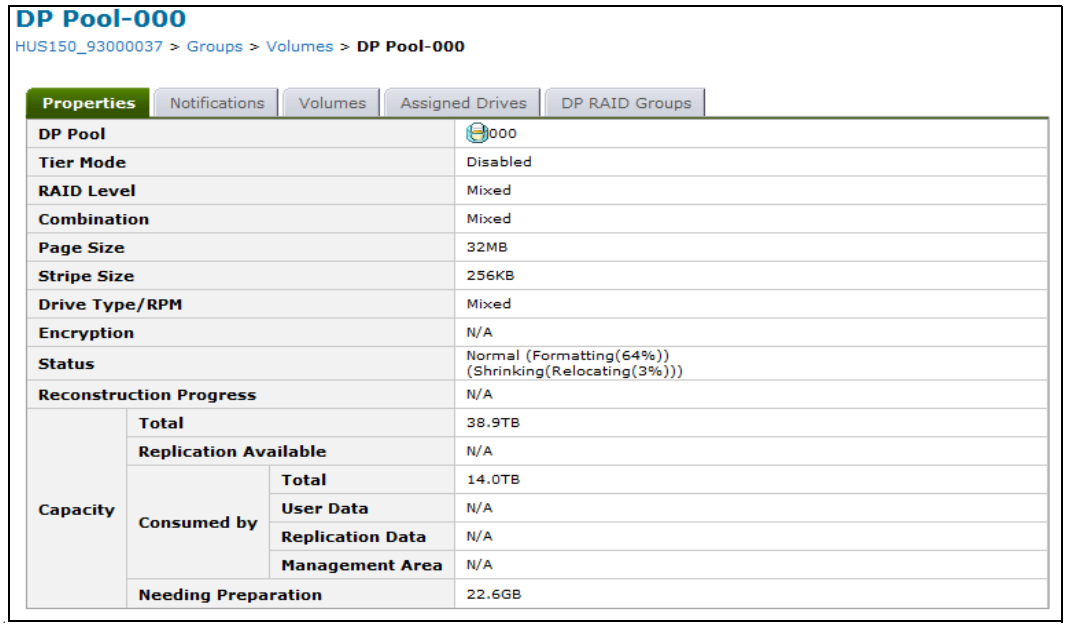


3. Select the DP RAID group to be shrunk, and then click **Shrink Pool Capacity**.
4. When a message appears, click **Confirm**.
5. At the next message appears, click **Close**.

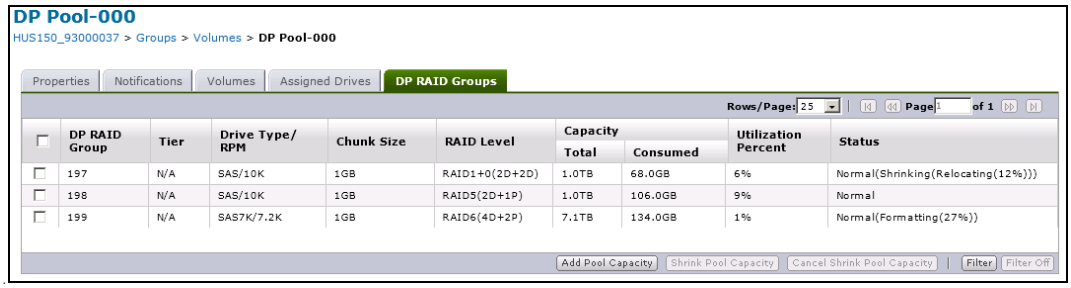
Canceling DP pool capacity shrinking

To cancel a DP pool capacity shrinking operation:

1. In the **DP Pools** tab, select the DP pool number you want to cancel the capacity shrinking. The DP Pool advanced screen appears.



2. Click the **DP RAID Groups** tab.



3. Select the DP RAID group to cancel the shrinking, and then click **Cancel Shrink Pool Capacity**.
4. When a message appears, click **Close**.

Managing DP-VOLs

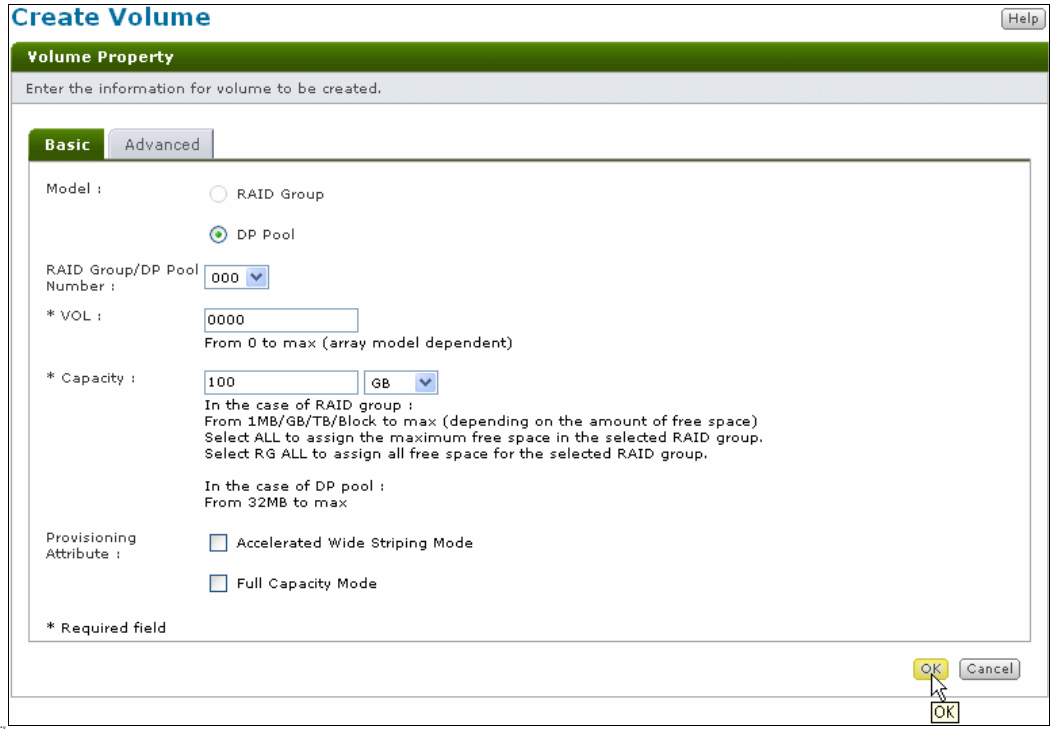
This section describes the following topics:

- Creating a New DP-VOL
- Deleting DP-VOLs from a DP pool
- Changing DP-VOL capacity

Creating a New DP-VOL

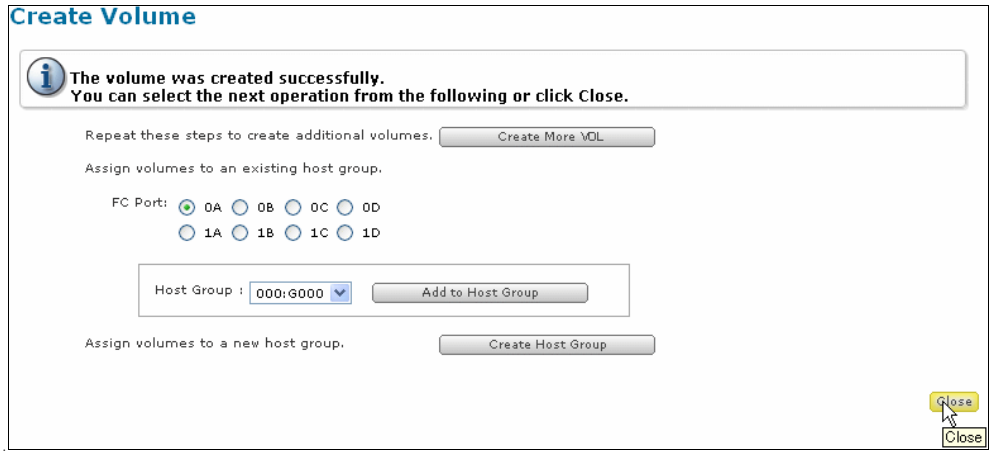
To create a new DP-VOL:

1. In the **Volumes** tab, click **Create VOL**. The Create Volume window opens.



2. On the **Basic** tab:
   - In **Type**, select **DP Pool**.
   - In the **RAID Group/DP Pool Number** list, select a DP pool number.
   - In **VOL**, specify a volume number to assign to the new DP-VOL.
   - Select the volume capacity unit from the list, then type the capacity amount that you want to assign.
3. For **Provisioning Attribute**:
   - Select the **Accelerated Wide Striping Mode** check box if necessary (see Accelerated Wide Striping Mode on page 2-10).
   - Check the **Full Capacity Mode** check box if necessary (see Full Capacity Mode on page 2-11).

4. Click **OK**. The volume is created successfully.
5. In the confirmation message, assign the created volume to the port and host group or iSCSI target, if necessary.
   - To create another volume, click **Create More VOL** and set the options or capacity as needed.
   - To terminate creating a volume, click **Close**.



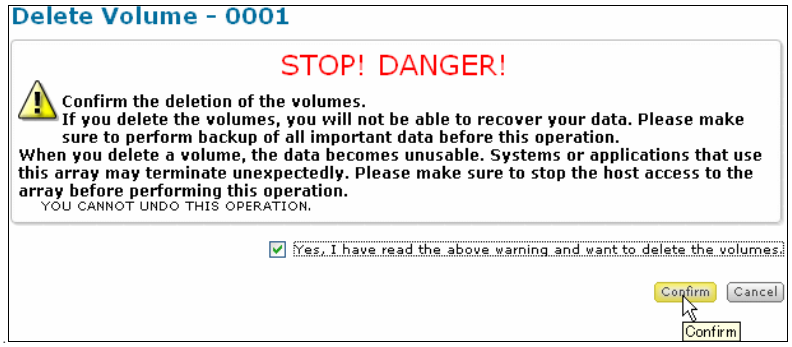
6. Confirm that the volume was created.

Deleting DP-VOLs from a DP pool

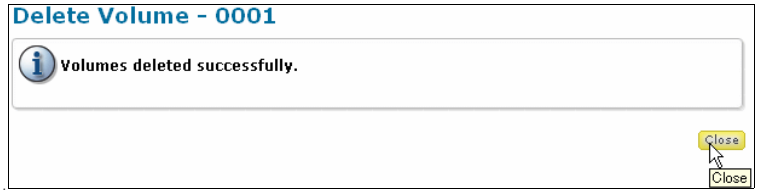
When deleting a DP-VOL from a DP pool, the DP pool areas that the DP-VOL was using are released, increasing the free capacity of the DP pool. The DP pool areas formerly assigned to the DP-VOL are formatted back to zeroes. A mapped DP-VOL is guarded and cannot be deleted. Therefore, cancel the mapping and then perform the formatting.

To delete a DP-VOL from a DP pool:

1. In the **Volumes** tab, select the **VOL** that you want to delete, and then click **Delete VOL**.
2. In the confirmation message, check the check box and click **Confirm**.



3. In the delete confirmation message, click **Close**.



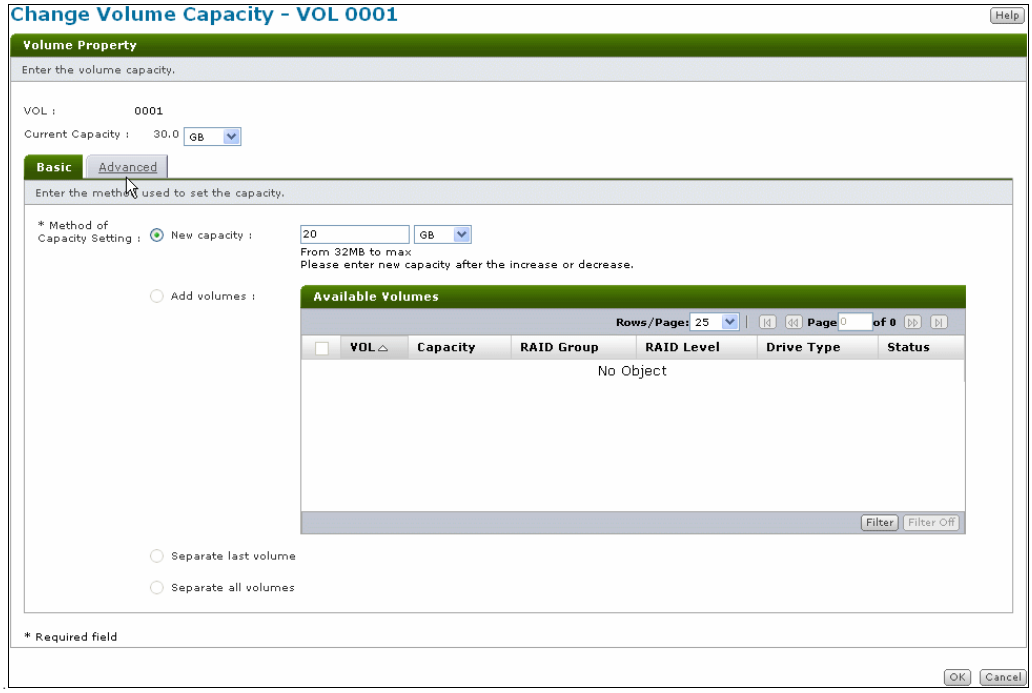
4. Confirm the deleted volume is not displayed.

Changing DP-VOL capacity

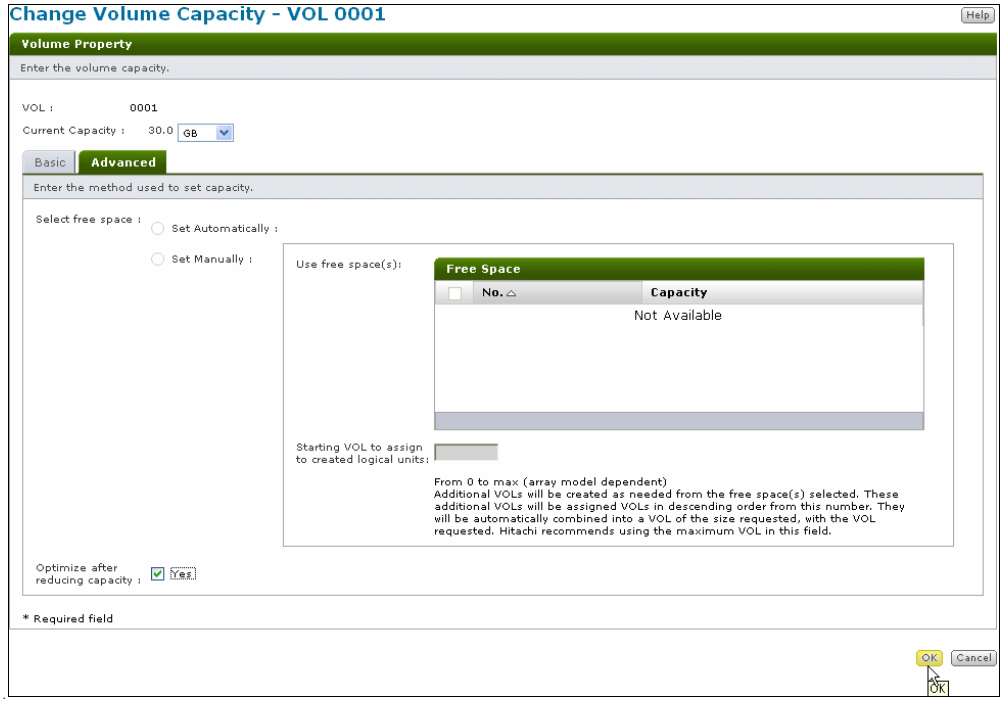
You can increase or decrease the capacity of the DP-VOL while the Hitachi Unified Storage system is operational. The procedure to change the capacity of the DP-VOL is the same as for changing capacity for a normal volume.

To change DP-VOL capacity:

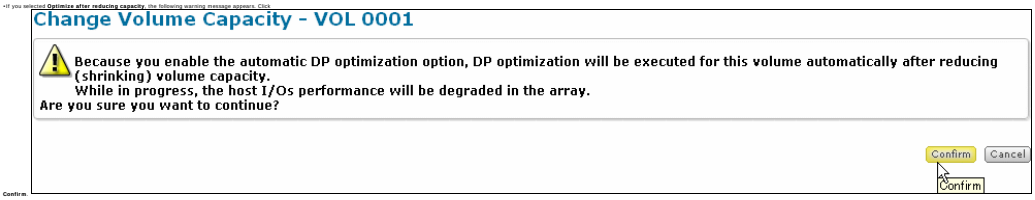
1. In the **Volumes** tab, select the **VOL** for which you want to change the capacity, and click **Change VOL Capacity**. The Change Volume Capacity window opens.



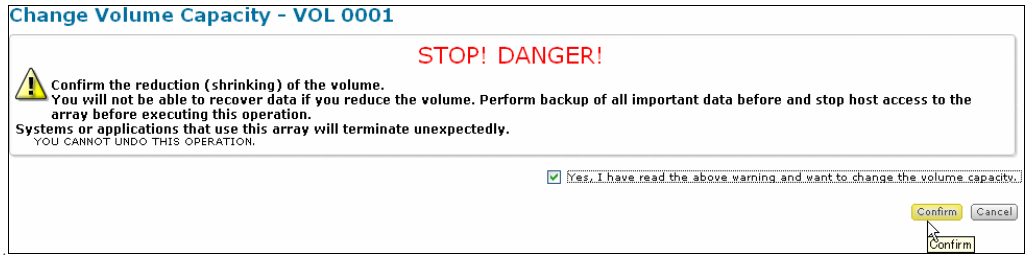
2. On the **Basic** tab, in **Method of Capacity Setting**, use **New capacity** to select the volume capacity unit from the list and enter the capacity amount.
3. Click the **Advanced** tab.



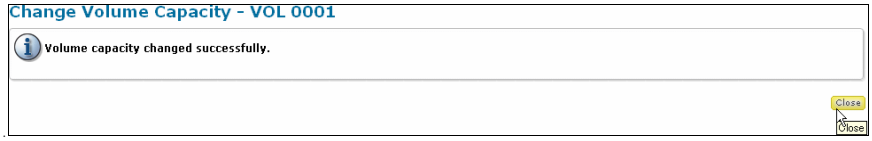
4. On the **Advanced** tab, select **Yes** to **Optimize after reducing capacity** if the DP-VOL should return capacity back to the DP Pool that had been formally assigned to the area of the DP-VOL being trimmed away.
5. Click **OK**.



6. If you decreased the existing capacity, a warning message appears.
   - To shrink the capacity, check the check box and click **Confirm**.
   - To cancel this operation, click **Cancel**.



7. In the changed confirmation message, click **Close**.



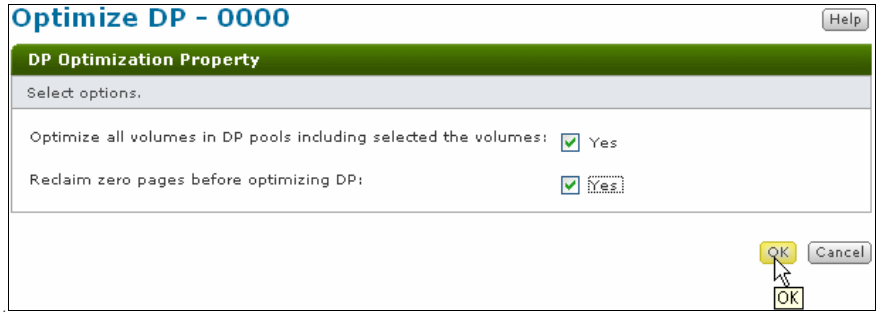
Optimizing DP

This section describes the following topics.

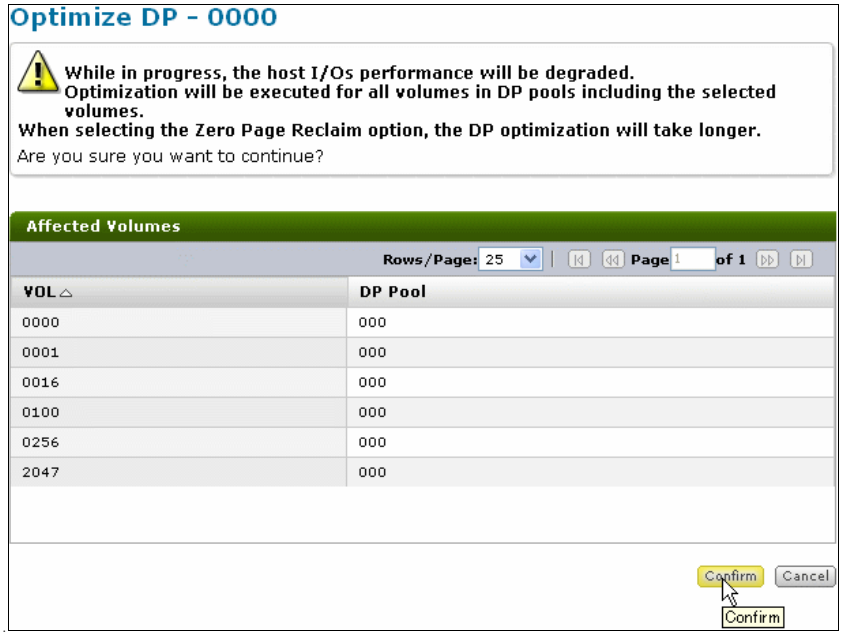
Optimizing the DP pool

To optimize the DP pool:

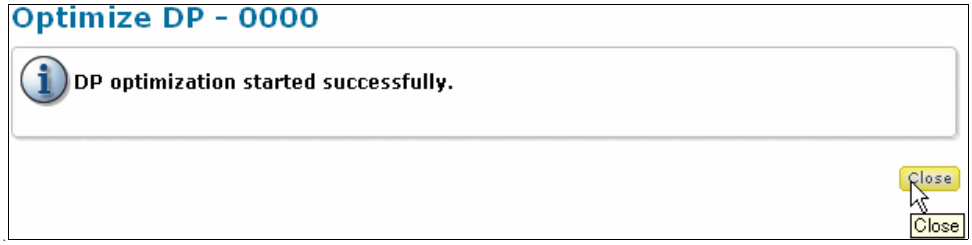
1. On the Performance menu, select **DP Optimization**.
2. Select the **VOL** for which you want to optimize in the DP pool. The standard is the DP-VOLs whose reclaimed capacity exceeds 15 GB.
3. Click **Optimize DP**.
4. In the **DP Optimization Property** dialog box, specify the optimization options and click **OK**.



5. In the confirmation message, **Confirm** to continue.



6. When the operation finishes successfully, click **Close**.



Canceling DP optimization

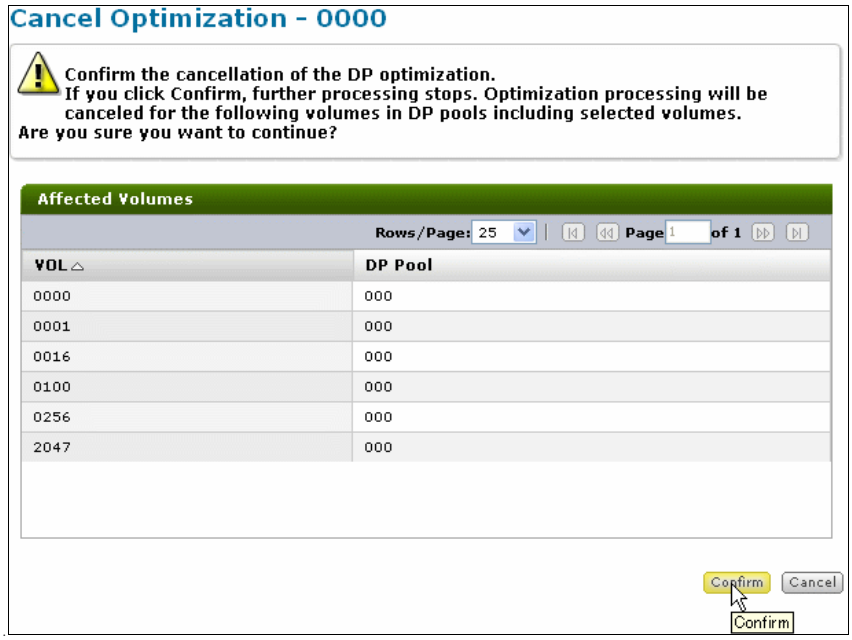
To cancel DP optimization:

1. On the Performance menu, select **DP Optimization**.
2. Select the **VOL** for which you want to cancel DP optimization
3. Click **Cancel Optimization**.

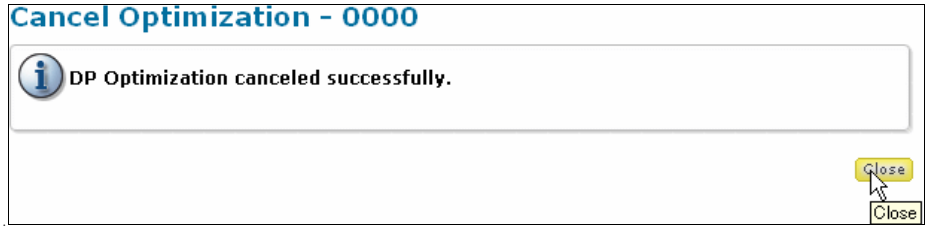
NOTE: If Optimization is cancelled, there will be some reclaimable capacity that has not been added back to the available pool capacity. Optimization must be run to completion, when convenient, to reclaim this capacity.

4. In the Optimization Cancellation property dialog box, specify the cancelation options and click **OK**.

5. In the confirmation message, click **Confirm** to continue.



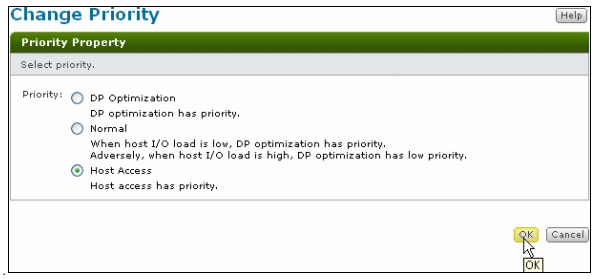
6. When the operation finishes successfully, click **Close**.



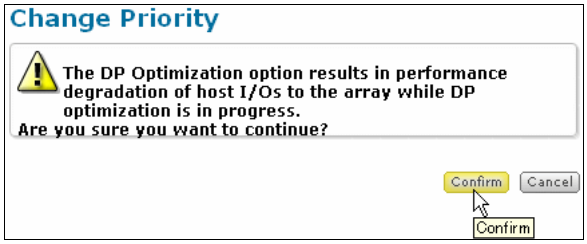
Changing optimization priority

To change optimization priority

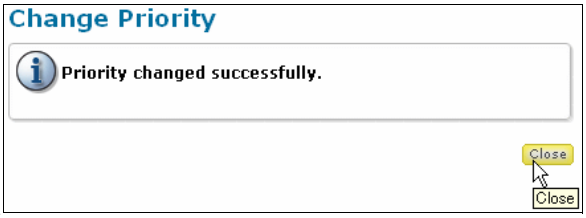
1. On the Performance menu, select **DP Optimization**.
2. Click **Change Priority**.
3. In the Priority Property dialog box, specify the priority option and click **OK**.



4. In the confirmation message, click **Confirm** to continue.



5. When the operation finishes successfully, click **Close**.

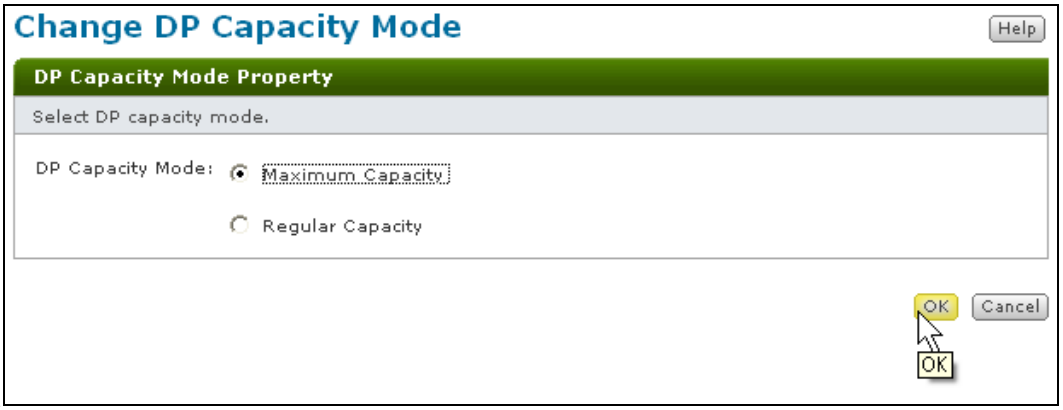


Changing DP Capacity Mode

The following procedures describe how to change DP Capacity Mode.

To change the DP Capacity Mode by memory reconfiguration

1. On the **Performance** menu, select **DP Optimization**.
2. Click **Change Capacity Mode**. The options selection dialog appears.
3. Specify the **DP Capacity Mode** option, and click **OK**.



4. When the confirmation message appears, click **Reconfigure Memory**.

NOTE: When using Cache Partition Manager, the **Reconfigure Memory** button is not displayed and memory reconfiguration cannot be performed.

5. When the message appears, click **Confirm**.

For enabling the setting of the operated option, restart the array or reconfigure the memory. The setting is not reflected until the restart or memory reconfiguration is completed.

6. At the next message, click **Close**. You return to the DP Optimization screen.

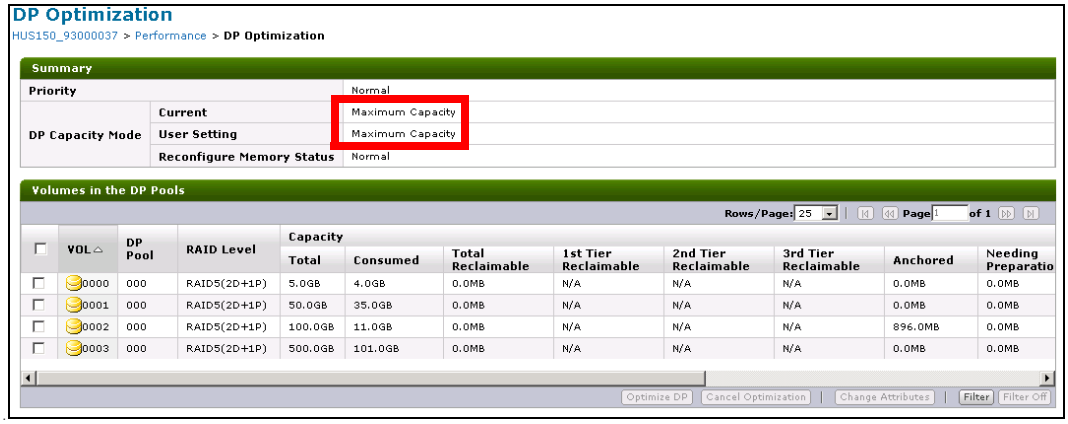
7. Confirm the **Reconfigure Memory Status** is **Reconfiguring(nn%)** or **Normal**.
   - If **Reconfigure Memory Status** is **Reconfiguring(nn%)**, wait a few minutes, click **Refresh Information**, and confirm the **Reconfigure Memory Status** changes to **Normal**.
   - If the **Reconfigure Memory Status** is **Failed(Code-01:Timeout)**, click **Change Capacity Mode**, and repeat steps 3 through 7.

   Code-01 occurs when the access from the host is frequent or the amount of the unwritten data in the cache memory is large.
   - If the **Reconfigure Memory Status** is Failed**(Code-02: Failure of Reconfigure Memory)**, click **Reconfigure Memory** on the DP Optimization screen and repeat steps 5 through 7.

   Code-02 occurs when the drive restoration processing starts in the background.
   - If the **Reconfigure Memory Status** is **Failed(Code-04: Failure of Reconfigure Memory)**, click **Resource** on the **Explorer** menu, return to the Arrays screen, select the array to change DP Capacity Mode, and click **Reboot Array**.

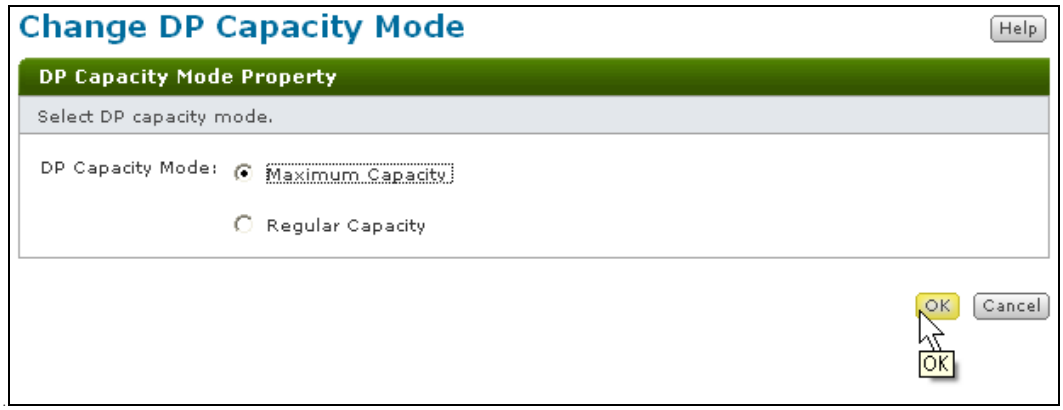
   Code-04 occurs when the unwritten data in the cache memory cannot be saved to the drive.
   - If the **Reconfigure Memory Status** is **Failed(Code-03: Failure of Reconfigure Memory)**, contact the HDS Support at portal.hds.com.

   Code-03 occurs when the copy of the management information in the cache memory fails.
8. After completing the memory reconfiguration, check that the **Current** value of the DP Capacity Mode changed to the set mode in the DP Optimization screen. If it did not change to the set mode, reconfigure the memory again. If it still did not change, see Chapter 6, Hitachi Dynamic Provisioning Troubleshooting.



To change the DP Capacity Mode by restarting the storage system

1. Check the precautions in Installation and rebooting on page 3-16.
2. On the **Performance** menu, select **DP Optimization**.
3. Click **Change Capacity Mode**. The options selection dialog appears.
4. Specify the **DP Capacity Mode** option, and click **OK**.



5. When using Cache Partition Manager, the confirmation message that the partition returns to the default setting is displayed. Click **Confirm**.
6. When the confirmation message appears, click **Reboot Array**.

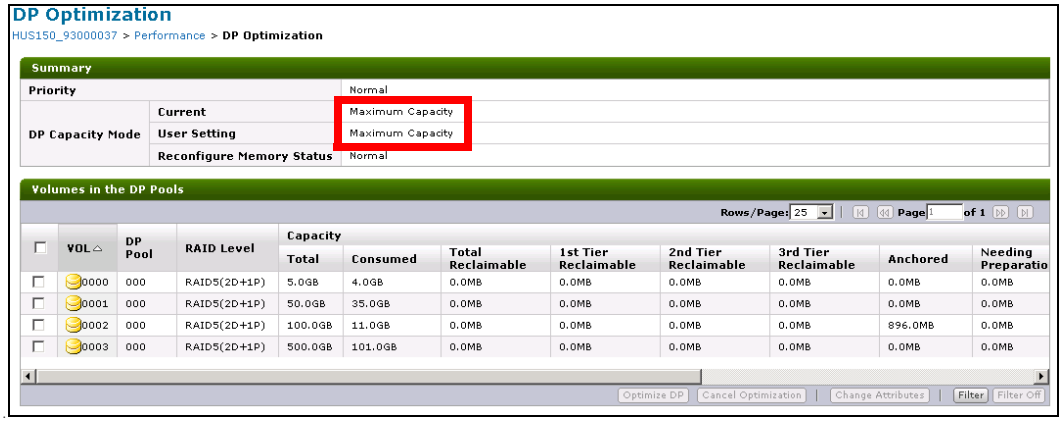
NOTE: When using Cache Partition Manager, the **Reconfigure Memory** button is not displayed and memory reconfiguration cannot be performed.

7. At the confirmation message, check the check box and click **Reboot Array** to restart the storage system.

For enabling the setting of the operated option, restart the storage system or reconfigure the memory. The setting does not take effect until the restart or memory reconfiguration completes.

After the storage system restarts, it does not access the host until the restart is completed. Check that the access from the host stopped, and then restart it. It takes approximately 7-to-25 minutes for the restart. If it takes longer than 25 minutes, check the status of the storage system.

8. After the restart completes, a message appears. Click **Close**.
9. After the storage system completes rebooting, check that the **Current** value of the DP Capacity Mode changed to the set mode in the DP Optimization screen. If it did not change to the set mode, restart the storage system again. If it still did not change, see Chapter 6, Hitachi Dynamic Provisioning Troubleshooting.



Canceling memory reconfiguration for DP Capacity Mode

To cancel the memory reconfiguration:

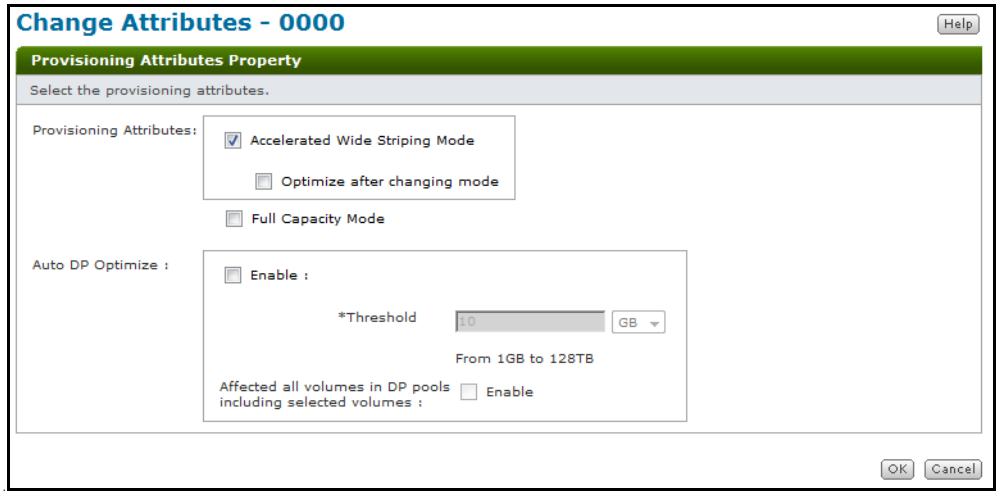
1. Click **Cancel Reconfigure** on the DP Optimization screen.
2. If canceling the memory reconfiguration succeeds, a message appears. Click **Close**.

If the memory reconfiguration occurs and the cache memory configuration rewrite starts, the memory reconfiguration cannot be canceled. Cancellation is possible only when the rate of progress of the Reconfigure Memory Status is less than 50 percent.

Changing provisioning attributes

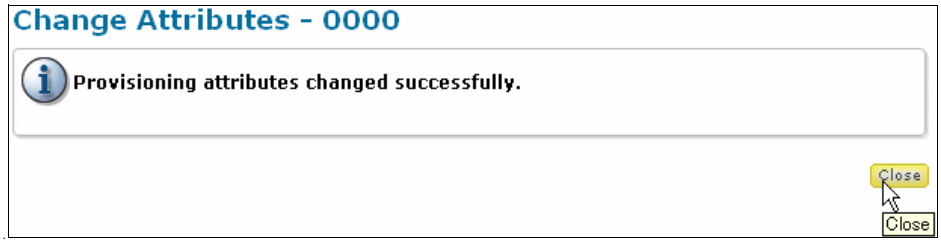
To change provisioning attributes:

1. On the DP Optimization screen, select the **VOL** whose attribute you want to change.
2. Click **Change Attributes**. The Change Attributes screen appears.



3. To change **Accelerated Wide Stripping**, **Full Capacity Mode**, or both **Provisioning Attribute**s, check the check boxes.
4. To optimize after changing mode, select the **Optimize after changing mode** check box.

5. To enable auto DP optimization, check the **Enable** check box for **Auto DP Optimize**. Enter a threshold value in the **Threshold** field and select the units of capacity. To disable Auto DP Optimize of Provisioning Attributes, uncheck the check box.
6. To apply the Auto DP Optimize setting to all DP volumes in the DP pool, check the **Enable** check box for **Affected all volumes in DP pools including selected volumes**.
7. Click **OK**.
8. When the following message appears, click **Close**.



Managing DP pool information

This section describes the following topics:

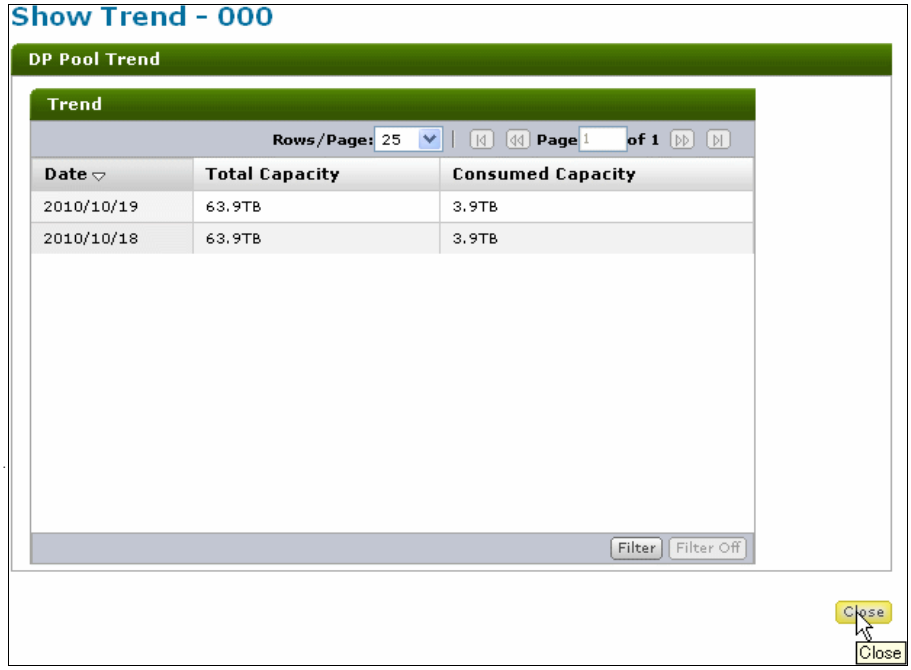
- Viewing DP pool trend information
- Exporting DP pool trend information
- Viewing DP pool trend information in the CSV file

Viewing DP pool trend information

You can view information on the total and consumed capacity of a DP pool.

To view DP pool trend information

1. On the Performance menu, select **DP Pool Trend**.
2. In the DP Pool Trend window, select the **DP Pool** that you want to view, and click **Show Trend**.



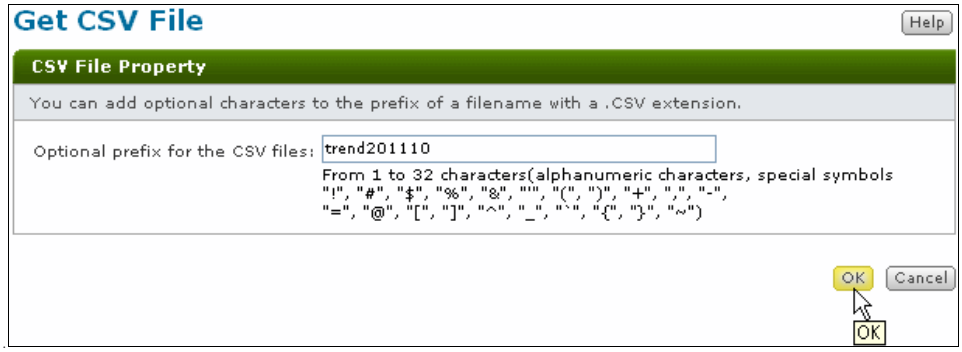
3. In the DP Pool Trend window, review and confirm the trend information for the selected DP pool, then click **Close**.

Exporting DP pool trend information

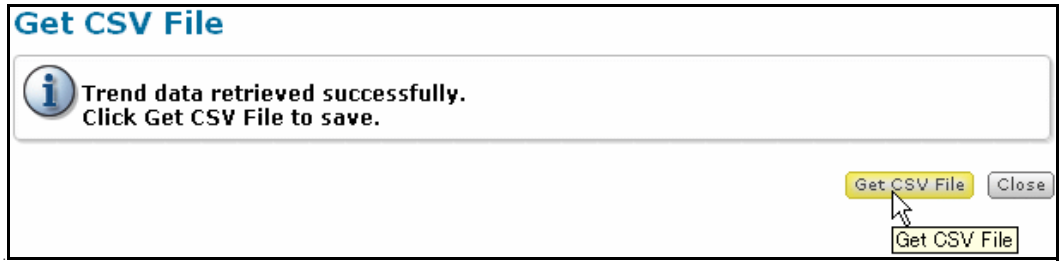
After viewing the DP pool trend information, you can export the information to a CSV file.

To export the DP pool trend information

1. In the DP Pool Trend window, click **Get CSV File**. The Get CSV File message appears.



2. Specify the prefix for the CSV file if necessary, and then click **OK**. The Get CSV File message appears.



3. In the File Download dialog box, click **Save**.
4. In the Save As dialog, specify the **Save in**, **File name**, and **Save as type** information, and then click **Save**.
5. When the Get CSV File message appears, click **Close**.
6. In the confirmation message, click **OK**. The information is saved in a Zip file.

Viewing DP pool trend information in the CSV file

After saving DP pool trend information to a CSV file, you can view the contents with a standard text editor.

To view DP pool trend information

1. Navigate to the folder where you saved the file and unzip the trend.zip file. The file contains the following three CSV text files.
   - *Optional prefix_array serial number_DPPool_Consumed_yyyyMMddmmss.csv* - DP pool consumed capacity information
   - *Optional prefix_array serial number_DPPool_LU_yyyyMMddmmss.csv* - DP-VOL information.
   - *Optional prefix_array serial number_DPPool_Total_yyyyMMddmmss.csv* - total DP pool capacity information.
2. Use a standard text editor to view the contents of the CSV text files.
   - DP pool consumed capacity information output format:

Table 5-1: When one or more items of the trend information exist

DP Pool consumed capacity	File header
From:2011/10/18	Oldest trend collection day
To:2011/10/19	Most recent trend collection day
No.[1],Date[2],0,1,2,…,62,63[3]	Where: [1] Serial number [2] Collection date (Christian era, month, day) [3] DP pool number
0,2011/10/19,100,10000,900,…,100,1000	
1,2011/10/18, -,1000,900,…,100,1000	
2,2011/10/17, -,1000,900,…, -,1000	
	(DP pools currently defined are all output)
	The DP pools that existed in the past, but are currently deleted are not output. When the information in the past does not exist, a hyphen is displayed. The unit of the displayed capacity is GB.

Table 5-2: When no trend information exists (one or more items of the DP pool exist)

DP pool consumed capacity	File header
From:	Oldest trend collection day (The date column is blank)

Table 5-2: When no trend information exists (one or more items of the DP pool exist)

DP pool consumed capacity	File header
To:	Most recent trend collection day (The date column is blank)
No.,Date,0,2	
---No Information---	A message is displayed (---No Information---) showing that there is no trend information.

Table 5-3: When no trend information exists (no DP pool exists)

DP pool consumed capacity	File header
From:	Oldest trend collection day (The date column is blank)
To:	Most recent trend collection day (The date column is blank)
No.,Date	
---No Information---	A message is displayed (---No Information---) showing that there is no trend information.

- DP-VOL information output format:

Table 5-4: When one or more items of the DP-VOL exist

Logical Unit in the DP pool	File header
Date:2011/10/16	The output date of the CSV file
DP Pool[1],LUN[2],Total Capacity[3],Consumed(%)[4]	Where: [1] DP pool number (The DP pools in which the DP-VOLs are defined are all output) [2] Volume number (The defined DP-VOLs belonging to the DP pool number are all output) [3] Capacity (The value converted into TB, GB, or MB is displayed to the first decimal place in units) [4] Usage (unit: %)
0,1,200.0GB,40	
0,1,1.5TB,40	
10,2,33.0MB,30	
10,13,300.0GB,10	

Table 5-5: When no DP-VOL exists

Logical Unit in the DP pool	File header
Date:2011/10/16	The output date of the CSV file
DP Pool,LUN,Total Capacity,Consumed(%)	
---No Information---	A message is displayed (---No Information---) showing that there is no DP-VOL.

- Total DP pool capacity output format:

Table 5-6: When one or more items of trend information exist

DP pool total capacity	File header
From:2011/10/18	Oldest trend collection day
To:2011/10/19	Most recent trend collection day

Table 5-6: When one or more items of trend information exist

DP pool total capacity	File header
No.[1],Date[2],0,1,2,…,62,63[3]	Where: [1] Serial number [2] Collection date (Christian era, month, day) [3] DP pool number
0,2011/10/19,100,10000,900,…,100,1000	
1,2011/10/18, -,1000,900,…,100,1000	
2,2011/10/17, -,1000,900,…, -,1000	
	(DP pools currently defined are all output)
	The DP pools existed in the past but currently deleted are not output. When the information in the past does not exist, a hyphen is displayed. The unit of the displayed capacity is GB.

Table 5-7: When no trend information exists (one or more items of the DP pool exists)

DP pool total capacity	File header
From:	Oldest trend collection day (The date column is blank)
To:	Most recent trend collection day (The date column is blank)
No.,Date,0,2	
---No Information---	A message is displayed (---No Information---) showing that there is no trend information.

Table 5-8: When no trend information exists (no DP pool exists)

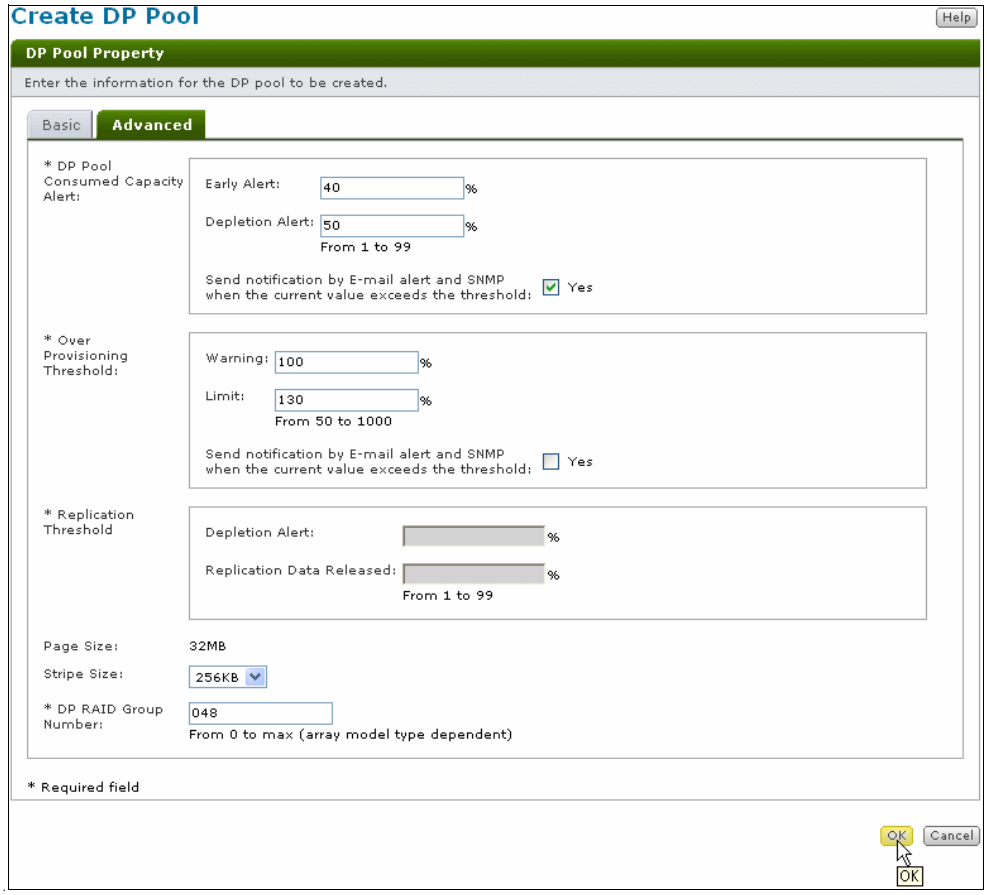
DP pool total capacity	File header
From:	Oldest trend collection day (The date column is blank)
To:	Most recent trend collection day (The date column is blank)
No.,Date	
---No Information---	A message is displayed (---No Information---) showing that there is no trend information.

Setting up e-mail notifications and SNMP traps

When the e-mail alert is turned on in Storage Navigator Modular 2, the system sends an e-mail alert warning that capacity is about to exceed threshold values.

To set up e-mail alerts and SNMP reporting:

1. Open the DP Pool Property window.
2. Click the **Advanced** tab.



3. Check **Send notification by E-mail alert and SNMP when the current value exceeds the threshold**.
4. Click **OK**.

6

Hitachi Dynamic Provisioning Troubleshooting

In the unlikely event you encounter a problem with Hitachi Dynamic Provisioning, refer to the information in this chapter to identify and resolve the problem.

Table 6-1 provides troubleshooting information for Hitachi Dynamic Provisioning operations.

Table 6-1: Troubleshooting for Hitachi Dynamic Provisioning

Problems	Causes	Solutions
DP pool capacity is depleted (DP pool status is Capacity Deplete).	There is no further available capacity in the DP pool.	Increase the DP pool capacity (see Adding DP pool capacity on page 5-9) or reduce the capacity in the DP pool as follows: • Select the option **Reclaim zero pages before optimizing DP** to execute the DP optimization for the DP-VOL in the depleted DP pool (see Optimizing DP on page 5-16). • Since user data will be lost, be sure the data on the DP-VOL is not needed before deleting, formatting, and reducing the DP-VOL in the DP pool. The capacity reduction by performing the DP optimization is not effective when there is no zero data in the relevant DP-VOL. Since Hitachi Dynamic Provisioning does not deplete the DP pool, use functions such as trend information, Hitachi Storage Navigator Modular 2 e-mail notifications, SNMP traps, and Windows Event Viewer to operate it without depleting the DP pool. If the DP pool is depleted, the application may end abnormally or a system failure may occur.
Cannot install Hitachi Dynamic Provisioning.	The necessary cache memory is not installed.	Install the cache memory necessary for installing Dynamic Provision.
DP pool usage rate exceeds the threshold values.	• There are too many DP-VOLs or the stored data is too large. • DP pool capacity is too low. • The threshold value of the DP pool is too small.	• Increase the DP pool capacity (see Adding DP pool capacity on page 6-13). This approach may require installation of new HDUs. • Increase the threshold value of the DP pool (see Changing DP pool thresholds on page 5-5). • Free volumes to add as DP-VOLs. If there are no free volumes, delete unneeded volumes or contact HDS Support at portal.hds.com to add the drives.
Cannot create the DP pool	Memory reconfiguration fails while reconfiguring the memory for changing the DP Capacity Mode from the maximum capacity to the regular capacity.	See Reconfiguring memory on page 3-10 and reconfigure the memory again.

Table 6-1: Troubleshooting for Hitachi Dynamic Provisioning (Continued)

Problems	Causes	Solutions
DP-VOL capacity exceeds the threshold values.	The capacity of the DP-VOLs is large and can affect the DP Pool capacity.	• If the free capacity of the DP pool is insufficient, copy the data from the DP-VOL to a normal volume and delete the DP-VOL. • Increase the DP pool capacity (see Adding DP pool capacity on page 6-13). • Increase the Over Provisioning threshold values of the DP pool (see Changing DP pool thresholds on page 5-5).
Cannot create the DP-VOL.	• The total capacity of the DP-VOL exceeds the total capacity of the system support. • The over provisioning threshold value is exceeded. • The DP pool is blocked or has been completely depleted. • The DP-VOL deletion processing of the target DP-VOL number is running in the background.	• Create a DP-VOL so the total capacity of the DP-VOL is within the total capacity of the system support. • Reduce the DP-VOL capacity in the pool or change the over provisioning threshold value, and then create a DP-VOL • Contact HDS Support at portal.hds.com. • Check the status of the DP-VOL. If the relevant DP-VOL is Undefined, wait for the display to turn off and perform the processing again. If it still cannot be created, contact HDS Support at portal.hds.com.
Cannot add a DP pool.	• The HDU requirements for the DP pool cannot be met. • The DP pool is blocked.	• Check whether the available HDUs meet the requirements of the DP RAID group for the DP pool (see DP-VOL and DP pool requirements on page 3-2). • Contact HDS Support at portal.hds.com.
Cannot shrink the DP pool.	• The requirements necessary for shrinking the DP pool are not met. • Part of the DP pool is blocked.	• Check whether the DP RAID group meets the requirements of the shrinking (see Shrinking DP pool capacity on page 2-4). • Contact HDS Support at portal.hds.com.

Table 6-1: Troubleshooting for Hitachi Dynamic Provisioning (Continued)

Problems	Causes	Solutions
An error is preventing a host from accessing a port.	• When the host tried to write data to a volume configured as a DP-VOL, the written data required new pool capacity to be assigned, but the pool did not have sufficient free space (pool utilization level was 100%). • Although the capacity was added after a DP pool was completely depleted, the total capacity of a DP pool is 2 TB or more and the free capacity is less than 100 GB or the total capacity of a DP pool is less than 2 TB and the free capacity is less than 5%. • The DP-VOL was prevented from accessing data because a portion of the DP pool is blocked. • Controller is blocked.	• Check the DP pool free capacity and lower the utilization level of a DP pool to at least 95% by: Adding a DP RAID group to the pool or Deleting DP-VOLs to free up pool capacity. • After a DP pool is completely depleted once, the normal access may not be performed unless the free capacity of a DP pool is 5% or more or 100 GB or more. Grow a DP pool capacity and secure the free capacity of 100 GB or more for the consumed capacity when the total capacity of a DP pool is 2 TB or more. When the total capacity of a DP pool is less than 2 TB, secure the free capacity of 5% or more. • Contact HDS Support at portal.hds.com.
A DP pool is blocked. You cannot make pool modifications.	A failure occurred in two or more HDUs. (RAID 6 would be more appropriate. Blocks will appear as I/O errors.)	Contact HDS Support at portal.hds.com.
A DP-VOL is blocked.	A failure occurred in two or more HDUs.	• Check whether the DP pool for which the DP-VOL is defined is blocked. • Contact HDS Support at portal.hds.com.
A DP pool cannot be recovered.	• The blocked part in the Unified Storage system is still undergoing recovery operations. • A DP pool is blocked.	• After waiting for a while, click Refresh Information on the upper right of the HSNM2 window, and then check the DP pool status in the DP Pool window. • Contact HDS Support at portal.hds.com.
An error occurs in the host application using a DP-VOL.	• Free space of the DP pool is insufficient. • A blocked DP pool. • A DP-VOL capacity is insufficient.	• Check the free capacity of the DP pool and increase the DP pool capacity. • Grow a DP-VOL capacity. • Contact HDS Support at portal.hds.com.

Table 6-1: Troubleshooting for Hitachi Dynamic Provisioning (Continued)

Problems	Causes	Solutions
When the host computer tries to access the port, an error occurs and the host cannot access the port.	The following has occurred to the volume that is a DP-VOL: • The host tried to write data onto the volume and the data being written requires new pool capacity to be assigned and the pool did not have sufficient free space (the pool utilization level was 100%) • Although the capacity was added after a DP pool was completely depleted, the total capacity of a DP pool is 2 TB or more and the free capacity is less than 100 GB, or the total capacity of a DP pool is less than 2 TB and the free capacity is less than 5%. • The DP-VOL was prevented from accessing data because a portion of the DP pool is blocked. • A controller is blocked.	• Check the free capacity of a DP pool and lower the utilization level of the DP pool to at least 95% by either adding a DP RAID group to the pool or deleting DP-VOLs to free up pool capacity. • After the DP pool is completely depleted once, it may be unavailable for normal access unless the free capacity of a DP pool is a minimum of 5% or 100 GB. Grow a DP pool capacity and ensure a free capacity of 100 GB or more for the consumed capacity when the total capacity of a DP pool is 2 TB or more. When the total capacity of a DP pool is less than 2 TB, ensure a minimum free capacity of 5%. • Contact HDS Support at portal.hds.com.
When operating Hitachi Storage Navigator Modular 2, a time-out occurs frequently.	• The load on the Unified Storage system is too heavy such that Storage Navigator Modular 2 computer cannot respond to the Unified Storage system. • The period of time until when time-out occurs is set too short.	• Wait a few minutes, then try the operation again. • Increase the time-out period in Storage Navigator Modular 2.
A DP-VOL capacity cannot be increased or shrunk.	The Over Provisioning Limit threshold has been reached. Retry the operation in about 10 minutes.	Contact HDS Support at portal.hds.com.
Backup and restore of a DP-VOL consumes capacity.	When using Hitachi Dynamic Provisioning, if restore is performed from the backup data, the actual capacity defined as the DP-VOL is consumed.	To use Hitachi Dynamic Provisioning effectively, either perform the copy in file units from the application to the DP-VOL or use the zero page reclaim feature of Optimize after restoring to the normal volume.

Table 6-1: Troubleshooting for Hitachi Dynamic Provisioning (Continued)

Problems	Causes	Solutions
DP pool optimization is rejected by Hitachi Storage Navigator Modular 2.	• The status of the DP-VOL for optimization is Detached, or Unformatted. • The forced parity correction status of the DP-VOL for optimization is Parity Correction, Restored, Waiting Parity Correction, Waiting Drive Reconstruction, Correction Skipped, Correction Aborted, Uncorrected, Uncorrected, and Drive Detached. • The DP pool with the DP-VOL for optimization is conducting drive recovery. • The status of the DP-VOL for optimization or the DP pool with that DP-VOL is Detached. • PIN over is occurring on the DP-VOL for optimization or on the DP pool with that DP-VOL. • The DP-VOL for optimization is part of a Modular Volume Migration (MVM) pair. • The DP-VOL for optimization or the DP pool with that DP-VOL has write uncompleted area. • The DP-VOL for optimization is transitioning to the Full Capacity Mode. • The DP-VOL for optimization is a DMLU for replication. • The DP optimization status of the DP-VOL for optimization is Accepting, Pending, Optimizing, Suspended, or Canceling.	
DP pool cannot be optimized (expected capacity cannot be reclaimed).	• Competing with host I/Os. • The processing to reclaim the capacity failed. There is insufficient free capacity in the pool to support the optimize operation.	• Perform the optimization when host I/Os load is light. • If there is no host I/O, the capacity is reclaimed as time goes by. The standard time to wait for reclaiming capacity when optimization completes is shown below. 10 GB: about 3 minutes 100 GB: about 30 minutes • Add capacity to the pool (additional DP RAID group).
DP pool optimization ends abnormally.	• DP pool is blocked. • DP pool capacity was consumed. • Destage timeout of the DP management information occurred.	• Add capacity to the pool. • Contact HDS Support at portal.hds.com.

Table 6-1: Troubleshooting for Hitachi Dynamic Provisioning (Continued)

Problems	Causes	Solutions
DP pool optimization does not start (optimization status is Pending).	• DP pool formatting may not be completed. • Preparation for the optimization processing is taking time because the capacity required to execute the optimization is large. • The optimization target volume is after the shrinking capacity and the page formatting may not be completed.	• Check the DP pool status and confirm that DP pool formatting is completed. If not, wait until it completes. The DP pool optimization starts automatically after the format operation has completed. • The average time to wait until optimization starts is shown below. 100 GB: approximately 12 minutes. 1 TB: approximately 2 hours. • Confirm the status of the optimization target volume and check that page formatting is completed. If not, wait for it to complete. DP pool optimization starts automatically after page formatting finishes.
DP pool optimization status (Suspended(100%)).	Displayed when waiting for the final processing during optimization completion processing. This is not an abnormal status.	The status recovers in about 10 seconds. Wait a minute or two and then check the status again.

Table 6-1: Troubleshooting for Hitachi Dynamic Provisioning (Continued)

Problems	Causes	Solutions
Cannot change the DP Capacity Mode	• The memory is not reconfigured or the array is not restarted. • If the array model is a Hitachi Unified Storage 110, it does not support the DP Capacity Mode. • The firmware version of the array is less than 0950/A.	• Reconfigure the memory or restart the array. • Check whether the array is a Hitachi Unified Storage 130 or 150, which supports the DP Capacity Mode. • Check whether the firmware version of the array is 0950/A or more. When changing the DP Capacity Mode by restarting the array, if "The setting change of the DP Capacity Mode has failed(Code-xx)" appears in the event log message (Event Log tab in the Alerts & Events window of Hitachi Storage Navigator Modular 2) of the array, follow the maintenance procedure according to the Code numbers shown below. (Code-01: Cache capacity is insufficient) 1. Check whether the cache memory is inserted correctly. 2. Check whether the cache capacity is correct (see Table 2-4 on page 2-9). 3. Add cache capacity. 4. Change the DP Capacity Mode again. 5. Reconfigure the memory or restart the array (it is possible to start the array after the array shutdown). (Code-02: Array shutdown is not completed) 1. Reconfigure the memory or restart the array (it is possible to start the array after the array shutdown). (Code-03: PIN over occurred) 1. Contact the service personnel and request for the PIN recovery. 2. If recovered, reconfigure the memory or restart the array (it is possible to start the array after the array shutdown).
The total capacity of the DP pools and the total value of the DP-VOL consumed capacity are mismatched.	• DP-VOL formatting is not performed after reinitializing the DP pool. • When formatting DP-VOLs whose Full Capacity Mode is enabled.	• Perform the DP-VOL formatting. • Wait until the DP-VOL formatting is completed.Contact HDS Support at portal.hds.com.

Table 6-1: Troubleshooting for Hitachi Dynamic Provisioning (Continued)

Problems	Causes	Solutions
Windows 2012 or VMware, DP pool capacity is not reclaimed when a file is deleted (UNMAP command is issued internally)	• The length of the issued UNMAP command is less than 1 GB • (UNMAP Short Length Mode is enabled.) • The reclaiming process is delayed.	• Perform DP Optimization with **Reclaim zero pages before optimizing DP**. • If Windows 2012 is used, perform drive optimization. • Capacity is reclaimed based on the following approximate times: 10 GB = approximately 20 seconds 100 GB = approximately 3 minutes
With Windows 2012 or VMware, host I/O slows when a file is deleted. (UNMAP command is issued internally.)	• CPU loading is high due to processing of the UNMAP command and page format. • Because the UNMAP Short Length is disabled, the Length of UNMAP command is long. • The array firmware version is earlier than 0977/D.	• Enable the UNMAP Short Length Mode. • If the array firmware version is earlier than 0977/D, change the Format Mode to “Host Access.” • If the array firmware is later than 0977/D, change the Format Mode to “Host Access” or “Normal.” • Update the array firmware to 0977/D or later.

If you cannot solve a problem using the above suggestions, or if you encounter a problem not listed, contact HDS Support at portal.hds.com.

7

Installing Hitachi Dynamic Provisioning when Cache Partition Manager is used

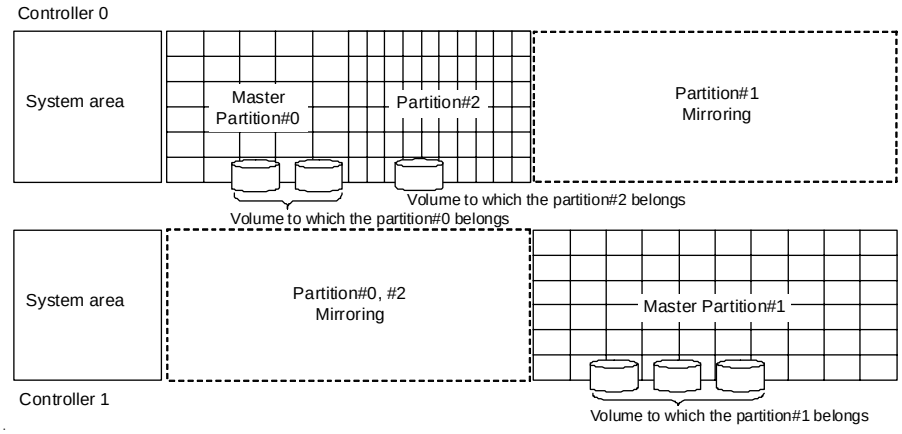
Hitachi Dynamic Provisioning uses a part of the cache area to manage the inner resources. When this happens, the cache capacity that Cache Partition Manager can use therefore decreases.

Ensure that the cache partition information is initialized as in the following figures, which show Hitachi Dynamic Provisioning installed and Cache Partition Manager in use.

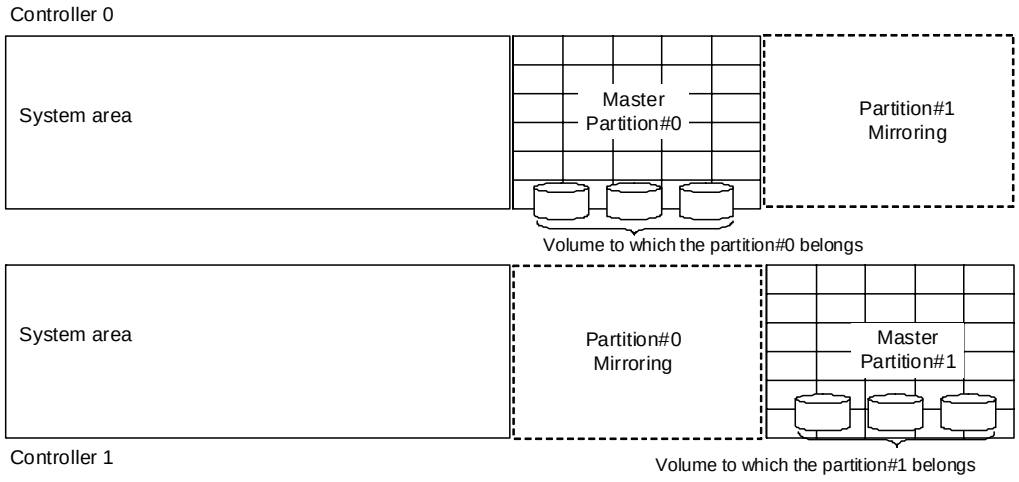
All the volumes are moved to the master partitions on the side of the default controller that controls them.

All sub-partitions are eliminated and the size of the each master partition is reduced to half of the user data area after installing Hitachi Dynamic Provisioning.

When Cache Partition Manager is used



Where Hitachi Dynamic Provisioning is installed while Cache Partition Manager is used



8

Capacity of Hitachi Dynamic Provisioning RAID Group

Table 8-1 and Table 8-2 on page 8-4 show the actual capacities of Hitachi Dynamic Provisioning RAID groups.

NOTE: When adding two or more DP RAID groups to a DP pool, estimate the DP pool capacity by adding the appropriate values.

Table 8-1: Actual capacities of Hitachi Dynamic Provisioning RAID groups stripe size: 256 kB (unit: GB)

		SAS				SSD		SAS 7.2K			FMD
RAID level	**Drive type**	**300**	**600**	**900**	**1200**	**200**	**400**	**2000**	**3000**	**4000**	**1600**
RAID 1	1D+D	264	532	816	1090	179	362	1819	2731	3643	1634
RAID 1+0	2D+D	532	1068	1636	2183	361	728	3642	5465	7289	3271
	3D+D	800	1603	2454	3274	543	1093	5461	8195	10930	4906
	4D+D	1068	2140	3275	4369	726	1460	7287	10934	14581	6546
	5D+D	1335	2673	4090	5357	907	1824	9100	13655	18209	8175
	6D+D	1603	3210	4911	6552	1090	2190	10926	16394	21863	9816
	7D+D	1869	3742	5725	7637	1271	2553	12736	19109	25482	11441
	8D+D	2140	4283	6553	8741	1455	2923	14577	21871	29166	13096

Table 8-1: Actual capacities of Hitachi Dynamic Provisioning RAID groups stripe size: 256 kB (unit: GB) (Continued)

		SAS				SSD		SAS 7.2K			FMD
RAID level	**Drive type**	**300**	**600**	**900**	**1200**	**200**	**400**	**2000**	**3000**	**4000**	**1600**
RAID 5	2D+1P	532	1068	1636	2183	361	728	3642	5465	7289	3271
	3D+1P	800	1603	2454	3274	543	1093	5461	8195	10930	4906
	4D+1P	1068	2140	3275	4369	726	1460	7287	10934	14581	6546
	5D+1P	1335	2673	4090	5457	907	1824	9100	13655	18209	8175
	6D+1P	1603	3210	4911	6552	1090	2190	10926	16394	21863	9816
	7D+1P	1869	3742	5725	7637	1271	2553	12736	19109	25482	11441
	8D+1P	2140	4283	6553	8741	1455	2923	14577	21871	29166	13096
	9D+1P	2043	4809	7358	9815	1635	3282	16367	24557	32748	14704
	10D+1P	2673	5349	8184	10917	1818	3651	18204	27313	36422	16354
	11D+1P	2938	5880	8996	12000	1999	4013	20010	30023	40036	17977
	12D+1P	3205	6413	9812	13088	2181	4377	21824	32744	43665	19607
	13D+1P	3469	6941	10619	14165	2360	4738	23620	35439	47258	21220
	14D+1P	3741	7487	11453	15278	2546	5110	25475	38221	50968	22886
	15D+1P	4001	8006	12248	16337	2723	5464	27242	40872	54502	24474

Table 8-1: Actual capacities of Hitachi Dynamic Provisioning RAID groups stripe size: 256 kB (unit: GB) (Continued)

		SAS				SSD		SAS 7.2K			FMD
RAID level	**Drive type**	**300**	**600**	**900**	**1200**	**200**	**400**	**2000**	**3000**	**4000**	**1600**
RAID 6	2D+2P	532	1068	1636	2183	361	728	3642	5465	7289	3271
	3D+2P	800	1603	2454	3274	543	1093	5461	8195	10930	4906
	4D+2P	1068	2140	3275	4369	726	1460	7287	10934	14581	6546
	5D+2P	1335	2673	4090	5457	907	1824	9100	13655	18209	8175
	6D+2P	1603	3210	4911	6552	1090	2190	10926	16394	21863	9816
	7D+2P	1869	3742	5725	7637	1271	2553	12736	19109	25482	11441
	8D+2P	2140	4283	6553	8741	1455	2923	14577	21871	29166	13096
	9D+2P	2403	4809	7358	9815	1635	3282	16367	24557	32748	14704
	10D+2P	2673	5349	8184	10917	1818	3651	18204	27313	36422	16354
	11D+2P	2938	5880	8996	12000	1999	4013	20010	30023	40036	17977
	12D+2P	3205	6413	9812	13088	2181	4377	21824	32744	43665	19607
	13D+2P	3469	6941	10619	14165	2360	4738	23620	35439	47258	21220
	14D+2P	3741	7487	11453	15278	2546	5110	25475	38221	50968	22886
	15D+2P	4001	8006	12248	16337	2723	5464	27242	40872	54502	24474
	16D+2P	4283	8659	13109	17486	2914	5849	29157	43746	58335	26195
	17D+2P	4549	9103	13925	18575	3096	6213	30972	46469	61966	27825
	18D+2P	4809	9622	14720	19634	3273	6567	32738	49118	65499	29444
	19D+2P	5076	10157	15538	20725	3455	6933	34557	51847	69138	31082
	20D+2P	5349	10702	16371	21837	3640	7305	36412	54630	72848	32712
	21D+2P	5595	11193	17123	22840	3808	7640	38084	57138	76193	34346
	22D+2P	5864	11732	17948	23940	3891	8008	39917	59889	79861	36006
	23D+2P	6126	12257	18750	25010	4170	8366	41701	62565	83430	37622
	24D+2P	6413	12830	19627	26180	4365	8758	43652	65492	87333	39275
	25D+2P	6687	13378	20465	27298	4551	9132	45516	68288	91061	40891
	26D+2P	6941	13886	21242	28334	4724	9479	47244	70881	94519	42511
	27D+2P	7215	14435	22081	29453	4911	9853	49109	73679	98250	44192
	28D+2P	7461	14926	22832	30455	5078	10188	50780	76186	101592	45776

Table 8-2: Actual capacities of Hitachi Dynamic Provisioning RAID groups stripe size: 64 kB (unit: GB)

		SAS				SSD		SAS 7.2K			FMD
RAID level	**Drive type**	**300**	**600**	**900**	**1200**	**200**	**400**	**2000**	**3000**	**4000**	**1600**
RAID 1	1D+D	264	532	816	1090	179	362	1819	2731	3643	1634
RAID 1+0	2D+D	532	1068	1636	2183	361	728	3642	5465	7289	3271
	3D+D	800	1603	2455	3275	544	1094	5463	8198	10934	4908
	4D+D	1068	2140	3275	4369	726	1460	7287	10934	14581	6546
	5D+D	1336	2675	4094	5462	908	1825	9109	13667	18226	8183
	6D+D	1604	3211	4913	6554	1091	2191	10930	16400	21871	9820
	7D+D	1871	3746	5732	7647	1273	2556	12752	19133	25515	11456
	8D+D	2140	4283	6553	8741	1455	2923	14577	21871	29166	13096
RAID 5	2D+1P	532	1068	1636	2183	361	728	3642	5465	7289	3271
	3D+1P	800	1604	2455	3275	544	1094	5463	8198	10934	4908
	4D+1P	1068	2140	3275	4369	726	1460	7287	10934	14581	6546
	5D+1P	1336	2675	4094	5462	908	1825	9109	13667	18226	8183
	6D+1P	1604	3211	4913	6554	1091	2191	10930	16400	21871	9820
	7D+1P	1871	3746	5732	7647	1273	2556	12752	19133	25515	11456
	8D+1P	2140	4283	6553	8741	1455	2923	14577	21871	29166	13096
	9D+1P	2047	4817	7370	9831	1637	3287	16394	24598	32802	14728
	10D+1P	2674	5352	8189	10924	1820	3653	18215	27330	36445	16364
	11D+1P	2942	5888	9008	12016	2002	4018	20037	30063	40089	18001
	12D+1P	3209	6423	9826	13107	2184	4384	21856	32792	43729	19636
	13D+1P	3477	6958	10645	14199	2366	4749	23677	35523	47370	21271
	14D+1P	3744	7493	11463	15291	2548	5114	25497	38254	51011	22906
	15D+1P	4012	8028	12281	16382	2730	5479	27216	40984	54652	24541

Table 8-2: Actual capacities of Hitachi Dynamic Provisioning RAID groups stripe size: 64 kB (unit: GB) (Continued)

		SAS				SSD		SAS 7.2K			FMD
RAID level	**Drive type**	**300**	**600**	**900**	**1200**	**200**	**400**	**2000**	**3000**	**4000**	**1600**
RAID 6	2D+2P	532	1068	1636	2183	361	728	3642	5465	7289	3271
	3D+2P	800	1604	2455	3275	544	1094	5463	8198	10934	4908
	4D+2P	1068	2140	3275	4369	726	1460	7287	10934	14581	6546
	5D+2P	1336	2675	4094	5462	908	1825	9109	13667	18226	8183
	6D+2P	1604	3211	4913	6554	1091	2191	10930	16400	21871	9820
	7D+2P	1871	3746	5732	7647	1273	2556	12752	19133	25515	11456
	8D+2P	2140	4283	6553	8741	1455	2923	14577	21871	29166	13096
	9D+2P	2407	4817	7370	9831	1637	3287	16394	24598	32802	14728
	10D+2P	2674	5352	8189	10924	1820	3653	18215	27330	36445	16364
	11D+2P	2942	5888	9008	12016	2002	4018	20037	30063	40089	18001
	12D+2P	3209	6423	9826	13107	2184	4384	21856	32792	43729	19636
	13D+2P	3477	6958	10645	14199	2366	4749	23677	35523	47370	21271
	14D+2P	3744	7493	11463	15291	2548	5114	25497	38254	51011	22906
	15D+2P	4012	8028	12281	16382	2730	5479	27316	40984	54652	24541
	16D+2P	4283	8659	13109	17486	2914	5849	29157	43746	58335	26195
	17D+2P	4549	9103	13925	18575	3096	6213	30972	46469	61966	27825
	18D+2P	4814	9633	14736	19656	3276	6575	32774	49172	65571	29444
	19D+2P	5082	10168	15556	20749	3459	6941	34597	51908	69218	31082
	20D+2P	5349	10702	16371	21837	3640	7305	36412	54630	72848	32712
	21D+2P	5616	11236	17189	22928	3822	7670	38230	57538	76486	34346
	22D+2P	5888	11780	18020	24036	4007	8040	40078	60130	80182	36006
	23D+2P	6152	12308	18829	25115	4187	8401	41877	62829	83781	37622
	24D+2P	6422	12849	19656	26218	4371	8771	43716	65588	87461	39275
	25D+2P	6687	13378	20465	27298	4551	9132	45516	68288	91061	40891
	26D+2P	6952	13908	21276	28379	4732	9494	47319	70994	94669	42511
	27D+2P	7227	14458	22118	29501	4919	9869	49190	73801	98412	44192
	28D+2P	7486	14977	22910	30559	5096	10233	50953	76446	101939	45776

9

Hitachi Dynamic Tiering overview

This chapter provides an introduction to Hitachi Dynamic Tiering.

The following topics are covered in this chapter:

- About Hitachi Dynamic Tiering
- Hitachi Dynamic Tiering concepts

About Hitachi Dynamic Tiering

Hitachi Dynamic Tiering improves performance by optimizing the use of high-performance storage tiers and low-cost storage tiers. Tiering refers to the movement of pages of data between storage tiers that reside in a storage system. In this way, frequently referenced data can be made available on the highest performing drives, while data that is infrequently referenced is migrated to lower performing, lower cost drives. As a result, Hitachi Dynamic Tiering enhances your ability to use storage that has different performance, capacity, and reliability characteristics more effectively.

Hitachi Dynamic Tiering enables the management of multiple storage tiers as a single entity. It presents a new type of virtual volume, with embedded smart tiering that monitors access and moves data at granular page levels. It allocates the volume into pages and automatically promotes pages that are referenced frequently to higher performance disk drives to ensure high I/O response time. It also self-optimizes for high performance and space efficiency to have the right data in the right place at the right time.

Hitachi Dynamic Tiering uses a dynamic storage pool, which is divided into pages. Virtual volumes are made up of pages from the dynamic storage pool. The pages can reside anywhere in the pool on any tier within that pool. Hitachi Dynamic Tiering determines which pages are best to place in higher performance tiers and which in lower performance tiers. The pages can be moved up and down between the tiers within the pool to optimize performance. In operation, a Hitachi Dynamic Tiering environment will have most of the highly referenced pages in the highest tier and the least referenced pages in the bottom tier.

Hitachi Dynamic Tiering tries to use as much of the higher tiers as possible. This provides the effective appearance that all the data resides on the fastest tier of storage — such as on solid-state drives (SSDs) and flash-module drives (FMDs) — while, in fact, most of the data resides on lower cost, lower performance storage tiers.

- Tier 1 consists of SSD and FMD drives.
- Tier 2 consists of 15 K and 10 K Serial Attached SCSI (SAS) drives.
- Tier 3 consists of 7.2 K SAS drives.

By default, Hitachi Dynamic Tiering automatically starts page migration periodically, eliminating time-consuming manual processes of data classification and movement typically associated with the use of tiered storage. However, you can also use Hitachi Storage Navigator Modular 2 to configure migration times between tiers manually.

Hitachi Dynamic Tiering virtual volumes are just another kind of volume in a tiered storage architecture. Just like disk types and RAID configurations, Hitachi Dynamic Tiering multi-tier volumes are another way of delivering tailored storage cost and performance service levels. These dynamically tiered volumes do, however, deliver superior service levels at less cost,

maximizing service levels and minimizing storage total cost of ownership. Capacity can be dynamically added to or removed from any tier at any time, simplifying your ability to size tiers for a pool.

Hitachi Dynamic Tiering concepts

With Hitachi Dynamic Tiering, a DP-VOL (sometimes referred to as a virtual volume) is a dynamically provisioned logical device that is presented to hosts. An HDT DP-VOL will have its pages distributed across up to three tiers of disk. Each tier is comprised of pool volumes that are based on a parity group consisting of one disk type (SAS, 10 K RPM). With Hitachi Dynamic Tiering, a pool can be configured using various types of drives, including SSDs, FMDs, SAS 15 K, SAS 10 K, and SAS 7.2 K drives.

Load areas

Figure 9-1 compares high and low load areas when Hitachi Dynamic Tiering is used or not used. In this figure:

- The vertical scale of the graph indicates an average number of I/Os by unit time.
- The horizontal scale of the graph indicates the capacity of the area where I/O is performed.
- The figure on the left shows data allocated to only one kind of drive (high-performance hard drive), without regard for the workload associated with the volumes.
- The figure on the right shows Hitachi Dynamic Tiering automatically allocating volumes associated with high workloads to a higher performance drive and volumes associated with low workloads to a lower performance drive.

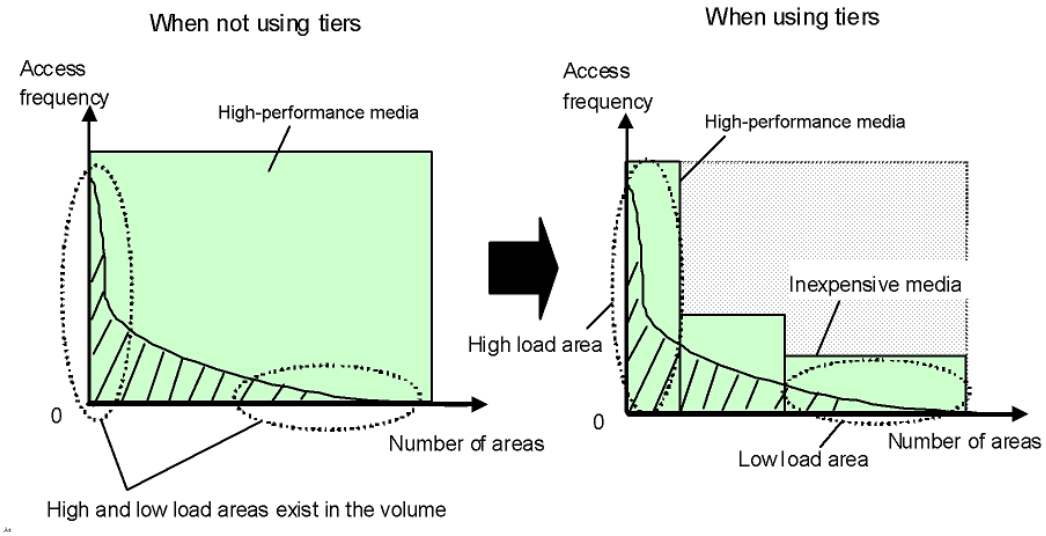


Figure 9-1: Advantage of Dynamic Tiering

Tiers

Hitachi Dynamic Tiering distributes host volume data across multiple tiers of storage in a pool. A pool can contain up to three tiers:

- High-speed layer
- Middle-speed layer
- Low-speed layer

Hitachi Dynamic Tiering determines tier use based on data-access levels. The high-access page is allocated to the high-speed layer, while the low-access page is allocated to the low-speed layer.

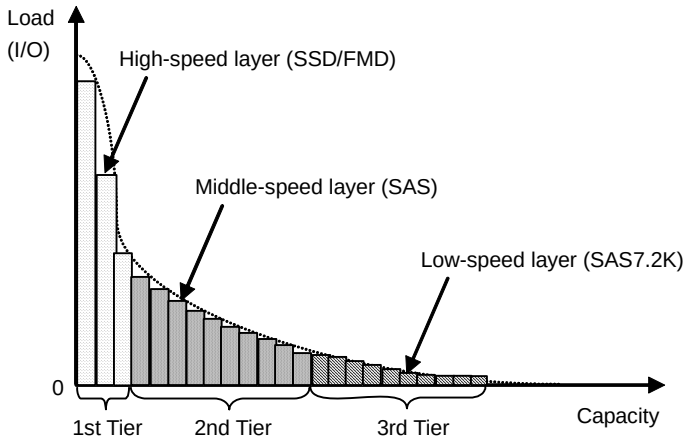


Figure 9-2: Tiers

When adding a DP RAID Group (DP-RG) to a Hitachi Dynamic Provisioning pool, the DP-RG is added to the appropriate tier according to the performance of the drives that make up the DP-RG. If the DP-RG corresponds to a tier not in the HDP pool, the Hitachi Dynamic Provisioning pool is updated appropriately. In Figure 9-3, for example, a DP-RG consisting of SSDs is being added to an Hitachi Dynamic Provisioning pool. Because SSDs are always in the first tier, the other existing tiers move to lower tiers as needed.

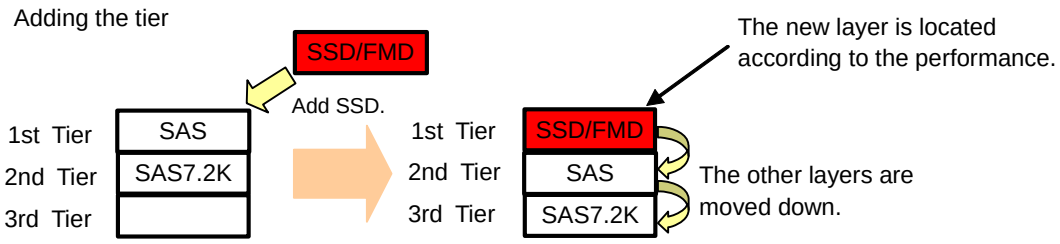


Figure 9-3: Adding a tier

Example of deleting the tier

If a tier runs out of DP RAID groups when you delete them, the tier is deleted from the pool.

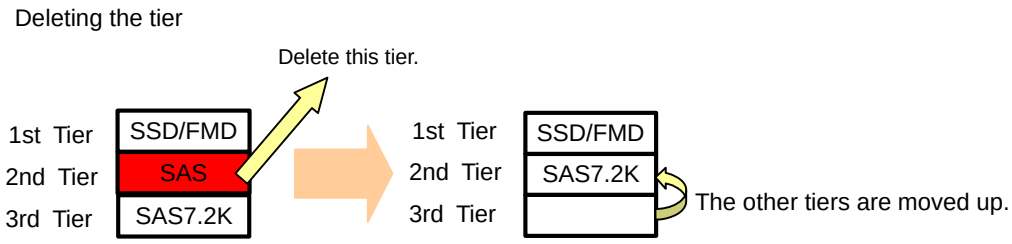


Figure 9-4: Deleting a tier

Dynamic Tiering workflow

Figure 9-5 on page 9-5 shows the workflow associated with migrating pages to appropriate tiers.

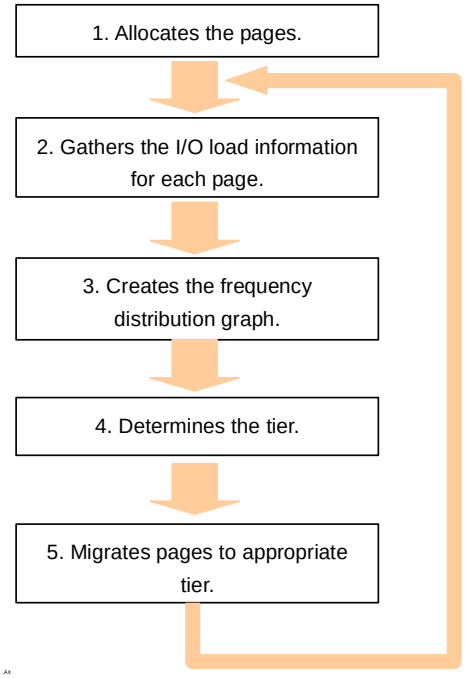


Figure 9-5: Hitachi Dynamic Tiering workflow

The following steps correspond to those in Figure 9-5 on page 9-5.

1. **Allocate the new page.**

   The new page is allocated to the upper tier. If the capacity of the upper tier is not sufficient to hold the page, the pages are allocated to the nearest lower tier. If the capacity of all tiers is insufficient, an error message is sent to the host.

2. **Gather I/O information about each page.**

Performance monitoring collects I/O load information about each page in a pool (the number of I/O loads in a certain range) to ascertain I/O load per page. I/Os that are not part of the page migration are ignored.

3. Create frequency distribution chart.

A frequency distribution chart is generated that shows the relationship between average I/O counts (I/O load) and capacity (total number of pages). You can use the Show Pool Frequency Distribution Chart window in Hitachi Storage Navigator Modular 2 to view this chart. The chart's vertical scale shows the average number of I/Os by hour. Its horizontal scale shows the capacity (GB) of the area where the I/Os are performed.

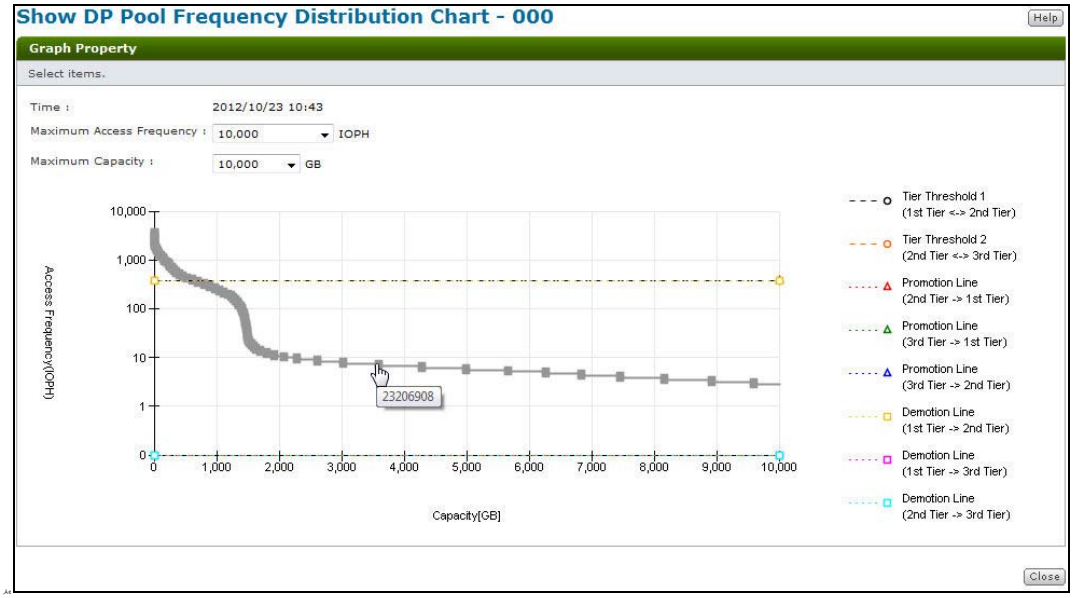


Figure 9-6: Sample Frequency Distribution Chart

4. Determine the appropriate tier for the page.

The page is allocated to the appropriate tier based on the performance monitoring information. This involves the following steps.

a. Determining the tier boundary.

The boundary value of a tier is calculated using the frequency distribution graph. Pages of higher I/O load are allocated to the upper tier in sequence. The tier boundary is defined as a value at which the total number of stored pages exceeds the capacity of the target tier or a value of the reached maximum I/O counts that each tier can process.

The maximum I/O counts that a tier can process is called "limit performance" and the rate of I/O counts to limit performance of each tier is called "performance utilization." If performance utilization is 100%, it means I/O counts in a tier exceed limit performance.

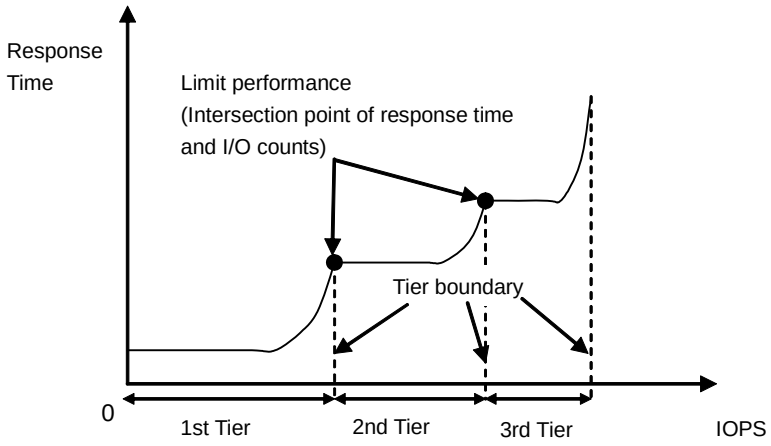


Figure 9-7: Limit performances and tier boundaries

b. Determining the tier range.

The tier range is based on tier boundaries. Tier boundaries are set as the lower limit for each tier range.

c. Determining the tier of a page.

The tier range where a page is located is judged to determine the tier to which the page moves.

5. Migrate the pages.

The pages move to the appropriate tier. After migration, page usage rates are averaged-out in all tiers. I/Os that occur by page migration are not monitored.

Tier relocation workflow

The workflow for tier relocation based on performance monitoring depends on whether the Auto Progress Mode feature in Hitachi Dynamic Provisioning is enabled or disabled.

- Enabled: Performance monitoring and tier relocation are performed automatically according to a predefined schedule. The schedule can be configured in Hitachi Dynamic Tiering on a weekly basis in 30-minute increments.
- Disabled: You can configure performance monitoring and tier relocation to start and stop at a specified time.

Tier relocation cannot be performed under the following conditions:

- The pool is completely depleted.
- Pages have no performance monitoring information.
- The pool is blocked.

Conditions when monitoring information stops

Table 9-1 lists when Hitachi Dynamic Tiering stops collecting monitoring information. Refer to the Solutions column for the action to be taken.

Table 9-1: Conditions for stopping monitoring information

Monitoring information collection stops when...	Solutions
Auto Progress Mode switches from Enable to Disable.	Start the monitoring collection and set automatic execution mode to Enabled.
A failure occurs.	Recover from the failure using the procedures in the maintenance manual.

Conditions when monitoring information is discarded

Table 9-2 lists when Hitachi Dynamic Tiering discards the monitoring information collected.

Table 9-2: Conditions for discarding monitoring information

Monitoring information collection is discarded when...	Solutions
The monitor is reset.	Collect monitoring information again.
Cache volatilization failure occurred.	Collect monitoring information again.
The DP pool is deleted.	Collect monitoring information again.
The tier mode of the DP pool is Disabled.	Change the tier mode to Enabled and collect monitoring information again.

Conditions when the tier relocation is cancelled

Table 9-3 lists the conditions that result in the cancellation of tier relocation. To complete relocation, refer to the Solutions column for the action to be taken.

Table 9-3: Conditions when tier relocation is cancelled

Monitoring information collection is cancelled when...	Solutions
The rules and regulations of the monitored information shown in the table above are met.	Relocation is performed after monitor collection.

Buffer space for new page assignments and tier relocation

Hitachi Dynamic Tiering uses buffer space when assigning new pages and relocating tiers.

For new page assignments, the new pages initially are assigned to the top tier, and then assigned to the lower tier while leaving the buffer space (2% per tier by default) for tier relocation. If tier capacity reaches 98%,

additional new pages are assigned to the buffer space, which is the remaining 2% of the tier. Figure 9-8 on page 9-9 shows the workflow associated with new page assignments.

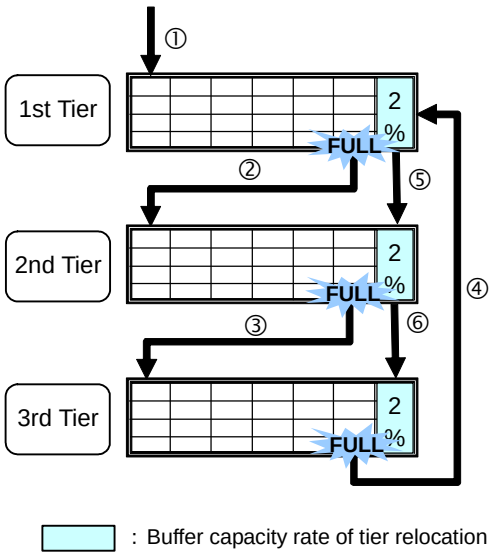


Figure 9-8: Workflow of new page assignments

Tier relocation also uses the buffer space. Each tier can be assigned to over 98% capacity of buffer space temporarily. Tier relocation secures the area for each tier associated with a new page assignment, which is performed after tier relocation.

Buffer space for New Page Assignment is set for drives. For example, if 1stTier:SSD(2%) and 2ndTier:SAS7.2K(10%) in the 2 Tier configuration, adding an SAS changes the values to 1st Tier: SSD(2%), 2ndTier: SAS(default value), and 3rdTier: SAS7.2K(10%).

Similarly, buffer space for Tier Relocation is set for drives. For example, if 1stTier:SSD(2%) and 2ndTier:SAS7.2K(10%) in the 2 Tier configuration, adding an SAS changes the values to 1st Tier: SSD(2%), 2ndTier: SAS(default value), and 3rdTier: SAS7.2K(10%). The following values are the default values and can be changed by Hitachi Storage Navigator Modular 2.

Table 9-4: Rate of Buffer Space

Tier order	Buffer area for tier relocation	Buffer area for new page assignment	Total
First tier	2%	0%	2%
Second tier	2%	8%	10%
Third tier	2%	8%	10%

These values are the default values set at the time of creating tiers by DP pool creation or adding tiers by DP pool capacity addition and can be changed by Hitachi Storage Navigator Modular 2.

If you change the tier order that existed when tiers were added, the order reverts to the way it was before the order was changed.

10

About Hitachi Dynamic Tiering operations

Hitachi Dynamic Tiering manages the DP pool in a tier and stores the data. This chapter describes DP pools and DP tiers used in Hitachi Dynamic Tiering, and then describes the Hitachi Dynamic Tiering function.

This chapter discusses the following topics:

- Hitachi Dynamic Tiering components
- Dynamic Tiering features
- Interoperability with other Hitachi software features
- Monitoring resources and tuning

Hitachi Dynamic Tiering components

Hitachi Dynamic Tiering utilizes Hitachi Dynamic Provisioning components. For this reason, Hitachi Dynamic Provisioning must be installed prior to using Hitachi Dynamic Tiering.

In addition to the Hitachi Dynamic Tiering application, Hitachi Dynamic Tiering consists of:

- DP pools
- DP RAID groups
- DP-VOLs
- Hitachi Dynamic Provisioning

Hitachi Dynamic Tiering and Hitachi Dynamic Provisioning

Hitachi Dynamic Tiering and Hitachi Dynamic Provisioning use DP volumes to access data in DP pools. DP pools are configured with multiple media and managed in the tier. DP-VOLs are managed in a DP-VOL management area associated with a DP pool. At least one DP-VOL and one DP pool are required to use Hitachi Dynamic Provisioning.

To manage a tier, a DP pool must be configured with DP-RGs of different types of media.

Figure 10-1 shows the functional differences between Hitachi Dynamic Provisioning and Hitachi Dynamic Tiering.

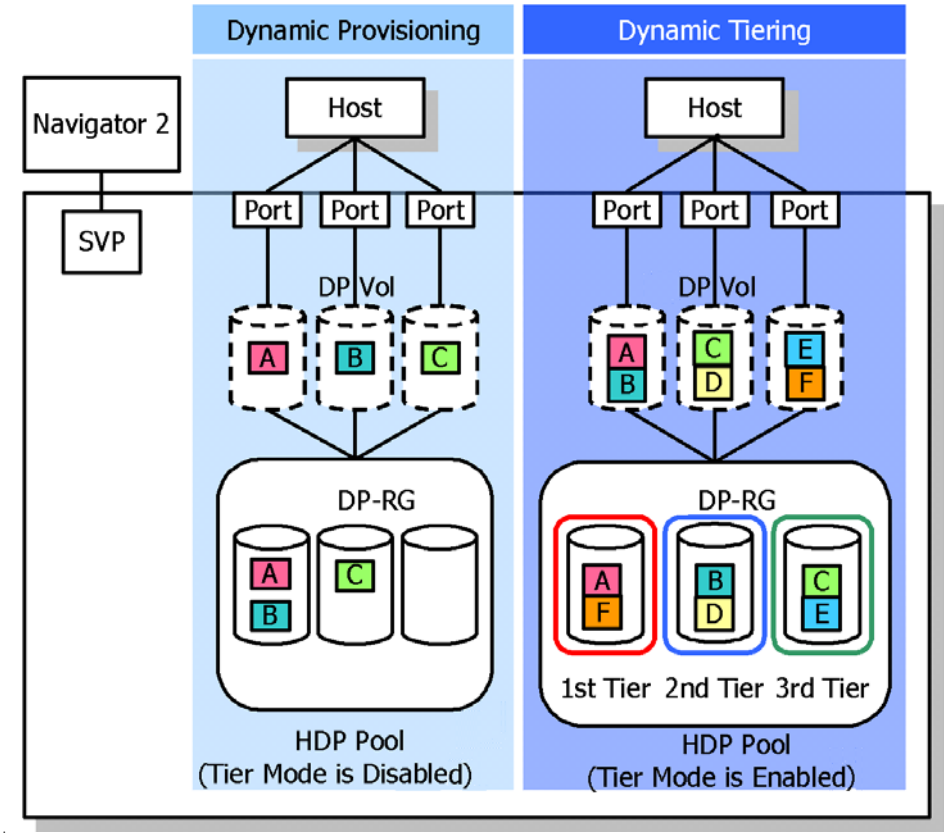


Figure 10-1: Hitachi Dynamic Tiering vs. Hitachi Dynamic Provisioning

Hitachi Dynamic Tiering

To operate Hitachi Dynamic Tiering, Hitachi Dynamic Provisioning and Hitachi Dynamic Tiering must be installed. Hitachi Dynamic Tiering is managed via Hitachi Storage Navigator Modular 2. The computer running Hitachi Storage Navigator Modular 2 connects to the array over a TCP/IP network.

Table 10-1 shows the supported Hitachi Dynamic Tiering configurations for Hitachi Unified Storage systems.

Table 10-1: Supported Hitachi Dynamic Tiering configurations

Item	Hitachi Unified Storage 110	Hitachi Unified Storage 130	Hitachi Unified Storage 150
Maximum number of DP-VOLs (The number of volumes is reduced by the number of RAID groups.)	2,048	4,096	4,096
DP-VOL capacity	32 MB to 128 TB	32 MB to 128 TB	32 MB to 128 TB
Maximum number of DP pools	50	64	64
DP pool capacity	650 TB	980 - 2600 TB If capacity exceeds 980 TB, change DP Capacity Mode to Maximum Capacity.	2,600 - 5200 TB If capacity exceeds 2,600 TB, change DP Capacity Mode to Maximum Capacity.

Table 10-2 shows the supported Hitachi Dynamic Tiering capacities for Hitachi Unified Storage systems. For more information, see DP Capacity Mode on page 10-10.

Table 10-2: Supported Hitachi Dynamic Tiering capacities

Hitachi Unified Storage	Cache memory per controller	DP capacity mode	Management capacity		User data capacity		
			Hitachi Dynamic Provisioning	Hitachi Dynamic Tiering	Hitachi Dynamic Provisioning is Enabled	Hitachi Dynamic Provisioning and Dynamic Tiering are Enabled	Hitachi Dynamic Provisioning and Dynamic Tiering are Disabled
110	4 GB/CTL	Not supported	420 MB	50 MB	1,000 MB	960 MB	1,420 MB
130	8 GB/CTL	Regular Capacity	640 MB	200 MB	4,020 MB	3,820 MB	4,660 MB
		Maximum Capacity	1,640 MB	200 MB	3,000 MB	2,800 MB	4,660 MB
	16 GB/CTL	Regular Capacity	640 MB	200 MB	10,640 MB	10,440 MB	11,280 MB
		Maximum Capacity	1,640 MB	200 MB	9,620 MB	9,420 MB	11,280 MB
150	8 GB/CTL	Regular Capacity	1,640 MB	200 MB	2,900 MB	2,700 MB	4,540 MB
	16 GB/CTL	Regular Capacity	1,640 MB	200 MB	9,520 MB	9,320 MB	11,640 MB
		Maximum Capacity	3,300 MB	200 MB	7,860 MB	7,660 MB	11,160 MB

Dynamic Tiering features

Hitachi Dynamic Tiering relocates data by managing Hitachi Dynamic Provisioning DP pools in a tier. The following sections describe the key features of Hitachi Dynamic Tiering.

Creating a DP Pool

To use Dynamic Provisioning, you create DP pools. A DP pool consists of one or more DP RAID groups.

For one DP pool:

- Hitachi Unified Storage 150 and 130 can register 4,096 DP-VOLS.
- Hitachi Unified Storage 110 can register 2,048 DP-VOLs.

The number of DP pools that can be created in one array varies by array model:

- Hitachi Unified Storage 150 and 130 support 64 DP pools
- Hitachi Unified Storage 110 supports 50 DP pools

You can add DP RAID groups to be registered in the DP pools, even when operating Hitachi Dynamic Tiering. If you delete a DP pool, all data in the DP pool and the DP-VOLs belonging to the DP pool are deleted.

Each DP pool has a number assigned to it. Two or more DP-VOLs can be defined for one DP pool. Two or more DP RAID groups can be stored in one DP pool.

You create DP pools using Hitachi Storage Navigator Modular 2 (see Creating a DP pool with Tier Mode enabled on page 13-3) or the Hitachi Dynamic Tiering command-line interface (refer to the *Hitachi Unified Storage Command Line Interface Reference Guide*).

Changing Tier Mode of a DP pool

You can register into a DP Pool RAID Groups of multiple types. However, you must integrate the combination in the same tier.

Observe the following guidelines when using Tier Mode:

- If Tier Mode is disabled, RAID groups of only the same type can be configured into a DP Pool.
- Existing Hitachi Dynamic Provisioning pools that do not include solid-state drives (SSDs) can be converted to a pool for use by Hitachi Dynamic Tiering by enabling Tier mode. This procedure is described under Changing the Tier Mode of a DP pool on page 13-7.
- Hitachi Dynamic Provisioning pools comprised only of SSDs cannot be converted into a pool that Hitachi Dynamic Tiering can use due to differences in the way Hitachi Dynamic Provisioning and Hitachi Dynamic Tiering implement chunk sizes. The reason for these differences are described under Tier Mode relationship between Hitachi Dynamic Provisioning and Tiering, below.

Tier Mode relationship between Hitachi Dynamic Provisioning and Tiering

While Hitachi Dynamic Provisioning pools consisting of SAS or near-line SAS drives can be converted to Hitachi Dynamic Tiering pools, Dynamic Provisioning pools consisting of SSDs cannot not be converted into Dynamic Provisioning pools. This section describes the theory of operation behind this approach. This section also provides guidelines to storage administrators who want to include SSDs in a Hitachi Dynamic Tiering pool.

When a host issues a data write command to a Hitachi Dynamic Provisioning pool comprised of SSDs:

1. Hitachi Dynamic Provisioning initially allocates a 1 GB chunk of the Dynamic Provisioning pool.
2. Thereafter, Hitachi Dynamic Provisioning allocates a 32 MB page into which the data is written.

As more write operations occur, additional 32 MB pages are allocated. Eventually, another 1 GB chunk of the pool is allocated and more 32 MB pages are used as necessary.

Within a Hitachi Dynamic Tiering Pool, the chunk size of the tier pool consisting of SSDs (that is, Tier 1) is 32 MB. This chunk size is also the page size. (The chunk size of a Hitachi Dynamic Tiering tier consisting of non-SSD disks is 1 GB and the pages are 32 MB.) When data is written to a tier of SSDs, Hitachi Dynamic Tiering allocates a 32 MB chunk (or “page”) to store this data. This process is followed whether the data is written from the host to the Hitachi Dynamic Tiering pool or whether a page is being promoted from Tier 2 or Tier 3 to Tier 1 of the Hitachi Dynamic Tiering pool. Hitachi Dynamic Tiering has adopted this approach to use SSD capacity in the most cost-efficient manner possible.

Instead of allocating 1 GB of SSD capacity, which might only be used partially over time, Hitachi Dynamic Tiering allocates 32 MB at a time to avoid wasting capacity. With SSDs having a higher cost-per-GB than other disks, this intelligent approach allows pricey disk space to be used as cost efficiently as possible.

There are two options available for including SSDs in a Hitachi Dynamic Tiering pool:

- Create a new Hitachi Dynamic Tiering pool (see Creating a DP pool with Tier Mode enabled on page 13-3). During this process, you select **SSD** in the **Drive Type/RPM** pull-down menu on the Create DP Pool window. You can also select other types of disks, such as SAS/10K, to create a Hitachi Dynamic Tiering pool with multiple tiers.
- Create a Hitachi Dynamic Tiering pool consisting of non-SSDs, and then add a set of SSDs for an additional tier to the Hitachi Dynamic Tiering pool consisting of non-SSDs. The system classifies the SSDs as tier 1 of the Hitachi Dynamic Tiering pool automatically and reclassifies the tiers of the existing Hitachi Dynamic Provisioning pool as lower tiers of the pool.

Creating a DP-VOL

A DP-VOL is a virtual volume that defines the relationship with the physical storage space. With Hitachi Dynamic Tiering and Hitachi Dynamic Provisioning, you create DP-VOLs for a DP pool with Tier Mode enabled.

You create DP-VOLs using Hitachi Storage Navigator Modular 2 (see Creating a DP-VOL on page 13-18) or the Hitachi Dynamic Tiering command-line interface (refer to the *Hitachi Unified Storage Command Line Interface Reference Guide*)

A DP-VOL must specify a DP pool number, DP-VOL capacity, and DP-VOL number. With Tier Mode enabled, two or more DP-VOLs can be created for a single DP pool. One DP-VOL cannot be defined for two or more DP pools.

Monitoring DP pool capacity

The same method for monitoring Hitachi Dynamic Provisioning is used to monitor Hitachi Dynamic Tiering capacity. When using Hitachi Dynamic Tiering, you define the DP pool capacity for a DP-VOL. If available capacity in the DP pool becomes insufficient, the host will not be able to access the DP pool. Therefore, monitor the consumed capacity for DP pools.

To alert users if capacity exceeds the threshold value, configure Hitachi Storage Navigator Modular 2 to generate an email about this situation. This condition also generates a Simple Network Management Protocol (SNMP) trap (see the *Hitachi Unified Storage Operations Guide*). For more information, see:

- DP Pool Trend window on page 12-14 for information about monitoring
- Monitoring resources and tuning on page 10-29 for information about resource monitoring and tuning.

You can also monitor system performance using Performance Monitor (see *Hitachi Unified Storage Operations Guide*) and using Hitachi Storage Navigator Modular 2 to monitor DP-VOLs.

Growing DP pool capacity

The DP pool capacity can grow by adding DP RAID groups to the DP pool. The total capacity for DP RAID groups registered in the DP pool is the capacity of that DP pool. Check the free capacity of the usable DP pool, and grow the DP pool as needed.

When growing DP pool capacity, observe the following guidelines:

- If Tier Mode is disabled, the DP RAID group being added to the DP pool is configured using the same RAID type as the existing DP RAID group, and the drive capacity to be added must equal or exceed the drive capacity which configures the existing DP pool.
- If Tier Mode is enabled, the DP RAID group being added to the DP pool is configured using the same RAID type within the tier, and the drive capacity to be added must be equal or exceed the drive capacity of the existing DP pool.

- When the firmware version is 0945/A or later, the RAID type does not have to be same as the existing RAID group.
- The maximum capacity of the DP pool varies by Hitachi Unified Storage model:
  - Hitachi Unified Storage 110: approximately 650 TB
  - Hitachi Unified Storage 130: approximately 980 TB
  - Hitachi Unified Storage 150: approximately 2,600 TB
- You cannot grow a DP pool that exceeds this upper limit.

If a pool depletion or pool capacity deletion threshold value alert is reported and you cannot grow the DP pool capacity, increase the free capacity by migrating the data to the another array and then grow the DP pool capacity. For more information see Adding DP pool capacity on page 13-14 for GUI operation and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operation.

The consumed capacity in the DP pool can be rebalanced by selecting Optimize after adding capacity when you add the DP pool capacity (see Optimizing a DP pool on page 10-9).

NOTE: For Hitachi Unified Storage 130 and 150 systems with firmware version 0950/A or later, the upper limit can be changed by setting the DP Capacity Mode to the maximum capacity of 2,600 TB (approx.) for the Hitachi Unified Storage 130 and 5,200 TB (approx.) for the Hitachi Unified Storage 150. For more information, see DP Capacity Mode on page 10-10.

Shrinking DP pool capacity

Deleting the DP RAID group from the DP pool can shrink DP pool capacity. When shrinking DP pool capacity, total DP pool capacity is shrunk. See Shrinking the DP pool capacity on page 13-15 for GUI operation and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operation.

DP pool capacity cannot be shrunk when the:

- Pool status to which the DP RAID group of a shrinking target belongs is exceeding the Depletion Alert threshold value.
- Pool capacity after shrinking exceeded the depletion threshold value.
- Pool to which the DP RAID group of a shrinking target belongs is blocked.
- DP-VOL in the pool to which the DP RAID group of a shrinking target belongs is blocked.
- DP-VOL in the pool to which the DP RAID group of a shrinking target belongs is unformatted.
- DP-VOL in the pool to which the DP RAID group of a shrinking target belongs is during online parity correction.
- DP RAID group of a shrinking target is during drive restoration. If a DP RAID group other than a shrinking target occurs during drive

restoration, the instruction is received. However, DP pool shrinking fails if the RAID group during drive restoration is selected as a migration destination.DP-VOL status in the pool to which the DP RAID group of a shrinking target belongs is during deletion or formatting.

- Drive firmware is being replaced while array power is turned on.
- Pool to which the DP RAID group of a shrinking target belongs is exceeding Limit Threshold of Over Provisioning. If the Limit Enforcement is enabled, the DP pool can be shrunk.
- Pool to which the DP RAID group of a shrinking target belongs exceeds Limit Threshold of Over Provisioning after shrinking. If the Limit Enforcement is enabled, the DP pool can be shrunk.
- Memory is being reconfigured.
- Pool which is changing background configuration exists.
- Shrinking target DP RAID group is the last DP RAID group in pool.
- DMLU exists in the pool to which the shrinking target DP RAID group belongs when the firmware version is less than 0970/A.
- Replication or management area capacity exists in pool to which shrinking target DP RAID group belongs. If replication or management area capacity exists in the DP pool, capacity shrinking may be possible. The DP RAID group added to the DP pool or as part of the DP RAID groups when the replication or management area capacity must be less than the number of DP RAID groups Í 1GB is a target.
- DP RAID group of a shrinking target exceeds Replication Data Released Threshold in the pool in which the group belongs after shrinking

Shrinking reduces the total DP pool capacity, so be extremely careful not to deplete the capacity. When executing host I/O, shrinking takes more time than when the host I/O is not occurring. Shrink times depend on factors such as the RAID range of the DP RAID group and the stripe range of the DP pool or drive types, even when shrinking the same capacity.

Canceling the DP pool capacity shrinking

If DP pool shrinking is canceled, the data that has already migrated during the shrinking operation does not return to the original DP RAID group. Optimize the DP as needed. See Optimizing the DP pool on page 13-29 for GUI operation and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operation.

Growing or shrinking DP-VOL capacity

You can use Hitachi Storage Navigator Modular 2 to grow or shrink the capacity of a DP-VOL. When the DP-VOL capacity is shrunk, the DP pool area that was shrunk is released and the free capacity of the DP pool increases. See Changing DP-VOL capacity on page 13-21 for GUI operation and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operation.

The consumed capacity in the DP pool can be rebalanced by selecting Optimize after reducing capacity when shrinking DP pool capacity (see Optimizing a DP pool on page 10-9).

Deleting a DP-VOL

When you delete a DP-VOL, the DP pool area that the DP-VOL was using is released and the free capacity of the DP pool increases. See Deleting DP-VOLs on page 13-20 for GUI operation and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operation. When the DP volume is deleted, the monitor data is cleared from the relevant volume.

Deleting a DP pool

To delete a DP pool, first delete all DP-VOLS and then delete the DP pool. After a DP pool is deleted, the capacity shown in Hitachi Storage Navigator Modular 2 may not match the capacity that was displayed prior to the original creation of the DP pool.

Check that the deletion operation for the DP-VOL is completed, and then delete the DP pool (see Deleting a DP pool on page 13-12 for GUI operation and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operation).

Optimizing a DP pool

DP pools can be optimized. When adding a DP RAID group to the DP pool or shrinking a DP-VOL, the usage rate between DP RAID groups becomes unbalanced. When performing the DP pool optimization, the unbalanced usage rate between DP RAID groups can be rebalanced for each DP-VOL.

If there is unused capacity in the DP-VOLs at this time, the DP pool area is released and the free capacity of the DP pool increases. When the DP pool has Tier Mode enabled, DP optimization is averaged per tier for each DP volume.

An optional function lets you reclaim zero data when optimizing a DP pool. When using this option, a page can be released by discarding zero data, and the usage rate is automatically averaged for the DP-VOLs in the DP pool. As a result, the free capacity of the DP pool should increase.

When optimizing the DP pool, host I/O performance for the DP-VOLs deteriorates temporarily.

See Optimizing the DP pool on page 13-29 for GUI operation and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operation.

Using the DP pool optimization process to reclaim the zero data offers the following advantages:

- When restoring data from a tape, zero data is reclaimed during the restore process, reducing the amount of DP pool capacity used.
- After Volume Migration from a normal volume to a DP-VOL, the unused data is reclaimed and the capacity can be reduced.

- When using ShadowImage to copy a normal volume to a DP-VOL, the capacity of the DP-VOL may be reduced due to the reclamation of zero data. In a ShadowImage configuration, where the primary volume is in the DP pool and the secondary volume is a standard volume not in the DP pool, reclaiming the zero data reduces the overall capacity used by the ShadowImage pair compared to a ShadowImage configuration that uses two standard volumes.
- DP optimization can release unused area in the file system, reducing the capacity used by the file system.

DP Capacity Mode

When the firmware version for a Hitachi Unified Storage 130 or 150 system is 0950/A or later, you can change the upper limit of the DP pool capacity. Table 10-3 on page 10-10 shows the upper limit in case the mode is changed. The DP Capacity Mode changes to the maximum capacity when creating a DP pool exceeding the regular capacity or creating/expanding a DP-VOL where the total capacity of the DP-VOL defined in the array exceeds the regular capacity.

See Chapter 13, Performing Hitachi Dynamic Tiering operations for GUI operations and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operations.

Table 10-3: Maximum DP pool capacity value by DP Capacity Mode

Hitachi Unified Storage System	DP Capacity Mode	
	Regular capacity	Maximum capacity
130	Approximately 980 TB	Approximately 2,600 TB
150	Approximately 2,600 TB	Approximately 5,200 TB

If at least one instance of **Maximum Capacity** appears in the DP Optimization screen (see DP Optimization window on page 4-19), the firmware version for the Hitachi Unified Storage 130 or 150 system must be 0950/A or later. DP Capacity Mode is not supported by the Hitachi Unified Storage 110.

For Hitachi Unified Storage 150 systems with 8 GB of cache per controller, the DP Capacity Mode cannot be changed to the maximum capacity. To use the maximum capacity, set the installed cache memory capacity per controller to 16 GB.

Changing the DP Capacity mode might require the storage system to be restarted. If you do not restart the storage system or reconfigure memory after changing the DP Capacity Mode, DP operations may be limited. When using Cache Partition Manager, reconfiguring the memory does not change the DP Capacity Mode; the storage system must be restarted for the changes to take effect. Changing to maximum capacity mode resets Cache Partition Manager to default settings after system reboots (restarts).

If the volume size cannot be set after the memory reconfiguration, the DP Capacity Mode cannot be changed using memory reconfiguration. Cancel the resident volume or make the resident volume capacity small, and then restart the storage system. When restarting the storage system, the set resident volume is cancelled.

When changing from the maximum capacity mode to the regular capacity mode, DP pools should not exist.

If a Hitachi Unified Storage 130 system will be upgraded to a Hitachi Unified Storage 150 system, the maximum cache supported increases from 8 GB per controller to 16 GB per controller.

Table 10-4: Supported capacity in Regular Capacity mode

Hitachi Unified Storage System	Cache memory capacity per controller	Management information capacity (Dynamic Provisioning)	Management information capacity (Dynamic Tiering)	User data area		
				Dynamic Provisioning is disabled	Only Dynamic Provisioning is used	Dynamic Provisioning and Dynamic Tiering are used
130	8 GB	640 MB	200 MB	4,660 MB	4,020 MB	3,820 MB
	16 GB			11,280 MB	10,640 MB	10,440 MB
150	8 GB	1,640 MB	200 MB	4,540 MB	2,900 MB	2,700 MB
	16 GB			11,160 MB	9,520 MB	9,320 MB

Table 10-5: Supported capacity in Maximum Capacity mode

Hitachi Unified Storage System	Cache memory capacity per controller	Management information capacity (Dynamic Provisioning)	Management information capacity (Dynamic Tiering)	User data area		
				Dynamic Provisioning is disabled	Only Dynamic Provisioning is used	Dynamic Provisioning and Dynamic Tiering are used
130	8 GB	1,640 MB	200 MB	4,660 MB	3,000 MB	2,800 MB
	16 GB			11,280 MB	9,620 MB	9,420 MB
150	8 GB	3,300 MB	200 MB	4,540 MB	Not supported	
	16 GB			11,160 MB	7,860 MB	7,660 MB

Auto DP optimization mode

Auto DP optimization mode monitors unused capacity of each tier in a DP volume and performs DP optimization automatically.

In the DP volume where auto DP optimization mode is set, the unused capacity of each tier is monitored at midnight every day and DP optimization starts when the unused capacity equals or exceeds the auto DP optimization threshold value.

If the tier usage rate equals or exceeds the depletion alert threshold value, excluding the Buffer Space for New Page Assignment and the Buffer Space for Tier Relocation, DP optimization mode starts if the unused capacity of the tier equals or exceeds 1 GB. Table 10-6 shows the conditions when auto DP optimization is performed.

Table 10-6: Conditions when auto DP optimization is performed

Usage rate of each tier	Conditions for performing auto DP optimization
Usage rate less than {100 - (Total value of two buffers)}	Unused of the tier piles equals or exceeds the threshold value of the auto DP optimization
Usage rate more than or equal to {100 - (Total value of two buffers)	Unused capacity of the tier equals or exceeds 1 GB

NOTE: The total value of two buffers indicates the total value of the Buffer Space for New Page Assignment and Buffer Space for Tier Relocation.

This mode can be changed in units of DP volumes in the Change Attributes window at any time. By default, it is disabled. For more information, see Changing provisioning attributes on page 13-36.

Auto DP optimization does not use the option to reclaim the zero data page. To reclaim zero data page, perform DP optimization manually.

Before DP optimization is performed, auto DP optimization is checked (the same way manual DP optimization is checked prior to executing the DP optimization). During this time, unnecessary capacity accumulates. As a result, if the conditions for executing auto DP optimization are met, when the conditions for executing the DP optimization are not met, DP optimization is not executed.

Auto Progress Mode

By enabling Auto Progress Mode, you can schedule the start/stop/reset monitor operation or relocation process for automatic execution. Disabling Auto Progress Mode lets you perform these operations manually. See Changing High Efficiency Relocation and Auto Progress Mode on page 13-37 for GUI operation and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operation.

Monitoring time

You can schedule the time when Auto Progress Mode is enabled. The schedule can be set for one week, in units of 30 minutes. See Changing monitoring periods on page 13-40 for GUI operation and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operation.

Relocation time

You can schedule the time when relocation is performed. The schedule can be set for one week, in units of 30 minutes. See Changing relocation periods on page 13-38 for GUI operation and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operation.

Buffer space for new page assignment

You can specify the tier from which new pages are allocated. Over time, these pages move to upper tiers. Upper tiers become full before other tiers.

If the amount of available space in a tier is less than or equal to the free space for assignment:

- Pages are not relocated to that tier and
- The pages of that tier are relocated to another tier to free up space.

You can change buffer space assignments per tier using the Buffer Space for New Page Assignment option. See Changing the Tier attribute for a DP pool on page 13-10 for GUI operation and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operation.

NOTE: Do not configure buffer space for New Page Assignment settings for nonexistent tiers when creating a new pool, even if you are allowed to do so. Otherwise, the value becomes the default setting when you add the tier.

Buffer space for tier relocation

Hitachi Dynamic Tiering uses buffer space to allow tier relocation to occur if the DP pool becomes depleted. This buffer space is used even when the DP pool has been depleted, so that new pages can be allocated.

Hitachi Dynamic Tiering allocates buffer space in each tier, so there is always space available to support the relocation of pages among tiers. The Buffer Space value can be set per tier. This value can be set per tier. See Changing the Tier attribute for a DP pool on page 13-10 for GUI operation and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operation.

When the free space in the DP pool is less than to the following values, the target DP pool tier relocation does not operate.

- Total of "Each Tier capacityÍ (Buffer Space for New Page Assignment + Buffer area ratio for relocation)".

NOTE: Do not configure buffer space for Tier Relocation settings for nonexistent tiers when creating a new pool, even if you are allowed to do so. Otherwise, the value becomes the default setting when you add the tier.

Relocation speed

The system provides three relocation speeds. Table 10-7 on page 10-14 describes the speeds. Use the appropriate speed based on use case.

Table 10-7: Relocation speeds

Speed level	Use case	Relocation speed	Effect on host performance
High	When prioritizing relocation	110 MB/s	Up to 20%
Middle	Default When there is host I/O, host I/O is prioritized. When there is no host I/O, relocation is prioritized.	6 MB/s to 110 MB/s	5% to 20%
Low	When you do not want to affect host performance	6 MB/s	Up to 5%

This value can be set per system. See Changing relocation speed on page 13-42 for GUI operation and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operation.

High Efficiency Relocation Mode

High Efficiency Relocation Mode allows Hitachi Dynamic Tiering to promote or demote pages when such actions can improve performance significantly and reduce CPU usage on the Hitachi Unified Storage system. If relocating a page will not improve performance, Hitachi Dynamic Tiering will not promote or demote the page when High Efficiency Relocation Mode is enabled.

Table 10-8 shows the effects when this mode is enabled or disabled. See Changing High Efficiency Relocation and Auto Progress Mode on page 13-37 for GUI operation and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operation.

Table 10-8: Displayed items with High Efficiency Relocation Mode enabled or disabled

Items	High Efficiency Relocation Mode setting	
	Enabled	Disabled
Relocation cycle	One minute	
Relocation termination time	One hour to a few hours	Depending on relocation amount
Target	Tier performance operation rate, tier capacity usage rate	
Progress	Tier performance operation rate, tier capacity usage rate	
Border value relation	Tier border, Promotion/Demotion (PD) line	Tier border

Table 10-8: Displayed items with High Efficiency Relocation Mode enabled or disabled (Continued)

Items		High Efficiency Relocation Mode setting	
		Enabled	Disabled
Relocation speed	High	When prioritizing relocation	
	Middle	Default When there is host I/O, host I/O is prioritized. When there is no host I/O, relocation is prioritized.	
	Low	When you do not want to affect host performance.	

Relocation operation conditions

The following information is reported as the relocation operation conditions.

- Relocation operation condition

  The following items can be checked by the relocation operation condition.

  - Page scanning status
  - Utilization rate per tier
  - Performance utilization rate per tier

Table 10-10 on page 10-17 describes the relocation operation status conditions.

Table 10-9: Items that indicate relocation operation status

Items			Unit	Specification	Purpose
1.	Scanning Status		Pool	Displays the page scanning progress (0% to 100%). It is updated each minute. <Calculation method> (Number of checked pages /Check target pages) 100(%)	Checks the relocation operation. Refer to the number of moved pages (and consider moving amount, reset timing, and other factors).
2.	Utilization Percent	Current	Tier	Displays the current tier usage rate (%).	Calculates the current used capacity percentage for the tier.
3.		Target	Tier	Displays the target tier usage rate (%).	Calculates the system-generated target capacity percentage to support optimized tier operations.
4.		Difference	Tier	Displays the tier usage rate (current value) - the tier usage rate (target value) (%).	Calculates the difference between the current and target percentages.

Table 10-9: Items that indicate relocation operation status (Continued)

Items			Unit	Specification	Purpose
5.	Performance Utilization	Current	Tier	Displays the current tier operation rate calculated by Hitachi Dynamic Tiering.	Calculates the current performance utilization.
6.		Target	Tier	Displays the target tier operation rate calculated by Hitachi Dynamic Tiering. It is updated each minute.	Calculates the target performance utilization.
7.		Difference	Tier	Displays the tier performance utilization (current) - the tier performance utilization (target) (%).	Calculates the difference between the current and target percentages.

Tier relocation cannot be performed in the following cases:

- There is no usage of the pool (it is completely depleted).
- Pages have no performance monitoring information.
- The pool is blocked.
- The parity correction is being executed with the array power on.
- DP-VOL is being deleted
- DP-VOL is being blocked.
- When the free space in the DP pool is less than to the following values.
- Total of "Each Tier capacityÍ (Buffer Space for New Page Assignment + Buffer area ratio for relocation)".

The tier relocation is not performed to the following page:

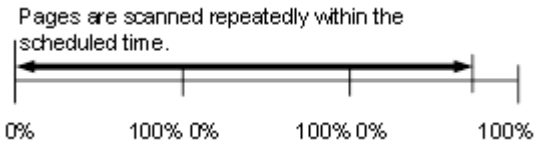
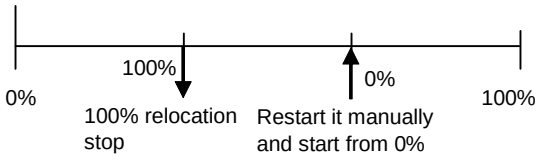
- Page to which the tier is not allocated

Relationship between the Auto Progress Mode and the Scanning Status

Table 10-10 on page 10-17 describes the relationship between Auto Progress Mode and the Scanning Status.

NOTE: When High Efficiency Relocation Mode is enabled, scanning speed adjusts automatically to complete scanning within one hour or several hours.

Table 10-10: Relationship between Auto Progress Mode and scanning status

Auto Progress Mode	Description	Example
Enabled	Pages are scanned repeatedly within the scheduled time. When the status becomes 100%, pages are scanned starting from 0% status.	
Disabled	When the status becomes 100%, page scanning stops. When relocation operations complete after the status becomes 100%, relocation does not operate unless you restart it manually.	

Frequency distribution output

In Hitachi Dynamic Tiering, statistics showing the rate of access frequency for each page of DP pools or DP-VOLs can be displayed and output in CSV format. Change maximum capacity and maximum access frequency as required.

For GUI operation, see:

- Displaying the frequency distribution of a DP pool on page 13-46
- Outputting the frequency distribution of a DP pool to a file on page 13-48
- Outputting the frequency distribution of a DP-VOL to a file on page 13-50

For CLI operation, refer to the *Hitachi Unified Storage Command Line Interface Reference Guide*.

Table 10-11: Displayed Items in frequency distribution

Items		Description
1.	Capacity (GB)	Consumed capacity (corresponding to the X-coordinate).
2.	Access Frequency (IOPH)	Access frequency (corresponding to the Y-coordinate).
3.	Total Access Frequency (IOPH)	Cumulative total of access frequency (corresponding to the Tips information).
4.	Tier Boundary	Thresholds between tiers.
5.	Promotion Line	Threshold for selecting pages to be promoted. It is shown only when High Effective Relocation Mode is enabled. If there is no change in promotion, the maximum value (3645106918) is shown.
6.	Demotion Line	Threshold for selecting pages to be demoted. It is shown only when High Effective Relocation Mode is enabled. If there is no change in demotion, this value matches the tier boundary value.
7.	Maximum Capacity	Maximum value for the X axis can be changed.
8.	Maximum Access Frequency	Maximum value for the Y axis can be changed.

Tier relocation cycle log

Hitachi Dynamic Tiering retains relocation information in a log. This information can be output as a comma-separated-value (CSV) file using Hitachi Storage Navigator Modular 2. Table 10-12 shows the information output from this log.

Table 10-12: Output items from the tier relocation cycle log

Items		Description
1.	Tier Boundary	Borderline for performing relocation
2.	PD Line	Borderline with higher priority than No.1
3.	Relocation Parameter	How frequently pages are promoted or demoted. Higher values mean pages are promoted/demoted frequently.
4.	Page Relocation Capacity	How much page capacity has been promoted/ demoted.
5.	Moving Average Tier Operating Ratio	Average value of the past tier operation rate
6.	Realtime Tier Operating Ratio	Current tier operation rate
7.	Goal Tier Operating Ratio	Target tier operation rate
8.	Access Frequency for Each Tier	Total number of I/Os per tier
9.	Page Usage Capacity	Page usage
10.	Frequency Distribution Chart	Frequency distribution (capacity, access frequency)

- CSV output format

The output format is shown below.

1. Tier relocation cycle log (Information of No.1 to No.9)
   - CSV output factor (per controller)

     Title - Title : Tier Relocation Cycle Log

     Acquired time - Get Time : 2012/05/11 12:34

     The above is output as a summary.

     The information of No.1 to No.9 is output per core.
2. Frequency distribution for every 1 to 2 hours (Information of No.10)
   - CSV output factor (per controller)

     Title - Title : Tier Relocation Cycle Log

     Acquired time - Get Time : 2012/05/11 12:34

     Information of No.10 is output per core in unit of pool in the following format. The summary is followed by the comma-delimited data.

     Entry No., Capacity (GB), Access Frequency (IOPH)
     0,0,1.04

- Format of output file name

  The format of the output file name for tier relocation cycle log is shown below. Outputting from the GUI is a zip file.

  - *Serial number_CTL number_relocation_cycle_LOG_acquired time.csv*

    Example:

    Serial number: controller #0 of 93000001,

Acquired time (=the time of pressing the CSV output button (RTC time)): 2012/05/11 12:34

93000001_CTL0_relocation_cycle_LOG_201205111234.CSV

NOTE: Previous information is also collected.

See Outputting the Tier Relocation Cycle Log on page 13-44 for GUI operation and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operation.

Page Relocation Log output

Hitachi Dynamic Tiering retains the page relocation condition in a log. This information can be output as a CSV file using Hitachi Storage Navigator Modular 2. Table 10-13 on page 10-20 shows the information output from this log. This information is output for each controller, as configured in Hitachi Storage Navigator Modular 2.

Table 10-13: Output items from the page relocation log

Items		Explanation
1.	End Relocation Time	Time when the page moving is completed (RTC time)
2.	DP VOL	DP-VOL number
3.	Page Offset	Page number in the DP-VOL
4.	Source Tier	Tier number of the moving source
5.	Destination Tier	Tier number of the moving destination
6.	Monitor Count	Monitor value of page
7.	Status	Page relocation status (Good, Retry(R), Retry(W), Skip)

- CSV output format

  The output file format of the page relocation log is shown below.

  Title : Page Relocation LOG Title
  Get Time : 2012/05/11 12:34 Acquired time

  Core : X Core
  ① ? ? ? ? ? ?

  End Relocation Time,DP VOL,Page Offset,Source Tier,Destination Tier,Monitor Count,Status
  2012/09/20 15:16,102,9472,3rd,1st,24,Skip
  2012/09/20 15:20,102,2657,3rd,1st,20,Skip

  Core : Y Core
  ① ? ? ? ? ? ?

  End Relocation Time,DP VOL,Page Offset,Source Tier,Destination Tier,Monitor Count,Status
  2012/09/20 15:16,102,9472,3rd,1st,24,Skip
  2012/09/20 15:20,102,2657,3rd,1st,20,Skip

  When there is no data:

  :

```
End Relocation Time,DP VOL,Page Offset,Source Tier,Destination Tier,Monitor Count,Status
--- No Information ---
```

NOTE: The circled numbers in the output format shown above correspond to the No. in Table 10-13.

- Format of output file name

  The output filename format of the page relocation log is shown below.

  When outputting a log in the GUI, the log is output as a zip file.

  - *Serial number_CTL number_page_relocation_LOG_acquired time.csv*

  Example:

  Serial number: controller #0 of 93000001,

  Acquired time (=the time of pressing the CSV output button (RTC time)): 2012/05/11 12:34

  93000001_CTL0_page_relocation_LOG_201205111234.csv

The CSV information is cleared under the following conditions:

- Controller block
- Storage system shutdown
- Firmware replacement

See Displaying the frequency distribution of a DP pool on page 13-46 for GUI operation and refer to the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operation.

Accelerated Wide Striping Mode

You can apply Accelerated Wide Striping Mode to the DP-VOL of a DP pool managed in a tier. If you do, the DP-RG corresponding to the allocation destination is relocated, which may cause undesired results. Therefore, we recommend you not use Accelerated Wide Striping Mode with tiers.

See Changing High Efficiency Relocation and Auto Progress Mode on page 13-37 for GUI operation and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operation.

Full Capacity Mode

When applying Full Capacity Mode to the virtual VOL of a DP pool managed in the tier, Anchored Capacity increases by relocation. For this reason, we recommend you perform DP optimization regularly.

See Changing provisioning attributes on page 13-36 for GUI operation and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operation.

New page assignment tier

The new page assignment tier options determine the assignment destination tier of new pages for the DP-VOL of a DP pool managed in a tier.

This option has three settings: High, Middle, and Low.

- **High**. Hitachi Dynamic Tiering assigns new pages to the first tier as much as possible. Priority transitions from the first tier to the second and third tiers when there is no free space for new pages in higher priority tiers.
- **Middle**. Hitachi Dynamic Tiering assigns new pages to the second tier as much as possible. Priority transitions from the second tier to the third and first tiers when there is no free space for new pages in higher priority tiers.
- **Low**. Hitachi Dynamic Tiering assigns new pages to the third tier as much as possible. Priority transitions from the third tier to the second and first tiers when there is no free space for new pages in higher priority tiers

See Changing relocation speed on page 13-42 for GUI operation and the *Hitachi Unified Storage Command Line Interface Reference Guide* for CLI operation.

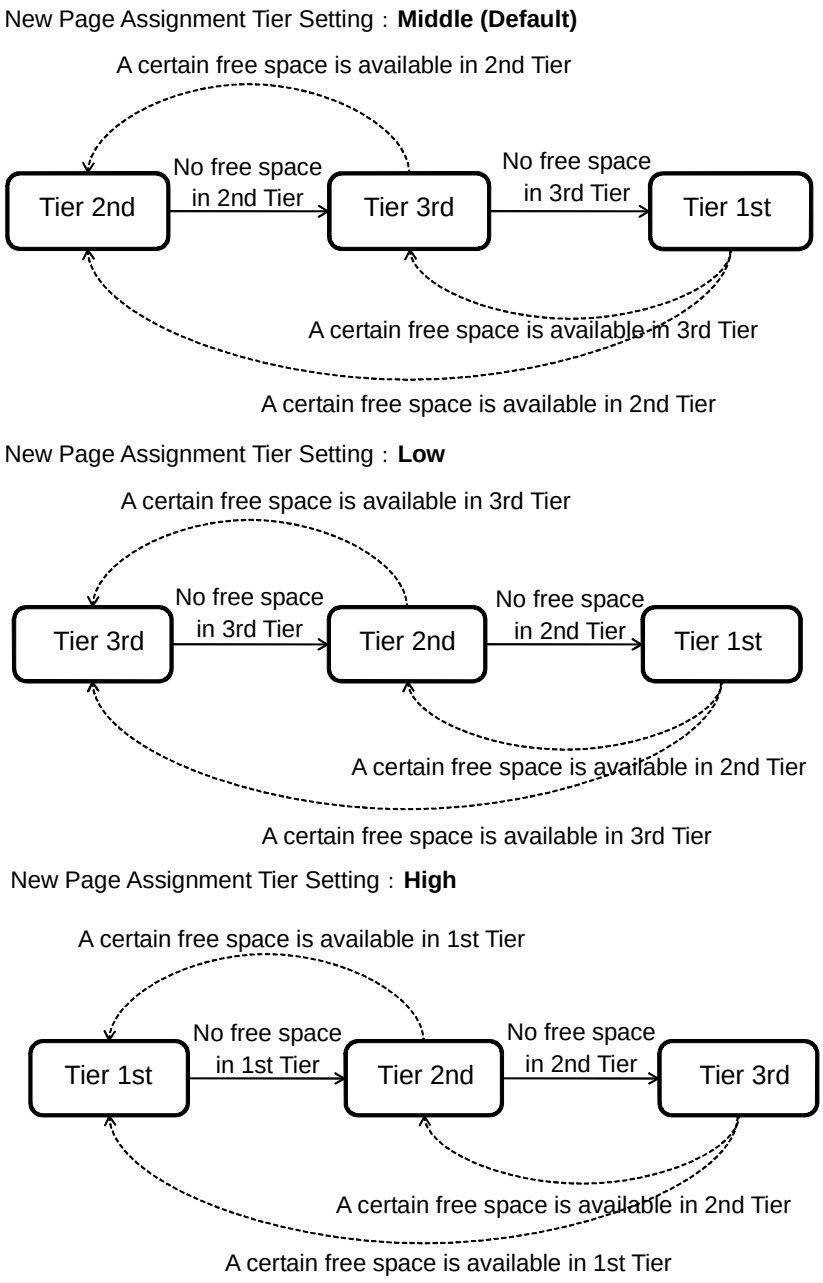


Figure 10-2: Determining assignment tiered (example with 3 tiers)

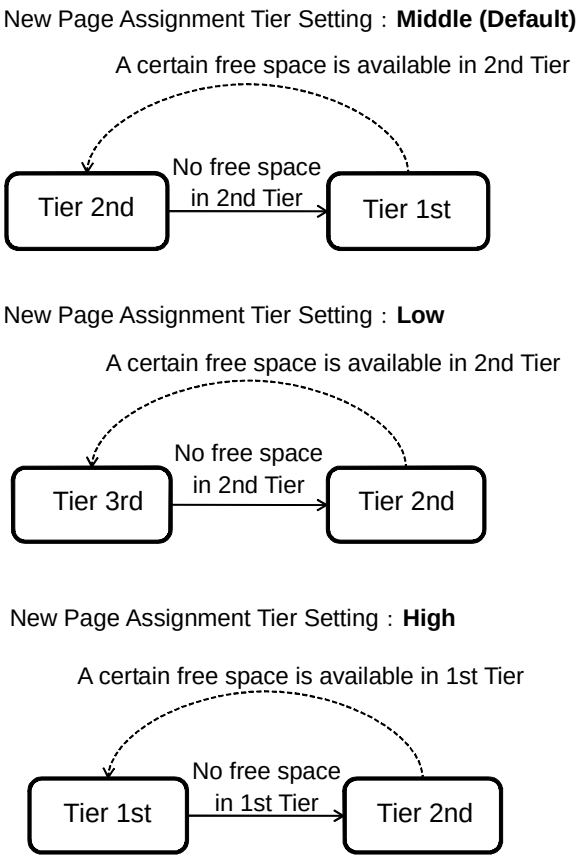


Figure 10-3: Determining assignment tiered (example with 2 tiers)

Prompt promotion

Instead of waiting for the general Pool scanning process to determine when promotion is necessary, prompt promotion considers factors such as the amount of I/O directed to tiers and then determines which tier is best to promote the page.

Monitored I/O

Hitachi Dynamic Tiering can monitor three types of I/O:

- Read/Write
- Read
- Write

Use this mode to perform tier relocation by I/O type. When using media such as SSDs or FMDs that support fast Read operations, use the Read setting.

NOTE: The count number of the pages being monitored does not change.

Disabling Tier Relocation

Relocation can be disabled for the DP volumes that belong to a DP pool managed by the tiers. Relocation operations are not performed for the DP volumes that have tier relocation disabled; however, monitoring continues when relocation is disabled.

Before disabling tier relocation, check **usage per tier of the relevant DP volume** to determine how it will affect future performance and affect other DP volumes registered in the same pool.

While relocating the attributed DP pool with Disabling Tier Relocation of the scanned DP volume enabled, the disable setting might not be reflected until the next scan.

Frequency distribution

The frequency distribution of the DP volume that sets the Disabling Tier Relocation is excluded from the frequency distribution per DP pool. However, it is displayed in the frequency distribution per DP volume.

Relocation operating conditions

For the relocation operating condition, the DP volume that sets the Disabling Tier Relocation is excluded. For the current tier use rate, however, the capacity of the DP volume that sets the Disabling Tier Relocation is added and displayed.

Relocation capacity

Relocation capacity of a DP volume that sets the Disabling Tier Relocation is excluded from the displayed DP pool tier relocation capacity per DP pool and the displayed volume tier relocation capacity per DP volume. For the displayed usage capacity for the volume tier relocation, the capacity of the volume that sets the Disabling Tier Relocation is added and displayed.

Real Time Relocation Speed

Current real-time relocation speed of the DP volume that belongs to a DP pool managed by tiers is displayed in MB/s as the average speed per minute. The DP volume with the real-time relocation speed is the currently relocated DP volume. Real-time relocation speed depends on the relocation speed setting **High / Medium / Low**, the host I/O pattern, and the load.

Real-time relocation speed provides information about the relocating DP volume that operates relocation and displays the target speed. Check with the page relocation log to confirm true speed.

Observe the following guidelines about real-time relocation speed:

- If the DP pool is relocating, the real-time relocation speed for the DP volume that is not a relocation target is shown as **0MB/s**.

- Since the average real-time relocation speed is one minute, the DP volume capacity is small. If relocation of a DP volume finishes within one minute, the relocation speed shown might be different that the true speed of the relocation.
- If the VOL switching is performed for the DP volume, you might have to wait one minute or more for the correct real-time relocation speed to be displayed.

Interoperability with other Hitachi software features

Table 10-14 shows the conditions for using Hitachi Dynamic Tiering with other Hitachi software features. In a Hitachi Unified Storage system, where the normal volume and the DP-VOL are mixed, the Hitachi software features can be used with the normal volume. A DP-VOL may suffer from restrictions placed on it by other Hitachi software features.

Table 10-14: Permitted use of Hitachi software features

Software feature	Conditions
Dynamic Provisioning	This is a prerequisite software feature.
	If Dynamic Provisioning is not installed, Hitachi Dynamic Tiering cannot be installed.
ShadowImage	The DP-VOL can be used for both P-VOL and S-VOL.
	The DP-VOL used by ShadowImage cannot increase in capacity.
	ShadowImage pairs can be created for DP-VOLs during the DP pool optimization.
	If Full Capacity Mode is enabled, set both P-VOL and S-VOL to the same mode status.
Copy on Write Snapshot	The DP-VOL can be used for P-VOL and S-VOL.
	Copy on Write Snapshot cannot be used with a DP pool on an SSD/FMD when Tier Mode is enabled.
TrueCopy or TrueCopy Extended	The DP-VOL can be used for both P-VOL and S-VOL.
	If Full Capacity Mode is enabled, set P-VOL and S-VOL to the same mode status.

Table 10-14: Permitted use of Hitachi software features (Continued)

Software feature	Conditions
TrueCopy Extended	The DP-VOL can be used for both P-VOL and S-VOL.
	If Full Capacity Mode is enabled, set P-VOL and S-VOL to the same mode status.
	The TCE pair operation cannot be performed in a DP pool (with Tier Mode enabled) configured with SSDs/FMDs only.
	The DP Capacity Mode cannot be changed by reconfiguring the memory while using Cache Partition Manager. When changing to the maximum capacity mode by restarting the storage system, the partition setting returns to the default.
	If you do not restarting the storage system or reconfigure memory after changing the DP Capacity Mode, Cache Partition Manager cannot be installed or validated.
LUN Manager and Cache Partition Manager	The DP-VOL can be set as well as the normal volume.
	DP pool of Hitachi Dynamic Provisioning cannot be set.
	DP Capacity Mode cannot be changed by reconfiguring the memory while using Cache Partition Manager. When changing to maximum capacity mode by restarting the array, the partition setting returns to the default.
	If you do not restart the array or reconfigure memory after changing the DP Capacity Mode, Cache Partition Manager cannot be installed or validated.
Volume Migration	Volume Migration cannot be created for the DP-VOLs during the DP pool optimization.
	DP pool optimization cannot be executed for DP-VOLs used by Volume Migration.
	If Full Capacity Mode is enabled, set both P-VOL and S-VOL the same mode status.
Cache Residency Manager	The DP-VOL cannot be used.
	DP pool of Hitachi Dynamic Provisioning cannot be used.
	DP pool of Hitachi Dynamic Tiering (with Tier Mode enabled) cannot be used.
Cache Residency Manager	The power saving function cannot be used for the DP RAID group belonging to the DP pool.
Power Saving/Power Saving Plus	The power saving function cannot be used for the DP RAID group belonging to the DP pool.

When using ShadowImage or TrueCopy DMLU, observe the following:

- If a Tier consists only of SSDs/FMDs, the DMLU cannot be created.
- If capacity is depleted, except for the SSD/FMD in the Tier, the DMLU cannot be created.

You cannot create Copy on Write Snap Shot and/or TrueCopy Extended Distance pairs with a DP pool that is configured from SSDs/FMDs only. To avoid this situation, the DP-Pool must consist of multiple tiers and tiers 2 and/or 3 must have free capacity available.

For a pool used by Hitachi Dynamic Tiering, you can calculate the capacity that can be used for replication management data by subtracting the SSD/FMD tier from the entire pool capacity. For the usable capacity and the usage rate, refer to Hitachi Storage Navigator Modular 2.

Table 10-15: Calculating pools

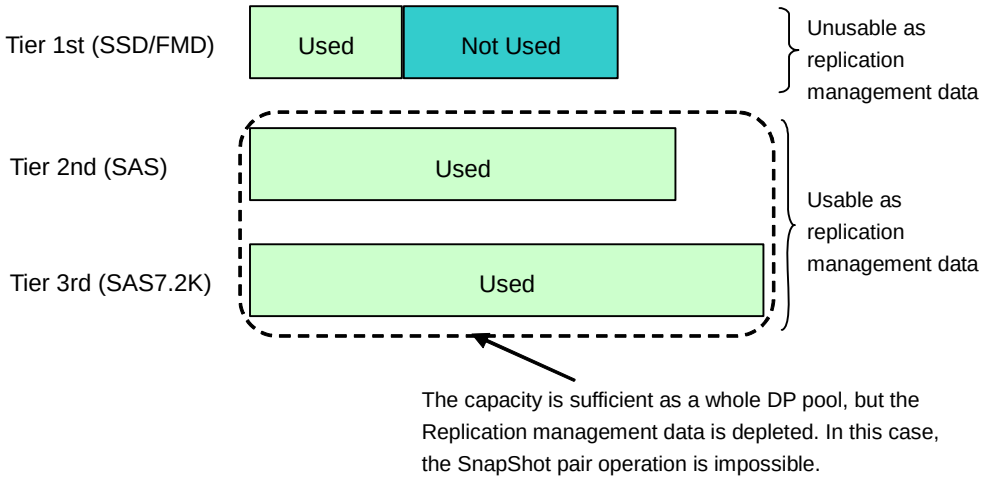
Items	Unit	Description	Remarks
Replication usable capacity (GB)	Pool	Entire capacity - Entire Tier capacity of the SSD/FMD **(Note)**	Displayed only when Copy on Write Snapshot/TrueCopy Extended Distance is unlocked
Replication usage rate (%)	Pool	(Use capacity - entire capacity of the SSD/FMD Tier) **(Note)** /Replication usable capacity Í 100	Displayed only when Copy on Write Snapshot/TrueCopy Extended Distance is unlocked

NOTE: The SSD/FMD tier is excluded when the tier mode of a DP pool is enabled. In this case, the usable capacity for replication is calculated based on the entire capacity of the pool, less the SSD/FMD tier capacity, as the SSD/FMD tier cannot be used for SS/TCE. If the mode of the DP pool is disabled, the usable replication capacity is the entire capacity of the DP pool.

Example: This example describes a scenario that prevents Copy on Write Snapshot from being used. In this example, the DP pool is not depleted, but usage for the replication is depleted. As a result, replication usage rate becomes 100%. Therefore, the Copy on Write Snapshot pair operation cannot be executed. While there is free capacity in DP pool, it all resides in the first tier and replication management data may not be located in the first tier. As a result, the Copy on Write Snap Shot pair operations will not function.

Replication cannot store data in an SSD/FMD tier, as described above. As a result, if a DP pool is not depleted and all tiers except for the SSD/FMD tier are depleted, replication cannot occur because it does not have available space to store data in the DP pool. In this case, data must be stored in tiers other than those for SSD/FMD.

In the following figure, both 2nd tier (SAS) and 3rd tier (SAS7.2 K) have been depleted for a DP pool and only the 1st tier (SSD/FMD) has been left; however, replication cannot store data in the 1st (SSD/FMD) tier.



Monitoring resources and tuning

The following sections describe the functions used to accumulate DP pool trend information and the information displayed in Performance Monitor to support the management of Hitachi Dynamic Provisioning.

Monitoring DP pool usage

DP pool usage rate and the DP-VOL usage rate can be displayed in the DP pool window and LUN property window, respectively. In this way, you can monitor the free capacity of a DP pool and DP-VOL, and estimate increases in capacity over time.

Table 10-16: Viewing Method of the DP Pool Usage

Usage rate of...	Viewing method
DP-VOL	• Usage rate can be displayed per DP-VOL. The usage rate of the DP-VOL is a ratio of the DP-VOL capacity and used data capacity. • The current value of the DP-VOL usage rate can be displayed.
DP pool	• The DP pool usage rate can be displayed per DP pool. • The current value of the DP pool usage rate can be displayed.

Figure 10-4 on page 10-30 shows an example of DP pool usage rate over time.

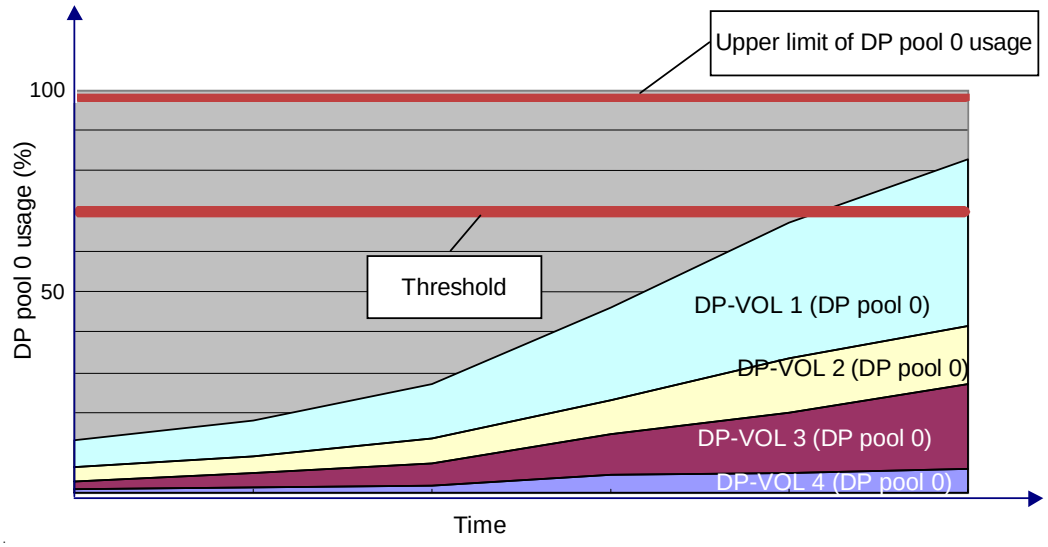


Figure 10-4: Example of DP pool usage rate over time

Alert threshold of DP pool usage capacity

DP pool usage is monitored by threshold value. A DP pool has two threshold values:

- Early Alert threshold value — threshold value that warns when capacity is near depletion
- Depletion Alert threshold value — threshold value that warns when additional capacity is required

The value of each threshold can be set as shown below. The values can be configured independently for usage conditions.

- Early Alert threshold value can be set in units of 1%, ranging from 1% to 99%. Default value is 40%.
- Depletion Alert threshold value can be set in units of 1%, ranging from 1% to 99%. Default value is 50%. This value must be larger than the Early Alert threshold value.

Select a notification method in Hitachi Storage Navigator Modular 2 to alert you in case DP pool usage exceeds the value above (see Table 10-17).

Table 10-17: Alert threshold notification method

Notification method	Notification timing (note 1)	Hitachi Storage Navigator Modular 2 alert method	
E-Mail	Over the threshold value (**Note 2**)	Uses e-mail alert function	
SNMP Trap		Uses SNMP Agent Support Function and set a parameter	
Windows Event Viewer	Interval time	Logs out to Windows Event Viewer (Note 3)	Sets time option for the **auerroralert** command (Note 4)

NOTE 1: Recovery information is not reported.

NOTE 2: The Depletion Alert threshold value is reported once in six hours, unless the DP pool unconsumed capacity improves.

NOTE 3: The DP pool status is output during command execution.

NOTE 4: Hitachi Storage Navigator Modular 2 GUI is not supported.

Figure 10-5 shows how the alert threshold monitors DP pool usage capacity.

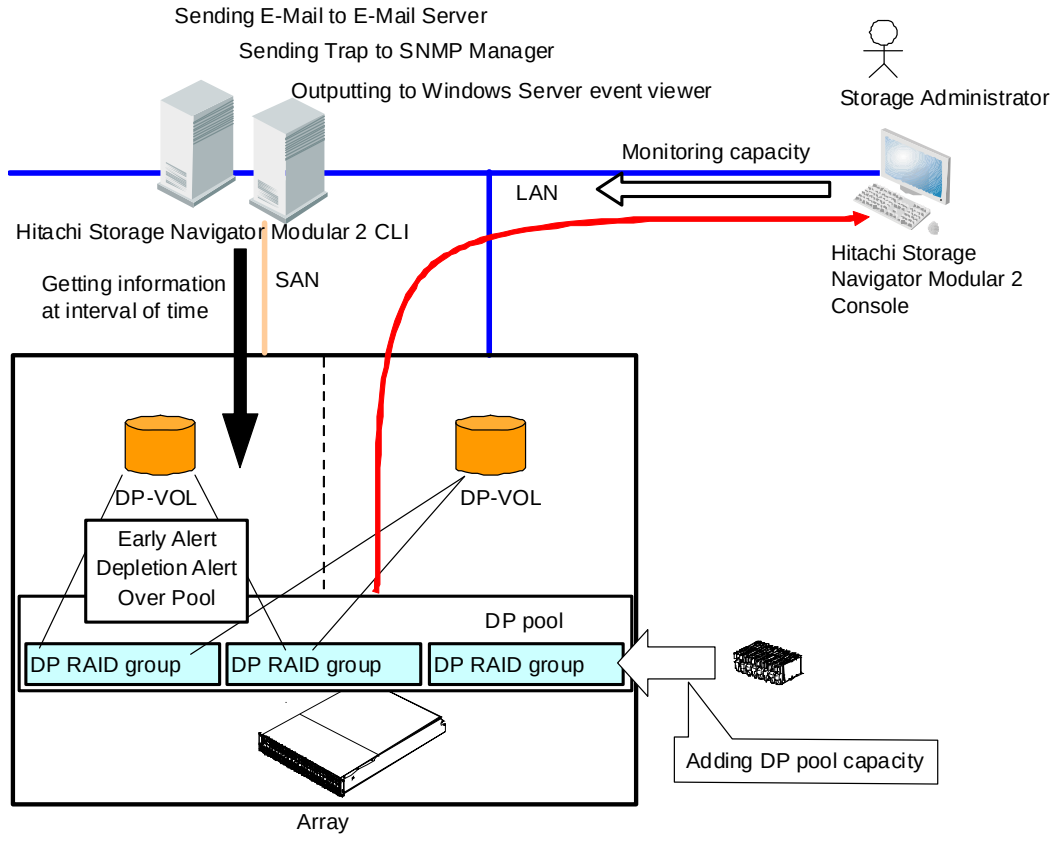


Figure 10-5: Monitoring alert threshold of DP pool usage capacity

Example: Assume the entire capacity of a DP pool is 1 TB and the Early Alert threshold value is 40%.

Figure 10-6 on page 10-32 shows the DP pool capacity when the Early Alert threshold value is 40%. If the DP pool consumed capacity exceeds 40% (400 GB) of the entire DP pool, this condition is reported by the e-mail function in Hitachi Storage Navigator Modular 2 or by an SNMP trap.

If the DP pool consumed capacity increases and exceeds the Deletion Alert threshold value (for example, 50%), this condition is also reported by e-mail or SNMP trap. The Deletion Alert threshold value is reported once every six hours while a new DP-VOL cannot be defined and/or grown, unless the DP pool unconsumed capacity improves. If the capacity does not increase, additional DP-VOLs cannot be defined and existing DP-VOLs cannot be grown. The array is operational, although a warning message appears when the definition/growing of the DP-VOL, DP Optimization, or LU mapping the host group/iSCSI target group is performed at the time of depletion or Depletion Alert status. We recommend you grow the capacity immediately.

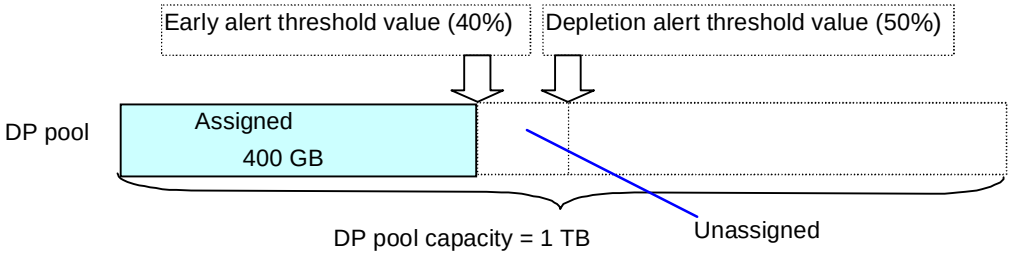


Figure 10-6: DP pool capacity when Early Alert Threshold value is 40%

Although Hitachi Dynamic Tiering monitors usage and alerts you when the usage reaches threshold values, best practices dictate that you remain aware about how much capacity is available and consumers for your pools to avoid having the application terminate unexpectedly or system failures.

Notification of threshold values can be selected as an option. During normal operation, enable this option. Otherwise, the application can terminate abnormally without noticing the depletion status or a system shutdown failure can occur.

To monitor the alert threshold of the DP pool usage capacity using the Windows Event Viewer, specify an interval time to the **auerroralert** command in the Hitachi Storage Navigator Modular 2 CLI. If *atheinterval* time is set too long, the interval to output the DP pool depletion message becomes long and the depletion message may be unable to be output.

Example: Figure 10-7 on page 10-33 shows the relationship with failure-monitoring times of e-mail, SNMP trap, and Windows Event Viewer when the DP pool consumed capacity is changed over time as shown Figure 10-7 on page 10-33. In Table 10-18, x = not supported and o = supported.

In this example, if the used capacity of a DP pool reaches a threshold value of 40%, and then the used capacity falls to 38%, the alert is not removed, as 38% is within -5% of the set threshold value of 40%. The 5% buffer configured below each threshold value is acceptable when there are frequent and small (under 5%) fluctuations in used capacity, as there would

be few alerts generated when small fluctuations occur. Without a buffer configured to 5%, alerts occur each time the used capacity reaches just below the threshold value and rises above the threshold value.

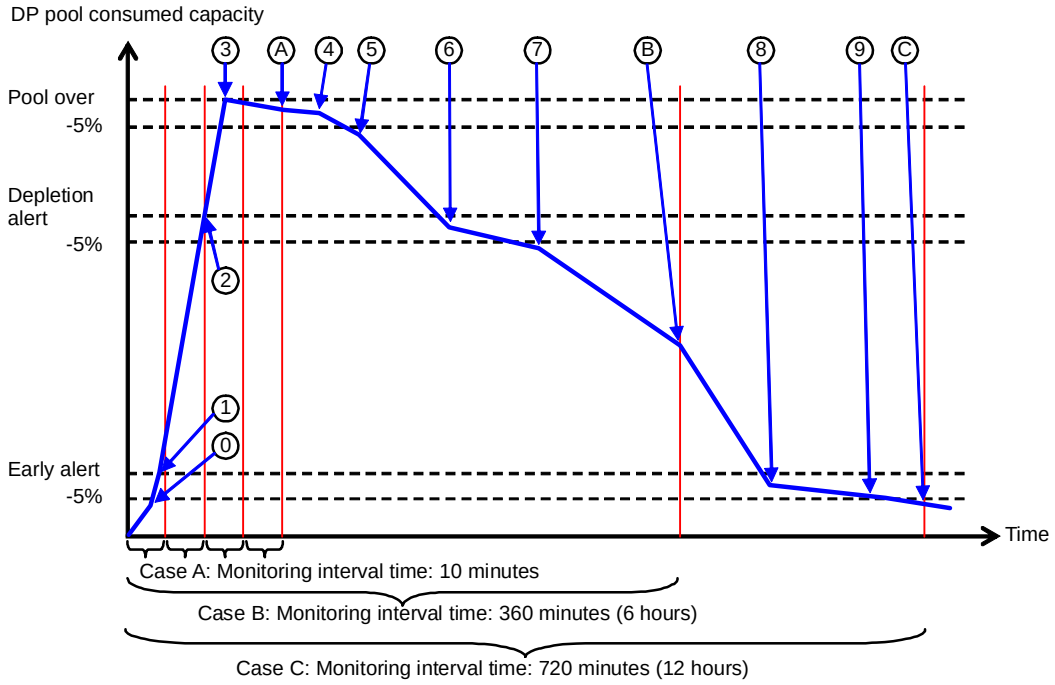


Figure 10-7: Relationship between the DP Pool consumed capacity and the threshold value report

Table 10-18: Notification by status

Items	Figure Number on Figure 10-7									
	0	1	2	3	4	5	6	7	8	9
Status in Hitachi Storage Navigator Modular 2	Normal	Early Alert	Depletion Alert	Capacity Over	Over capacity	Depletion Alert	Depletion Alert	Early Alert	Early Alert	Early Alert
E-Mail **(Note)**	x	O	O	O	x	x	x	x	x	x
SNMP **(Note)**	x	O	O	O	x	x	x	x	x	x
Windows Event Viewer	x	O	O	O	x	x	x	x	x	x

Case A: In Figure 10-7, 1, 2, and 3 are output. At point A, since the capacity deletion is already output, it is not output again. The next time it is output, the capacity must be less than 5% of the threshold value.

Case B: The early alert log in the current status is output.

Case C: Since the current status is Normal, nothing is output in the log.

NOTE: The Depletion Alert threshold value is reported once in six hours, unless the DP pool unconsumed capacity improves.

DP-VOL over provisioning threshold

The DP-VOL setting in the DP pool is monitored by the threshold value. The DP-VOL has two threshold values:

- Warning — threshold value to notice the definition excess of the DP-VOL
- Limit — threshold value to notice the limit definition excess of the DP-VOL

The value of each threshold can be set as shown below.

- Warning Alert threshold value: This can be set in units of 1%, ranging from 50% to 1000%. Default value is 100%.
- Limit Alert threshold value: This can be set in units of 1%, ranging from 50% to 1000%. Default value is 130%. It is required to set a value larger than the Warning Alert threshold value.

Select a notification method in Hitachi Storage Navigator Modular 2 to alert you in case DP pool usage exceeds the value above (see Table 10-19).

Table 10-19: Over Provisioning threshold notification method

Notification method	Notification timing	Alert method in Hitachi Storage Navigator Modular 2
E-Mail	Over the Provisioning threshold value	Use e-mail alert function
SNMP Trap		Install SNMP Agent Support Function and set a parameter

Example: Assume the entire capacity of a DP pool is 1 TB and the Warning Alert threshold value is 100%

Figure 10-8 on page 10-35 shows the DP pool capacity when the Warning Alert threshold value is 100%. At this time, if the DP-VOL with a capacity of 1 TB is defined, it becomes 100% of the DP pool capacity and is reported by e-mail and SNMP trap.

Assume there is a DP pool capacity of 1 TB, a threshold value set to 130%, and that you have a volume of 1 TB. If you create an additional volume larger than 300 GB into the DP pool, an alert would warn you that the total capacity of the two volumes would exceed 1.3 TB, which is 130% of the entire capacity of the DP pool. If the limit threshold value is exceeded, adding or extending the DP-VOL and enabling Accelerated Wide Striping Mode are restricted until DP pool capacity is added.

If the version of the firmware is 0935/A or later, you can add or expand a volume and enable Accelerated Wide Striping Mode when the limit threshold is exceeded by enabling the **Limit Enforcement** option. Exercise care because adding a volume exceeding the limit threshold increases the risk of pool capacity depletion.

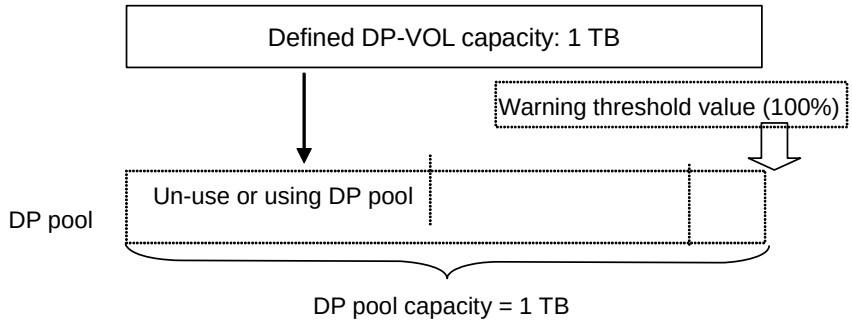


Figure 10-8: DP pool capacity when warning alert threshold value is 100%

The ways that the Over Provisioning threshold is calculated depends on whether Accelerated Wide Striping Mode for the DP volumes is enabled or disabled.

- If Accelerated Wide Striping Mode is disabled, the Over Provisioning Threshold =Total Capacity of DP Volumes in DP Pool / DP Pool Capacity
- If Accelerated Wide Striping Mode is enabled, the Over Provisioning Threshold = (SUM (ceiling (STDlun)) + SUM (ceilingRG (AWSlun))) / DP Pool Capacity
  - **SUM**: Total.
  - **STDlun**: Size of the normal DP volume in units of GB.
  - **ceiling (STDlun)**: Size of the DP volume rounded up to the nearest GB.
  - **AWSlun**: Size of each DP volume whose AWS (Accelerated Wide Striping) is enabled in units of GB.
  - **ceilingRG (AWSlun)**: Size of the DP volume rounded up to the nearest value that is an integer multiple of the number of RAID groups in the pool. If the pool has four RAID groups, AWSlun should be 4, 8, 12, 16 ... GB. However, if there is a page of a fraction within the number of RAID groups, do not round it up.

NOTE: If Tier Mode is enabled and the SSD/FMD drives are in the pool, use the same calculation method as when Accelerated Wide Spring Mode is disabled, even if the mode is enabled.

Example: Assume the DP pool capacity is 100 GB, the number of DPRAID groups is 20, and the number of DP volumes is four (128 MB, 100 GB, 4 GB and 10 GB).

- If Accelerated Wide Striping Mode is disabled, the Over Provisioning Threshold = (1 + 100 + 4 + 10) / 100 Í 100 = 115.0%.

- If Accelerated Wide Striping Mode is enabled:
  - Over Provisioning Threshold = (4 + 100 + 20 + 20) / 100 Í 100 =144.0%.
  - AWSlun = 1 GB, 100 GB, 4 GB and 10 GB.
  - ceilingRG (AWSlun) = 4 GB (Note), 100 GB, 20 GB, and 20 GB.

NOTE: Convert 20 GB to 4 GB for the page of any fraction within the number of RAID groups.

DP pool status

Table 10-20 shows the DP pool status displayed in Hitachi Storage Navigator Modular 2.

Table 10-20: DP pool status

Status	Meaning
Normal	Indicates that this DP pool is normal.
Check Component	Indicates that a disk drive in the DP pool is being rebuilt or in copy back operation, or that unformatted volumes exist in the DP pool. Copy back is a copy feature that transfers data from a spare disk to a newly added drive after data transfers from an old drive to the spare.
Regression	At least one DP RAID group is regressed. It is necessary to replace the blocked drive.
Detached	At least one DP RAID group is detached. It is necessary to reconfigure the DP pool.

DP pool formatting status

The DP pool formatting progress level is displayed in the form of **Formatting (nn%)**, where n is 1 to 99. The capacity of the displayed progress level is usable. See DP pool capacity shrink status conditions on page 10-38 for information about the DP pool capacity shrinking status.

DP pool optimization status conditions

Table 10-21 shows the DP pool optimization status conditions displayed in Hitachi Storage Navigator Modular 2.

Table 10-21: DP pool optimization status

Status	Meaning
Normal	Non-optimized
Accepting	Accepts optimizing
Pending(n)	Waits for optimizing to begin. (n) shows order.
Optimizing(nn%)	Optimizing DP. (nn%) shows optimization as a percentage.

Table 10-21: DP pool optimization status (Continued)

Status	Meaning
Suspended(nn%)	Optimization suspended by a status change of an array system. When the status of an array system changes, optimization resumes automatically.
Canceling	Receives cancellation of optimization by a user.
Failed(Code-nn: error message)	Optimization failed because problems occurred in the array. Following the direction of the error codes and error messages below, optimize again. If it fails again, contact HDS support at portal.hds.com. • Failed(Code-01:DP Pool Detachment) = optimization failed because the DP pool with the optimized DP volume is detached. Please Optimize again after recovering the DP pool. • Failed(Code-02:DP Pool Depletion) = optimization failed because not enough capacity is available to optimize. Please optimize again after adding the required DP pool capacity. • Failed(Code-03:Destage Time-out) = optimization failed because the host I/O load for optimizing DP volumes and the DP pool to which it belongs is too high. Please optimize again while the host I/O load is low. If it fails again, stop the array and then restart it.

If the DP optimization status is Suspended(50%) or does not change from Pending(n), the internal processing might be running. Check the progress of the internal processing in the next screen, and wait for DP optimization to start.

- The capacity of Needing Preparation in the DP Optimization Screen is not zero (0).
- When the recoverable capacity in the DP Optimization screen increases or decreases.

DP RAID Group status conditions

Table 10-22 shows the DP RAID Group status conditions displayed in Hitachi Storage Navigator Modular 2.

Table 10-22: DP RAID Group status conditions

Status condition	Description
Normal	DP RAID group is normal.
Check Component	Drive (HDU) that configures the DP RAID group is in copy back mode or the unformatted volume is included.
Regression	DP RAID group is regressed. Replace the blocked drive.
Detached	DP RAID group is detached. Reconfigure the DP pool.

Check the Reconstruction Progress in units of DP pools.

The DP RAID Group formatting progress level is displayed in the form of **Formatting (nn%)**, where n is 1 to 99. The capacity of the displayed progress level is usable.

DP pool capacity shrink status conditions

Table 10-23 on page 10-38 shows the DP pool capacity shrink status conditions displayed in Hitachi Storage Navigator Modular 2.

Table 10-23: DP RAID Group status conditions

Status condition	Description
Shrinking(Relocating(nn%))	The DP pool capacity shrinking data is relocating. The number in parentheses shows the progress level.
Shrinking(Reconfiguring(nn%))	The DP pool capacity shrinking data is relocating and changing the configuration. The number in parentheses shows the progress level. DP pool shrinking cannot be canceled.
Shrinking(Pending)	Waiting for DP pool capacity shrinking to start.
Shrinking(Suspended)	DP pool capacity shrinking is interrupted due to changes of the array status. This operation automatically restarts while the array status changes.
Shrinking(Canceling)	A user request to cancel DP pool capacity shrinking has been accepted.

Table 10-23: DP RAID Group status conditions (Continued)

Status condition	Description
Shrinking(Failed(Code-nn: error message))	Shrinking failed because problems occurred in the array. Follow the directions of the error codes and messages below. If it fails again, contact HDS Support at portal.hds.com. • Failed (Code-01) DP Pool was blocked. Processing failed because the status of the DP pool to which the DP RAID group number (RAID group number) belongs is not normal. Cancel the pool capacity shrinking of the DP RAID group number (RAID group number) displayed as an error and execute it again after the recovery. See A DP pool is blocked. on page 14-6. • Failed (Code-02) DP-VOL was blocked. Processing failed because the status of the DP-VOL to which the DP RAID group number (RAID group number) belongs is not normal. Cancel the pool capacity shrinking of the DP RAID group number (RAID group number) displayed as an error and execute it again after the recovery and see A DP-VOL is blocked. on page 14-6. • Failed (Code-03) DP pool was depleted. Processing failed because the DP pool to which the DP RAID group number (RAID group number) belongs is depleted. Cancel the pool capacity shrinking of the DP RAID group number (RAID group number) displayed as an error and execute it again after the recovery and see DP pool capacity is depleted (DP pool status is Capacity Deplete). on page 14-5. • Failed (Code-04) The array is abnormal. Processing failed because an abnormal array is detected in the DP RAID group number (RAID group number). Cancel the pool capacity shrinking of the DP RAID group number (RAID group number) and contact the service personnel to recover the PIN.

Shrinking(Failed(Code-nn: error message))	• Failed (Code-05) The array is abnormal. Processing failed because an abnormal array is detected in the DP RAID group number (RAID group number). Cancel the pool capacity shrinking of the DP RAID group number (RAID group number) and contact the service personnel to recover the PIN. • Failed (Code-06) DP management information destage timed out Processing failed because the management information destage timed out in the DP pool to which the DP RAID group number (RAID group number) belongs. Cancel the pool capacity shrinking of the DP RAID group number (RAID group number) displayed as an error, stop the array and then restart it. • Failed (Code-07) Invalid DP pool was detected. Processing failed because invalid management information was detected in the DP pool to which the DP RAID group number (RAID group number) belongs. Cancel the pool capacity shrinking of the DP RAID group number (RAID group number) displayed as an error, stop the array and then restart it. • Failed (Code-08) Online forced parity recovery is executed. Processing failed because the online forced parity recovery is executed for the DP-VOL to which the DP RAID group number (RAID group number) belongs. Cancel the pool capacity shrinking of the DP RAID group number (RAID group number) displayed as an error and contact the service personnel to execute it again after completing the online forced parity recovery of the DP-VOL • Failed (Code-09) Drive is restored. Processing failed because the drive is being restored in the DP pool to which the DP RAID group number (RAID group number) belongs. Cancel the pool capacity shrinking of the DP RAID group number (RAID group number) displayed as an error and execute it again after completing the drive restoration.

Performance management

Hitachi Storage Navigator Modular 2 lets you monitor how frequently data is accessed, along with performance operation rates. By reviewing this information, you can determine configuration variables for relocating data to appropriate tiers to improve performance.

DP Pool Monitor Status

Table 10-24 shows the DP pool monitor status displayed in Hitachi Storage Navigator Modular 2.

Table 10-24: DP pool monitor status

Status (monitor availability)	Description
Collection	State in which monitoring is operating when one minute elapsed after starting the collection and there is monitor information.
	State in which monitoring is operating when less than one minute elapsed after staring the collection and there is no monitor information.
Stop (There is a monitor)	State in which monitoring stops when there is monitor information.
Stop (There is no monitor)	State in which monitoring stops when there is no monitor information.
Reset	State in which the monitor is reset.
Error Recovery	Since a failure occurred, the monitor data is recovered by the cache or the drive.

DP Pool relocation status

Table 10-25 shows the status of the DP pool relocation displayed in Hitachi Storage Navigator Modular 2.

Table 10-25: DP Pool Relocation Status

Status	Description
Operating	Status where relocation is operating
Stop	Status where relocation is stopped
Temporarily stopping	Status where the monitor is reset

DP Pool or DP-VOL frequency distribution

Hitachi Dynamic Tiering can monitor the frequency distribution of a DP pool or virtual VOL.

The frequency distribution is statistical information that presents the accesses per page, as shown in Figure 10-8 on page 10-33.

Create the frequency distribution to decide the:

- Tier configuration based on the degree of bias of the access frequency
- Rough relative order of each page not sorting all pages by the access frequency

For more information, see Frequency distribution output on page 10-18.

Using log information

In Hitachi Dynamic Tiering, you can refer to log information to check the monitor or relocation operation.

Log information can be acquired from Hitachi Storage Navigator Modular 2 for each controller. The log information is shown for each controller separately.

- Tier relocation cycle log can be used for the relocation operation check and performance analysis.
- Page relocation log can be used for checking the page moving condition.

11

Preparing for Hitachi Dynamic Tiering operations

This chapter describes the requirements and restrictions for using Hitachi Dynamic Tiering. It also describes how to install, uninstall, disable, and enable Hitachi Dynamic Tiering.

The following topics are covered in this chapter:

Requirements and restrictions

To operate Hitachi Dynamic Tiering, you need:

- A license key or license file for a dual-controller Hitachi Unified Storage system equipped with drives
- Hitachi Dynamic Provisioning

Requirements of DP-VOLs and DP Pools

Table 11-1 shows requirements of the DP-VOLs. Table 11-2 on page 11-3 shows requirements of the DP pool.

Table 11-1: DP-VOL requirements

Items	Requirements
Volume type	A DP-VOL cannot be created in the RAID group. You cannot specify the following volumes as DP-VOL: • A unified volume • A volume defined by Cache Residency Manager You cannot set a DP-VOL in blocked status. If a volume exceeds the maximum value of the DP pool capacity, the depletion threshold value, or the limit over provisioning threshold value, a new DP-VOL cannot be set. The array remains operational, but a warning message appears when the definition/growing of a DP-VOL, DP Optimization, or LU mapping to host group/iSCSI target group is performed at the time of depletion or Depletion Alert status. We recommend you grow the capacity immediately.
Data allocation unit	32 MB Allocates at least 32 MB area in the DP pool for writing from the host.
Volume capacity	32 MB to 128 TB
Volume initialization	Volume is already formatted at DP pool creation. Therefore, you do not have to create the DP-VOL. Use this when recovering failures by the DP-VOL or restoring DP-VOL data.
Maximum volume number	Per one DP pool: • Hitachi Unified Storage 150 and Hitachi Unified Storage 130: 4,096 max. • Hitachi Unified Storage 110: 2,048 max. Per one array: • Hitachi Unified Storage 150 and Hitachi Unified Storage 130: 4,096 max. • Hitachi Unified Storage 110: 2,048 max.
Growth capacity	It can grow the capacity of the DP-VOL online.
Shrink of capacity	You can shrink the capacity of the DP-VOL online. To reduce used capacity efficiently, shrink the capacity by GB. When shrinking DP-VOL capacity, select the **Optimize after reducing capacity** option to equalize the used capacity across the DP-RGs in a tier.
Deleting	You can delete the DP-VOL online.

Table 11-2: Requirements of DP pools with Tier Mode enabled

Items	Requirements
RAID level of the DP RAID group	RAID 0 is not supported. Only the DP RAID group of the same RAID level can be registered in the same DP pool. When the firmware version is 0945/A or later, the DP RAID group in different RAID levels can be registered in the DP pool. However, as performance may vary, be extremely careful when mixing the different RAID levels. When the firmware version is 0945/A or later, DP RAID groups with different drive types can be mixed in the DP pool. Performance can vary, so exercise care when mixing the different RAID levels.
Number of DP RAID group	Hitachi Unified Storage 150: 200 max. Assign a DP RAID group number from 0 to 199 to identify the DP RAID group. Hitachi Unified Storage 130: 75 max. Assign a DP RAID group number from 0 to 74 to identify the DP RAID group. Hitachi Unified Storage 110: 50 max. Assign a DP RAID group number from 0 to 49 to identify the DP RAID group.
Drive type	If the drive types are supported by the array, they can be used for the drive type. 2.5-inch drives and 3.5-inch drives are treated as different drives.
DP pool deletion	When the DP-VOL is defined, the DP-VOL must be deleted to delete the DP pool.
DP pool capacity	The maximum array capacity (see Table 10-1 on page 10-3).
DP pool number	Hitachi Unified Storage 150 and Hitachi Unified Storage 130: 64 max. Hitachi Unified Storage 110: 50 max. DP pool IDs (0 to 63 or 0 to 49) are assigned as DP pool identifiers.

Table 11-2: Requirements of DP pools with Tier Mode enabled (Continued)

Items	Requirements
Threshold value	The DP pool usage is monitored by the threshold value. The DP pool has two threshold values. • Early Alert threshold value: This can be set in units of 1% in the 1% to 99% range. The default value is 40%. • Depletion Alert threshold value: This can be set in units of 1% in the 1% to 99% range. The default value is 50%. It is required to set a value larger than the Early Alert threshold value. If the over-provisioning level exceeds the above-mentioned values, the system sends an e-mail alert to warn users and reports the SNMP trap if the optional email reporting function and SNMP trap report are enabled in Hitachi Storage Navigator Modular 2. Adding DP-VOLs is restricted until DP pool capacity is added. The array is operational, although a warning message appears when definition/growing of the DP-VOL, DP Optimization, or LU mapping to host group/iSCSI target group is performed at the time of depletion or Depletion Alert status. However, we recommend you grow the capacity immediately because the capacity is not actually increased. The DP-VOL capacity in the DP pool is monitored by the threshold value. The DP-VOL has two threshold values: • Warning Alert threshold value: Set in units of 1% in the 50% to 1000% range. Default value is 100%. • Limit Alert threshold value: Set in units of 1% in the 50% to 1000% range. Default value is 130%. Set a value larger than the Warning Alert threshold value. If the total logical capacity associated with a pool compared to the physical pool capacity exceeds the above-mentioned value, the Depletion Alert notice sends e-mail, warns the user, reports the SNMP trap, and prevents new DP-VOL creation against the pool while the threshold is exceeded. Setting the threshold value is an option and is activated only when the check boxes are checked. The addition operation of the DP-VOLs is restricted until the DP pool capacity is added.
Growth capacity	Lets you grow the capacity of the DP pool online. Due to the addition in units of drive, the DP RAID group can be added. The usage rate is averaged for the DP-VOLs concerned by selecting Optimize after reducing capacity at the time of adding the DP pool capacity. If the firmware version is 0950/A or later in a Hitachi Unified Storage 130 or 150 array, the upper limit of the DP pool capacity can be changed by changing the DP Capacity Mode.
Capacity shrinking	DP pool capacity can be shrunk online.
Changing the Tier Mode	By changing the Tier Mode, you can select whether to execute the DP pool tier management or not. However, when changing tier management from enabled to disabled, there should be only one tier in the pool. Changing tier mode initializes the monitor information.

Requirements for Hitachi Dynamic Tiering

To use Hitachi Dynamic Tiering, the array hardware and firmware must be configured as described in the following sections.

License requirements

To operate Hitachi Dynamic Tiering, install the application in the array in advance. Installation requires you to purchase a Hitachi Dynamic Tiering license.

Operating system and file system capacities

The amount of capacity reduction realized depends on the operating system and file system. Table 11-3 shows the capacity reductions for operating systems and file systems.

Table 11-3: Operating system and file system capacity

Operating system	File system	Metadata writing	DP pool capacity consumed
Windows Server™ 2003	NTFS	Writes metadata to first block (see Note).	Yes
Windows Server™ 2008	NTFS	Writes metadata to first block. (Note)	Yes
Linux®	XFS	Writes metadata in Allocation Group Size intervals.	Yes
	Ext2 Ext3	Writes the metadata in 128 MB intervals.	Yes About 33% of the size of the DP pool. Default block size for these file systems is 4 kB. This results in 33% of the DP-VOL acquiring DP pool pages. If the file system block size is changed to 2 kB or less, the DP-VOL Page consumption becomes 100%.
Solaris®	UFS	Writes the metadata in 52 MB increments.	Yes
	VxFS	Writes metadata to first block.	No

Table 11-3: Operating system and file system capacity (Continued)

Operating system	File system	Metadata writing	DP pool capacity consumed
AIX®	JFS	Writes metadata in intervals of 8 MB.	Yes 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.	Yes
	VxFS	Writes metadata to first block.	Yes
HP-UX®	JFS (VxFS)	Writes metadata to first block.	Yes
	HFS	Writes metadata in 10 MB intervals.	No

Yes = has the reduction effect.

No = does not have the reduction effect.

NOTE: Refers to basic disk only. If dynamic disk is used, metadata is written to another first block.

Precautions

Observe the precautions in Table 11-4 when using Hitachi Dynamic Tiering.

Table 11-4: Hitachi Dynamic Tiering precautions

Situation	Precaution
Deleting DP pool capacity	When the firmware version is less than 0945/A, the DP RAID group registered in the DP pool cannot be released from the DP pool. To delete the DP pool capacity, it is necessary to create the DP pool again by creating another DP pool or deleting the DP pool.
Adding capacity to the DP pool	Host I/O performance deteriorates because the DP RAID group is formatted after it is added. Check the progress of the format in the Status column of the DP pool.
Shrinking DP pool capacity	Host I/O performance may deteriorate due to the data moving processing when DP pool capacity is shrunk. Check the progress of the shrink operation in the Status columns of the DP pool and DP RAID group.

Table 11-4: Hitachi Dynamic Tiering precautions (Continued)

Situation	Precaution
Shrinking DP-VOL capacity	Depending on the I/O pattern, the free capacity may not be assigned to other DP-VOLs, but reserved as the consumed capacity for the shrunk DP-VOLs. Host I/O performance deteriorates because the shrunk area is formatted after the shrink. Check the progress of the format in the Status column of the DP pool where the DP-VOL belongs.
Deleting a DP-VOL	Host I/O performance deteriorates because the deleted area is formatted after the deleting. Check the progress of the format in the Status column of the DP pool where the DP-VOL belongs.
Creating a DP pool, adding the DP pool capacity, shrinking the DP pool capacity, deleting the DP pool capacity, or reinitiailizing the DP-pool	When the DP pool was created or the capacity was added, formatting occurs for the DP pool. If host I/O is performed during the formatting, depletion of the usable capacity can occur. Since the formatting progress is displayed when checking the Status column of the DP pool, check whether there is sufficient usable capacity according to the formatting progress, and then start the operation. While the DP pool capacity is deleted, the other DP pool operation processing (creation/capacity addition/re-initialization) cannot be performed. Wait 10 minutes, and then perform this task. While shrinking DP pool capacity (status is Reconfiguring), creation, capacity addition, capacity shrinking, and re-initialization tasks cannot be performed in the same DP pool. Wait 10 minutes, and then perform this task. Check the Reconfiguring progress level of the Status columns for the DP pool and DP RAID group.
Mixed drive types	When drive types such as SAS and SAS7.2K are mixed in the array, formatting, the entire format time may be prolonged due to the effect caused by formatting slow drives. Avoid mixing the drive types where formatting occurs when creating/expanding the DP pool. When the firmware version is 0945/A or later, if drive types are mixed in the DP pool, performance may deteriorate due to slow drives.
Reduced memory	Memory cannot be reduced when Dynamic Tiering is being used. Perform the reduction when Dynamic Tiering is not in use.

Table 11-4: Hitachi Dynamic Tiering precautions (Continued)

Situation	Precaution
Optimizing a DP pool	Optimization can fail when competing against host I/O activity. As a result, it can take time to optimize the DP pool. Standard processing time is approximately one week for allocating capacities of 10 TB. Since the DP pool is used for page migration, a DP pool's consumed capacity and reclaimed capacity temporarily increases during the page migration. The sum total value of the total capacity of DP pools and the used amount of DP-VOLs in the pool may not match. Furthermore, reclaimable capacity may not change immediately after optimization completes, but it will change during the optimization. It takes approximately 20 seconds to reclaim 10 GB of capacity. When the firmware version is less than 0937/A, the array firmware cannot be updated while optimizing the DP pool. Therefore, stop optimizing the DP pool to update the firmware. If the current firmware version is 0937/A or later, it cannot be updated when changing to a firmware version earlier than 0937/A. When updating the firmware, stop the DP pool optimization once and then update the firmware. If zero data does not exist, even if zero data is deleted, the free capacity of the DP pool cannot be reduced. Default optimization priority mode is Standard mode. If you change the mode when performing optimization, DP optimization is given priority and the host I/O performance deteriorates. If you change the mode to host access priority, the host I/O is given priority and optimization time increases.
Windows 2008 Precautions	DP-VOLs cannot be shrunk for use by dynamic disk.
Using path-switching software	If path switching software is used to check paths: • Consumed capacity of the DP pool may temporarily increase or decrease by 1 GB per volume. • The DP pool may be depleted temporarily, depending on its free capacity. Check the free capacity of the DP pool in advance.
Powering on the array with data in cache	Powering on the array with data in cache may start DP pool formatting. If this occurs, go to Storage Navigator 2 and check the DP pool Status column for format progress. If progress is displayed, I/O performance may deteriorate or usable capability may be depleted. Start the operation after confirming there is sufficient capacity based on the format progress.

Reconfiguring memory

Observe the following memory reconfiguration guidelines when installing, uninstalling, invalidating, validating memory, or reconfiguring memory.

I/O processing performance

I/O performance using sequential write patterns deteriorates approximately 20% to 30% by releasing user data in cache memory and performing memory reconfiguration with Hitachi Dynamic Provisioning. In other patterns, I/O performance deteriorates less than 10%.

Time-out for memory reconfiguration processing

If there are large amounts of I/O coming into an array, data saving to a drive's cache can take time and may time out. In this case, repeat processing when I/O coming into the array is small.

Inhibiting memory reconfiguration

Memory reconfiguration is inhibited under the following conditions to increase the data amount to the cache. Perform memory reconfiguration processing after completing other functions or recovering the failure.

- Cache partition other than master cache partition (partition 0 and partition 1) in use
- Cache partition being changed
- DP pool in optimization
- RAID group is growing
- LU ownership is changing
- Cache Residency volume is operating
- Remote path and/or pair of TrueCopy or TrueCopy Extended Distance is operating
- Copy on Write Snapshot volumes is operating
- DMLU is operating
- Volume is being formatted
- Volume is performing parity correction
- IP address for maintenance or management in operation
- SSL information in operation
- Array firmware is updating
- Power OFF of array is being performed
- Spin-down or spin-up by Power Saving/Power Saving Plus feature in operation
- Inhibiting the operation of other functions during memory reconfiguration

- When the memory reconfiguration processing fails due to the factors other than time-out
- RAID group grown operation
- Replication Pair operation
- Dynamic Provisioning operation
- Hitachi Dynamic Tiering operation
- Cache Residency Manager setting operation
- Volume formatting operation
- Volume parity correction operation
- Cache Partition Manager operation
- Modular Volume Migration operation
- Array firmware updating operation
- Installing, uninstalling, enabling, or disabling of extra-cost option operation
- Volume operation
- Volume unifying operation
- DP pool shrinking operation

If memory reconfiguration fails when uninstalling, and DP Capacity Mode is set to maximum capacity mode, you might not be able to downgrade firmware, depending on when the failure occurred. Follow the recovery procedure when memory reconfiguration status is **Failed (Code-nn: Error Message)** in Table 11-5 to complete the memory reconfiguration and execute the downgrade again.

Table 11-5: Memory reconfiguration status

Status	Description
Normal	Memory reconfiguration processing is completed normally. The memory reconfiguration status in the DP Capacity Mode is displayed as **Normal** even if the memory reconfiguration is unnecessary.
Pending	Waiting for the memory reconfiguration. Even if the memory reconfiguration instruction is executed and the message indicating the inoperable status is output, it changes to this status because the instruction is received.
Reconfiguring(nn%)	Memory reconfiguration is operating. (nn%) shows reconfiguring as a percent.
N/A	Out of memory reconfiguration target.

Table 11-5: Memory reconfiguration status (Continued)

Status	Description
Failed(Code-nn: error message)	Memory reconfiguration failed because array failures have occurred. Recover the status according to the following troubleshooting for each error code and each error message. If it still fails, contact HDS support at portal.hds.com. • Failed(Code-01: Time out) Code-01 occurs when the access from the host is frequent or the amount of the unwritten data in the cache memory is large. Execute the memory reconfiguration operation again when the access from the host decreases. • Failed(Code-02: Failure of Reconfigure Memory) Code-02 occurs when the drive restoration processing starts in the background. Execute the memory reconfiguration operation again after the drive restoration processing is completed. • Failed(Code-03: Failure of Reconfigure Memory) Code-03 occurs when the copy of the management information in the cache memory fails. The controller replacement is required. Contact HDS support at portal.hds.com. • Failed(Code-04: Failure of Reconfigure Memory) Code-04 occurs when the unwritten data in the cache memory cannot be saved to the drive. The restart of the array is required.

NOTE: Dynamic Provisioning license, Dynamic Tiering license, and DP capacity mode affect the status of memory reconfiguration. If the memory reconfiguration of the other function is executed while one function is in the **Pending** status, the memory reconfiguration of the function in the **Pending** status starts as well. The following example describes the behavior of the **Pending** status:

1. After installing the Dynamic Provisioning license, change the status of memory reconfiguration to **Pending** without reconfiguring the memory or restarting the storage system.

2. Change Dynamic Tiering to the **Pending** status in the same way.

3. Change the DP Capacity Mode to the **Maximum Capacity** mode, and either start memory reconfiguration or restart the storage system.

Three Performing memory reconfigurations or array restarts are required if performed separately. However, the above steps allow only one memory reconfiguration or array restart. Memory reconfiguration can be canceled only when the rate of progress of the memory reconfiguration is less than 50 percent.

Installing Hitachi Dynamic Tiering

Because Hitachi Dynamic Tiering requires a separate license key, Hitachi Dynamic Tiering cannot usually be selected (locked) when first using the array. To make Hitachi Dynamic Tiering available, you must install Hitachi Dynamic Tiering and make its function selectable (unlocked).

Hitachi Dynamic Tiering can be installed with or without requiring the array to be rebooted. You perform the installation using either the Hitachi Storage Navigator Modular 2 graphical user interface (GUI) or command-line interface (CLI). The following sections describe how to use the GUI. For installation procedures using the CLI, refer to the *Hitachi Unified Storage Command Line Interface Reference Guide*.

Before installing or uninstalling Hitachi Dynamic Tiering, confirm that the array is operating normally. If a failure such as a controller block occurs, the installation or uninstallation cannot be performed.

Exercise care when cache partition information is initialized as shown in Installing Hitachi Dynamic Provisioning when Cache Partition Manager is used on page 7-1 when Cache Partition Manager is being used.

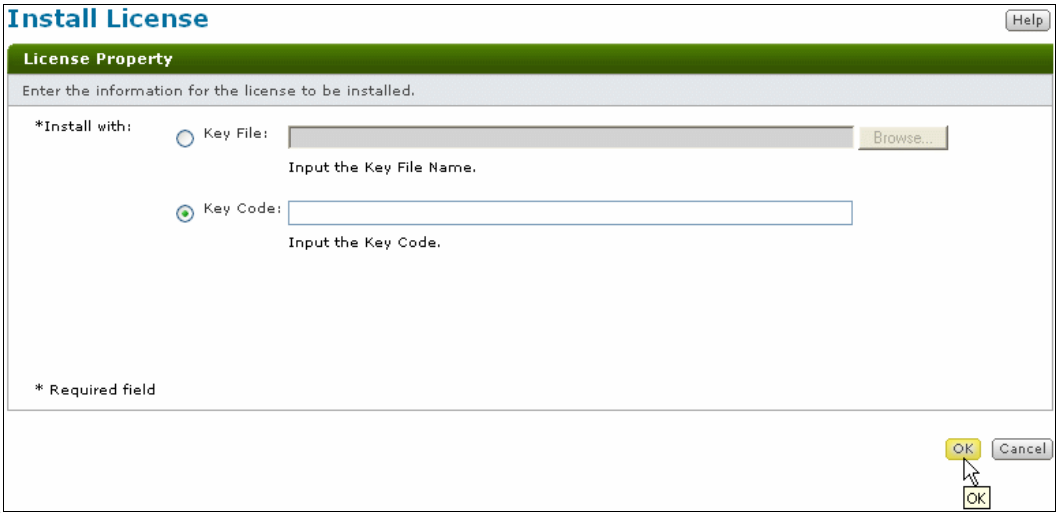
Hitachi Dynamic Tiering requires a key code or key file for installation. Installation can be performed without rebooting the array (described below) or booting the array (see Installing and rebooting on page 11-14).

Installing without rebooting

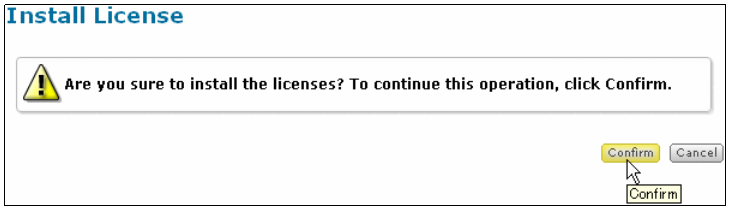
To install Hitachi Dynamic Tiering without requiring the array to be rebooted:

1. Start Storage Navigator Modular 2.
2. Log in as a registered user to Storage Navigator Modular 2.
3. Select the array where you will install Hitachi Dynamic Tiering.
4. Click **Show & Configure Array**.
5. Select **Install License** in the **Common Array Task**.

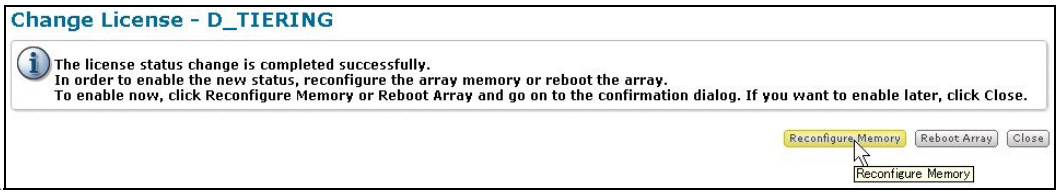
6. In the Install License window:
   - To install the option using the key file, select **Key File** and click the **Browse** button to specify the path for the key file name.
   - To install the option using the key code, select **Key Code** and then type the key code.



7. Click **OK**.
8. In the Install License message, click **Confirm**.



9. When the next window appears, click **Reconfigure Memory**.



10. At the next message, click **Confirm**.
11. At the next message, click **Close**.
12. When the Licenses list appears, confirm the **Reconfigure Memory Status** is **Reconfiguring(nn%)** or **Normal**.
13. If the **Reconfigure Memory Status** is **Reconfiguring(nn%)**, wait a few minutes and then click **Refresh Information**. Confirm the **Reconfigure Memory Status** changed to **Normal**.
14. if the **Reconfigure Memory Status** is **Failed(Code-01:Timeout)**, click **Install License** and repeat steps 6 through 12.

    Code-01 occurs when the access from the host is frequent or the amount of the unwritten data in the cache memory is large.
15. If the **Reconfigure Memory Status** is **Failed(Code-02: Failure of Reconfigure Memory)**, check the **D_TIERING** check box in the **Installed Storage Features** list, and then click **Reconfigure Memory**. Repeat steps 10 through 12.

    Code-02 occurs when the drive restoration processing starts in the background.

16. If the **Reconfigure Memory Status** is **Failed(Code-04: Failure of Reconfigure Memory)**, click **Resource** on the **Explorer** menu to return to the Arrays screen.

Code-04 occurs when the unwritten data in the cache memory cannot be saved to the drive.

17. Select the array in which you will install Dynamic Tiering, and then click **Reboot Array**.
18. If the **Reconfigure Memory Status** is **Failed(Code-03: Failure of Reconfigure Memory)**, contact HDS Support at portal.hds.com.

    Code-03 occurs when the copy of the management information in the cache memory fails.

Installation of Hitachi Dynamic Tiering is now complete.

Installing and rebooting

The following procedure installs Hitachi Dynamic Tiering and requires the array to be rebooted.

If a power saving instruction is executed on a link that is not experiencing I/O along with the Power Saving or Power Saving Plus option, installing, uninstalling, or changing Hitachi Dynamic Provisioning while the power saving status is **Normal (Command Monitoring)** changes the status to **Normal (Spin Down Failure: PS OFF/ON)** and may cause spin-down to fail. If spin-down fails, execute spin-down again. Check that the spin-down instruction has not been issued and that there is no RAID group whose power saving status is **Normal (Command Monitoring)** resulting from a power saving instruction on a non-I/O link before installing, uninstalling, or changing Hitachi Dynamic Provisioning.

When you install, uninstall, enable, or disable Hitachi Dynamic Tiering when a drive array is used on the remote side of TrueCopy or TrueCopy Extended Distance, the following conditions occur with the restart of the drive array.

- Both paths of TrueCopy or TrueCopy Extended Distance are blocked. When a path is blocked, a TRAP occurs that notifies the SNMP Agent Support Function. The TrueCopy or TrueCopy Extended Distance path recovers from the blockade automatically after the drive array restarts.
- If the pair status of TrueCopy or TrueCopy Extended Distance is **Paired** or **Synchronizing**, it changes to **Failure**. When you restart the drive array, install, uninstall, enable, or disable Hitachi Dynamic Tiering after changing the pair status of TrueCopy or TrueCopy Extended Distance to **Split**.

- If the NAS unit is connected to the drive array, have the drive array administrator check whether the NAS unit is connected and NAS service is operational.

  Ask the NAS unit administrator to check whether a failure has occurred by checking the NAS administration software. In case of a failure, execute the maintenance operation together with the NAS maintenance personal.

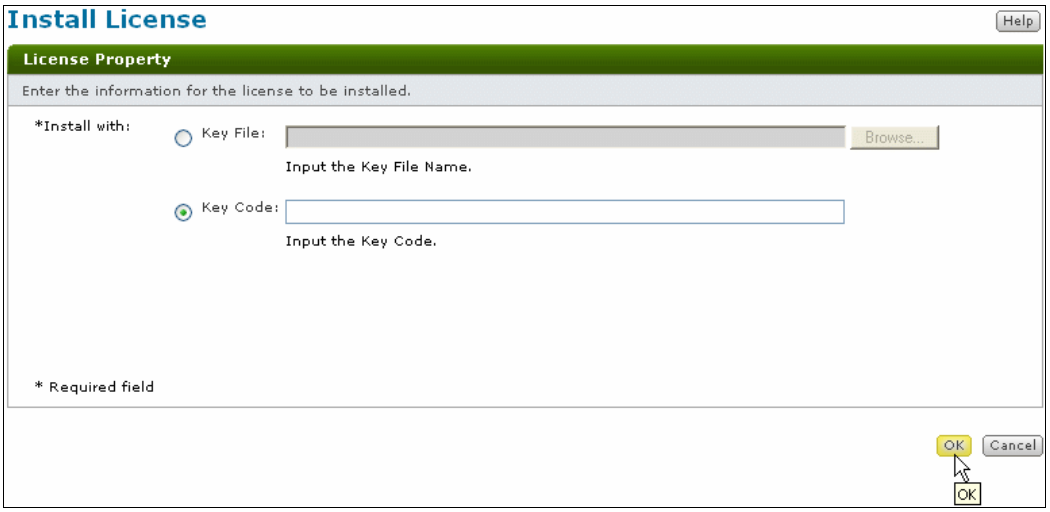
  If the NAS unit is connected, contact the NAS unit administrator for termination of NAS OS and shutdown of the NAS unit. After completing this operation, contact the NAS unit administrator to reboot the NAS unit.

  After rebooting, have the NAS unit administrator refer to “Recovering from FC path errors” in the *Hitachi NAS Manager User's Guide* and check the status of the Fibre Channel (FC) path and to recover the FC path if it is in a failure status.

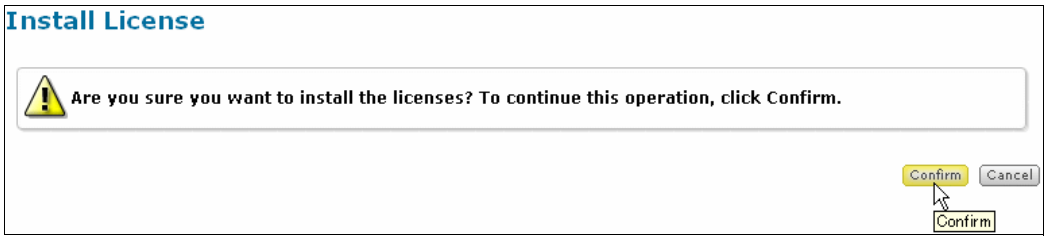
  If there are personnel for the NAS unit maintenance, contact the NAS unit maintenance personnel to reboot the NAS unit.

1. Start Storage Navigator Modular 2.
2. Log in as registered user to Storage Navigator Modular 2.
3. Select the array where you will install Hitachi Dynamic Tiering.
4. Click **Show & Configure Array**.
5. Select the **Install License** icon in the Common Array Task.

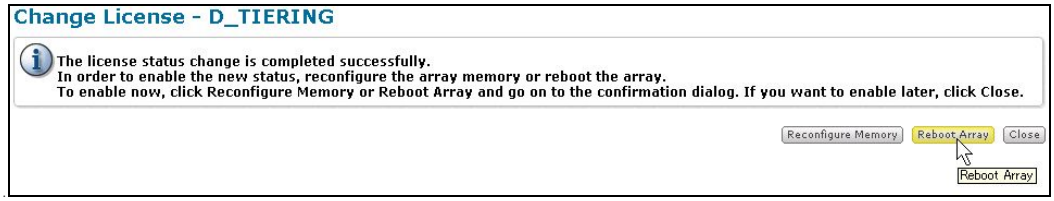
The Install License window appears.



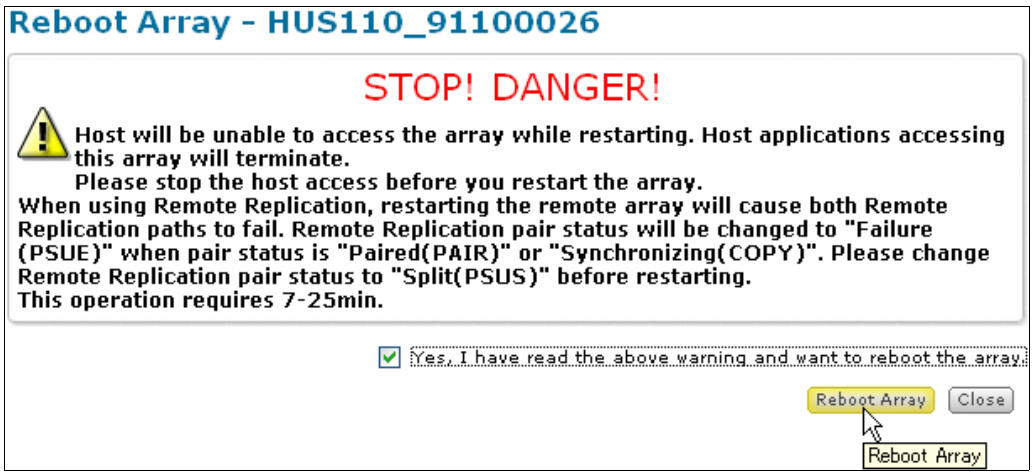
6. To install the option using the key code, click the **Key Code** radio button, and then enter the key code. To install the option using the key file, click the **Key File** radio button, and then use the **Browse** button to specify the path for the key file name. Click **OK**.
7. When a window requests a confirmation to install Hitachi Dynamic Tiering, click **Confirm**.



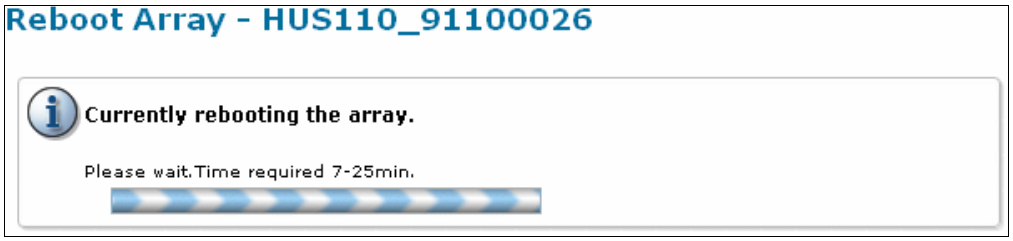
8. When the following window appears, click **Reboot Array**.



9. When a message confirms that this optional feature is installed, check the check box and click **Reboot Array**.

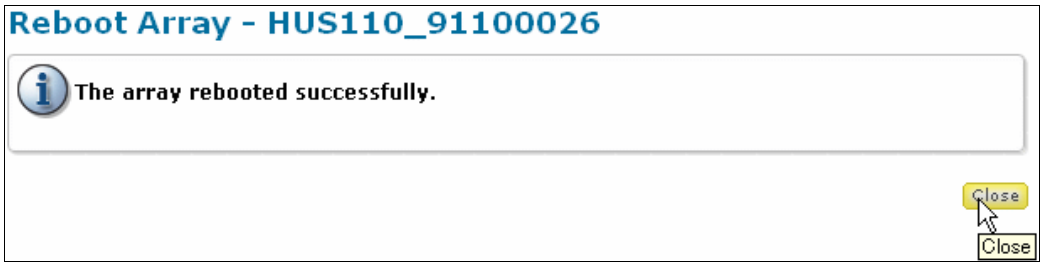


NOTE: To install the option, restart the array. The feature will close upon restarting the array. The array cannot access the host until the reboot is completed and the system restarts. Be sure the host has stopped accessing data before beginning the restart process. Restart usually takes from 7 to 25 minutes.



However, it may take time for the array to respond, depending upon the condition of the array. If it does not respond after 25 minutes or more, check the condition of the array.

10. When a message states that the restart is successful, click **Close**.



Installation of Hitachi Dynamic Tiering is now complete.

Uninstalling Hitachi Dynamic Tiering

To uninstall Hitachi Dynamic Tiering, the key code or key file is required. Once uninstalled, Hitachi Dynamic Tiering cannot be used (locked) until it is installed using the key code or key file.

Hitachi Dynamic Tiering can be uninstalled with or without requiring the array to be rebooted. You perform the uninstallation using either the Hitachi Storage Navigator Modular 2 graphical user interface (GUI) or command-line interface (CLI). The following sections describe how to use the GUI. For installation procedures using the CLI, refer to the *Hitachi Unified Storage Command Line Interface Reference Guide*.

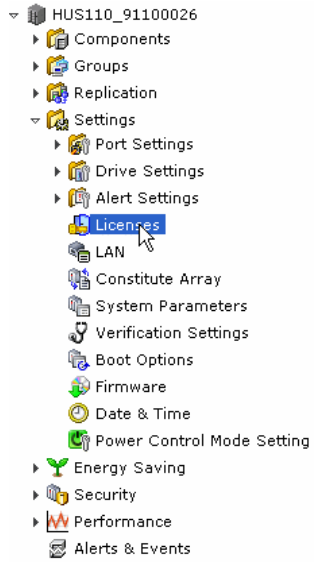
The following conditions must be satisfied to uninstall Hitachi Dynamic Tiering:

- The controller should not be blocked.
- There should be no DP pools whose Tier Mode is enabled.

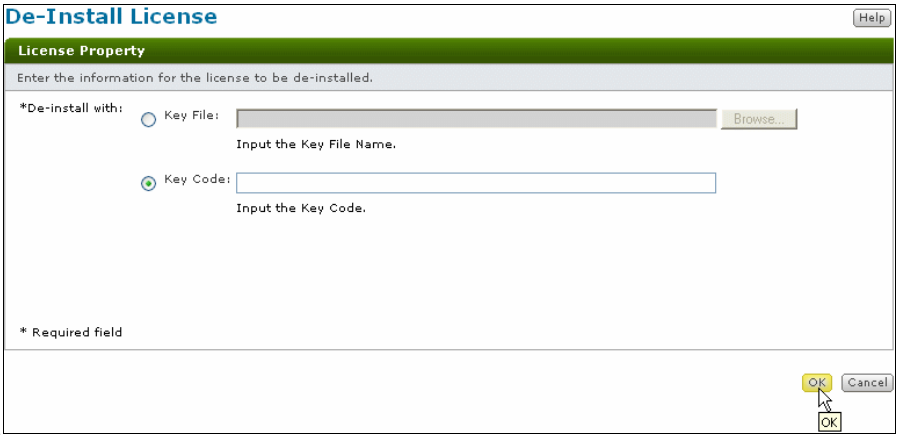
Uninstalling without rebooting

To uninstall Hitachi Dynamic Tiering without requiring the array to be rebooted:

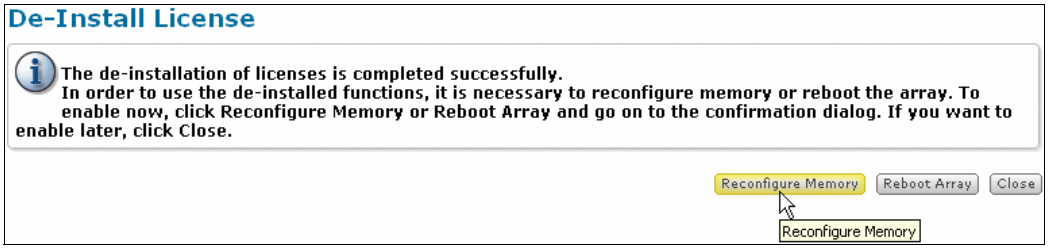
1. Start Storage Navigator Modular 2 and log in.
2. Select the array where you will uninstall Hitachi Dynamic Tiering.
3. Click **Show & Configure Array**.
4. Select **Licenses** in the **Settings** tree view.



5. In the **Licenses** list, click **De-install License**.
6. In the De-Install License window, enter the key code and click **OK**.



7. To uninstall Hitachi Dynamic Tiering using the key code, click the **Key Code** radio button, and then enter the key code. To uninstall Hitachi Dynamic Tiering using the key file, click the **Key File** radio button, and then use the **Browse** button to specify the path for the key file name. Click **OK**.
8. When a window requests a confirmation to install Hitachi Dynamic Tiering option, click **Reconfigure Memory**.



9. When the following message appears, click **Close**.

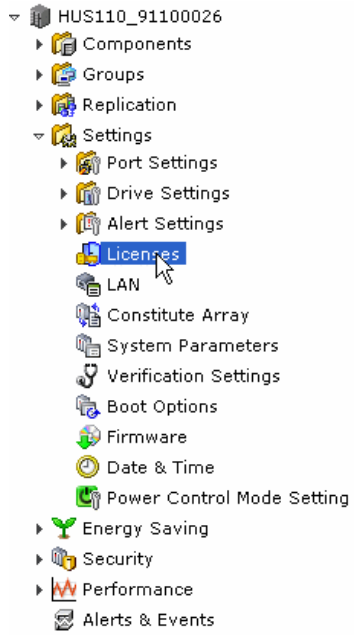
10. The Licenses list appears.

Uninstallation of Hitachi Dynamic Tiering is now complete

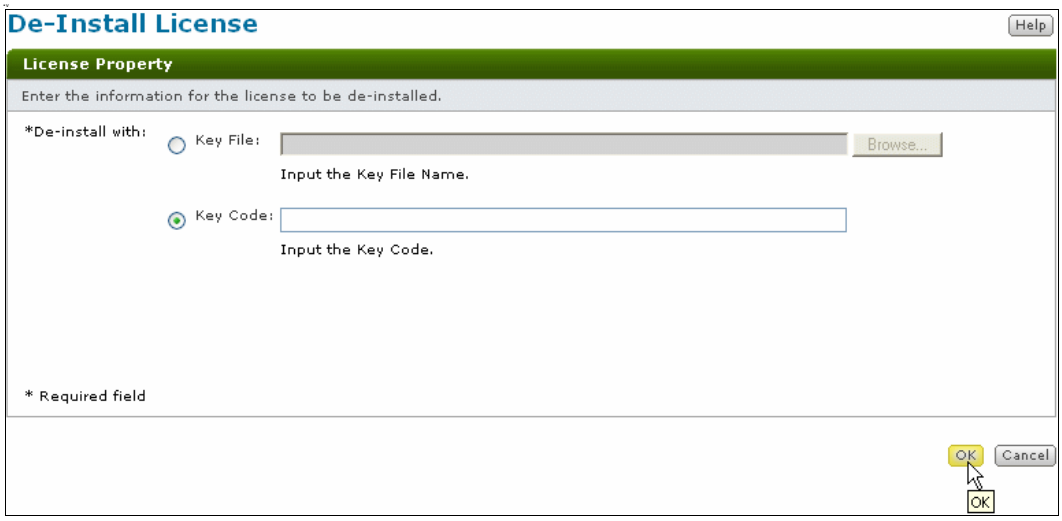
Uninstalling and rebooting

The following procedure uninstalls Hitachi Dynamic Tiering and requires the array to be rebooted.

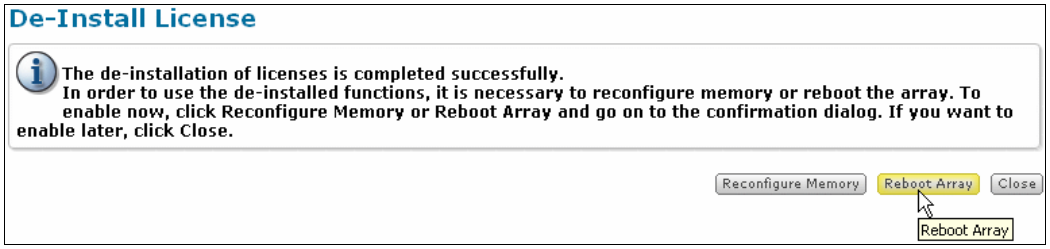
1. Start Storage Navigator Modular 2 and log in.
2. Select the array where you will uninstall Hitachi Dynamic Tiering.
3. Click **Show & Configure Array**.
4. Select **Licenses** in the **Settings** tree view.



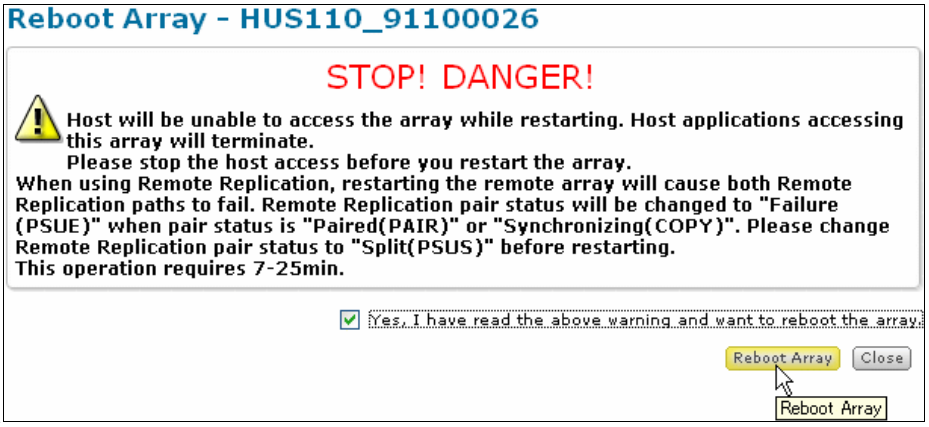
5. In the **Licenses** list, click **De-install License**. The De-Install License window appears.
6. To uninstall Hitachi Dynamic Tiering using the key code, click the **Key Code** radio button, and then enter the key code. To uninstall Hitachi Dynamic Tiering using the key file, click the **Key File** radio button, and then use the **Browse** button to specify the path for the key file name. Click **OK**.



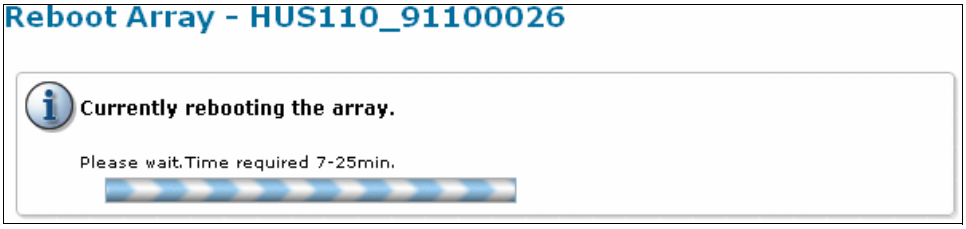
7. In the De-Install License confirmation message, click **Reboot Array**.



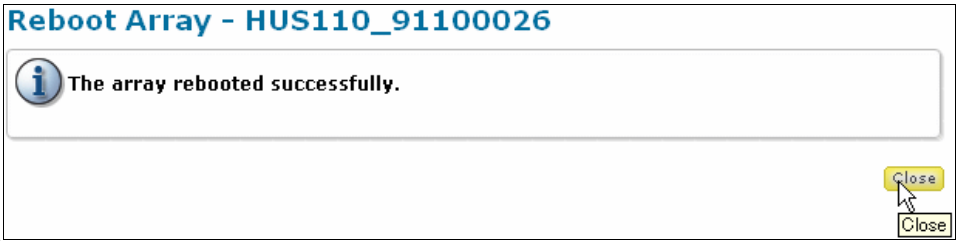
8. When the following message appears, check the check box and click **Reboot Array**.



NOTE: To install the option, reboot the array. The host or application cannot access the array until the reboot is complete and the system restarts. Be sure the host stops accessing data before restarting. It can take from 7 to 25 minutes for the array to restart, depending on the condition of the array. If it does not respond after 25 minutes or more, check the condition of the array.



9. When the message confirms that the restart is successful, click **Close**.



Uninstallation of Hitachi Dynamic Tiering is now complete.

Enabling or disabling Hitachi Dynamic Tiering

After Hitachi Dynamic Tiering is installed, it can be enabled or disabled with or without requiring the array to reboot.

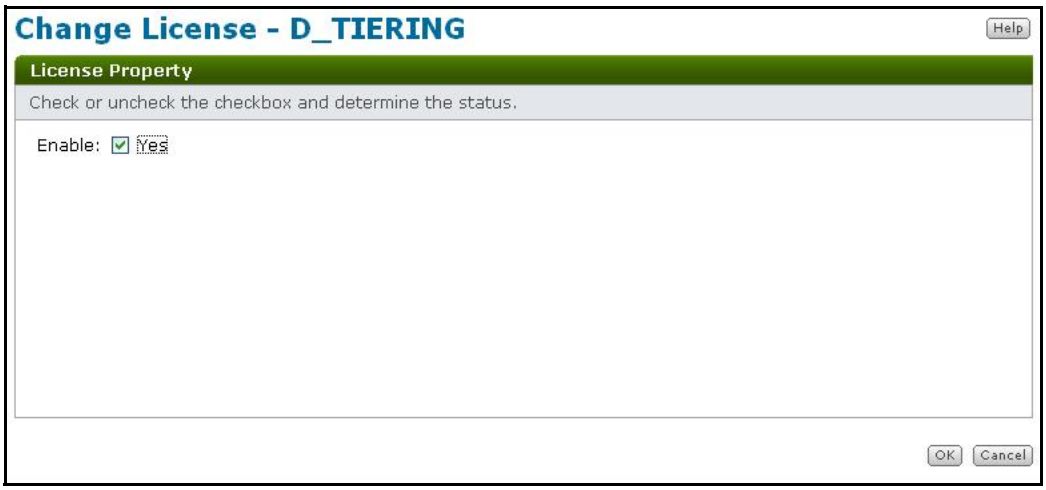
The following conditions must be satisfied to enable or disable Hitachi Dynamic Tiering:

- The controller should not be blocked.
- There should be no DP pools whose Tier Mode is enabled.

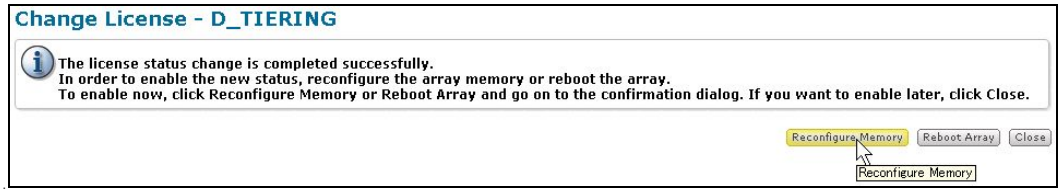
Enabling or disabling without rebooting

To enable or disable Hitachi Dynamic Tiering without rebooting:

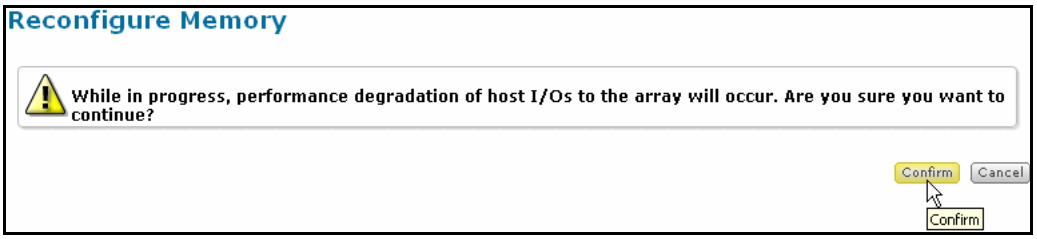
1. Start Storage Navigator Modular 2.
2. Log in as registered user to Storage Navigator Modular 2.
3. Select the array where you will set Hitachi Dynamic Tiering.
4. Click **Show & Configure Array**.
5. Select **Licenses** in the **Settings** tree view.
6. Select the **D_TIERING** in the Licenses list.
7. Click **Change Status**. The Change License window appears.



8. Perform the appropriate task:
   - To disable Hitachi Dynamic Tiering, uncheck **Enable**.
   - To enable Hitachi Dynamic Tiering, check **Enable**.
9. Click **OK**.
10. When the Change License message appears, click **Reconfigure Memory**.



11. When the Licenses list appears, confirm that **Pending** appears in the **Reconfigure Memory Status** column.
12. Check the check box **D_PROVISIONIN** and click **Reconfigure Memory**.
13. When the following message appears, click **Confirm**.



14. When the license list appears, confirm the **Reconfigure Memory Status** is **Reconfiguring(nn%)** or **Normal**.
15. If the **Reconfigure Memory Status** is **Reconfiguring(nn%)**, wait a few minutes and then click **Refresh Information**. Confirm the **Reconfigure Memory Status** changes to **Normal**.
16. If the **Reconfigure Memory Status** is **Failed(Code-01:Timeout)**, click **Install License** and repeat steps 6 through 15.

    Code-01 occurs when the access from the host is frequent or the amount of the unwritten data in the cache memory is large.
17. If the **Reconfigure Memory Status** is **Failed(Code-02: Failure of Reconfigure Memory)**, check the **D_PROVISIONING** check box in the **Installed Storage Features** list, and then click **Reconfigure Memory**. Repeat steps 13 through15.

    Code-02 occurs when the drive restoration processing starts in the background.
18. If the **Reconfigure Memory Status** is **Failed(Code-04: Failure of Reconfigure Memory)**, click **Resource** on the **Explorer** menu to return to Arrays screen.

    Code-04 occurs when the unwritten data in the cache memory cannot be saved to the drive.
19. Select the array in which you will install Dynamic Tiering, and then click **Reboot Array**.
20. If the **Reconfigure Memory Status** is **Failed(Code-03: Failure of Reconfigure Memory)**, contact HDS Support at portal.hds.com.

    Code-03 occurs when the copy of the management information in the cache memory fails.

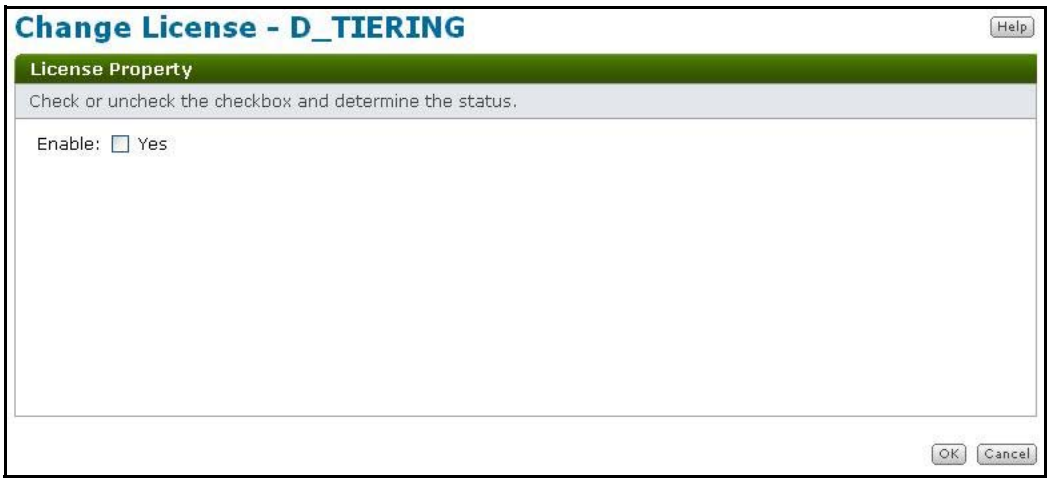
Enabling or disabling of Hitachi Dynamic Tiering is now complete.

Enabling or disabling and rebooting

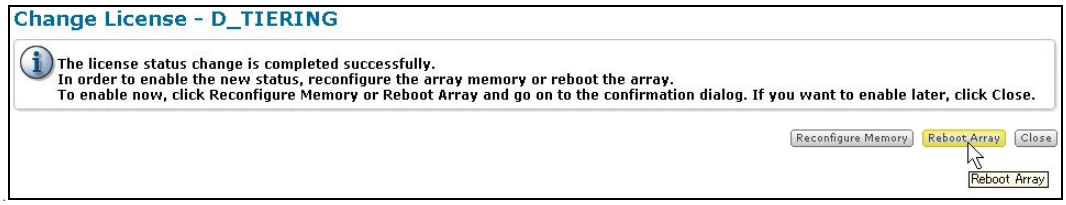
To enable or disable Hitachi Dynamic Tiering and reboot the array:

1. Start Storage Navigator Modular 2.
2. Log in as registered user to Storage Navigator Modular 2.
3. Select the array where you will set Hitachi Dynamic Tiering.
4. Click **Show & Configure Array**.
5. Select the **Licenses** icon in the **Settings** tree view.
6. Select the **D_PROVISIONING** in the **Licenses** list.

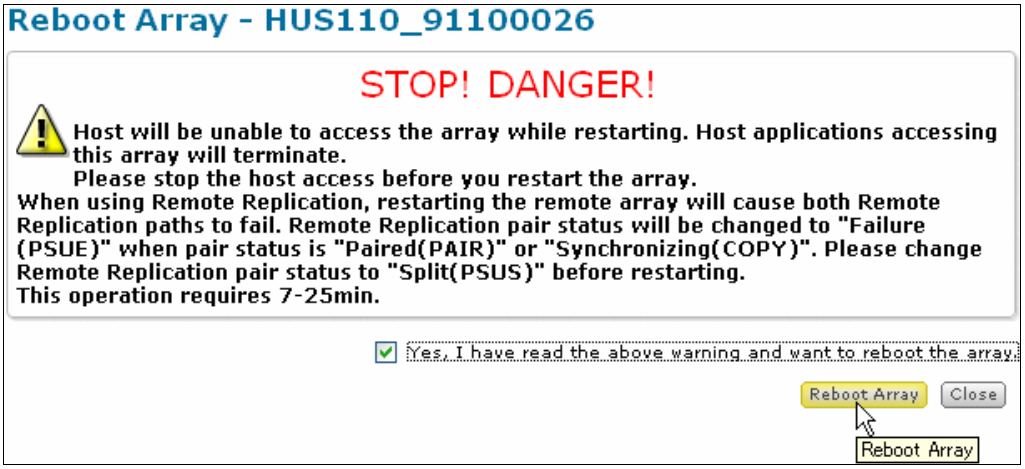
   Click **Change Status**. The Change License window appears



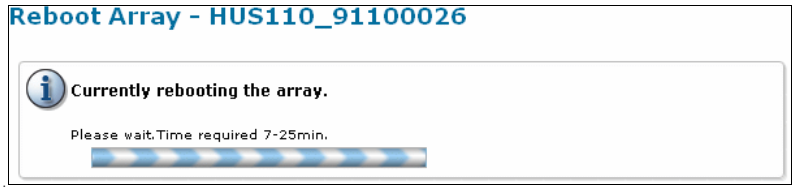
7. Perform the appropriate task:
   - To disable Hitachi Dynamic Tiering, uncheck **Enable**.
   - To enable Hitachi Dynamic Tiering, check **Enable**.
8. A message appears confirmation that feature is set. Click Reboot Array.
9. When the next message appears, click **Reboot Array**.



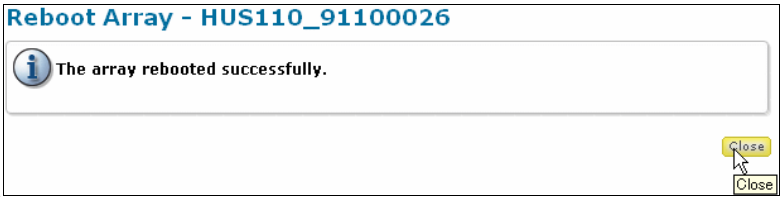
10. When a message confirms that this optional feature is set, check the check box and click **Reboot Array**.



NOTE: To install the option, reboot the array. The host or application cannot access the array until the reboot is complete and the system restarts. Be sure the host stops accessing data before restarting. It can take from 7 to 25 minutes for the array to restart, depending on the condition of the array. If it does not respond after 25 minutes or more, check the condition of the array.



11. In the Reboot Array message, click **Close**.



Enabling or disabling of Hitachi Dynamic Tiering is now complete.

12

Using the Hitachi Dynamic Tiering GUI

This chapter describes how to use the Hitachi Dynamic Tiering graphical user interface (GUI) via Hitachi Storage Navigator Modular 2.

The following topics are covered in this chapter:

DP Pools tab

Figure 12-1 shows the **DP Pools** tab on the Volumes window.

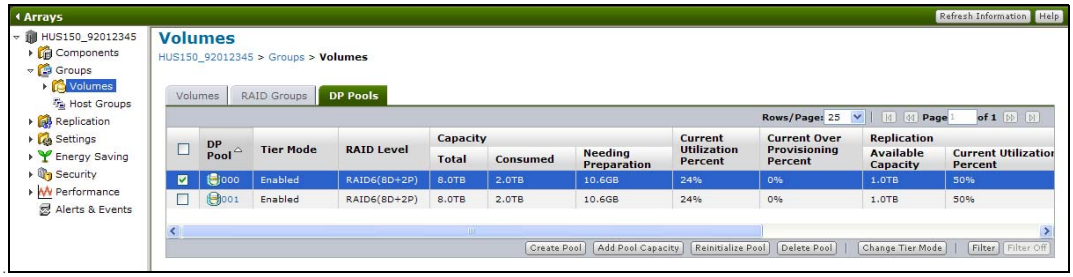


Figure 12-1: DP Pools tab

Table 12-1: Items on the DP Pools tab

Item	Description
DP Pool	Shows the created DP pools.
Tier Mode	Shows whether Tier Mode is enabled or disabled.
RAID Level	Shows the RAID level that created DP pool.If two or more tiers are set when the Tier Mode is enabled, Mixed is displayed.
Capacity	• Total: Shows the DP pool capacity. • Consumed: Shows the assigned capacity to the DP-VOL. The assigned capacity displays by the unit of 1024 MB. • Needing Preparation: Shows the unused area collected by the user's instruction, such as shrinking the volume. Shows the remaining capacity during the collection.
Utilization Percent	Shows the DP pool utilization percentage.
Over Provisioning Percent	Shows the DP-VOL over provisioning percentage in the DP pool.
Replication	• Available Capacity: Shows the capacity available in the DP pool (the capacity subtracting the SSD/FMD Tier from the entire pool capacity). When Snapshot or TrueCopy Extended Distance is disabled, N/A is shown. • Utilization Percent: Shows the rate of the capacity subtracting the SSD/FMD Tier use capacity from the replication use capacity in proportion to the replication usable capacity. When Copy on Write Snapshot or TrueCopy Extended Distance is disabled, N/A is shown.
Stripe Size	Shows the stripe size of the DP pool.
Drive Type/RPM	Shows the drive type and rotational speed. If two or more tiers are set when the **Tier** Mode is enabled, Mixed is displayed.
Encryption	Shows the encryption status of the drives which configure the DP pool.

Table 12-1: Items on the DP Pools tab (Continued)

Item	Description

Status	Shows the **DP pool status** as a primary value, and **DP pool formatting progress** and **DP pool capacity status** as secondary values in parentheses.
	
	For example, if **DP pool status** is **Normal** and **DP pool capacity status** is **Depletion Alert over**, the Status shows Normal (Depletion Alert over).
	
	• **DP pool status** — one of the following:
	  • Normal: Indicates that this DP pool is normal.
	  • Check Component: Indicates that the drive (HDU) which configures the DP pool is during copy back or the unformatted volume is included.
	  • Regression: At least one DP RAID group is regressed. It is necessary to replace the blocked drive.
	  • Detached: At least one DP RAID group is detached. It is necessary to reconfigure the DP pool.
	• **DP pool formatting status** — displayed as Formatting (nn%) where n is 1 to 99. The capacity of the displayed progress level is usable.
	• **DP pool capacity status** — one of the following status indications for DP pool consumed capacity:
	  • Early Alert Over: The consumed capacity exceeds the Early Alert Threshold.
	  • Depletion Alert Over: The consumed capacity exceeds the Depletion Alert Threshold.
	  • Capacity Depleted: The DP pool capacity is depleted or exhausted. You cannot create or grow volumes to increase capacity under Dynamic Provisioning. The array is operable, although a warning message appears if the definition/growing of the DP-VOL, DP Optimization, or LU mapping to host group/ iSCSI target group is performed during depletion or Depletion Alert status. We recommend you grow the capacity immediately.

Reconstruction Progress	Shows the DP pool reconstruction progress.

Table 12-2: Buttons on the DP Pools tab

Click this button...	To...
Create Pool	Create a DP pool.
Add Pool Capacity	Add a DP pool capacity.
Reinitialize Pool	Recover a DP pool.
Delete Pool	Delete a DP pool.
Change Tier Mode	Change the Tier Mode.

Figure 12-2 to Figure 12-6 on page 12-9 show the DP pool property when selecting a specified DP pool number.

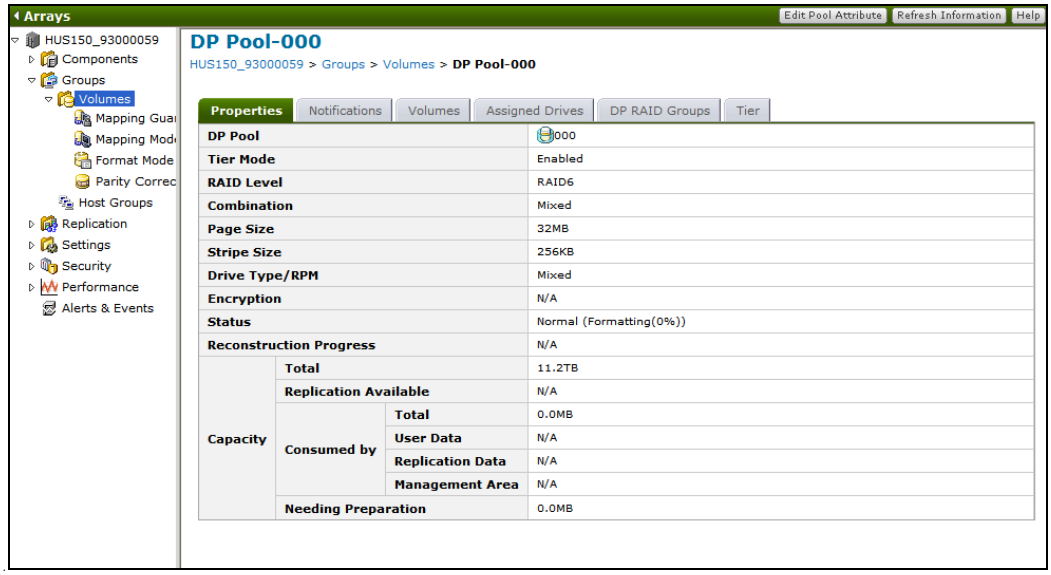


Figure 12-2: DP Pool (Properties tab)

Table 12-3: Items on the Properties tab

Item	Description
DP Pool	Shows the DP pool number.
Tier Mode	Shows whether Tier Mode is enabled or disabled.
RAID Level	Shows the RAID level that created DP pool.
Combination	Shows the RAID combination: D: data P: parity
Page Size	Shows the page size. (fixed 32 MB)
Stripe Size	Shows the stripe size of the DP pool.
Drive Type/RPM	Shows the drive type and rotational speed.
Encryption	Shows the encryption status of the drives which configure the DP pool.
Status	Shows the DP pool status.
Reconstruction Progress	Shows the DP pool reconstruction progress.

Table 12-3: Items on the Properties tab

Item	Description
Capacity	• Total: DP pool capacity. • Replication Available: Capacity available in the DP pool (the capacity subtracting the SSD/FMD Tier from the entire pool capacity). When Snapshot or TrueCopy Extended Distance is disabled, N/A is shown. • Consumed: Assigned capacity to the DP-VOL. The assigned capacity displays by the unit of 1024 MB. • Needing Preparation: The unused area collected by the user's instruction, such as shrinking the volume. Shows the remaining capacity during the collection.

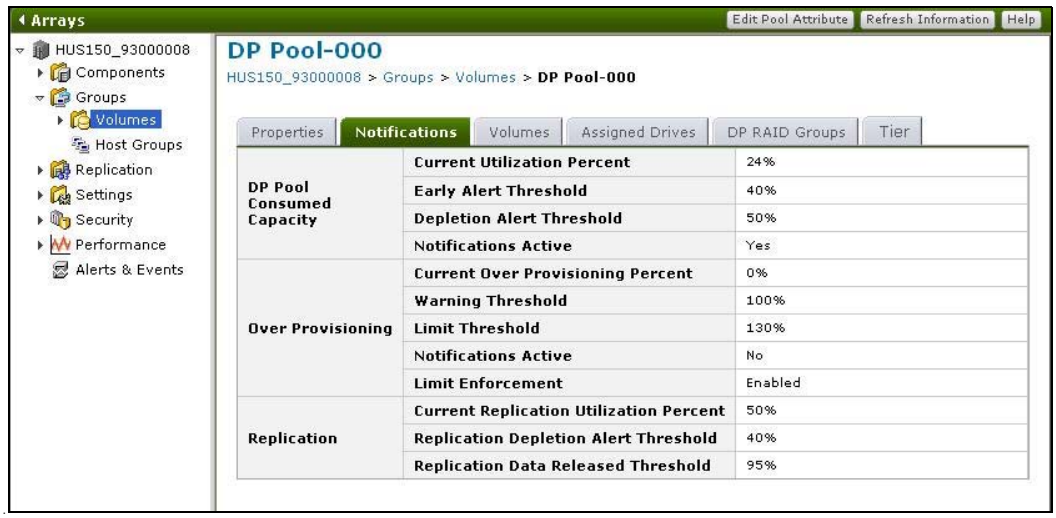


Figure 12-3: DP Pool properties (Notifications tab)

Table 12-4: Items on the Notifications tab

Item	Description
DP Pool Consumed Capacity Alert	• Current Utilization Percent: Shows the current utilization percent. • Early Alert: Shows the initial alert threshold value. • Depletion Alert: Shows the depletion alert threshold value. • Notifications Active: Shows the alert notice setting (Yes or No).
Over Provisioning Threshold	• Current Over Provisioning Percent: Shows the current over provisioning percent. • Warning: Shows the warning threshold value. • Limit: Shows the limit threshold value. • Notifications Active: Shows the alert notice setting (Yes or No). • Limit Enforcement: Shows whether limit enforcement is enabled or disabled.
Replication	• Current Replication Utilization Percent: Shows the capacity available in the DP pool (the capacity subtracting the SSD/FMD Tier from the entire pool capacity). If Copy on Write Snapshot or TrueCopy Extended Distance is disabled, N/A appears. • Replication Depletion Alert Threshold: Shows the depletion alert threshold value. When Snapshot is disabled, N/A is shown. • Replication Data Released Threshold: Shows the depletion data released threshold value. If Copy on Write Snapshot is disabled, N/A appears

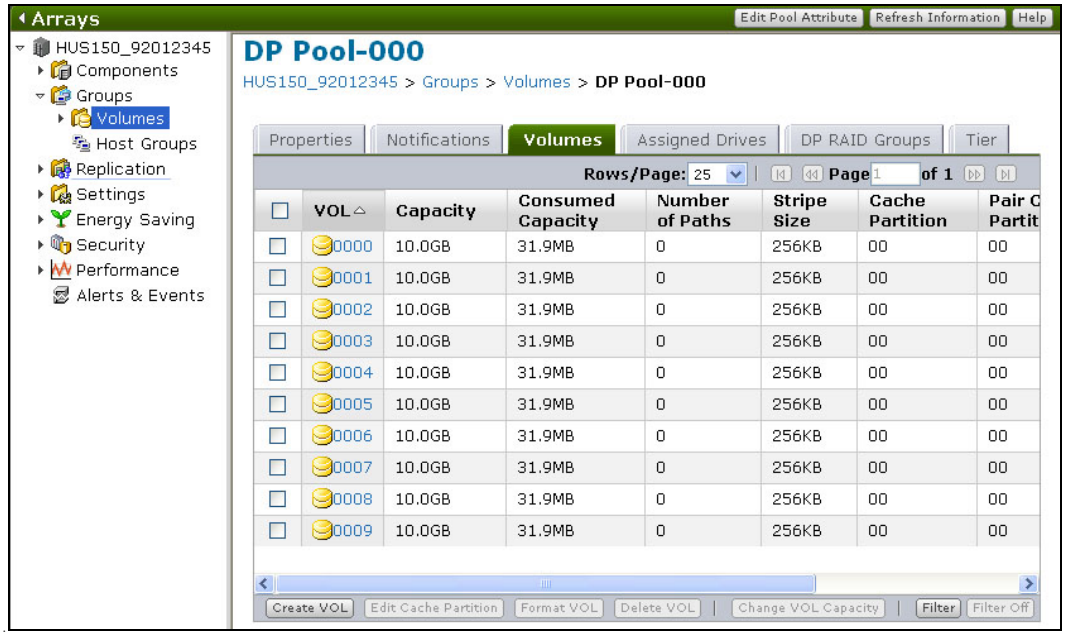


Figure 12-4: DP Pool properties (Volumes tab)

Table 12-5: Items on the Volumes tab

Item	Description
VOL	Shows the created DP-VOL number.
Capacity	Shows the assigned capacity to the DP-VOL.
Consumed Capacity	Shows the consumed capacity of the DP-VOL.
Number of Paths	Shows the mapping information.
Stripe Size	Shows the stripe size of the DP-VOL.
Cache Partition	Shows the cache partition number using the DP-VOL.
Pair Cache Partition	Shows the paired cache partition number to be using the DP-VOL.
Status	Shows the status of the DP-VOL.

Table 12-6: Buttons on the Volumes tab

Click this button...	To...
Create VOL	Create a DP-VOL.
Format VOL	Format the volume.
Delete VOL	Delete the DP-VOL.
Change VOL Capacity	Change the DP-VOL.

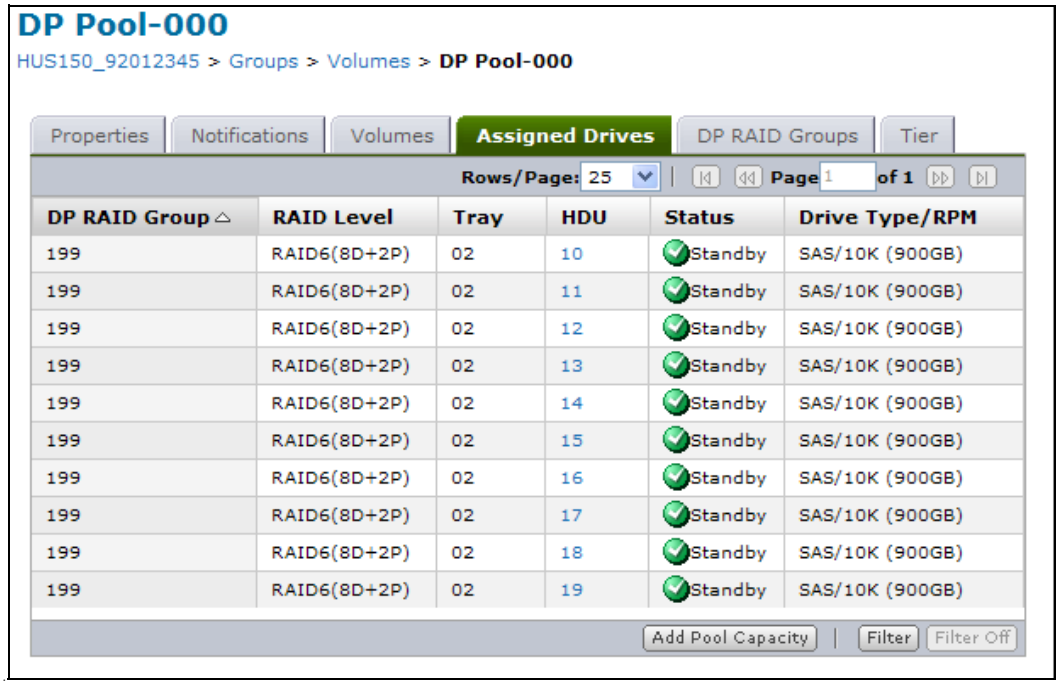


Figure 12-5: DP Pool properties (Assigned Drives tab)

Table 12-7: Items on the Assigned Drives tab

Item	Description
DP RAID Group	Shows the RAID group number of the DP pool.
RAID Level	Shows the RAID level that created DP pool.
Tray	Shows the tray number.
HDU	Shows the drive number.
Status	Shows the drive status.
Drive Type/RPM	Shows the drive type and rotational speed.

Table 12-8: Button on the Assigned Drives tab

Click this button...	To...
Add Pool Capacity	Add DP pool capacity.

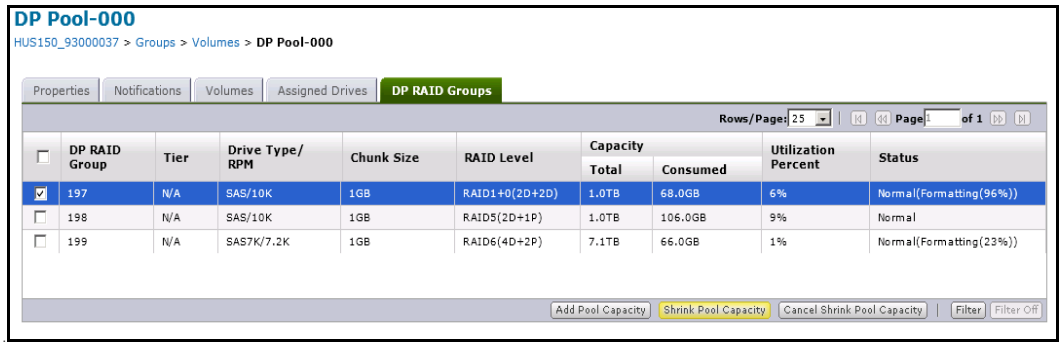


Figure 12-6: DP Pool properties (DP RAID Groups tab)

Table 12-9: Items on the DP RAID Groups tab

Item	Description
DP RAID Group	Shows the RAID group number of the DP pool.
Tier	Shows the tier to which the DP RAID Group is assigned.
Drive Type/RPM	Shows the drive type and rotational speed.
Chunk Size:	Shows the chunk size of the DP RAID group.
RAID Level:	Shows the RAID level that created DP pool.
Capacity	• Total: Shows the DP pool capacity. • Consumed: Shows the assigned capacity to the DP-VOL. The assigned capacity is shown in units of 1024 MB.
Utilization Percent	Shows the current utilization percent.

Table 12-10: Button on the DP RAID Groups tab

Click this button...	To...
Add Pool Capacity	Add DP pool capacity.
Shrink Pool Capacity	Click to shrink DP pool capacity.
Cancel Shrink Pool Capacity	Click to cancel the DP pool shrink operation.

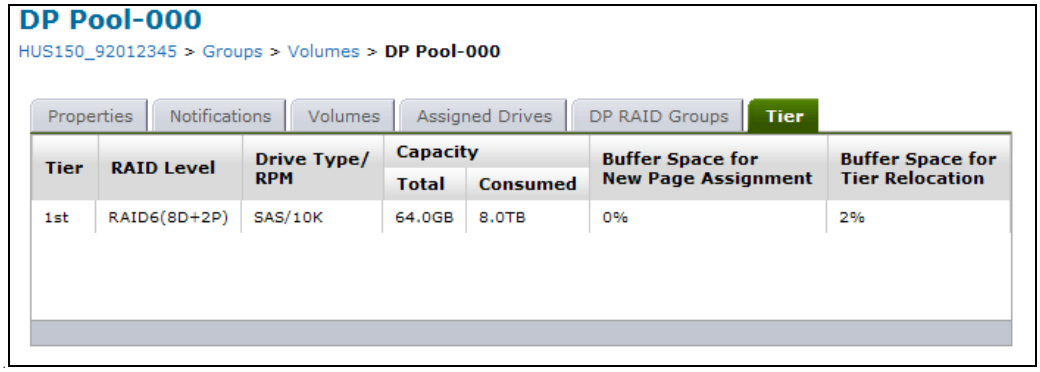


Figure 12-7: DP Pool properties (Tier tab)

Table 12-11: Items on the Tier tab

Item	Description
Tier	Shows the tier to which the DP Pool is assigned.
RAID Level	Shows the RAID level for DP RAID group defined in the DP pool.
Drive Type/RPM	Shows the drive type and rotational speed.
Capacity	• Total: Shows the DP pool capacity. • Consumed: Shows the assigned capacity to the DP-VOL. The assigned capacity displays by the unit of 1024 MB.
Buffer Space for New Page Assignment	Shows the buffer space for new page assignments.
Buffer Space for Tier Relocation	Shows the buffer space for tier relocations.

Volumes window

Figure 12-8 shows the Volumes window. You use this window to create, format, and delete volumes and change volume capacity.

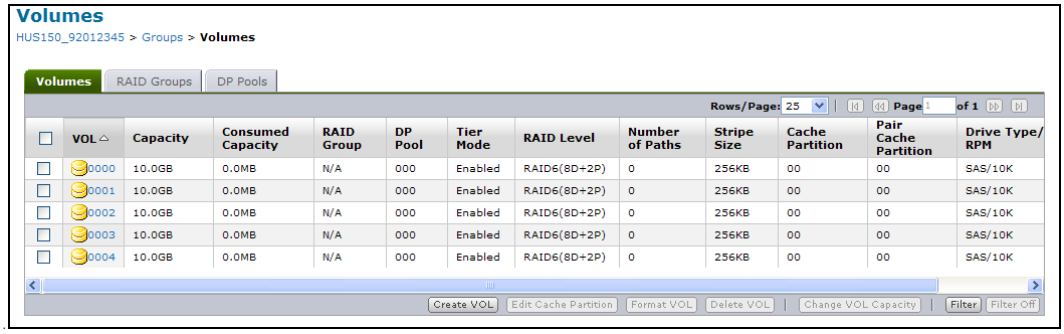


Figure 12-8: Volumes window

Table 12-12: Items on the Volumes tab

Item	Description
VOL	Shows the created volume number.
Capacity	Shows the created volume capacity.
Consumed Capacity	Shows the consumed capacity of the DP-VOL.
RAID Group	Shows the RAID group number of the volume.
Tier Mode	Shows whether Tier Mode is enabled or disabled when the volume is being deleted or a V-VOL, N/A is shown.
RAID Level	Shows the RAID level that created volume.
Number of Paths	Shows the mapping information.
Stripe Size	Shows the stripe size of the volume.
Cache Partition	Shows the cache partition number using the volume.
Pair Cache Partition	Shows the paired cache partition number to be using the volume.
Drive Type/RPM	Shows the drive type and rotational speed.
Status	Shows the volume status.

Table 12-13: Buttons on the Volumes tab

Click this button...	To...
Create VOL	Create a volume.
Format VOL	Format the volume.
Delete VOL	Delete the volume.
Change VOL Capacity	Change the volume.

Figure 12-9 shows the **VOL** property when a specified VOL is selected.

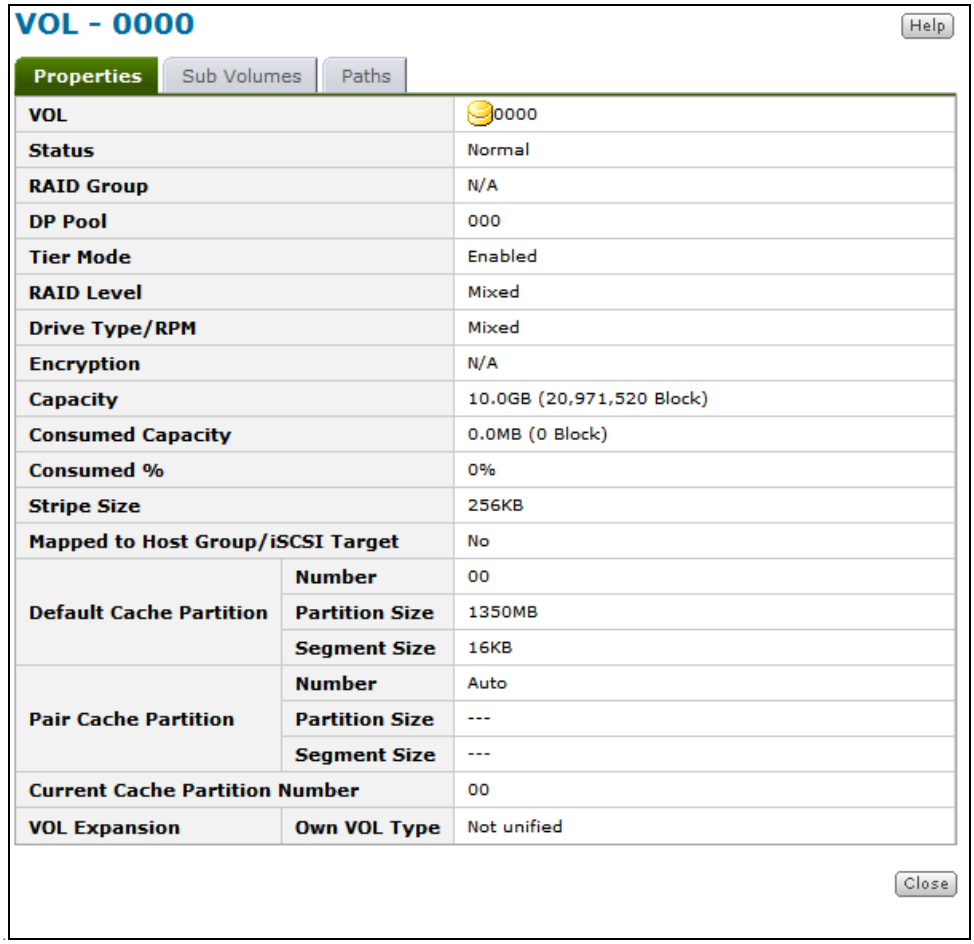


Figure 12-9: VOL Property window

Table 12-14: Items on the Properties window

Item	Description
VOL	Shows the created volume number.
Status	Shows the volume status.
RAID Group	Shows the RAID group number of the volume.
DP Pool	Shows the DP pool number.
Tier Mode	Shows whether Tier Mode is enabled or disabled when the volume is being deleted or a V-VOL, N/A is shown.
RAID Level	Shows the RAID level that created volume.
Drive Type/RPM	Shows the drive type and rotational speed.
Capacity	Shows the created volume capacity.

Table 12-14: Items on the Properties window (Continued)

Item	Description
Consumed Capacity	Shows the consumed capacity of the DP-VOL.
Consumed %	Shows the consumed percentage of the DP-VOL.
Stripe Size	Shows the stripe size of the volume.
Mapped to Host Group/iSCSI Target	Shows the mapping information.
Default Cache Partition	• Number: Shows the default cache partition number. • Partition Size: Shows the default cache partition size. • Segment Size: Shows the default cache partition segment size.
Pair Cache Partition	• Number: Shows the paired cache partition number. • Partition Size: Shows the paired cache partition size. • Segment Size: Shows the paired cache partition segment size.
Current Cache Partition Number	Shows the current cache partition number.
VOL Expansion	Own VOL Type: Shows the unified volume attribute.

DP Pool Trend window

Figure 12-10 shows DP Pool Trend window.

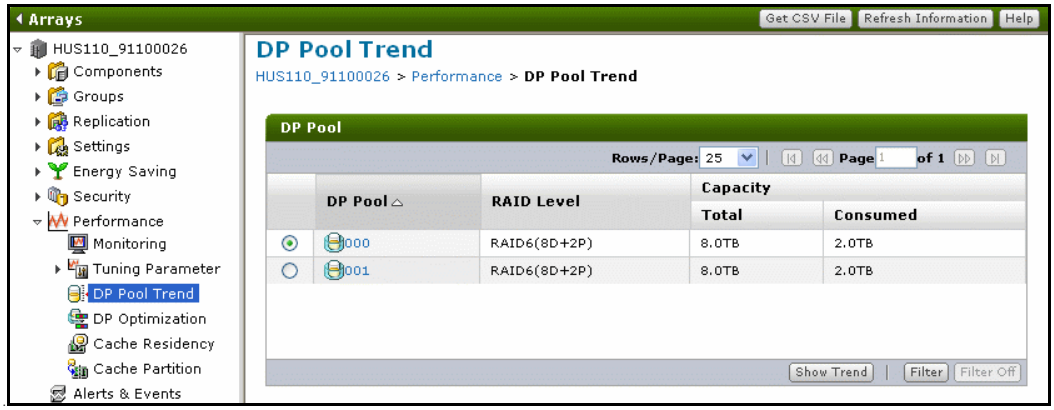


Figure 12-10: DP Pool Trend window

Table 12-15: Items on the DP Pool Trend window

Item	Description
DP Pool	Shows the DP pool number
RAID Level	Shows the RAID level that created DP pool.
Capacity	• Total: Shows the DP pool capacity. • Consumed: Shows the assigned capacity to the DP-VOL. The assigned capacity displays by the unit of 1024 MB.

Table 12-16: Button on the DP Trend window

Click this button...	To...
Show Trend	Display the trend.

DP Optimization window

Figure 12-11 and Figure 12-12 show the DP Optimization window.

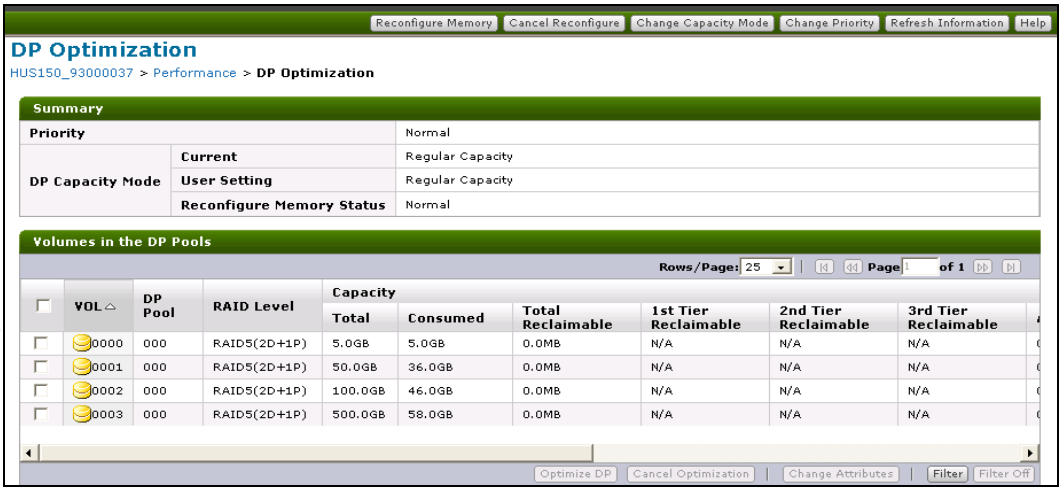


Figure 12-11: DP Optimization window (1 of 2)

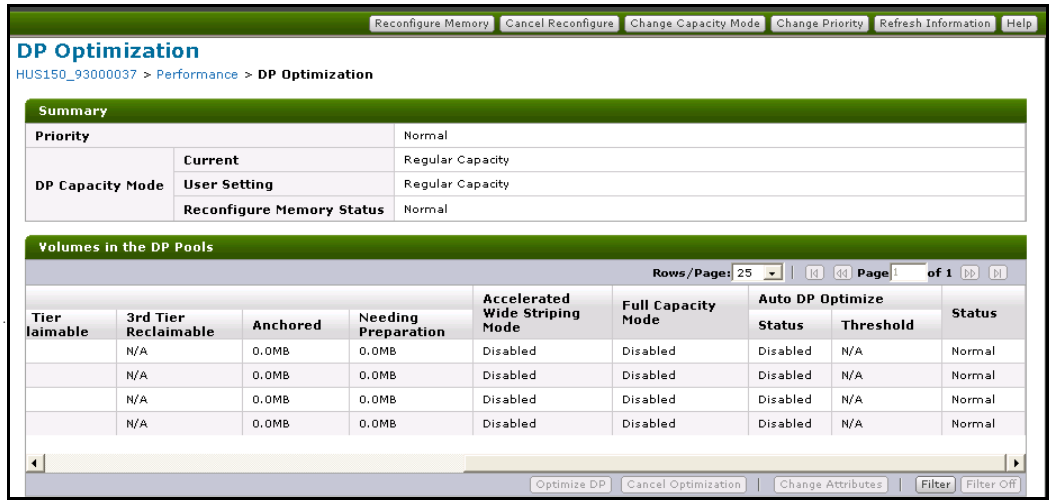


Figure 12-12: DP Optimization window (2 of 2)

Table 12-17: Item on Summary

Item	Description
Priority	Shows the priority of the DP optimization.

Table 12-17: Item on Summary

Item	Description
DP Capacity Mode	• Current: Current value of the DP Capacity Mode. • User Setting: Value specified by the user of the DP Capacity Mode. If the DP Capacity Mode is changed, this value is set and the Current value of the DP Capacity Mode is updated after restarting the array or reconfiguring the memory. • Reconfigure Memory Status: Memory reconfiguration status (see Table 11-5 on page 11-10).

Table 12-18: Items on DP Optimization window

Item	Description
VOl	Shows the created volume number.
DP Pool	Shows the DP pool number.
RAID Level	Shows the RAID level that created volume.
Capacity	• Total: Shows the capacity assigned to the DP-VOL. • Consumed: Shows the capacity used in the DP-VOL. • Total Reclaimable: Shows the reclaimable capacity to the DP-VOL. The standard is the DP-VOLs whose reclaim capacity exceeds 15 GB. The capacity can be increased temporarily after ending optimization. Capacity can be recovered periodically, even if the DP optimization is not performed, after shrinking the DP-VOLs when using VMware, and after the initial copy is performed using ShadowImage, TrueCopy, and/or TrueCopy Extended Distance. • 1st Tier Reclaimable: Shows the reclaimable capacity in the first tier of the DP pool. • 2nd Tier Reclaimable: Shows the reclaimable capacity in the second tier of the DP pool. • 3rd Tier Reclaimable: Shows the reclaimable capacity in the third tier of the DP pool. • Anchored: Shows the unused capacity in the chunk by volume. If Accelerated Wide Striping Mode is enabled or the capacity is less than 1 GBs, all Anchored capacity cannot be used. • Needing Preparation: Shows the remaining capacity following operations such as shrinking a volume.

Table 12-18: Items on DP Optimization window (Continued)

Item	Description
Accelerated Wide Striping Mode	Shows whether Accelerated Wide Striping Mode is enabled or disabled.
Full Capacity Mode	Shows whether Full Capacity Mode is enabled or disabled.
Auto DP Optimize	Status: Shows whether Auto DP Optimize is enabled or disabled. Threshold: When automatic DP optimization mode is enabled, this indicates the threshold value to execute the DP optimization automatically at the monitoring time at midnight. When the use rate of the tier with the target volumes is less than the use rate excluding the free space rate for new assignment and the buffer area rate for relocation, and the recoverable capacity of the tier equals or exceeds this threshold value, the DP optimization of the tier occurs automatically. If the usage rate of the tier with the target volumes equals or exceeds the usage rate excluding the Buffer Space for New Page Assignment and the Buffer Space for Tier Relocation, and the unnecessary capacity of the tier equals or exceeds 1 GB, DP optimization starts.
Status	Shows the DP-VOL status.

Table 12-19: Buttons on the DP Optimization window

Click this button...	To...
Optimize DP	Optimize the DP pool.
Cancel Optimization	Cancel DP optimization.
Change Attributes	Change the enabled or disabled enabled or disabled status of Accelerated Wide Striping Mode, the Full Capacity Mode, and/or Auto DP Optimize.
Change Priority	Set or change the priority of DP optimization.
Change Capacity Mode	Changes the upper limit of the maximum capacity of the DP pool.
Reconfigure Memory	Starts memory reconfiguration.
Cancel Reconfigure	Stops memory reconfiguration.

DP Tier Management windows

Figure 12-13 shows **DP Pools** tab and the **Volumes** tab on DP Tier Management window. In the DP Tier Management window, only the DP pool (with Tier Mode enabled) and the volumes that belong to the DP pool (with Tier Mode enabled) are displayed.

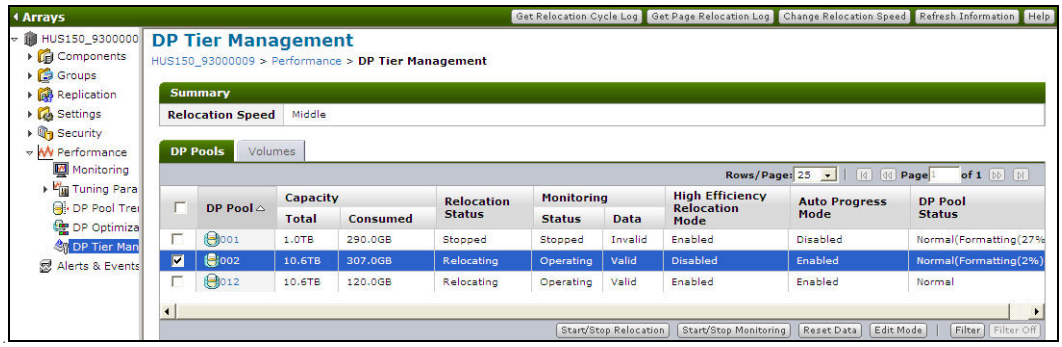


Figure 12-13: DP Tier Management window (DP Pools tab)

Table 12-20: Items on the Summary window

Item	Description
Relocation Speed	Shows the speed used to perform the relocation.

Table 12-21: Buttons on the DP Tier Management window

Click this button...	To...
Get Relocation Cycle Log	Access the relocation cycle log.
Get Page Relocation Log	Access the page relocation log.
Change Relocation Speed	Change the speed at which relocation is performed.

Table 12-22: Items on the DP Pools tab

Item	Description
DP Pool	Shows the SP pool number
Capacity	• Total: Shows the DP pool capacity. • Consumed: Shows the assigned capacity to the DP-VOL. The assigned capacity is shown in unit of 1024 MB.
Relocation Status	Shows the relocation status.
Monitoring	• Status: Shows the monitor status. • Data: Shows the availability of the collected data.
High Efficiency Relocation Mode	Shows whether High Efficiency Relocation Mode is enabled or disabled.
Auto Progress Mode	Shows whether Auto Progress Mode is enabled or disabled.
DP Pool Status	Shows the DP pool status.

Table 12-23: Buttons on the DP Pools tab

Click this button...	To...
Start/Stop Relocation	Start or stop tier relocation.
Start/Stop Monitoring	Starting or stop DP pool monitoring.
Reset Data	Reset the monitor collected data.
Edit Mode	Change the enabled or disabled setting for High Efficiency Relocation Mode and Auto Progress Mode.

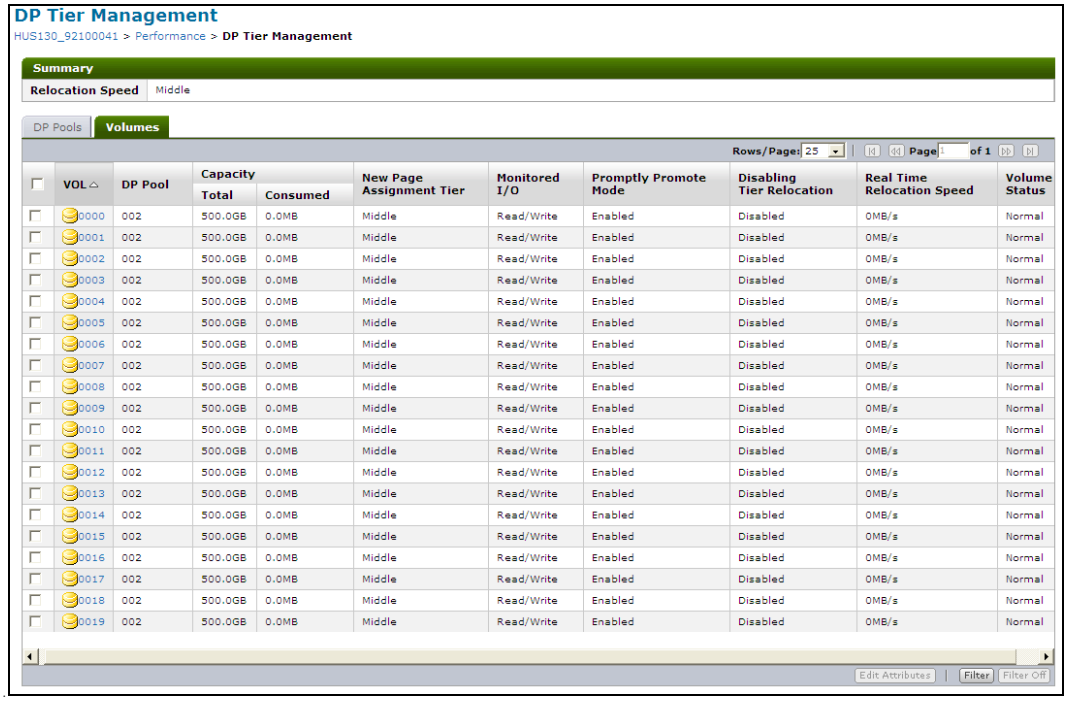


Figure 12-14: DP Tier Management window (Volumes tab)

Table 12-24: Items on the Volumes tab

Item	Description
VOL	Shows the created DP-VOL number.
DP Pool	Shows the DP pool number.
Capacity	• Total: Shows the DP pool capacity. • Consumed: Shows the assigned capacity to the DP-VOL. The assigned capacity is shown in units of 1024 MB.
Buffer Space for New Page Assignment	Show the tier which is assigned to a new page.
Monitored I/O	Shows the type of I/O to be monitored.
Promptly Promote Mode	Shows whether Promptly Promote Mode is enabled or disabled.
Disabling Tier Relocation	Shows whether relocation is enabled or disabled.
Real Time Relocation Speed	Shows the relocation speed.
Volume Status	Shows the volume status.

Table 12-25: Button on the DP Pools tab

Click this button...	To...
Edit Attribute	Change the enabled or disabled setting for New Page Assignment Tier, Monitored I/O, Promptly Promote Mode, and Disabling Tier Relocation.

Figure 12-15 through Figure 12-18 on page 12-25 show the **Properties**, **Scanning Details**, **Relocation Periods**, and **Monitoring Periods** tabs on the DP Pool window.

Figure 12-15: DP Pool window (Properties tab)

Table 12-26: Items on the Properties tab

Scanning Status	Shows the scanning progress status. If only the 1st Tier exists, N/A is shown.
High Efficiency Relocation Mode	Shows enabled or disabled of High Efficiency Relocation Mode.
Auto Progress Mode	Shows enabled or disabled of Auto Progress Mode.
Relocation Status	Shows the relocation Status. If only the 1st Tier exists, N/A is shown.
Monitoring	• Status: Shows the monitoring status. • Data: Shows the availability of the collected data.

Table 12-27: Buttons on the Properties tab

Click this button to...	To...
Edit Mode	Switch between enable or disable for High Efficiency Relocation Mode and Auto Progress Mode.
Start/Stop Relocation	Start or stop tier relocation.
Start/Stop Monitoring	Start or stop monitoring of the DP pool.

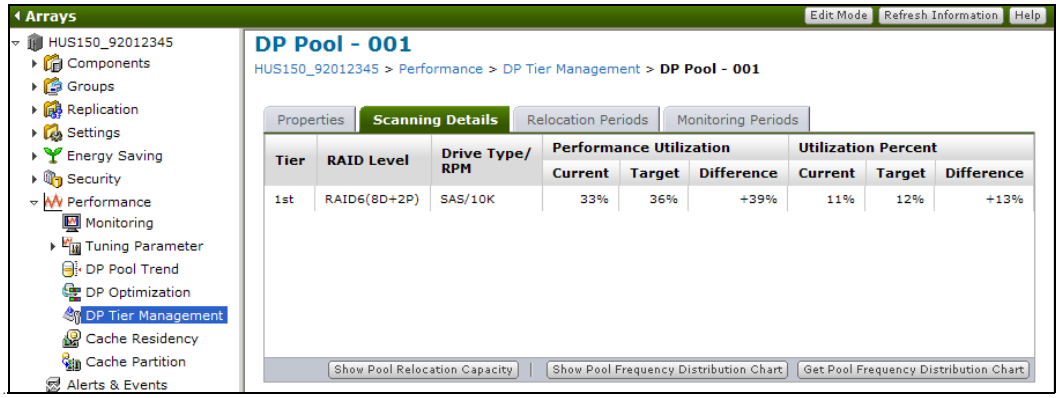


Figure 12-16: DP Pool window (Scanning Details tab)

Table 12-28: Items on the Scanning Details tab

Item	Description
Tier	Shows the tier to which the DP RAID Group is assigned.
RAID Level	Shows the RAID level that created DP pool.
Drive Type/RPM	Shows the drive type and rotational speed.
Performance Utilization	• Current: Shows the current performance utilization. • Target: Shows the target performance utilization. • Difference: Shows the difference between the current and target percentages.
Utilization Percent	• Current: Shows the current used capacity percentage for the tier. • Target: Shows the system-generated target capacity percentage to support optimized tier operations. • Difference: Shows the difference between the current and target percentages.

Table 12-29: Buttons on the Scanning Details tab

Click this button...	To...
Edit Mode	Switch between enable or disable for High Efficiency Relocation Mode and Auto Progress Mode
Show Pool Relocation Capacity:	Display the relocation capacity of the DP pool.
Get Pool Frequency Distribution Chart	Display the DP pool frequency distribution chart.

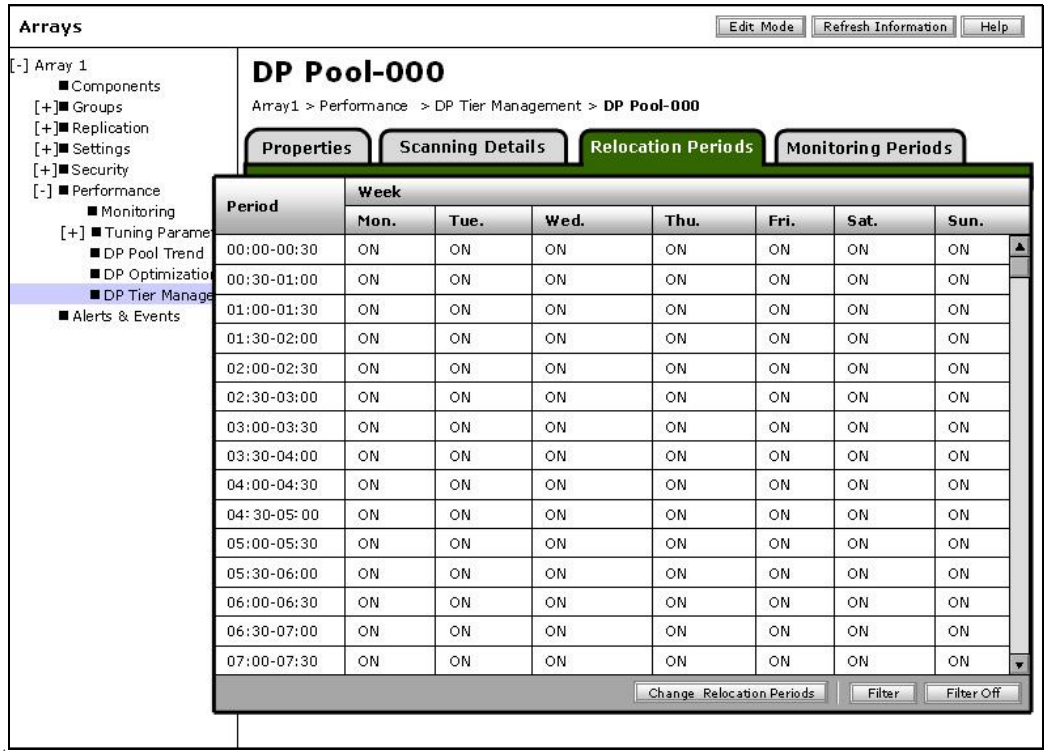


Figure 12-17: DP Pool window (Relocation Periods tab)

The **Relocation Periods** tab appears when Auto Progress Mode is enabled.

Table 12-30: Items on the Relocation Periods tab

Item	Description
Period	Execution time between 00:00 and 24:00, displayed in units of 30 minutes.
Week	Execution time is displayed by the day of the week.

Table 12-31: Button on the Change Relocation Periods tab

Click this button...	To...
Change Relocation Periods	Change relocation periods.

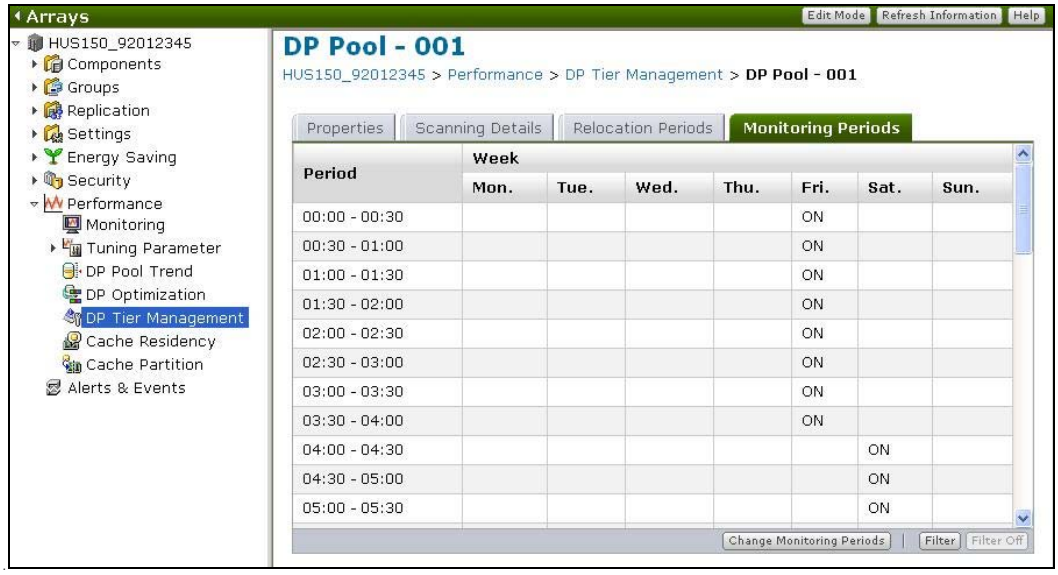


Figure 12-18: DP Pool window (Monitoring Periods tab)

The **Monitoring Periods** tab appears when Auto Progress Mode is enabled.

Table 12-32: Items on the Monitoring Periods tab

Item	Description
Period	Execution time between 00:00 and 24:00, displayed in units of 30 minutes.
Week	Execution time displayed by the day of the week.

Table 12-33: Button on the Change Monitoring Periods tab

Click this button...	To...
Change Relocation Periods	Change monitoring periods.

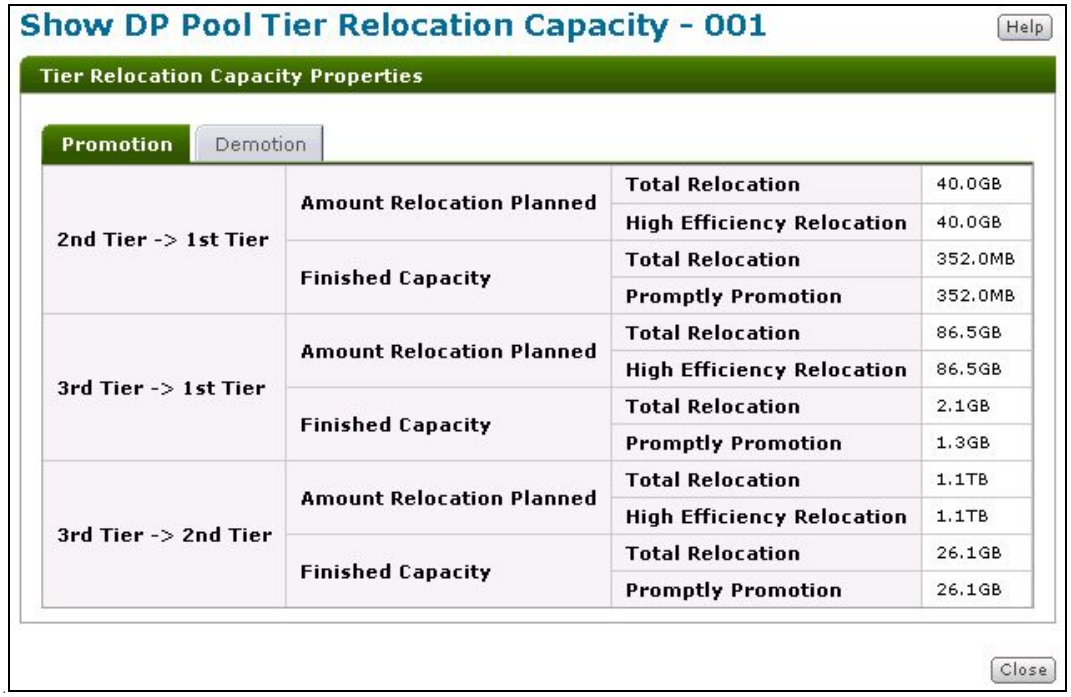


Figure 12-19: Show DP Pool Tier Relocation Capacity window (Promotion tab)

Table 12-34: Items on the Promotion tab

Item	Description
-xx Tier -> xx Tier	Shows tiers from which a page has moved (left) and tiers to which a page has moved (right).
Amount Relocation Planned	Shows amount that remains to be relocated. • Total Relocation: Shows the amount targeted to be relocated. • High Efficiency Relocation: Shows the amount of efficiency associated with the targeted relocation amount.
Finished Capacity	Shows the amount relocated: • Total Relocation: Shows total amount relocated. • Promptly Promotion: Shows amount relocated by prompt promotion.

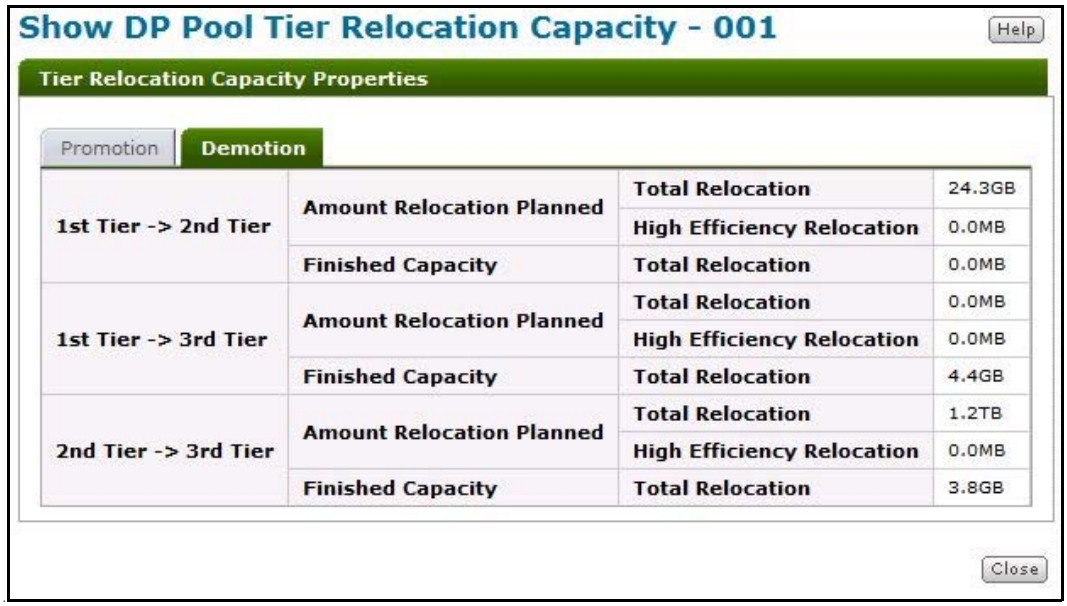


Figure 12-20: Show DP Pool Tier Relocation Capacity window (Demotion tab)

Table 12-35: Items on the Demotion tab

Item	Description
-xx Tier -> xx Tier	Shows tiers from which a page has moved (left) and tiers to which a page has moved (right).
Amount Relocation Planned	Shows amount that remains to be relocated. • Total Relocation: Shows the amount targeted to be relocated. • High Efficiency Relocation: Shows the amount of efficiency associated with the targeted relocation amount.
Finished Capacity	Shows the amount relocated: • Total Relocation: Shows total amount relocated.

Figure 12-21 shows the property screen when selecting DP volume number.

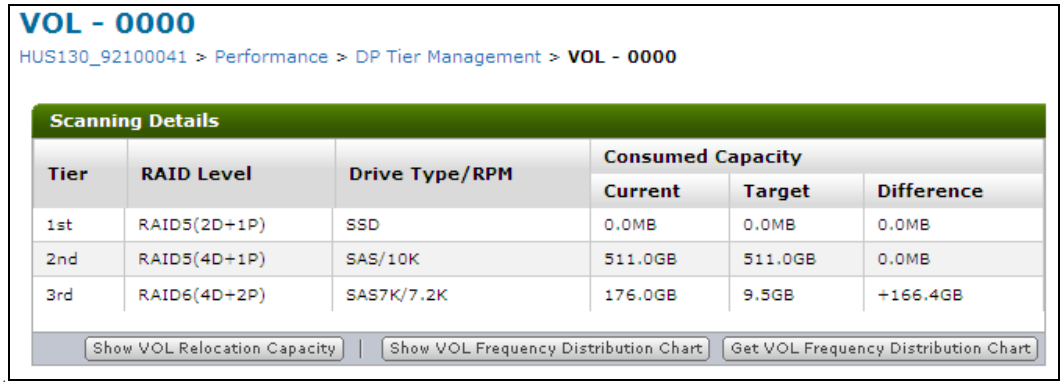


Figure 12-21: DP Volume Property window

Table 12-36: Items on the Scanning Details tab

Item	Description
Tier	Shows tier defined for DP volume.
RAID Level	Shows the RAID level of the DP RAID Group defined for DP volume.
Drive Type/RPM	Shows the Drive Type and rotational speed. If multiple tiers are set with Tier Mode enabled, **Mixed** is displayed.
Consumed Capacity	Shows one of the following values: • Current: Shows the current tier utilization capacity. • Target: Shows the target tier utilization capacity. • Difference: Shows the difference between the current and target.

Table 12-37: Buttons on the Property window

Button	Description
Show VOL Relocation Capacity	Click this button to view the DP volume relocation capacity.
Show VOL Frequency Distribution Chart	Click this button to view the DP volume frequency distribution chart.
Get VOL Frequency Distribution Chart	Click this button to view the DP volume frequency distribution chart.

Figure 12-22 shows the property screen for volume tier relocation capacity.

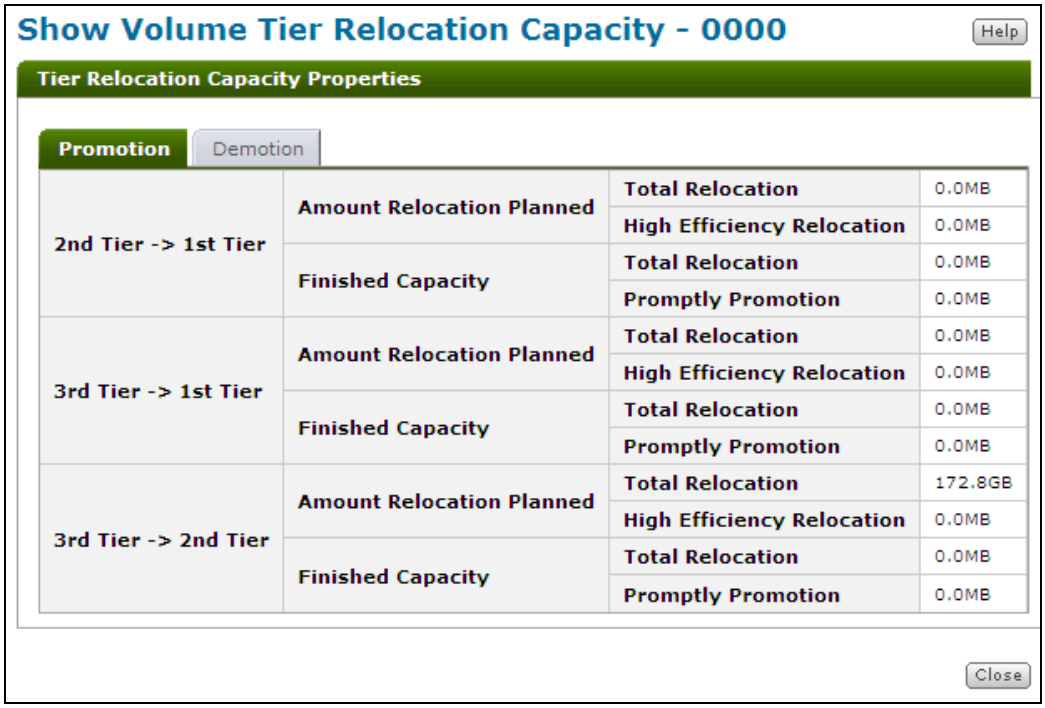


Figure 12-22: Show Volume Tier Relocation Capacity window (Promotion tab)

The information shown in the **Promotion** tab and **Demotion** tab indicate that the DP pool tier relocation capacity is divided per DP volume belonging to the relevant DP pool.

13

Performing Hitachi Dynamic Tiering operations

This chapter provides procedures for performing Hitachi Dynamic Tiering operations using the Hitachi Storage Navigator Modular 2 graphical user interface (GUI).

The following topics are covered in this chapter:

Hitachi Dynamic Tiering workflow

Figure 13-1 shows the Dynamic Tiering workflow.

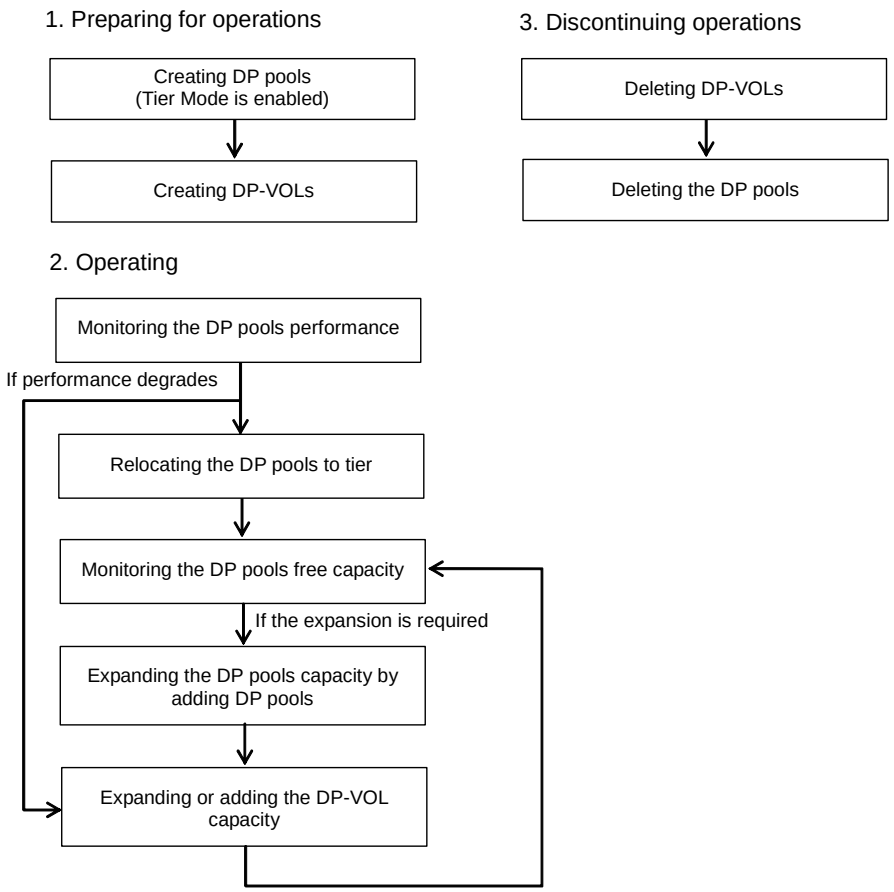


Figure 13-1: Dynamic Tiering workflow

Managing DP pools

This section describes the following topics:

- Creating a DP pool with Tier Mode enabled
- Changing the Tier Mode of a DP pool
- Changing the basic attribute of a DP pool
- Changing the Tier attribute for a DP pool
- Deleting a DP pool
- Reinitializing a DP pool
- Adding DP pool capacity
- Shrinking the DP pool capacity
- Canceling DP pool capacity shrinking

Creating a DP pool with Tier Mode enabled

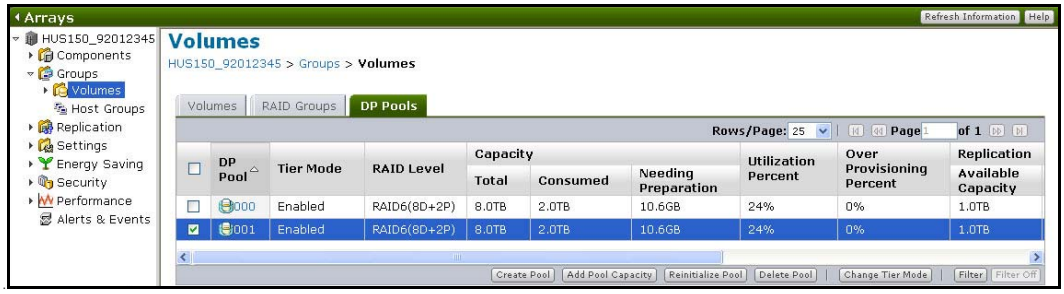
The time to create DP pools depends on factors such as the number and capacity of:

- DP pools to be created.
- HDUs to be added to a DP pool.

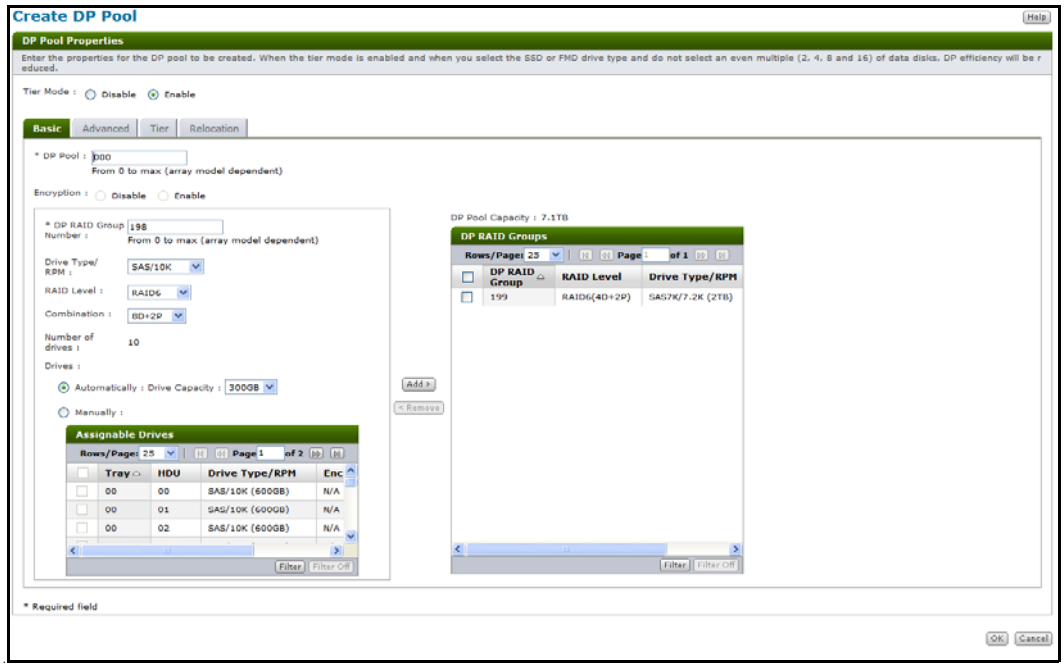
When creating many DP pools or adding large-capacity HDUs to a DP pool, it may take significant time to complete the procedure.

To create a new DP pool:

1. On the **Pools** tab on the Volumes window, click **Create Pool**.



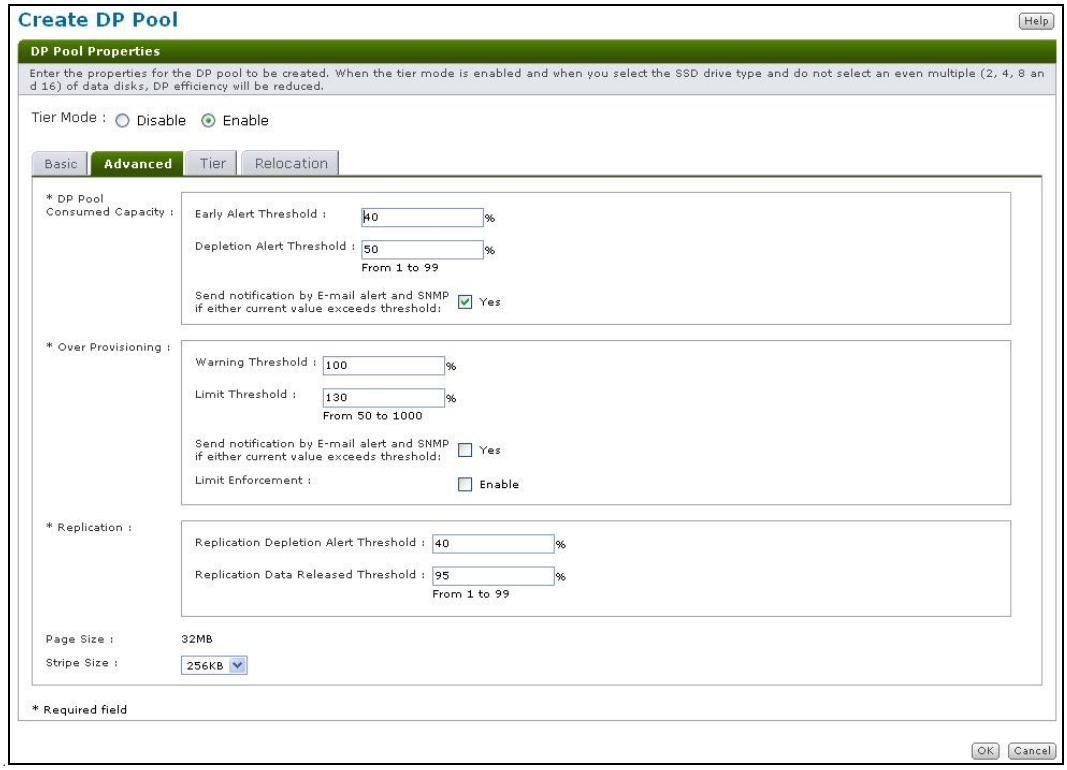
The Create DP Pool window appears.



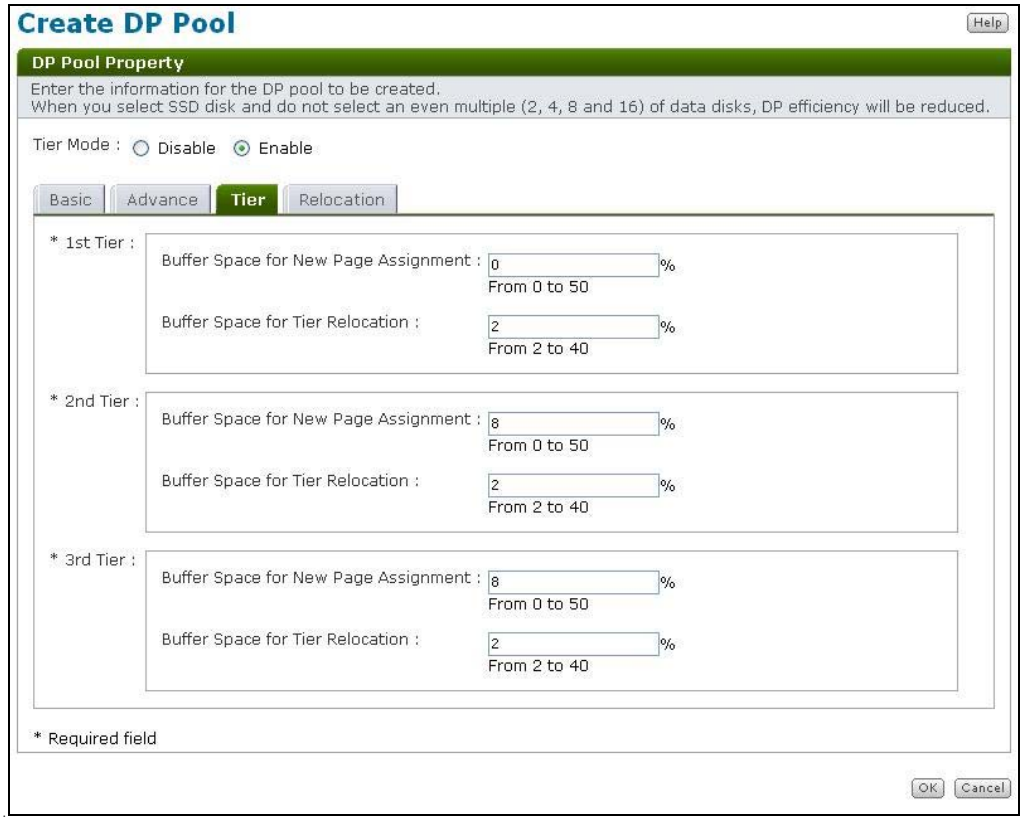
2. For **Tier Mode**, click **Enable**.
3. In the **DP Pool** field, enter a unique DP pool number for identifying this DP pool. The value must fall within the permitted range for your array.
   - Hitachi Unified Storage 150 and 130: 0 to 63
   - Hitachi Unified Storage 110: 0 to 49
4. In the **DP RAID Group Number** field, enter a unique DP RAID group number for identifying this RAID Group. The value must fall within the permitted range for your array.
   - Hitachi Unified Storage 150: 0 to 63
   - Hitachi Unified Storage 130: 0 to 199
   - Hitachi Unified Storage 110: 0 to 49
5. Using the **Drive Type/RPM** drop-down list, select a drive type.
6. Using the **RAID Level** drop-down list, select a RAID level.
7. Using the **Combination** drop-down list, select a combination.
8. Select whether to set the drive automatically or manually.
   - **Automatically**: Select a drive capacity from the **Drive Capacity** drop-down list.
   - **Manually**: Check the same number of HDU check boxes that correspond to the number displayed in the **Number of drives**.
9. Click the **Add** button. A DP RAID group is added to the DP RAID Groups list.

When selecting two or more DP RAID groups, repeat this procedure from step 4.

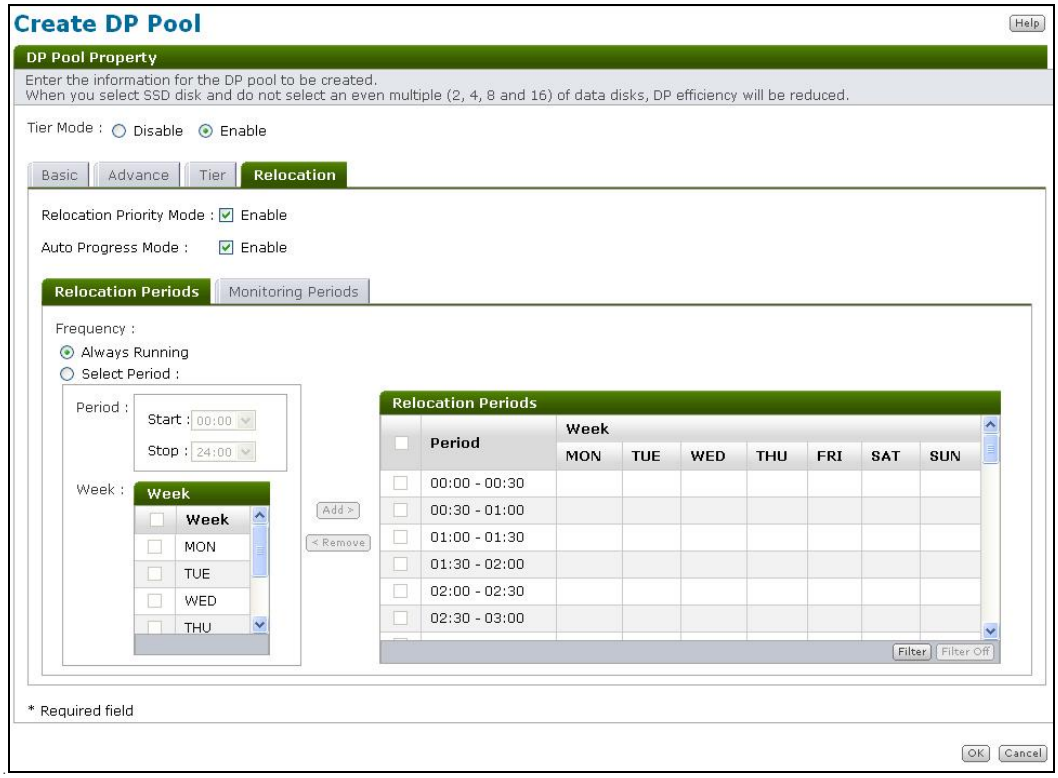
10. Click the **Advanced** tab.



11. Enter the **Early Alert Threshold** and **Depletion Alert Threshold** for the **DP Pool Consumed Capacity** if necessary.
12. For **Over Provisioning**, enter the **Warning Threshold** and the **Limit Threshold** if necessary.
13. To have email sent and an SNMP trap generated if the current value exceeds the threshold, check the **Send notification by E-mail alert and SNMP if the current value exceeds the threshold** check box.
14. Check or uncheck **Limit Enforcement**, as necessary.
15. For **Replication**, enter the **Replication Depletion Alert Threshold** and **Replication Data Released Threshold** if necessary.
16. Using the **Stripe Size** drop-down list, select a stripe size if necessary.
17. Click the **Tier** tab.



18. For **1st Tier**, **2nd Tier**, and **3rd Tier**, enter the **Buffer Space for New Page Assignment** and **Buffer Space for Tier Relocation** if necessary.
19. Click the **Relocation** tab.



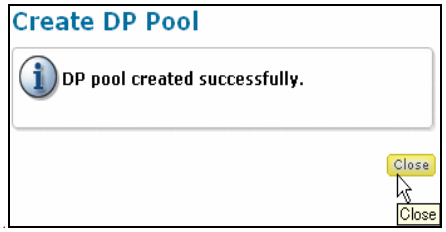
20. Check or uncheck the **High Efficiency Relocation Mode** and **Auto Progress Mode** check boxes as necessary.
21. The settings on the **Relocation Periods** tab and **Monitoring Periods** tab are the same.

    If you enable **Auto Progress Mode**, select a **Frequency** setting of **Always Running** or **Select Period** on the **Relocation Periods** tab or **Monitoring Periods** tab.

    If you select **Select Period**, configure the following settings:

    - **Period**: Select the time from the **Start** and **Stop** drop-down lists. The time can be selected in the units of 30 minutes.
    - **Week**: Select a day of week when the relocation or monitoring is performed. Check the topmost check box to select all days.

    After selecting the **Period** and **Week** settings, click **Add**. The selected period and week are shown on the **Relocation Periods** list or **Monitoring Periods** list. **ON** indicates the selected period and day of week.
22. Click **OK**. When the following message appears, click **Close**.



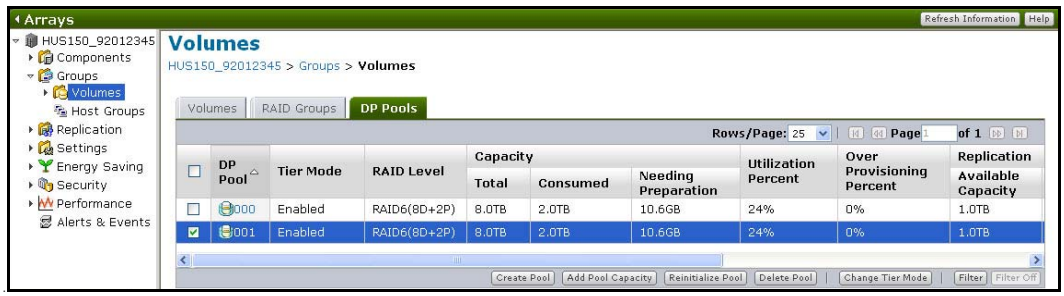
Creating a DP pool (Tier Mode is enabled) is now complete. You can now create a DP-VOL.

Changing the Tier Mode of a DP pool

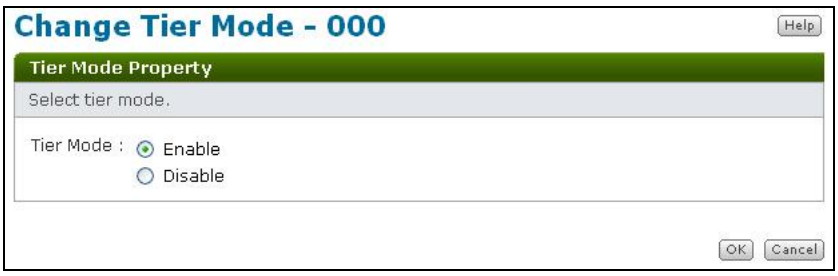
The following procedure describes how to change the Tier Mode of a DP pool. If Tier Mode is disabled, the media in a DP RAID group to be registered in the DP pool cannot be mixed in order to configure the DP pool.

NOTE: A Hitachi Dynamic Provisioning pool that consists of SSDs only cannot be converted into a Hitachi Dynamic Tiering pool. For more information, see Tier Mode relationship between Hitachi Dynamic Provisioning and Tiering on page 10-5.

1. On the **DP Pools** tab of the Volumes window, click the DP Pool whose Tier Mode setting you want to change.



2. Click the **Change Tier Mode** button. The Change Tier Mode window appears.



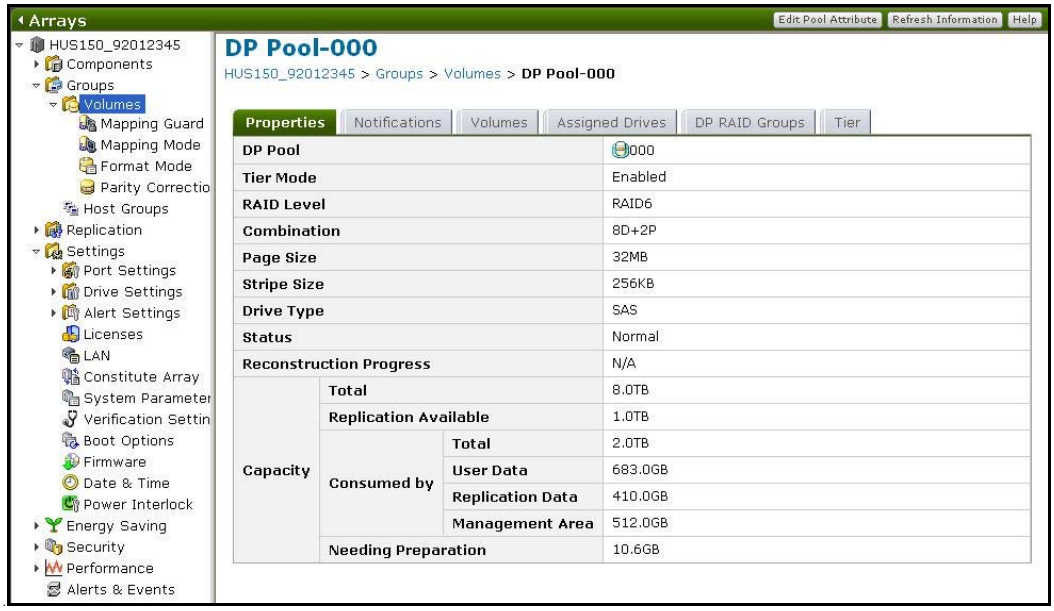
3. To enable the Tier Mode, check **Enable**. To disable Tier Mode, check **Disable**.
4. Click **OK**. When a message appears, click **Close**.

Changing the basic attribute of a DP pool

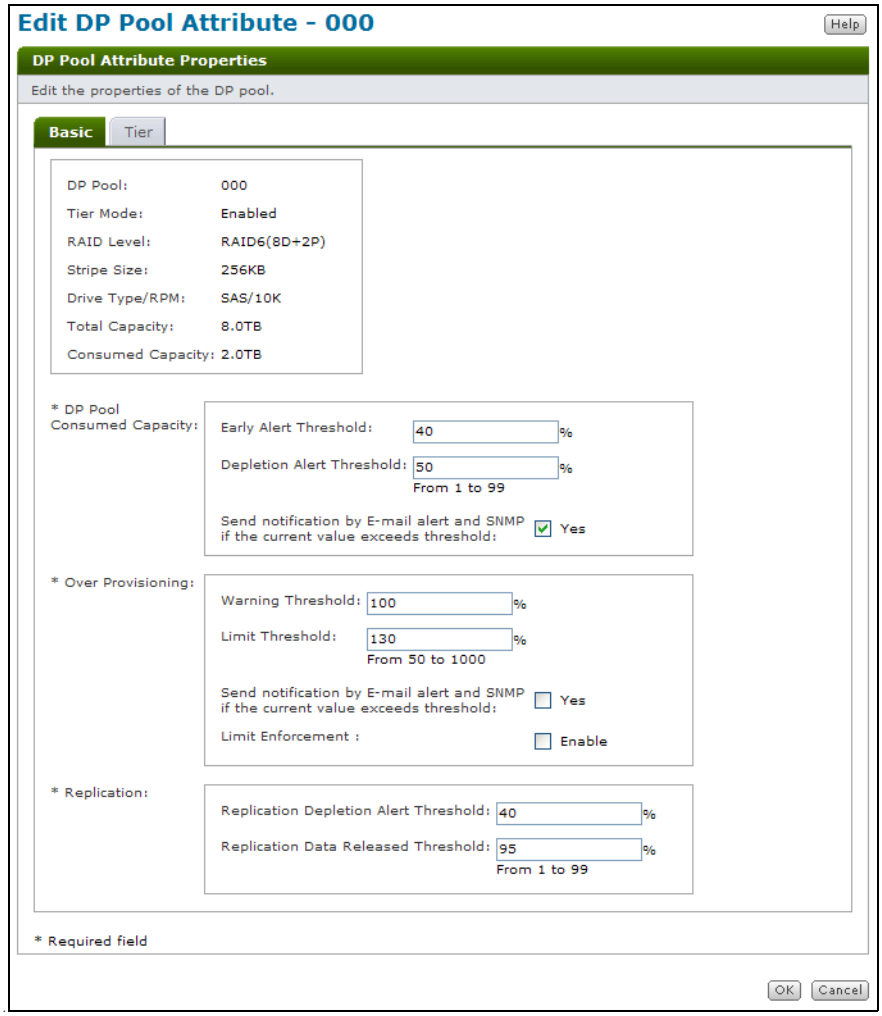
After you create a DP pool, you can change the threshold value.

To change the DP pool attributes:

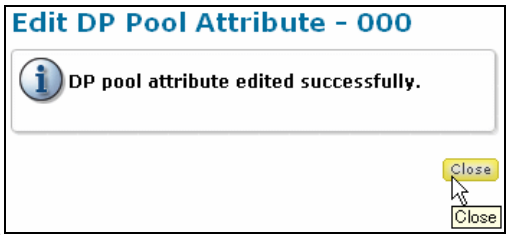
1. In the **Properties** tab on the DP Pool window, click **Edit Pool Attribute**.



The Edit DP Pool Attribute window appears.



2. For **DP Pool Consumed Capacity Alert**, enter the **Early Alert Threshold** and **Depletion Alert Threshold** percentages if necessary.
3. For **Over Provisioning**, enter the **Warning Threshold** and **Limit Threshold** percentages if necessary.
4. To have email sent and an SNMP trap generated if the current value exceeds the threshold, check the **Send notification by E-mail alert and SNMP if the current value exceeds the threshold** check box.
5. Check or uncheck **Limit Enforcement** if necessary.
6. For **Replication**, enter the **Replication Depletion Alert Threshold** and **Replication Data Released Threshold** if necessary.
7. Click **OK**. When the following message appears, click **Close**.

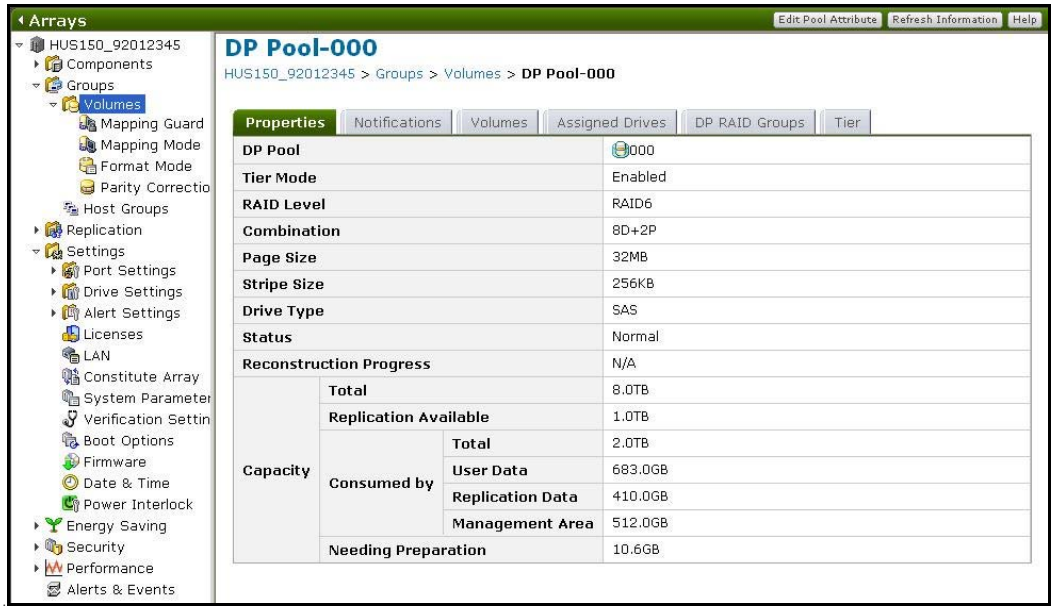


Changing the Tier attribute for a DP pool

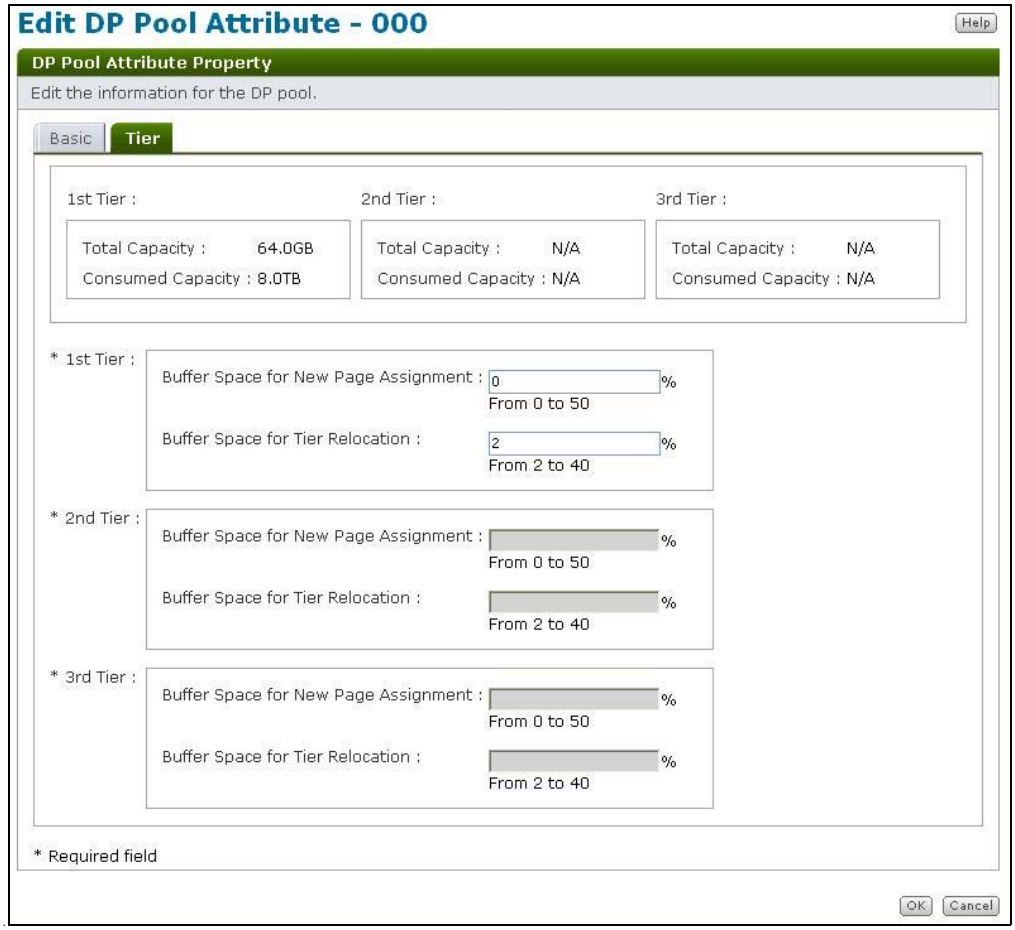
After creating a DP pool, you can change the Buffer Space for New Page Assignment and the Buffer Space for Tier Relocation settings for the DP pool tier.

To change the Tier attribute for a DP pool:

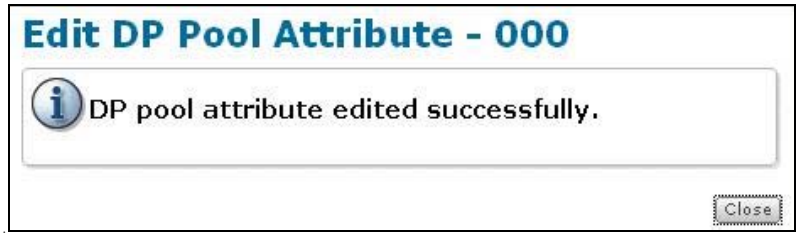
1. In the **Properties** tab on the DP Pool window, click **Edit Pool Attribute**.



2. At the Edit DP Pool Attribute window, click the **Tier** tab.



3. For **1st Tier**, **2nd Tier**, and **3rd Tier**, enter the **Buffer Space for New Page Assignment** and **Buffer Space for Tier Relocation** settings if necessary.
4. Click **OK**. When the following message appears, click **Close**.



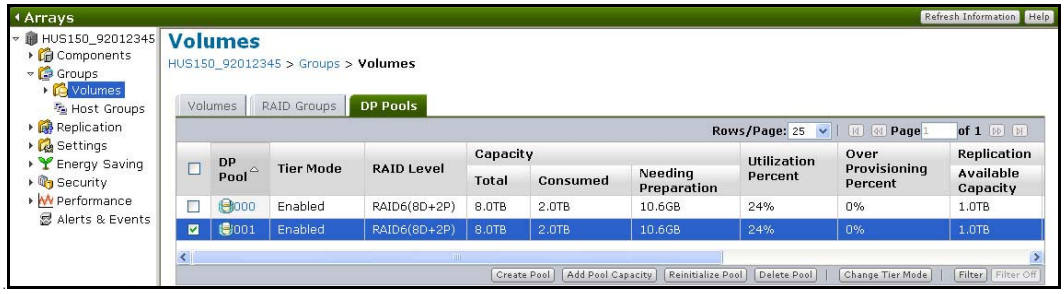
Deleting a DP pool

Typically, you delete one DP pool at a time. However, you can delete multiple DP pools at the same time.

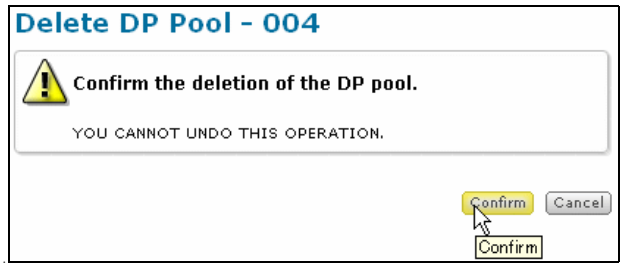
NOTE: Before deleting a DP pool, delete the DP-VOL defined as the DP pool (see Deleting DP-VOLs on page 13-20).

To delete one or more DP pools:

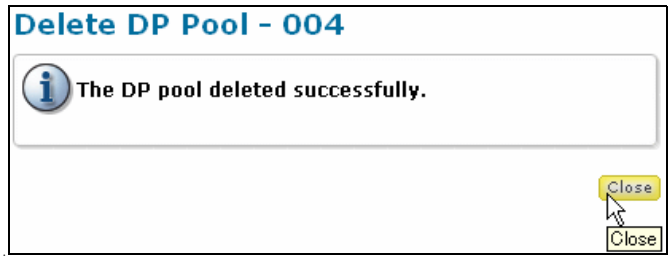
1. In the **DP Pools** tab on the Volumes window, check the check boxes of each DP pool you want to delete.



2. Click **Delete Pool**.
3. When a confirmation message appears, click **Confirm**.



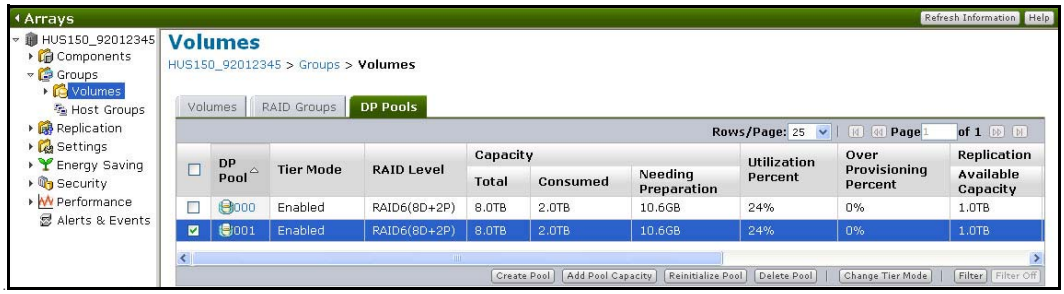
4.When the following message appears, click **Close**.



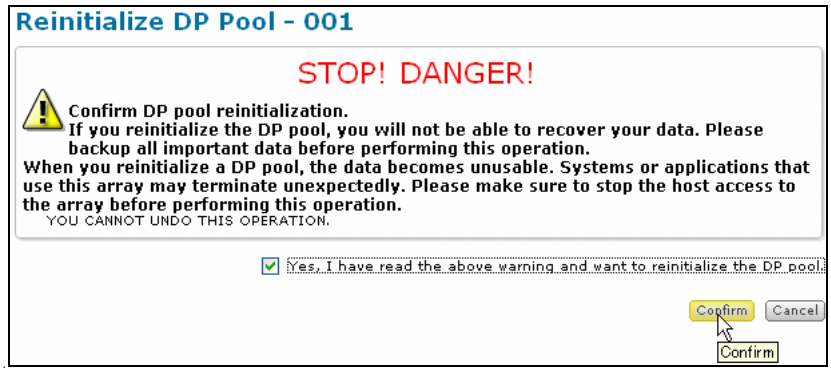
Reinitializing a DP pool

Normally, you should not have to reinitialize a DP pool. You might need to perform this procedure, however, if you need to recover a DP pool after recovering from a failure. For example, if a DP-VOL is blocked due to an HDU failure, use this procedure to recover the HDU where the failure occurred. If the status of the DP-VOL is Unformat, perform the volume format.

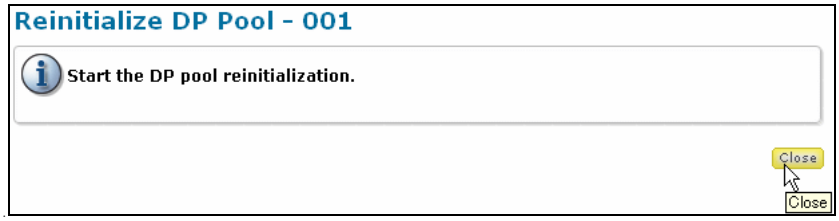
1. In the **DP Pools** tab on the Volumes window, check the check boxes of the DP pool you want to recover.



2. Click **Reinitialize Pool**.
3. A warning message appears, check the check box and click **Confirm**.



4. When the following message appears, click **Close**.

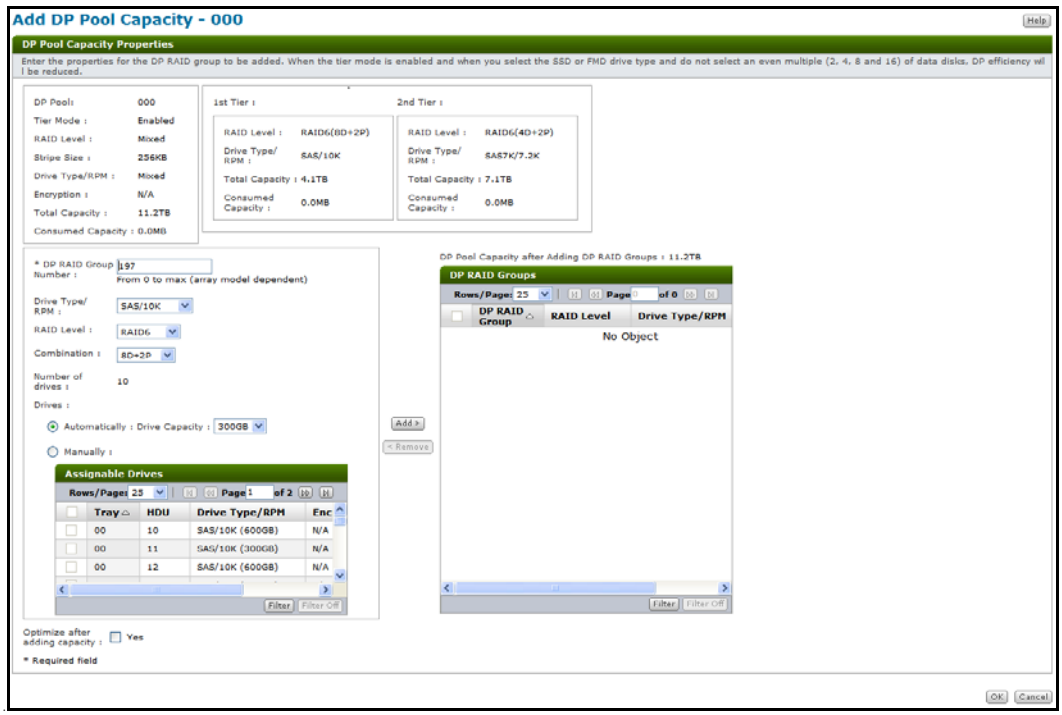


5. Select the **VOL** whose status is **Unformat**, and then click **VOL Format**.

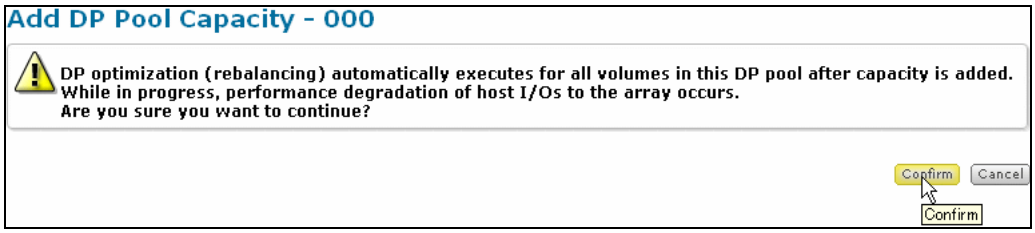
Adding DP pool capacity

To add DP pool capacity:

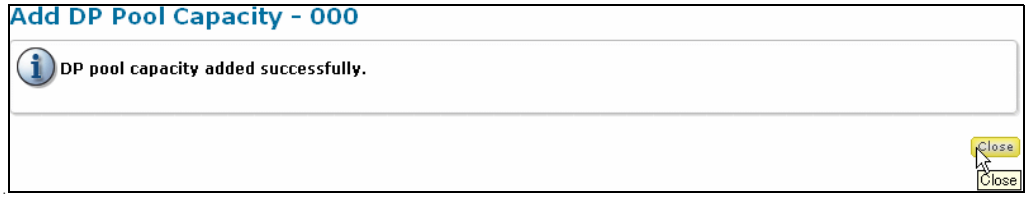
1. On the **DP Pools** tab of the Volumes window, check the DP pool number to which you want to add DP pool capacity.
2. Click **Add Pool Capacity**. The Add DP Pool Capacity window appears.



3. In the **Drives** selection, select one of the following:
   - **Automatically**: Enter a drive number in the **Number of drives** field. For **Number of drives**, enter the number of drives that is the same as the combination of the pools x 1.
   - **Manually**: Check a check box for an appropriate combination. Specify a **Tray** and **HDU** from the **Assignable Drives** list that is the same as the combination of pools.
4. To optimize after adding capacity, check the **Optimize after adding capacity** check box. When checked, the array performs DP optimization automatically after adding DP pool capacity.
5. Enter the **DP RAID Group Number** if necessary.
6. Click the **Add** button. A DP RAID group is added to the **DP RAID Groups** list. When selecting two or more DP RAID groups, repeat steps 3 through 6.
7. Click **OK**. When the following message appears, click **Confirm**.



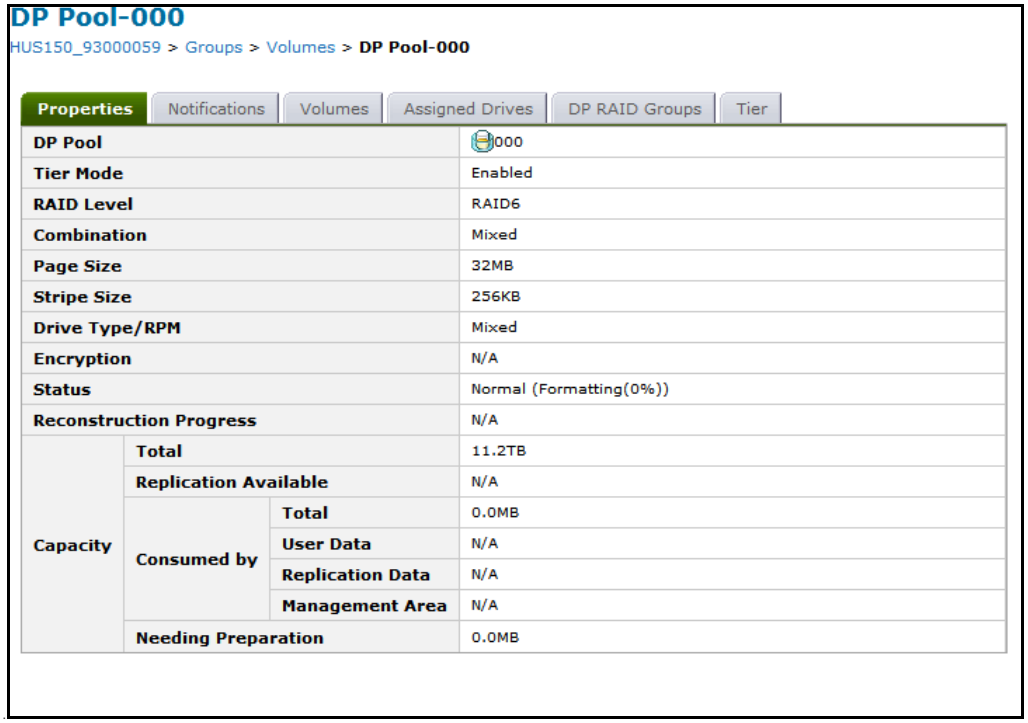
8. When the following message appears, click **Close**.



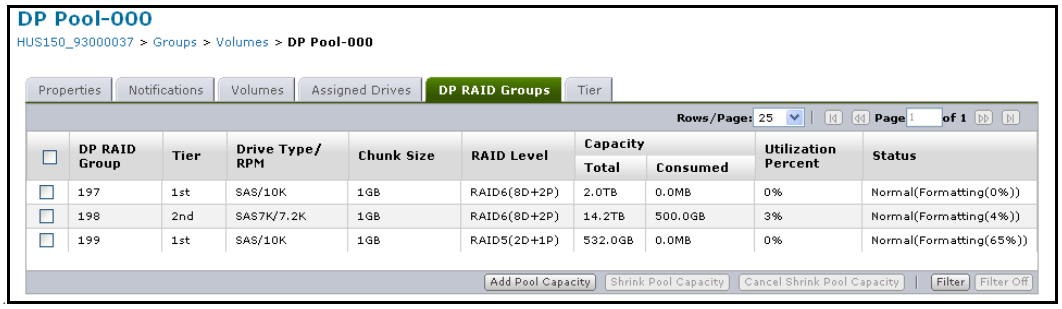
Shrinking the DP pool capacity

To shrink the DP pool capacity:

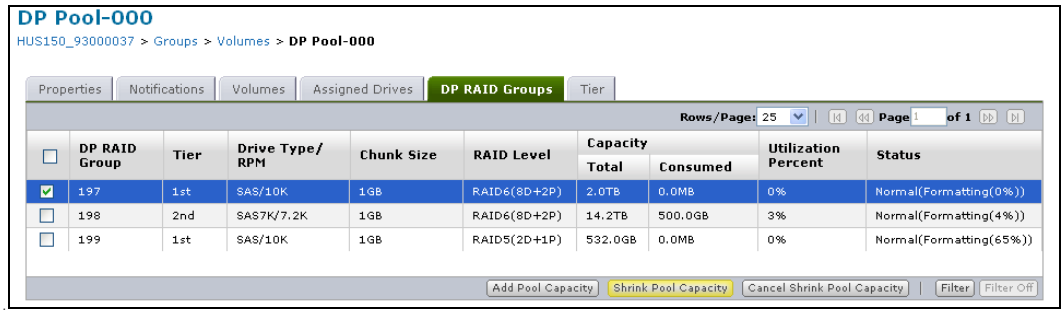
1. On the **DP Pools** tab of the Volumes window, select the DP pool number where you want to change capacity. The DP Pool advanced screen appears.



2. Click the **DP RAID Groups** tab.



3. Select the DP RAID group to be shrunk, and then click **Shrink Pool Capacity**.

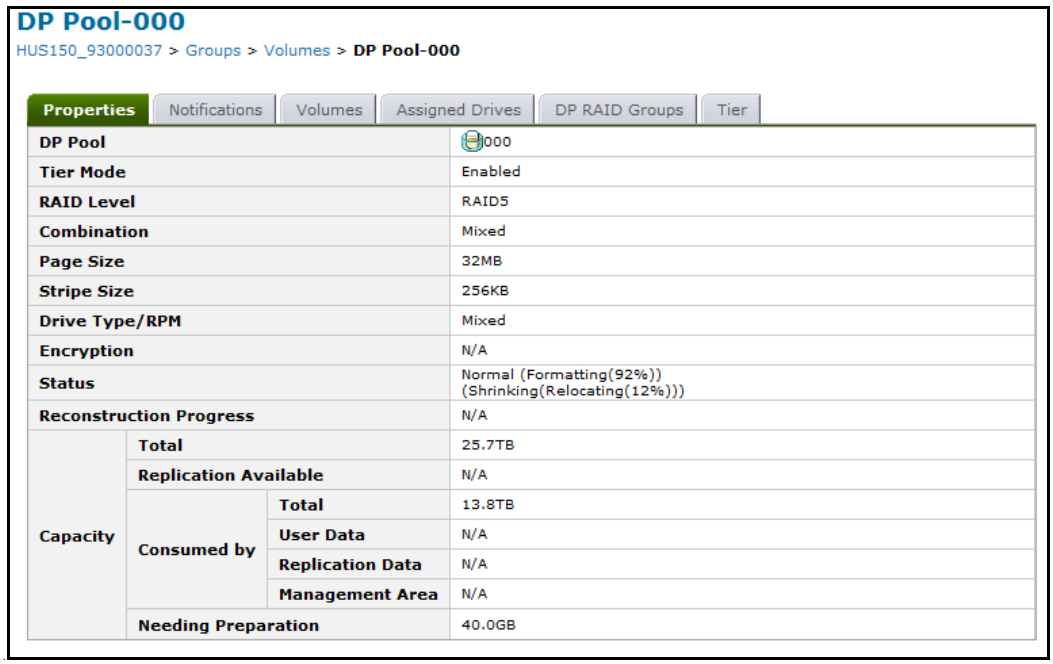


4. When a message appears, click **Confirm**.
5. At the next message, click **Close**.

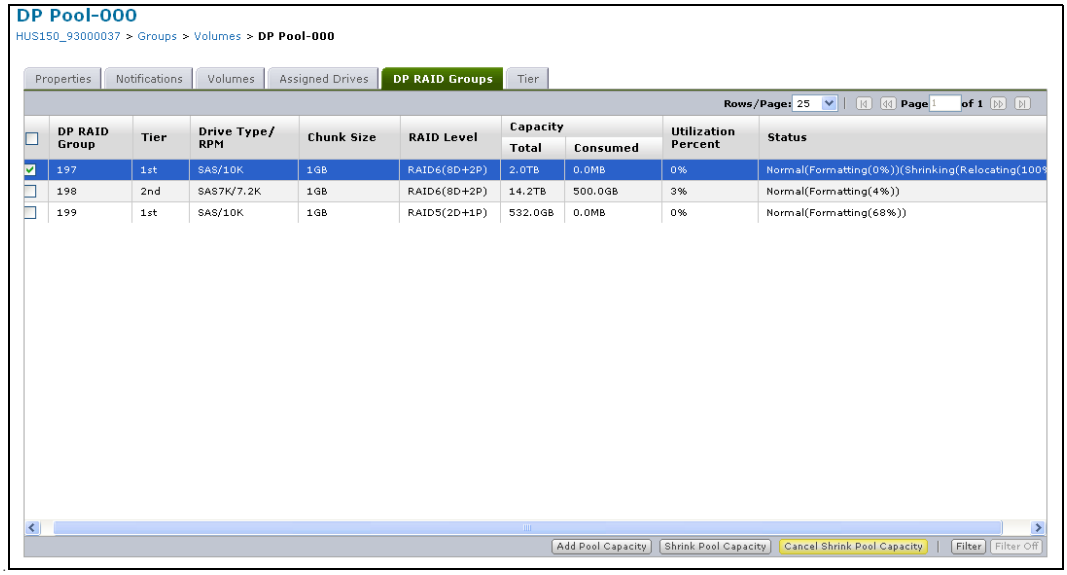
Canceling DP pool capacity shrinking

To cancel a DP pool capacity shrinking operation:

1. On the **DP Pools** tab of the Volumes window, select the DP pool number you want to cancel the capacity shrinking. The DP Pool advanced screen appears.



2. Click the **DP RAID Groups** tab.



3. Select the DP RAID group to cancel the shrinking, and then click **Cancel Shrink Pool Capacity**.
4. When a message appears, click **Close**.

Managing DP-VOLs

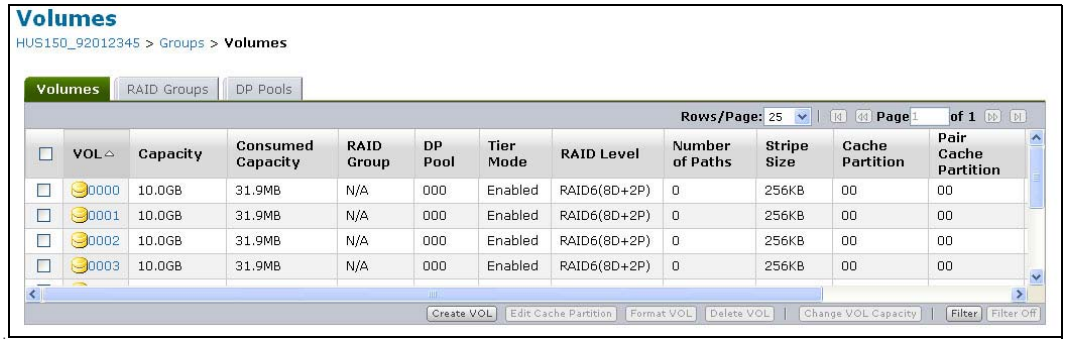
This section describes the following topics:

- Creating a DP-VOL
- Deleting DP-VOLs
- Changing DP-VOL capacity

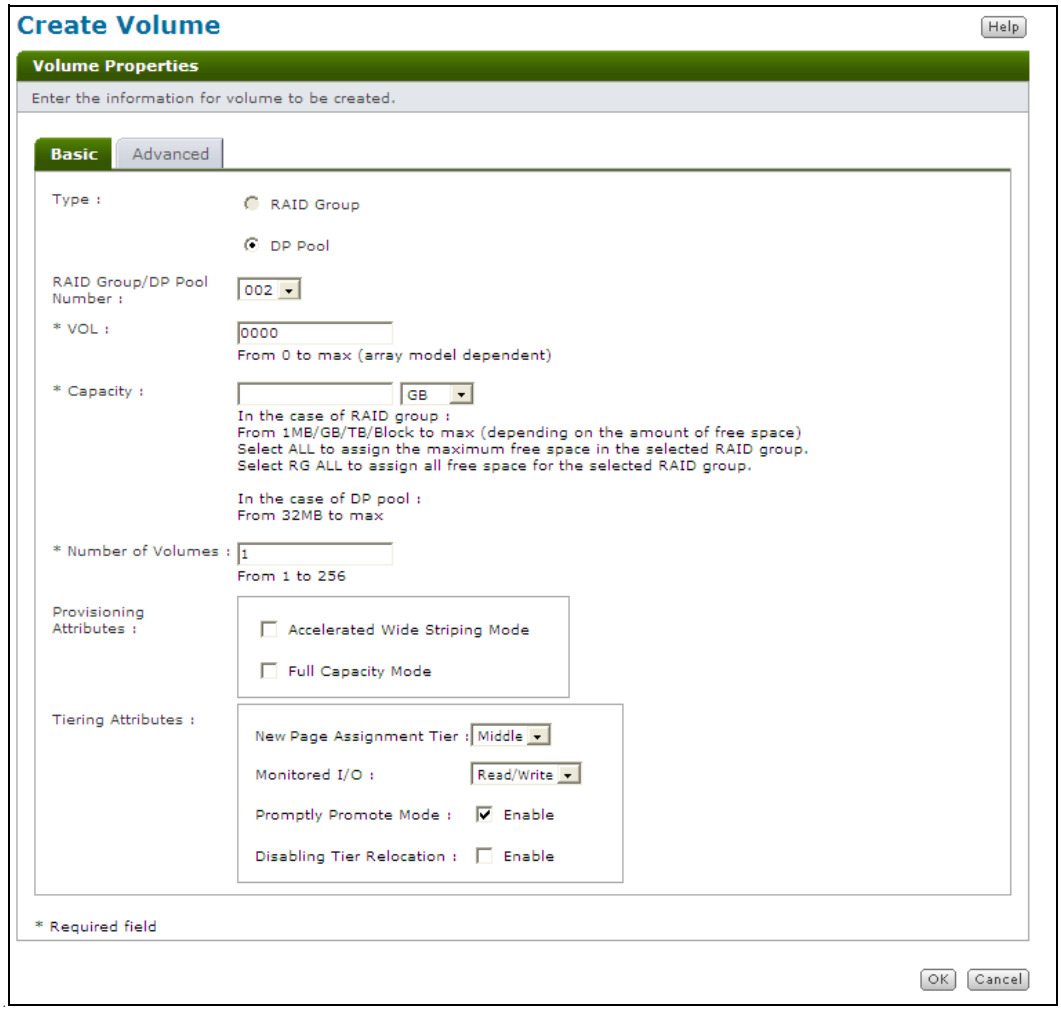
Creating a DP-VOL

To create a new DP-VOL:

1. In the Volumes window, click **Create VOL**.



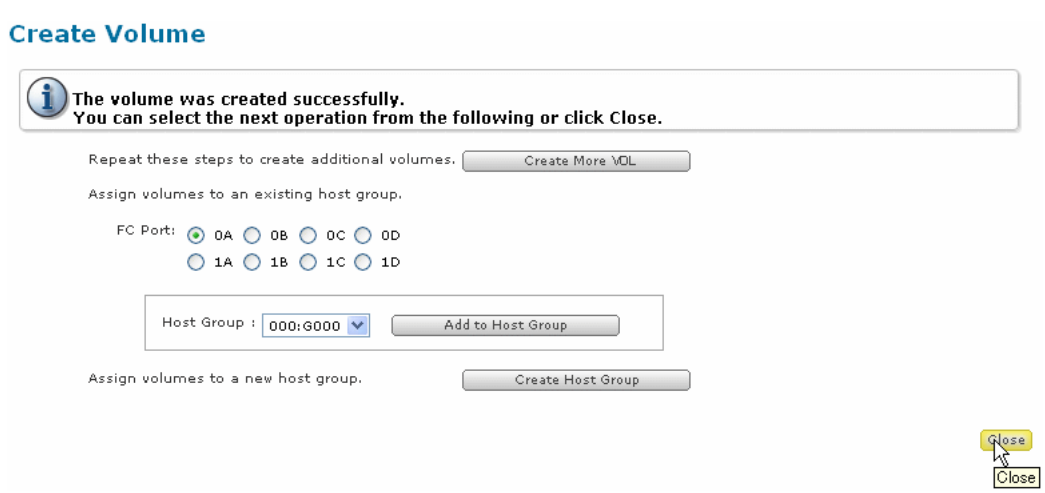
The Create Volume window appears.



2. For **Type**, select a DP Pool.
3. Using the **RAID Group/DP Pool Number** drop-down list, select a DP pool number.
4. In the **VOL** field, specify a volume number that you want to assign to the DP-VOL.
5. Using the **Capacity** drop-down list, select the volume capacity unit. Then enter a capacity that you want to assign.
6. For **Provisioning Attributes**:
   - Check the **Accelerated Wide Striping Mode** check box if necessary (see Accelerated Wide Striping Mode on page 10-21).
   - Check the **Full Capacity Mode** check box if necessary (see Full Capacity Mode on page 10-21).
7. For **Tiering Attribute**:
   - Use the **New Page Assignment Tier** drop-down list to select a tier that you want to assign if necessary (see New page assignment tier on page 10-22).
   - Use the **Monitored I/O** drop-down list to select a monitored I/O type that you want to assign if necessary (see Monitored I/O on page 10-24).

- Check the **Promptly Promote Mode** check box if necessary (see Prompt promotion on page 10-24).
- Select the **Disabling Tier Relocation** check box for **Tiering Attribute** if necessary (see Disabling Tier Relocation on page 10-25).

8. Click **OK**. The volume was created message window appears.
9. Assign the created volume to the port and Host Group or iSCSI Target if necessary.
   - To create more volumes, click **Create More VOL** and set options and capacity as needed.
   - To end volume creation, click **Close**.



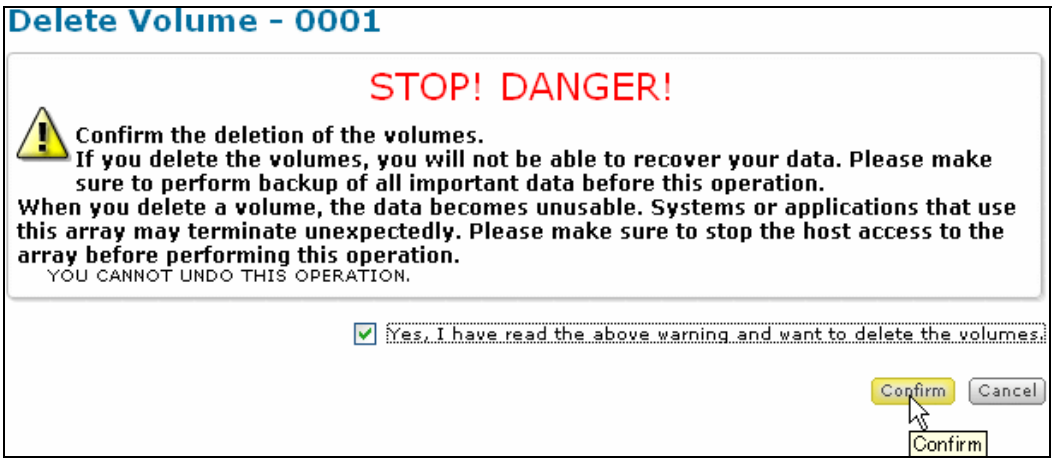
10. When the Volumes window appears, confirm that the volume was created.

Deleting DP-VOLs

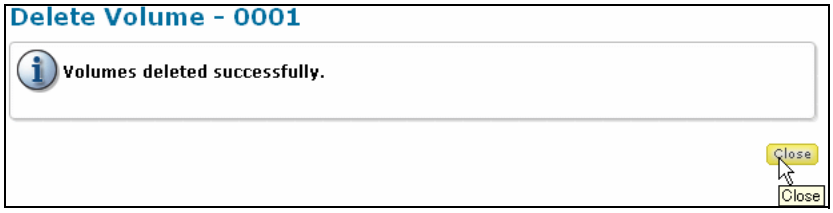
If the DP-VOL is deleted, the page associated with the DP-VOL is also deleted and formatted. If the DP-VOL is mapped, the DP-VOL is guarded and is not deleted; in this case, cancel the mapping and then perform the formatting.

To delete a DP-VOL from a DP pool:

1. Select the VOL that you want to delete, click Delete VOL. A warning message appears.



2. Check the check box and click **Confirm**.
3. When the following message appears, click **Close**.

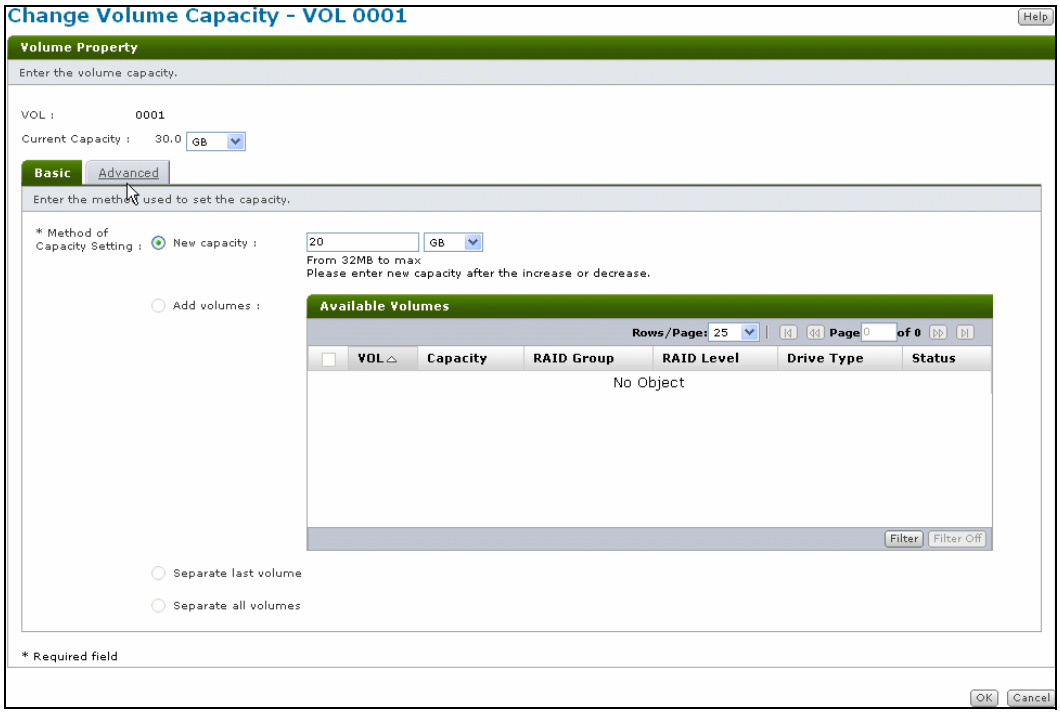


4. Confirm the deleted volume is no longer displayed.

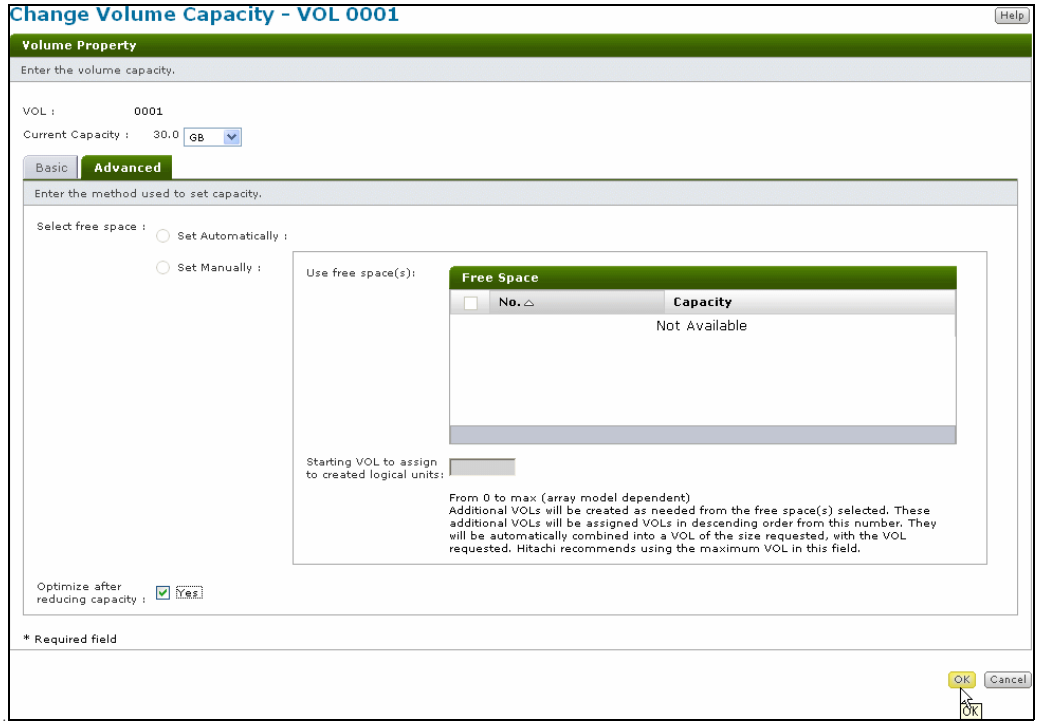
Changing DP-VOL capacity

To change the DP-VOL capacity:

1. Select the VOL where you want to change the capacity and click **Change VOL Capacity**. The Change Volume Capacity window appears.

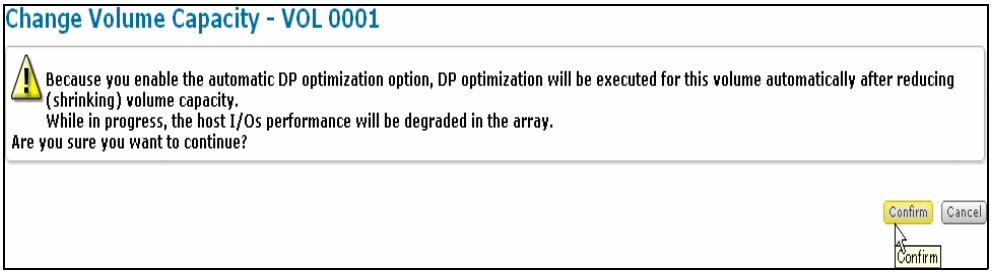


2. Using **Method of Capacity Setting**, select a volume capacity unit from the drop-down list and then enter a capacity value in the field to the left of the drop-down list.
3. Click the **Advanced** tab.

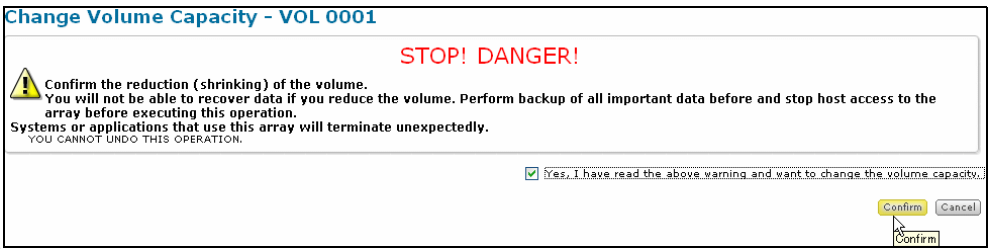


4. To optimize after shrinking capacity, check the **Optimize after reducing capacity** check box.
5. Click **OK**.

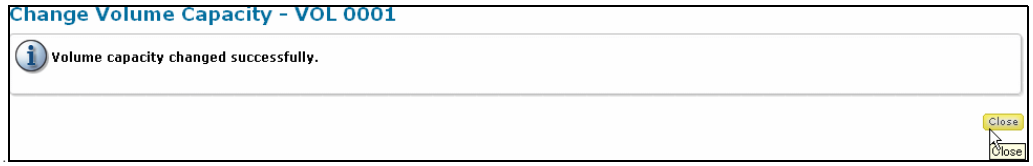
6. If you checked **Optimize after reducing capacity**, the following warning message appears. Click **Confirm**.



7. If you shrunk the capacity, the following warning message appears.
   - To shrink the capacity, check the check box and click **Confirm**.
   - To cancel this operation, click **Cancel**.



8. When the following message appears, click **Close**.



Managing DP pool information

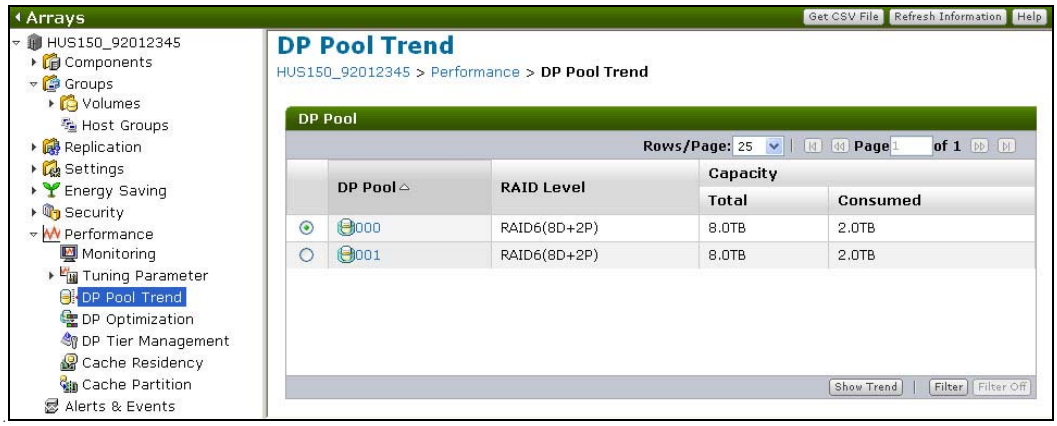
This section describes the following topics:

- Viewing DP pool trend information
- Exporting DP pool trend information
- Viewing DP pool trend information in the CSV file

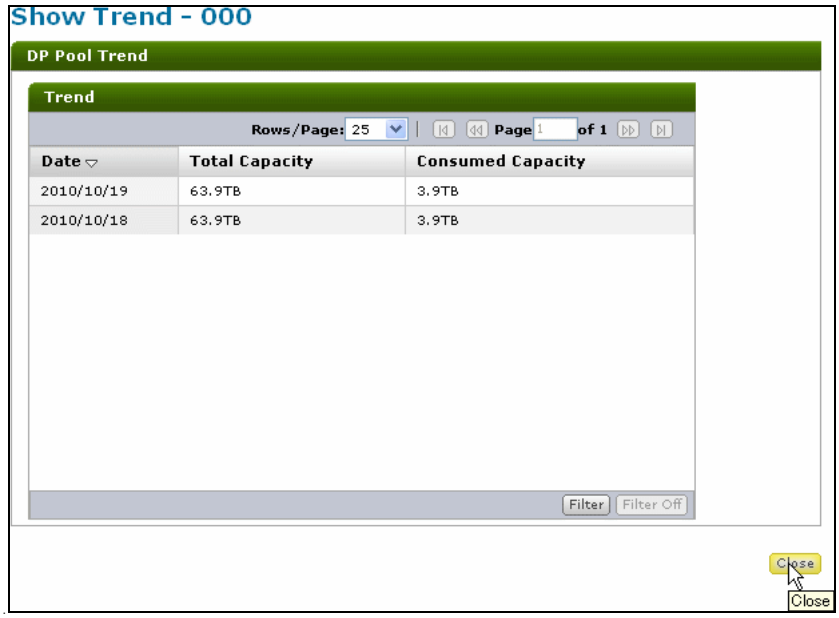
Viewing DP pool trend information

To view the DP pool trend information:

1. On the **Performance** menu, click **DP Pool Trend**. The DP Pool Trend window appears.



2. Click the radio button that corresponds to the **DP Pool number** you want to view.
3. Click **Show Trend**. The specified DP Pool Trend appears.

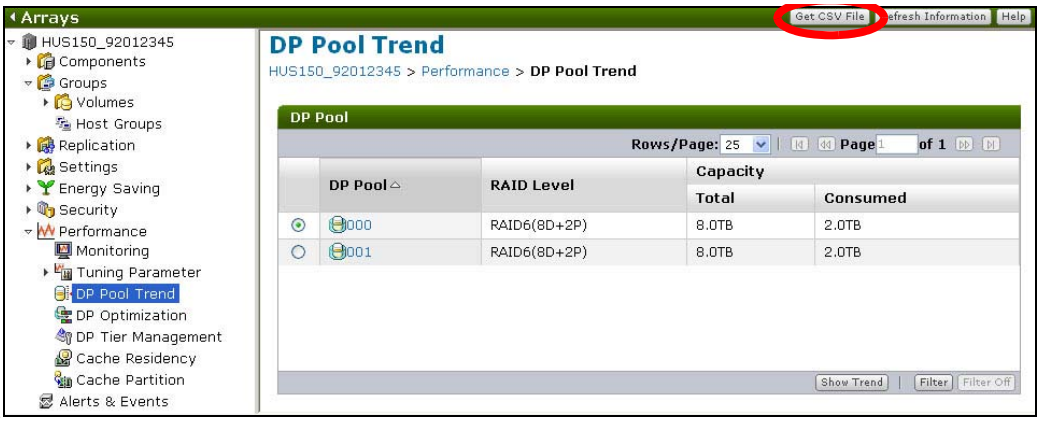


4. Confirm the viewed contents and click **Close**.

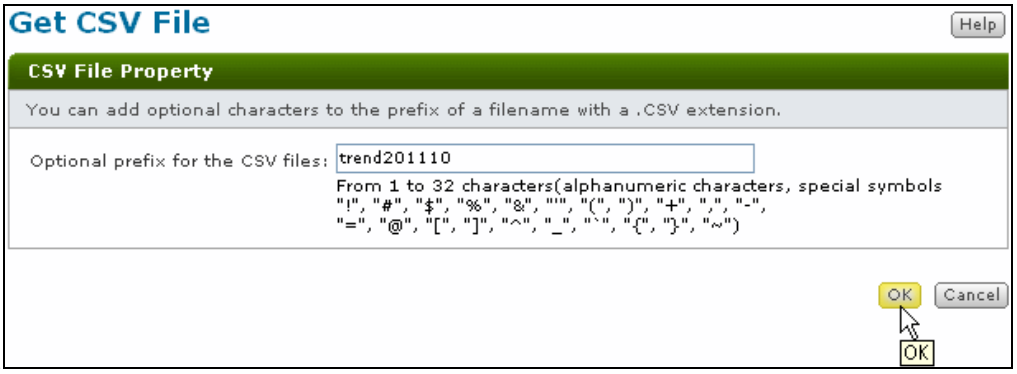
Exporting DP pool trend information

After viewing the DP pool trend information, you can export the information to a CSV file:

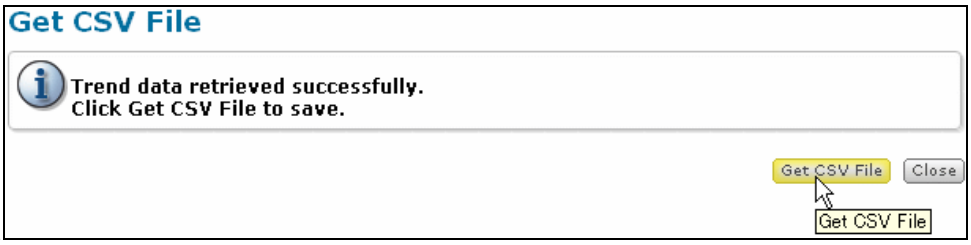
1. At the top-right side of the DP Pool Trend window, click **Get CSV File**.



The Get CSV File message appears.



2. Specify the prefix for the CSV file if necessary, and then click **OK**. The Get CSV File message appears.



3. In the File Download dialog box, click **Save**.
4. In the Save As dialog, specify the **Save in**, **File name**, and **Save as type** information, and then click **Save**.
5. When the Get CSV File message appears, click **Close**.
6. In the confirmation message, click **OK**. The information is saved in a Zip file.

Viewing DP pool trend information in the CSV file

After saving DP pool trend information to a CSV file, you can view the contents with a standard text editor.

To view DP pool trend information

1. Navigate to the folder where you saved the file and unzip the trend.zip file. The file contains the following three CSV text files.
   - *Optional prefix_array serial number_DPPool_Consumed_yyyyMMddmmss.csv* - DP pool consumed capacity information
   - *Optional prefix_array serial number_DPPool_LU_yyyyMMddmmss.csv* - DP-VOL information.
   - *Optional prefix_array serial number_DPPool_Total_yyyyMMddmmss.csv* - total DP pool capacity information.
2. Use a standard text editor to view the contents of the CSV text files.
   - DP pool consumed capacity information output format:

Table 13-1: When one or more items of the trend information exist

DP Pool consumed capacity	File header
From:2011/10/18	Oldest trend collection day
To:2011/10/19	Most recent trend collection day
No.[1],Date[2],0,1,2,…,62,63[3]	Where: [1] Serial number [2] Collection date (Christian era, month, day) [3] DP pool number
0,2011/10/19,100,10000,900,…,100,1000	
1,2011/10/18, -,1000,900,…,100,1000	
2,2011/10/17, -,1000,900,…, -,1000	
	(DP pools currently defined are all output)
	The DP pools that existed in the past, but are currently deleted are not output. When the information in the past does not exist, a hyphen is displayed. The unit of the displayed capacity is GB.

Table 13-2: When no trend information exists (one or more items of the DP pool exist)

DP pool consumed capacity	File header
From:	Oldest trend collection day (The date column is blank)
To:	Most recent trend collection day (The date column is blank)
No.,Date,0,2	
---No Information---	A message is displayed (---No Information---) showing that there is no trend information.

Table 13-3: When no trend information exists (no DP pool exists)

DP pool consumed capacity	File header
From:	Oldest trend collection day (The date column is blank)
To:	Most recent trend collection day (The date column is blank)
No.,Date	
---No Information---	A message is displayed (---No Information---) showing that there is no trend information.

- DP-VOL information output format:

Table 13-4: When one or more items of the DP-VOL exist

Logical Unit in the DP pool	File header
Date:2011/10/16	The output date of the CSV file
DP Pool[1],LUN[2],Total Capacity[3],Consumed(%)[4]	Where: [1] DP pool number (The DP pools in which the DP-VOLs are defined are all output) [2] Volume number (The defined DP-VOLs belonging to the DP pool number are all output) [3] Capacity (The value converted into TB, GB, or MB is displayed to the first decimal place in units) [4] Usage (unit: %)
0,1,200.0GB,40	
0,1,1.5TB,40	
10,2,33.0MB,30	
10,13,300.0GB,10	

Table 13-5: When no DP-VOL exists

Logical Unit in the DP pool	File header
Date:2011/10/16	The output date of the CSV file
DP Pool,LUN,Total Capacity,Consumed(%)	
---No Information---	A message is displayed (---No Information---) showing that there is no DP-VOL.

- Total DP pool capacity output format:

Table 13-6: When one or more items of trend information exist

DP pool total capacity	File header
From:2011/10/18	Oldest trend collection day
To:2011/10/19	Most recent trend collection day
No.[1],Date[2],0,1,2,…,62,63[3]	Where: [1] Serial number [2] Collection date (Christian era, month, day) [3] DP pool number
0,2011/10/19,100,10000,900,…,100,1000	
1,2011/10/18, -,1000,900,…,100,1000	
2,2011/10/17, -,1000,900,…, -,1000	
	(DP pools currently defined are all output)
	The DP pools existed in the past but currently deleted are not output. When the information in the past does not exist, a hyphen is displayed. The unit of the displayed capacity is GB.

Table 13-7: When no trend information exists (one or more items of the DP pool exists)

DP pool total capacity	File header
From:	Oldest trend collection day (The date column is blank)
To:	Most recent trend collection day (The date column is blank)
No.,Date,0,2	
---No Information---	A message is displayed (---No Information---) showing that there is no trend information.

Table 13-8: When no trend information exists (no DP pool exists)

DP pool total capacity	File header
From:	Oldest trend collection day (The date column is blank)
To:	Most recent trend collection day (The date column is blank)
No.,Date	
---No Information---	A message is displayed (---No Information---) showing that there is no trend information.

Optimizing DP

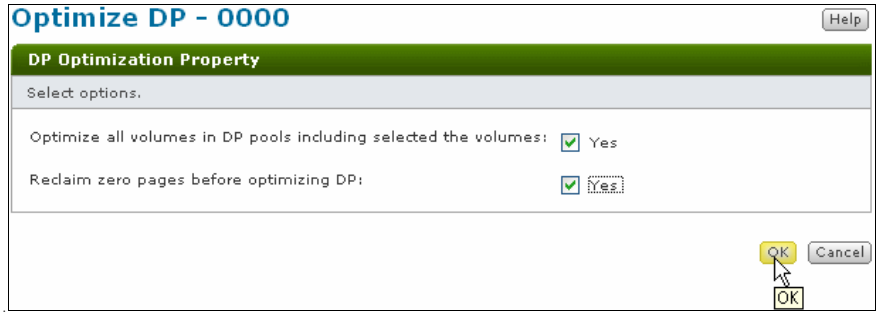
This section describes the following topics.

- Optimizing the DP pool
- Canceling DP optimization
- Changing optimization priority
- Changing DP Capacity Mode
- Canceling memory reconfiguration for DP Capacity Mode
- Changing provisioning attributes

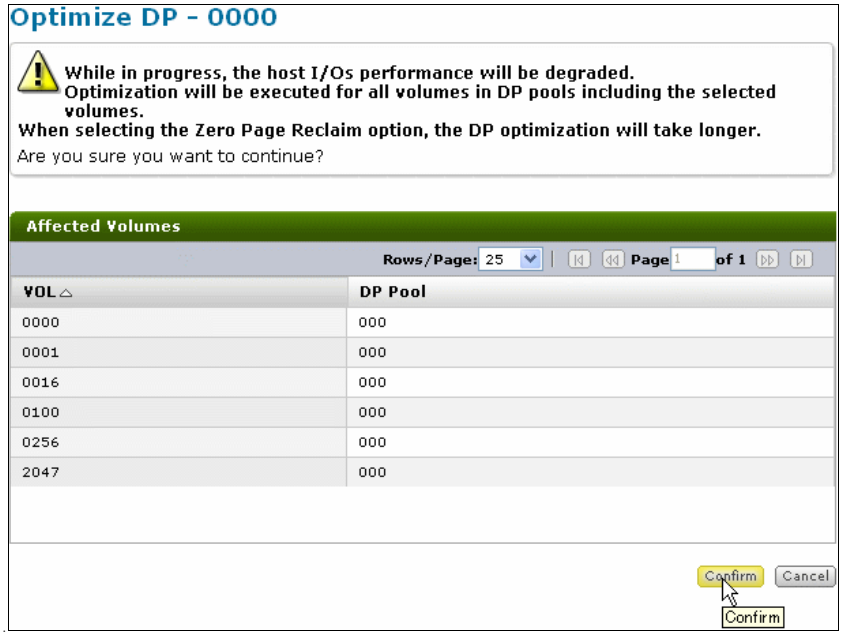
Optimizing the DP pool

To optimize the DP pool:

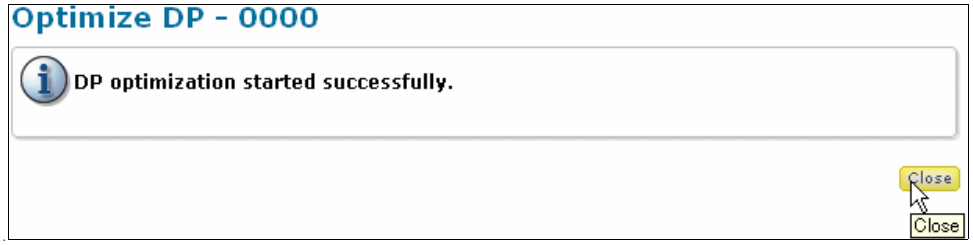
1. On the Performance menu, select **DP Optimization**.
2. Select the **VOL** for which you want to optimize in the DP pool. The standard is the DP-VOLs whose reclaimed capacity exceeds 15 GB.
3. Click **Optimize DP**.
4. In the **DP Optimization Property** dialog box, specify the optimization options and click **OK**.



5. In the confirmation message, **Confirm** to continue.



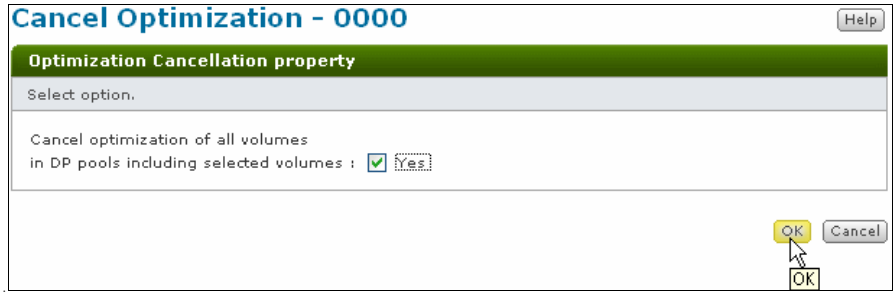
6. When the operation finishes successfully, click **Close**.



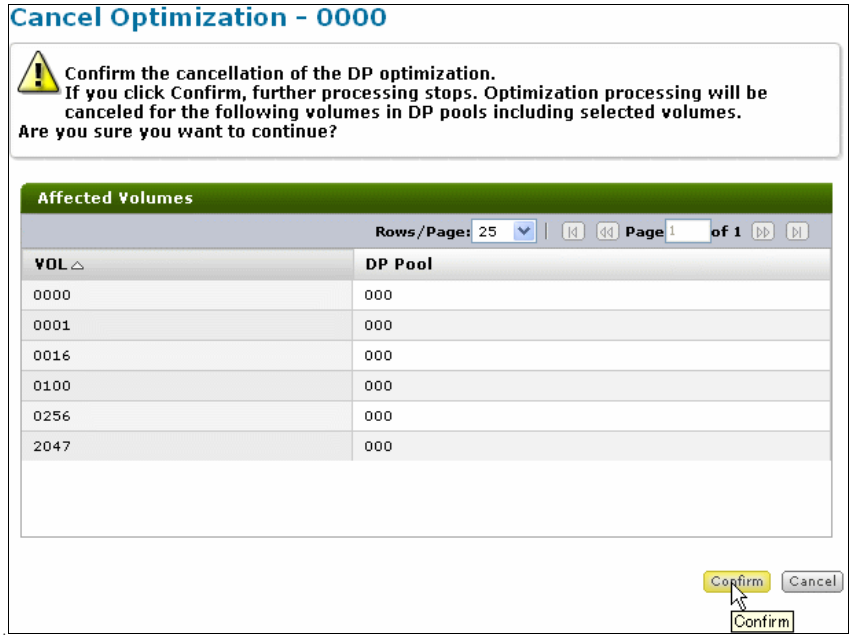
Canceling DP optimization

To cancel DP optimization:

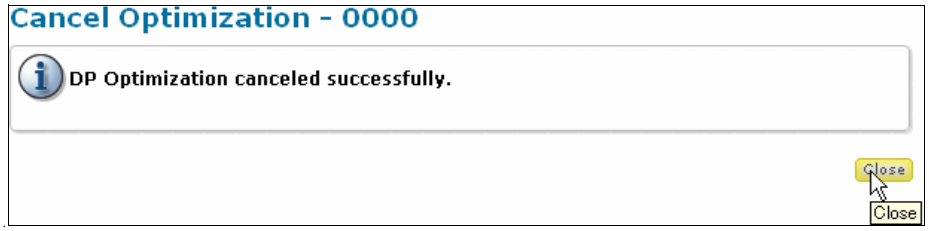
1. On the Performance menu, select **DP Optimization**.
2. Select the **VOL** for which you want to cancel DP optimization.
3. Click **Cancel Optimization**.
4. In the Optimization Cancellation property dialog box, specify the cancelation options and click **OK**.



5. In the confirmation message, click **Confirm** to continue.



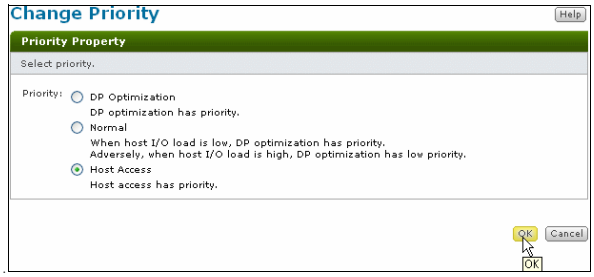
6. When the operation finishes successfully, click **Close**.



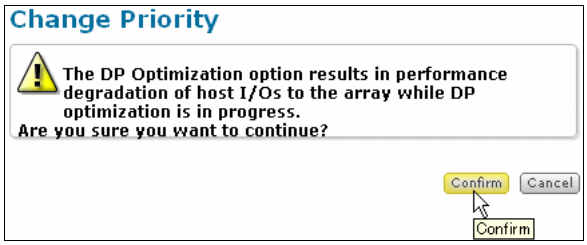
Changing optimization priority

To change optimization priority:

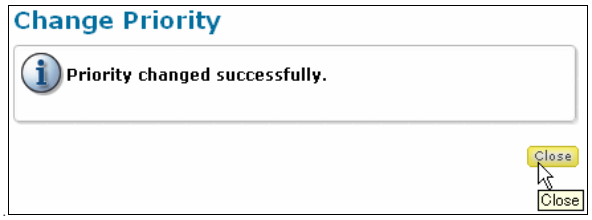
1. On the Performance menu, select **DP Optimization**.
2. Click **Change Priority**.
3. In the Priority Property dialog box, specify the priority option and click **OK**.



4. In the confirmation message, click **Confirm** to continue.



5. When the operation finishes successfully, click **Close**.

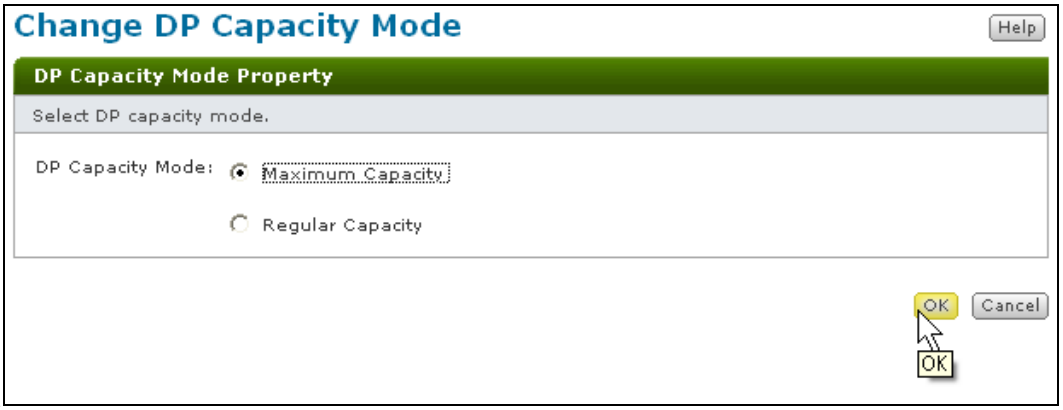


Changing DP Capacity Mode

The following procedures describe how to change DP Capacity Mode.

To change the DP Capacity Mode by the memory reconfiguration:

1. On the **Performance** menu, select **DP Optimization**.
2. Click **Change Capacity Mode**. The options selection dialog appears.
3. Specify the **DP Capacity Mode** option, and click **OK**.



4. When the confirmation message appears, click **Reconfigure Memory**.

NOTE: When using Cache Partition Manager, the **Reconfigure Memory** button is not displayed and memory reconfiguration cannot be performed.

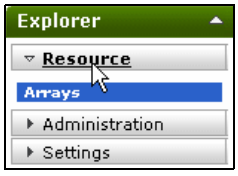
5. When the message appears, click **Confirm**.

For enabling the setting of the operated option, restart the array or reconfigure the memory. The setting is not reflected until the restart or memory reconfiguration is completed.

6. At the next message, click **Close**. You return to the DP Optimization screen.
7. Confirm the **Reconfigure Memory Status** is **Reconfiguring(nn%)** or **Normal**.
   - If **Reconfigure Memory Status** is **Reconfiguring(nn%)**, wait a few minutes, click **Refresh Information**, and confirm the **Reconfigure Memory Status** changes to **Normal**.
   - If the **Reconfigure Memory Status** is **Failed(Code-01:Timeout)**, click **Change Capacity Mode**, and repeat steps 3 through 7.

   Code-01 occurs when the access from the host is frequent or the amount of the unwritten data in the cache memory is large.
   - If the **Reconfigure Memory Status** is Faile**d(Code-02: Failure of Reconfigure Memory)**, click **Reconfigure Memory** on the DP Optimization screen and repeat steps 5 through 7.

   Code-02 occurs when the drive restoration processing starts in the background.
   - If the **Reconfigure Memory Status** is **Failed(Code-04: Failure of Reconfigure Memory)**, click **Resource** on the **Explorer** menu, return to the Arrays screen, select the array to change DP Capacity Mode, and click **Reboot Array**.

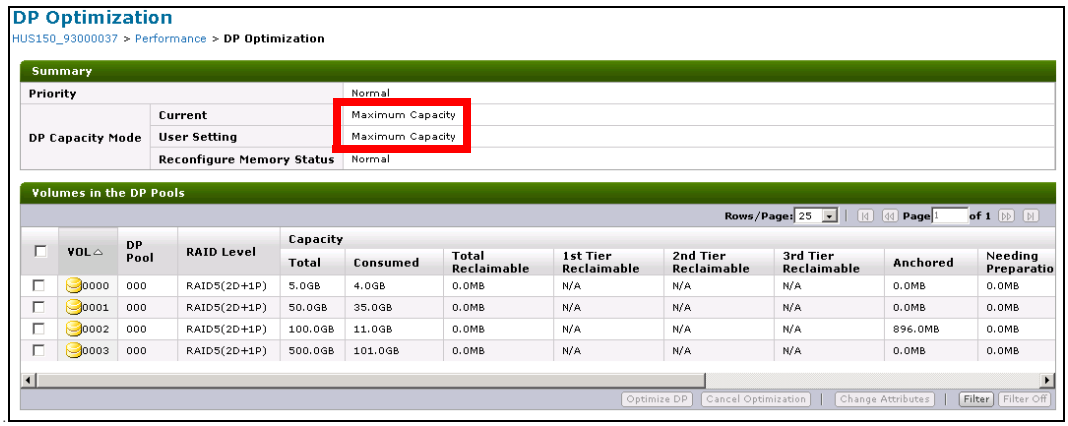


Code-04 occurs when the unwritten data in the cache memory cannot be saved to the drive.

- If the **Reconfigure Memory Status** is **Failed(Code-03: Failure of Reconfigure Memory)**, contact the HDS Support at portal.hds.com.

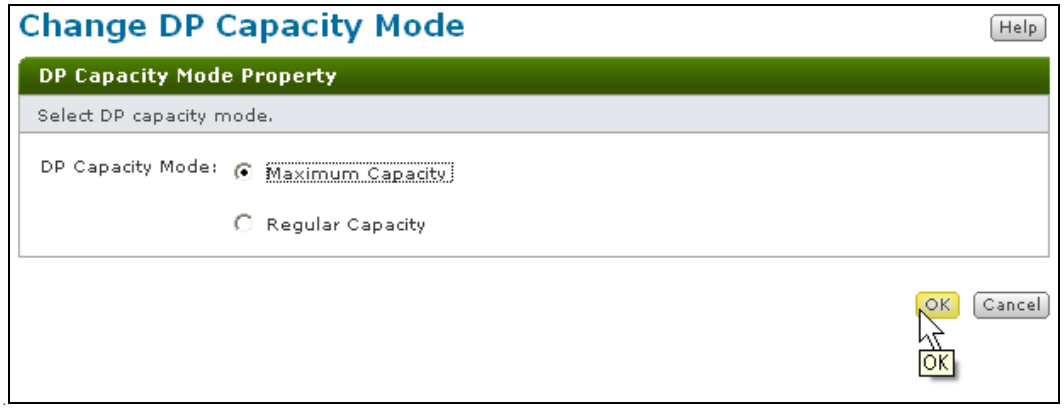
Code-03 occurs when the copy of the management information in the cache memory fails.

8. After completing the memory reconfiguration, check that the **Current** value of the DP Capacity Mode changed to the set mode in the DP Optimization screen. If it did not change to the set mode, reconfigure the memory again. If it still did not change, see Chapter 6, Hitachi Dynamic Provisioning Troubleshooting.



To change the DP Capacity Mode by restarting the storage system:

1. Check the precautions in Installation and rebooting on page 3-16.
2. On the **Performance** menu, select **DP Optimization**.
3. Click **Change Capacity Mode**. The options selection dialog appears.
4. Specify the **DP Capacity Mode** option, and click **OK**.



5. When using Cache Partition Manager, the confirmation message that the partition returns to the default setting is displayed. Click **Confirm**.
6. When the confirmation message appears, click **Reboot Array**.

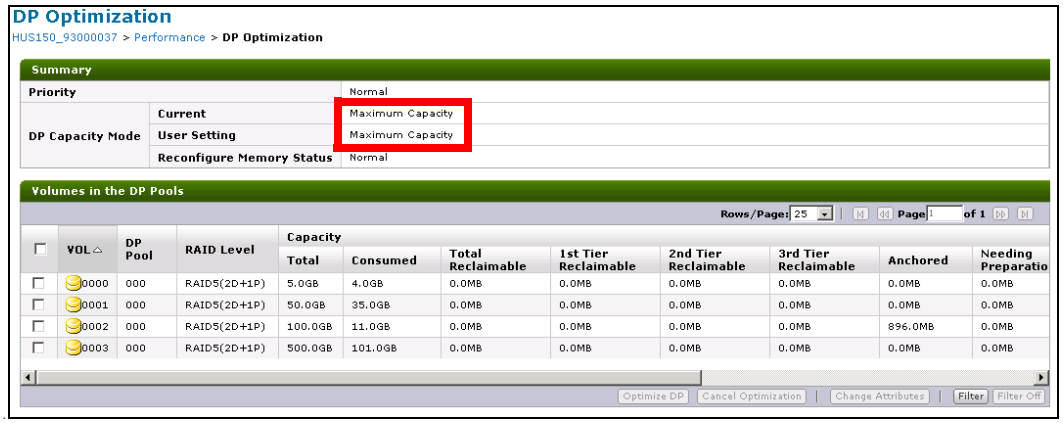
NOTE: When using Cache Partition Manager, the **Reconfigure Memory** button is not displayed and memory reconfiguration cannot be performed.

7. At the confirmation message, check the check box and click **Reboot Array** to restart the storage system.

For enabling the setting of the operated option, restart the storage system or reconfigure the memory. The setting does not take effect until the restart or memory reconfiguration completes.

After the storage system restarts, it does not access the host until the restart is completed. Check that the access from the host stopped, and then restart it. It takes approximately 7-to-25 minutes for the restart. If it takes longer than 25 minutes, check the status of the storage system.

8. After the restart completes, a message appears. Click **Close**.
9. After the storage system completes rebooting, check that the **Current** value of the DP Capacity Mode changed to the set mode in the DP Optimization screen. If it did not change to the set mode, restart the storage system again. If it still did not change, see Chapter 6, Hitachi Dynamic Provisioning Troubleshooting.



Canceling memory reconfiguration for DP Capacity Mode

To cancel the memory reconfiguration:

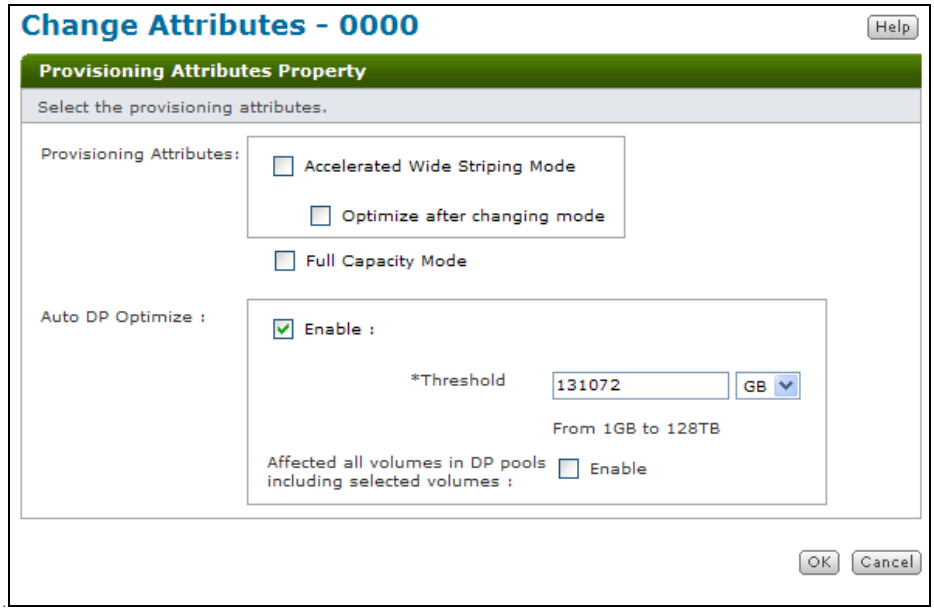
1. Click **Cancel Reconfigure** on the DP Optimization screen.
2. If canceling the memory reconfiguration succeeds, a message appears. Click **Close**.

If the memory reconfiguration occurs and the cache memory configuration rewrite starts, the memory reconfiguration cannot be canceled. Cancellation is possible only when the rate of progress of the Reconfigure Memory Status is less than 50 percent.

Changing provisioning attributes

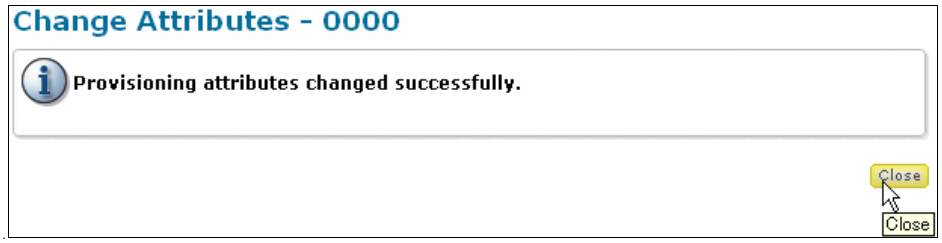
To change provisioning attributes:

1. On the DP Optimization window, select the **VOL** whose attribute you want to change.
2. Click **Change Attributes**. The Change Attributes window appears.



3. To change **Accelerated Wide Stripping**, **Full Capacity Mode**, or both **Provisioning Attribute**s, check the check boxes.
4. To optimize after changing mode, select the **Optimize after changing mode** check box.
5. To enable auto DP optimization, check the **Enable** check box for **Auto DP Optimize**. Enter a threshold value in the **Threshold** field and select the units of capacity. To disable Auto DP Optimize of Provisioning Attributes, uncheck the check box.
6. To apply the Auto DP Optimize setting to all DP volumes in the DP pool, check the **Enable** check box for **Affected all volumes in DP pools including selected volumes**.
7. Click **OK**.

8. When the following message appears, click **Close**.



Managing DP Tiers

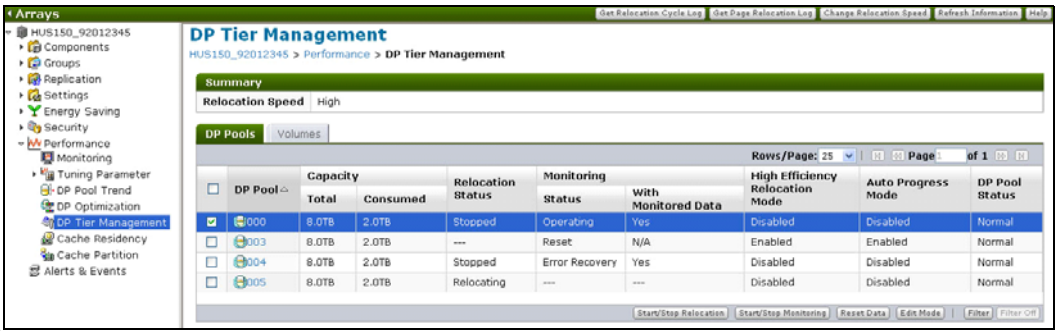
This section described the following topics:

- Changing High Efficiency Relocation and Auto Progress Mode
- Changing relocation periods
- Changing monitoring periods
- Changing relocation speed
- Changing DP-VOL tiering attributes
- Outputting the Tier Relocation Cycle Log
- Outputting the Page Relocation Log
- Displaying the frequency distribution of a DP pool
- Viewing the frequency distribution of a DP-VOL
- Outputting the frequency distribution of a DP pool to a file
- Outputting the frequency distribution of a DP-VOL to a file

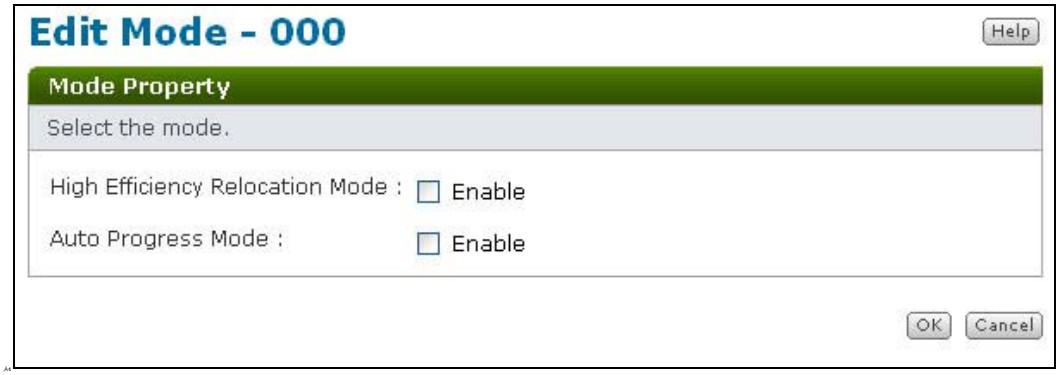
Changing High Efficiency Relocation and Auto Progress Mode

To change High Efficiency Relocation Mode and Auto Progress Mode:

1. On the **Performance** menu, click **DP Tier Management**. The DP Tier Management window appears.



2. Click the button that corresponds to the DP pool number whose modes you want to change.
3. Click **Edit Mode**. The Edit Mode window appears.

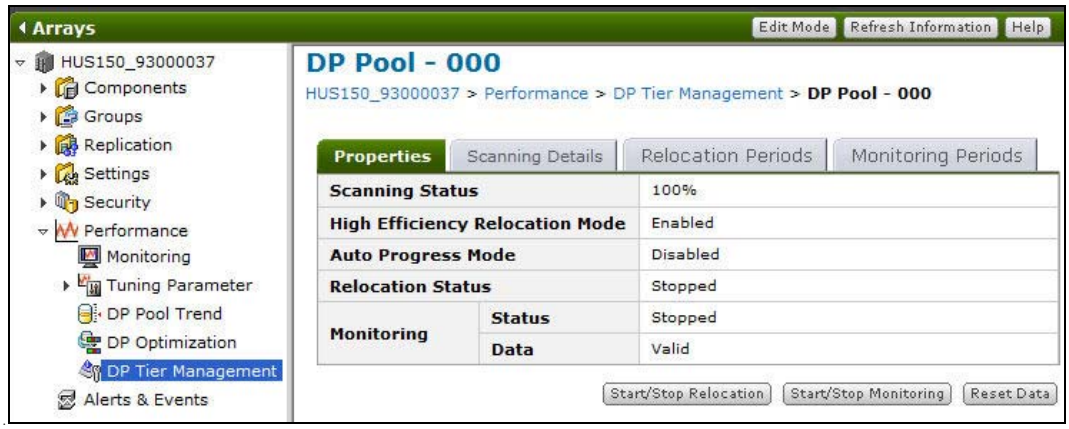


4. To disable High Efficiency Relocation Mode, uncheck the **High Efficiency Relocation Mode** check box. To enable High Efficiency Relocation Mode, check the check box.
5. To disable the Auto Progress Mode, uncheck the **Auto Progress Mode** check box. To enable the Auto Progress Mode, check the check box.
6. Click **OK**. When the following message appears, click **Close**.

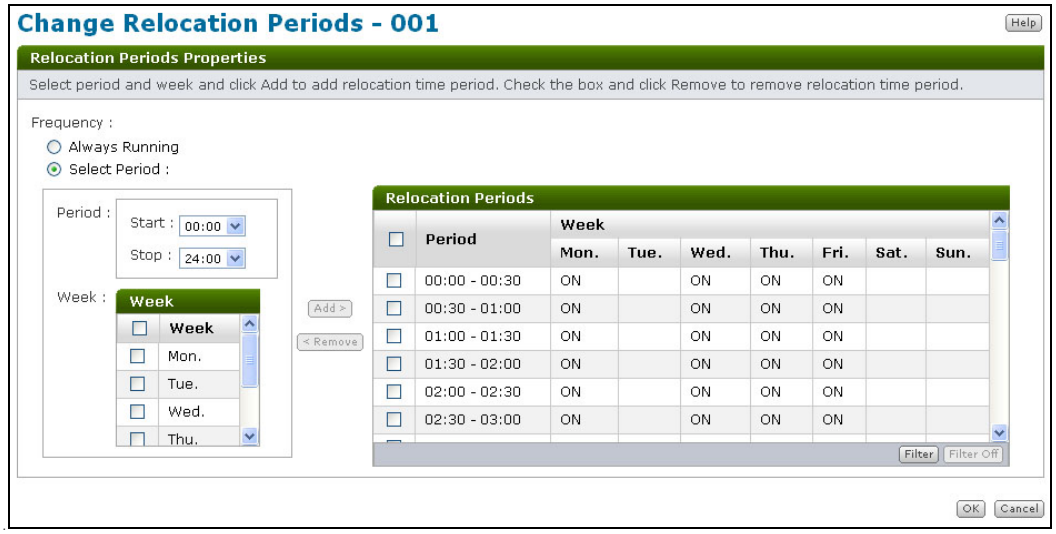
Changing relocation periods

To change relocation periods:

1. Click the button that corresponds to the DP pool number whose relocation periods you want to change. The specified DP Pool window appears.



2. Click the **Relocation Periods** tab.
3. Click **Change Relocation Periods**. The Change Relocation Periods window appears.



4. To change the frequency, click **Always Running** or **Select Period** in the **Frequency** area of the Relocation Periods Properties window.
5. If you selected **Select Period**, configure the following settings if necessary:
   a. To add a new period, set the period and week.

      Period: Select the start and end time from the **Start** and **Stop** drop-down lists. You can specify them in units of 30 minutes.

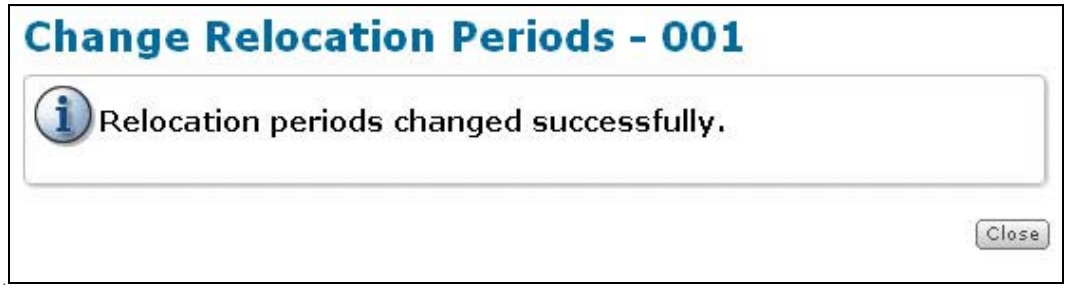
      Week: Select the day you want to execute. To select all days, check the check box to the left of **Week**.

   b. After you complete the **Period** and **Week** settings, click **Add**. The specified period is reflected in the Relocation Periods list, and **ON** appears in the specified period on the **Relocation Periods** list.

   The following items appear in the **Relocation Periods** list.

   - **Period**: Operation time lines are displayed between 00:00 and 24:00 in 30-minute blocks.
   - **Week**: Weekly operation time lines are displayed for each day of the week.

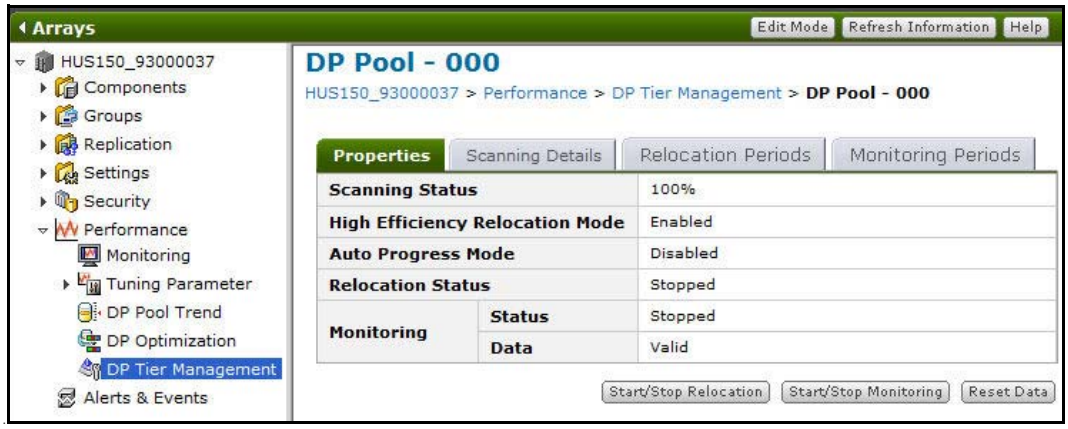
   c. To remove the period, click the check box to the left of the period that you want to remove on the Relocation Periods list, and then click **Remove**.
6. Click **OK**. When the following message appears, click **Close**.



Changing monitoring periods

To change monitoring periods:

1. Click the button that corresponds to the DP pool number whose monitoring periods you want to change. The specified DP Pool window appears.



2. Click the **Monitoring Periods** tab. The Monitoring Periods window appears (see Figure 13-2).
3. Click **Change Monitoring Periods**. The Change Monitoring Periods window appears.

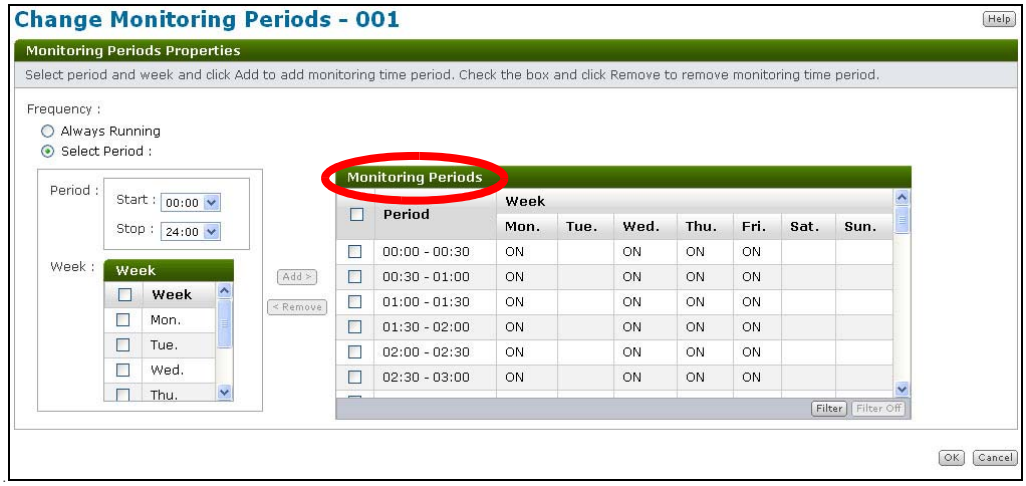


Figure 13-2: Monitoring Periods window

4. To change the frequency, select **Always Running** or **Select Period** in the **Frequency** area of the Monitoring Periods Properties window.
5. If you selected **Select Period**, configure the following settings if necessary:
   a. To add a new period, set the period and week.

      Period: Select the start and end time from the **Start** and **Stop** drop-down lists. You can specify them in units of 30 minutes.

      Week: Select the day you want to run. To select all days, check the check box to the left of **Week**.

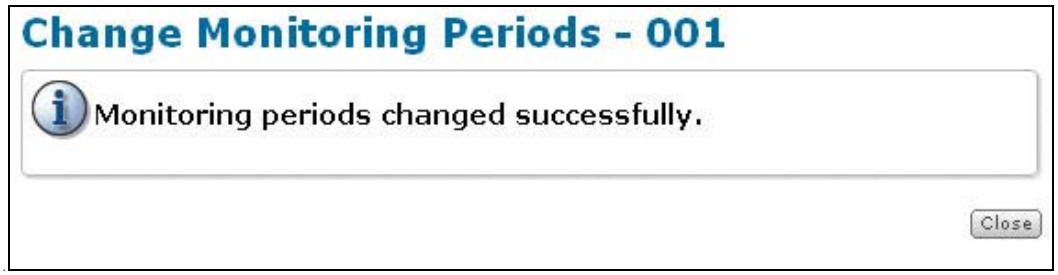
b. After you complete the **Period** and **Week** settings, click **Add**. The specified period is reflected in the Monitoring Periods list, and **ON** appears in the specified period on the **Monitoring Periods** list.

The following items appear in the **Monitoring Periods** list.

- **Period**: Operation time lines are displayed between 00:00 and 24:00 in 30-minute blocks.
- **Week**: Weekly operation time lines are displayed for each day of the week.

c. To remove the period, click the check box to the left of the period that you want to remove on the Relocation Periods list, and then click **Remove**.

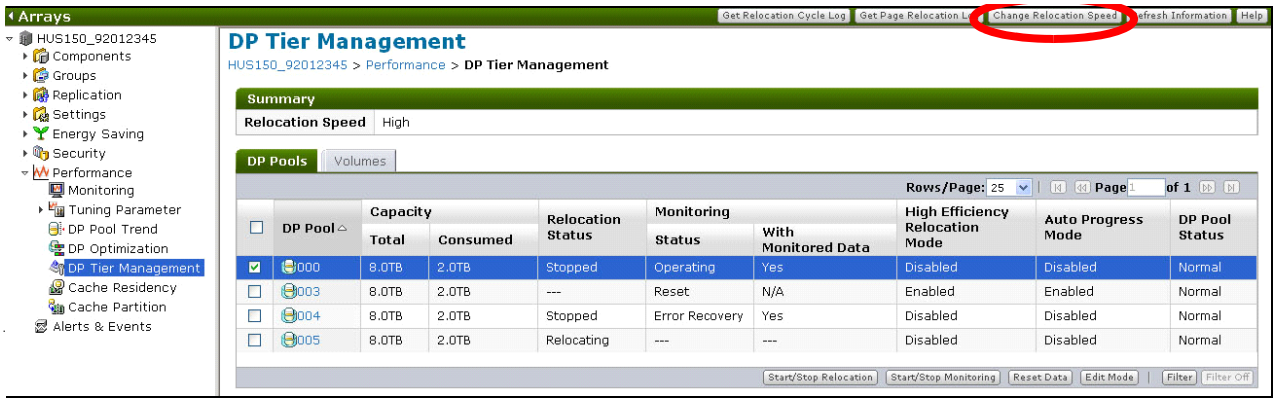
6. Click **OK**. When the following message appears, click **Close**.



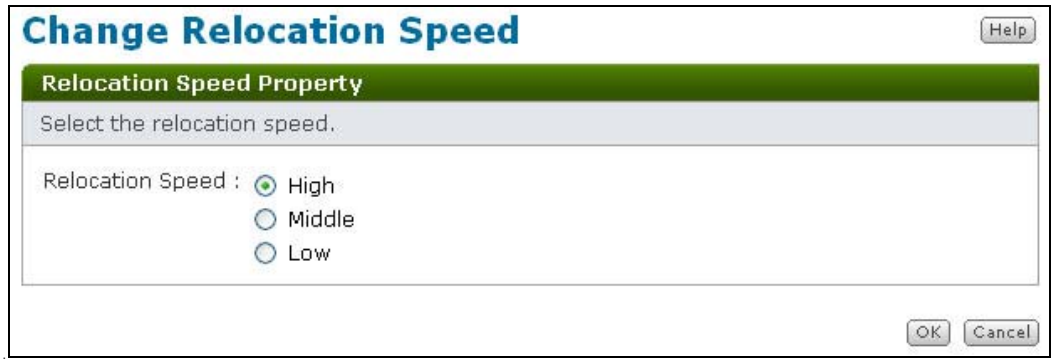
Changing relocation speed

To change relocation speed:

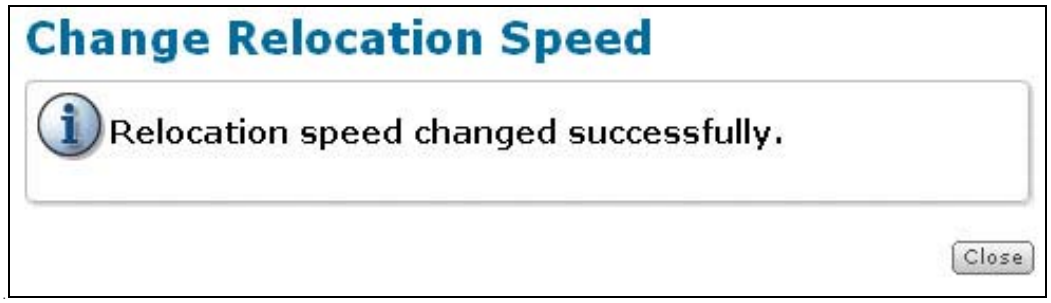
1. Click **Change Relocation Speed** at the top-right area of the DP Tier Management window.



The Change Relocation Speed window appears.



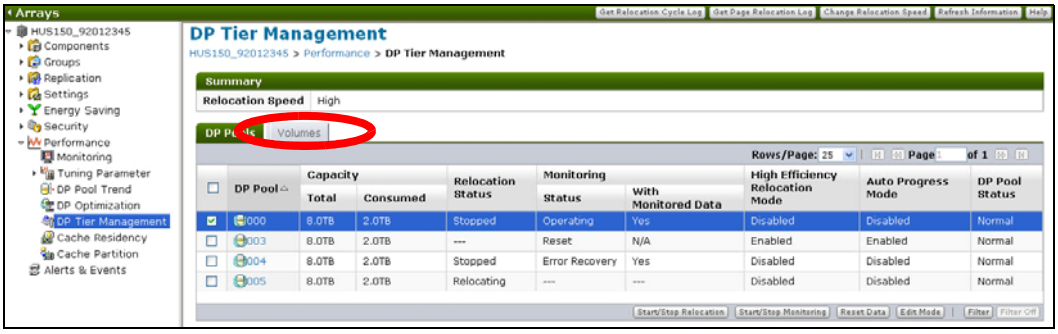
2. Click the radio button that corresponds to the speed you want to select.
3. Click **OK**. When the following message appears, click **Close**.



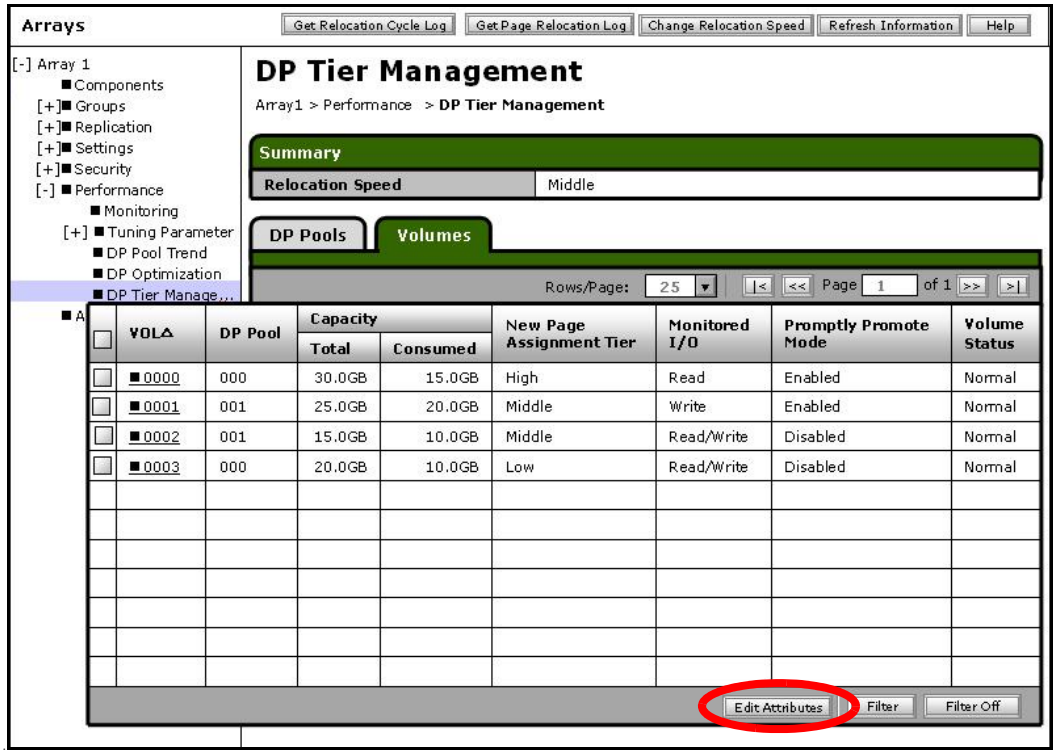
Changing DP-VOL tiering attributes

To change the New Page Assignment Tier, the Monitored I/O, Promptly Promote Mode, and Disabling Tier Relocation of the DP-VOLs:

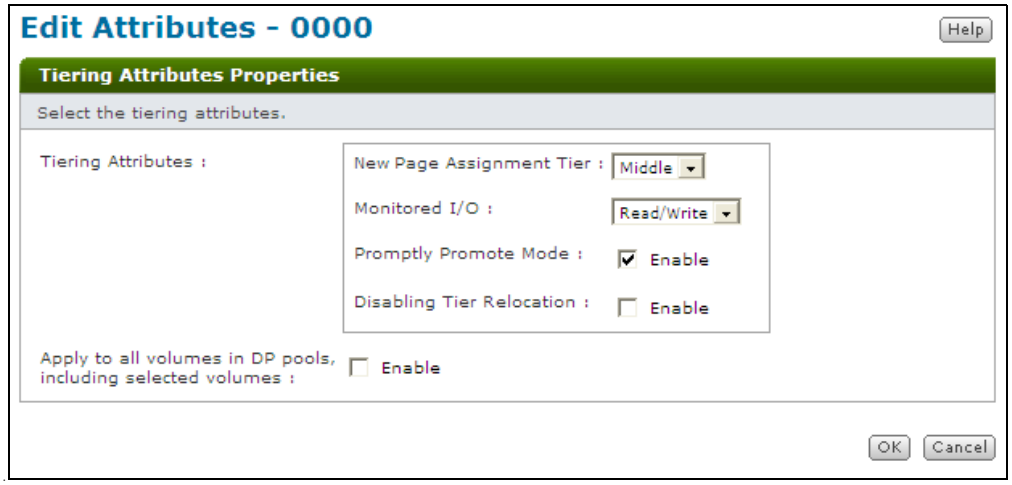
1. Click the **Volumes** tab on the DP Tier Management window.



2. Click the **VOL** whose tiering attributes you want to change, and click **Edit Attributes**.



The Edit Attributes window appears.



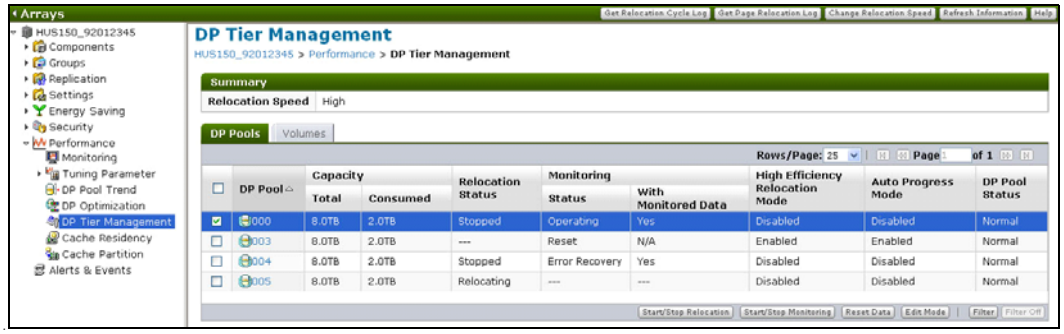
3. To change the New Page Assignment Tier, select a tier that you want to assign from the **New Page Assignment Tier** drop-down list.

4. To change the Monitored I/O, select a monitored I/O type that you want to assign from the **Monitored I/O** drop-down list.
5. To change the Promptly Promote Mode, check the **Promptly Promote Mode** check box.
6. To change the Disabling Tier Relocation setting, select the **Disabling Tier Relocation** check box of the **Tiering Attribute**.
7. To apply the **Tiering Attributes** settings to all DP-VOLs of the DP pool, including the selected DP-VOLs, check the **Enable** check box next to **Promote all volumes in DP pools including selected volumes**.
8. Click **OK**. When the following message appears, click **Close**.

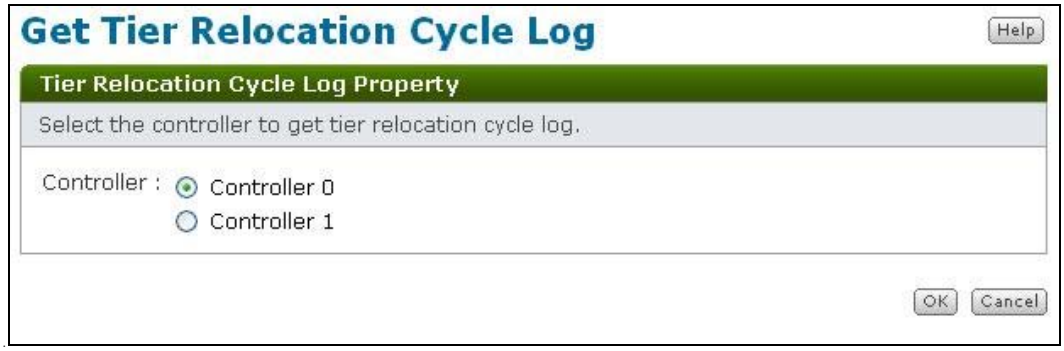
Outputting the Tier Relocation Cycle Log

To output the Tier Relocation Cycle Log:

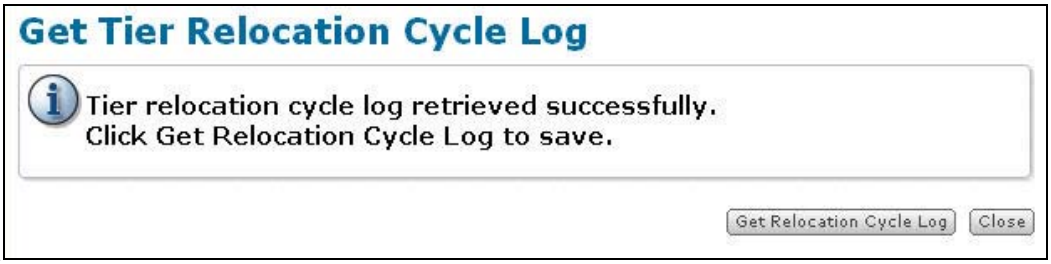
1. Click **Get Relocation Cycle Log** at the top-right area of the DP Tier Management window.



The Get Tier Relocation Cycle Log window appears.



2. Click the radio button of the Controller from which the Tier Relocation Cycle Log is obtained.
3. Click **OK**.
4. When the following message appears, click **Get Relocation Cycle Log**.



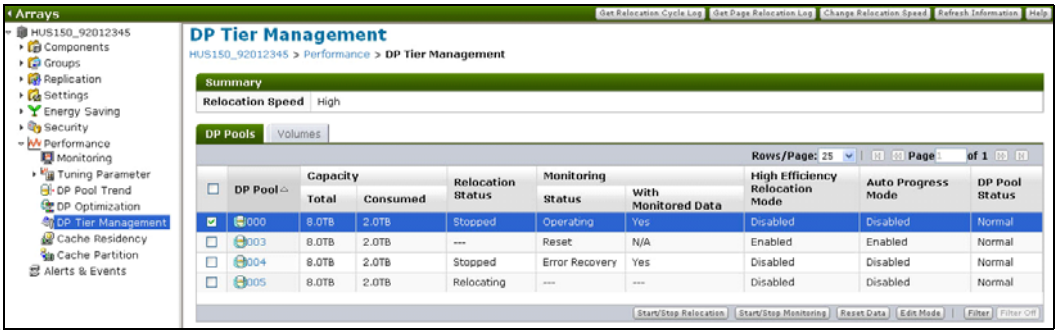
5. When the File Download dialog appears, click **Save**. The Save As dialog box appears.
6. In the Save As dialog box, specify the **Save in**, **File name**, and **Save as type** information, and then click **Save**.
7. When the Get Tier Relocation Cycle Log message appears, click **Close**.

For information about CSV file output, see Tier relocation cycle log on page 10-18.

Outputting the Page Relocation Log

To output the Page Relocation Log:

1. Click **Get Page Relocation Log** at the top-right area of the DP Tier Management window.



The Get Page Relocation Log screen appears

2. For **Controller**, click the Controller Box whose Page Relocation Log you want to obtain.
3. Click **OK**.
4. When the Get Page Relocation Log message appears, click **Get Page Relocation Log**.
5. When the File download dialog box appears, click **Save**.

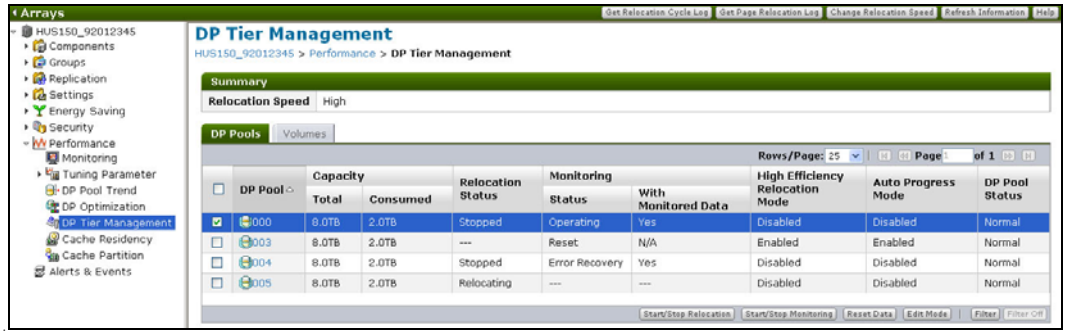
6. When the Save As dialog box appears, enter a file name, select the location where you want to save the log, select a “Save as type,” and click **Save**.
7. When the Get Page Relocation Log message appears, click **Close**.

For information about CSV file output, see Page Relocation Log output on page 10-20.

Displaying the frequency distribution of a DP pool

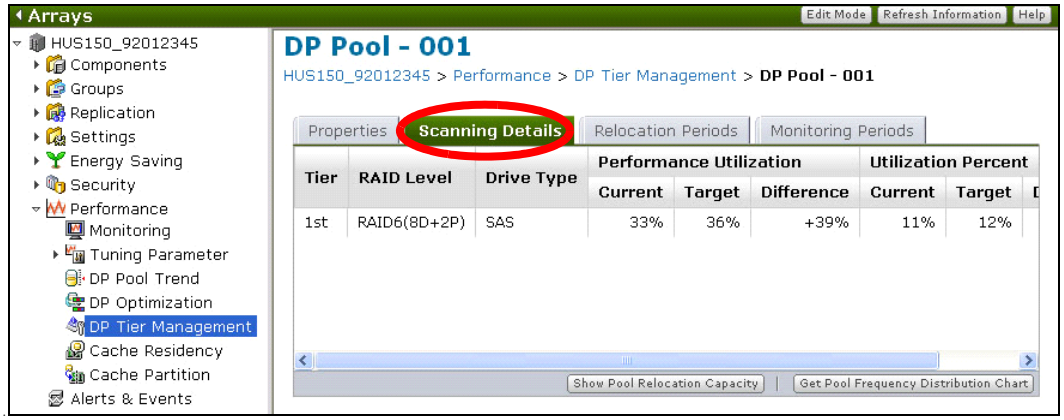
To display the frequency distribution of a DP pool:

1. On the **DP Pools** tab of the DP Tier Management window, click the radio button of the DP pool whose Frequency Distribution Chart you want to view.

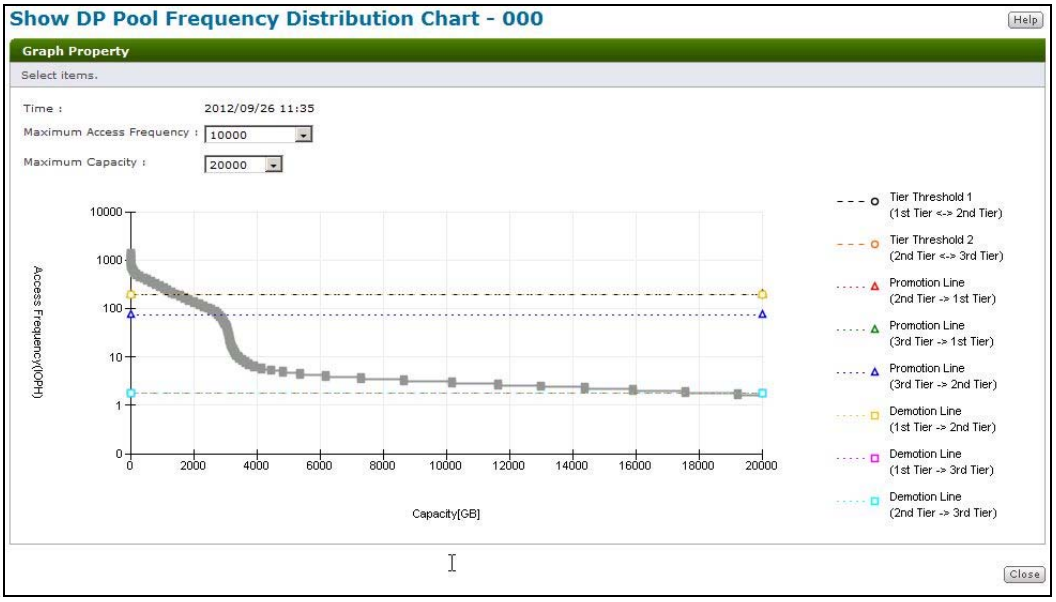


The DP Pool window appears.

2. Click the **Scanning Details** tab.



3. Click **Show Pool Frequency Distribution Chart**. The Show Pool Frequency Distribution Chart appears.

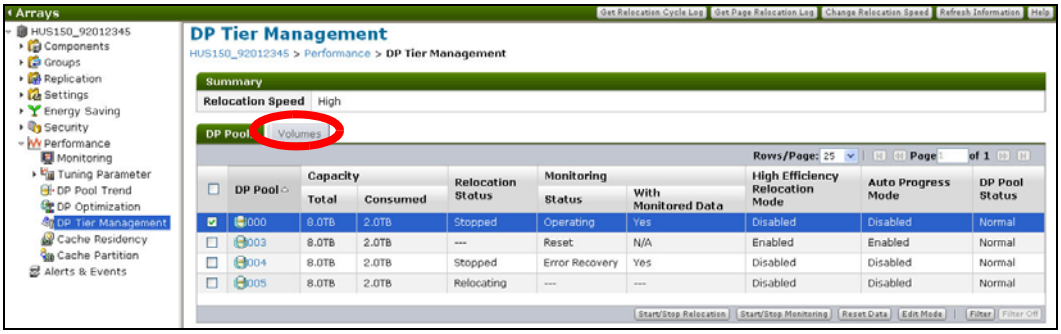


4. Confirm the displayed contents and click **Close**.

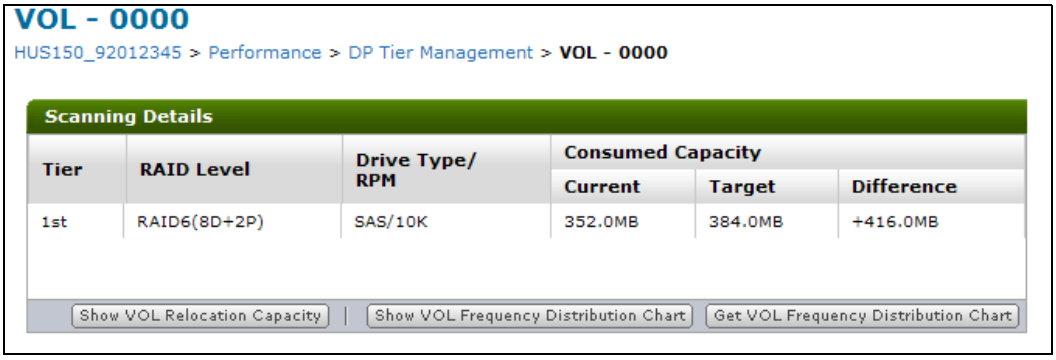
Viewing the frequency distribution of a DP-VOL

To view the frequency distribution of a DP-VOL:

1. Click the **Volumes** tab on the DP Tier Management window.



2. Click the VOL whose Frequency Distribution Chart you want to view. The VOL screen appears.



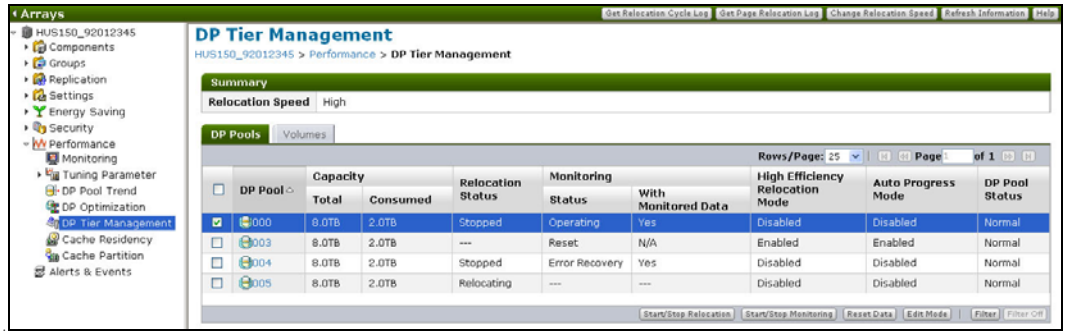
3. Click the **Show VOL Frequency Distribution Chart**. The Show VOL Frequency Distribution Chart appears.

4. Confirm the displayed contents and click **Close**.

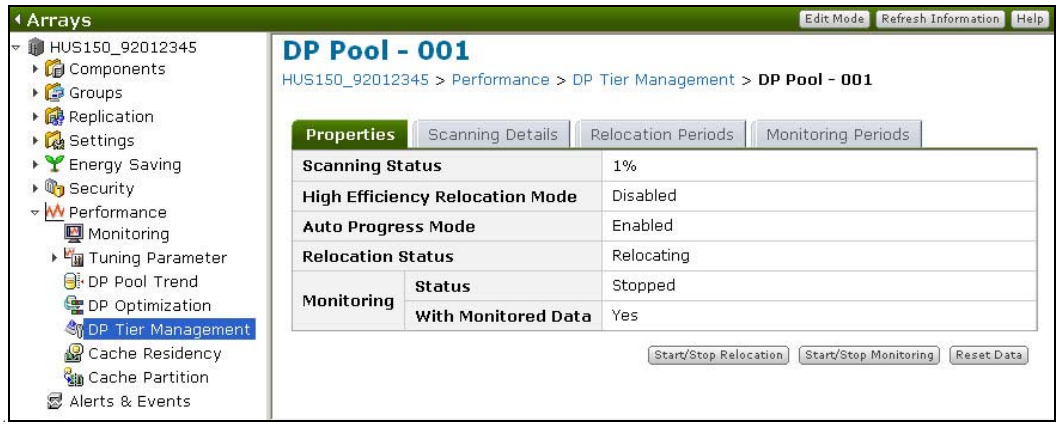
Outputting the frequency distribution of a DP pool to a file

To output the frequency distribution of a DP pool to a file:

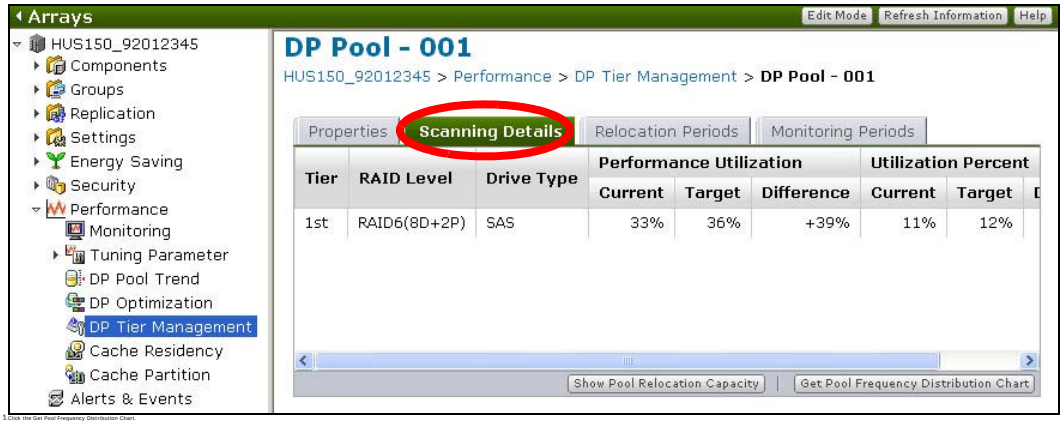
1. On the **DP Pools** tab of the DP Tier Management window, click the radio button of the DP pool whose frequency distribution you want to output.



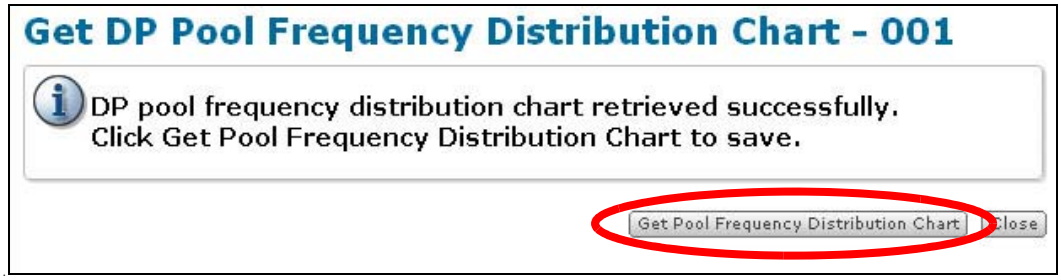
The DP Pool window appears.



2. Click the **Scanning Details** tab.



The Get Pool Frequency Distribution Chart message appears.



3. Click **Get Pool Frequency Distribution Chart** at the lower right side of the message.
4. Click **Get CSV File**.
5. When the File Download dialog appears, click **Save**. The Save As dialog box appears.
6. In the Save As dialog box, specify the **Save in**, **File name**, and **Save as type** information, and then click **Save**.
7. When the Get Pool Frequency Distribution Chart message appears, click **Close**.

The compressed DP pool frequency distribution file contains the following csv file:

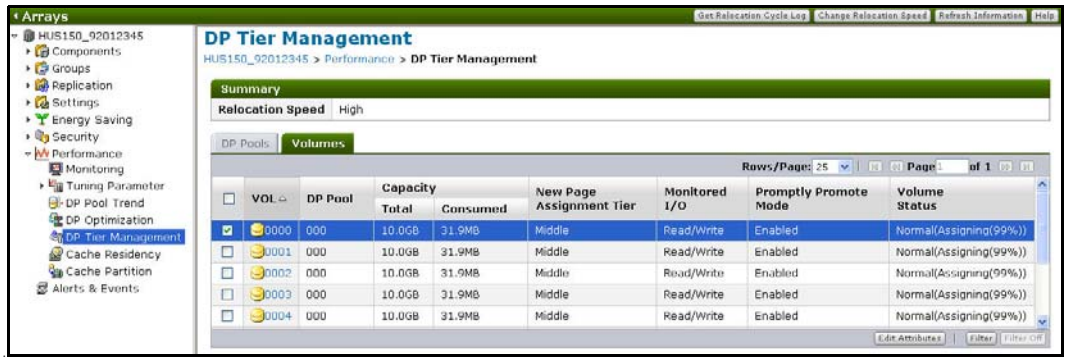
Array serial number_FrequencyDistribution_pool number_yyyyMMddhhmm.csv

For information about the CSV file, see DP Pool or DP-VOL frequency distribution on page 10-41.

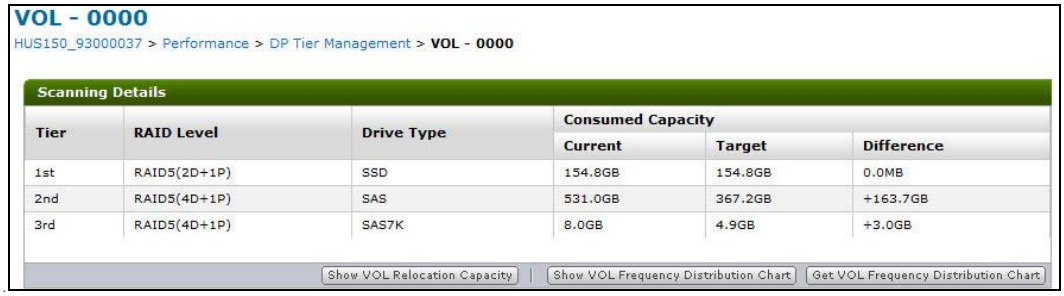
Viewing the frequency distribution of the DP-VOL

To view the frequency distribution of the DP-VOL:

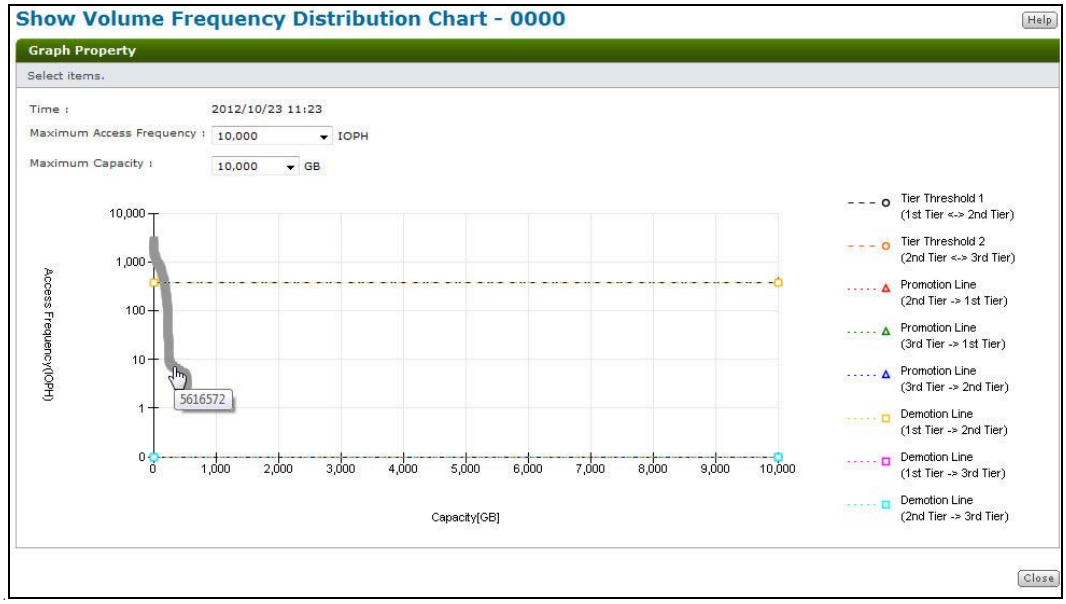
1. Click the **Volumes** tab on the DP Tier Management screen.



2. Click the **VOL** whose frequency distribution chart you want to view. The VOL screen appears.



3. Click **Show VOL Frequency Distribution Chart**. The Show VOL Frequency Distribution Chart appears.

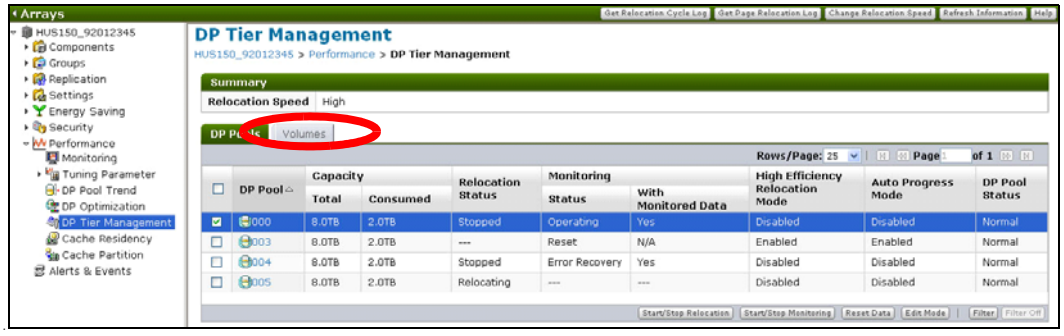


4. Confirm the viewed contents and click **Close**.

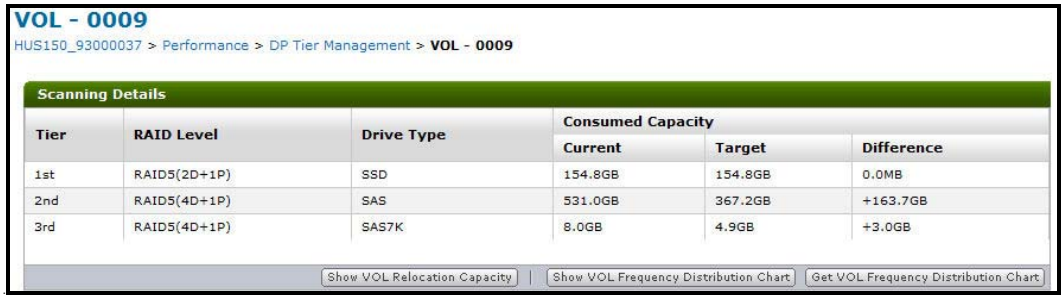
Outputting the frequency distribution of a DP-VOL to a file

To output the frequency distribution of a DP-VOL to a file:

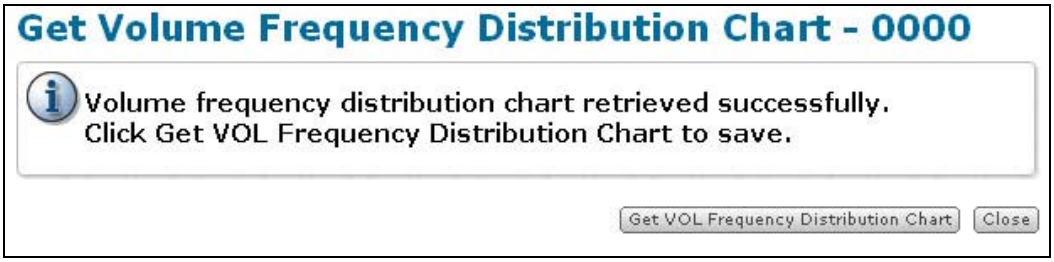
1. Click the **Volumes** tab on the DP Tier Management window.



2. Click the **VOL** whose frequency distribution you want to output. The VOL screen appears.



3. Click **Get VOL Frequency Distribution Chart**. The Get VOL Frequency Distribution Chart message appears.



4. Click **Get VOL Frequency Distribution Chart**.
5. Click **Get CSV File**.
6. When the File Download dialog box appears, click **Save**. The Save As dialog box appears.
7. In the Save As dialog box, specify the **Save in**, **File name**, and **Save as type** information, and then click **Save**.
8. When the Get Volume Frequency Distribution Chart message appears, click **Close**.

The compressed volume frequency distribution file contains the following csv file:

Array serial number_FrequencyDistribution_vol number_yyyyMMddhhmm.csv

For information about the CSV file, see DP Pool or DP-VOL frequency distribution on page 10-41.

14

Hitachi Dynamic Tiering Troubleshooting

In the unlikely event you encounter a problem with Hitachi Dynamic Tiering, refer to the information in this chapter to identify and resolve the problem.

Table 14-1 provides troubleshooting information for Hitachi Dynamic Tiering operations.

Table 14-1: Troubleshooting for Hitachi Dynamic Tiering

Problems	Causes	Solutions
Cannot install Hitachi Dynamic Tiering.	• Hitachi Dynamic Provisioning is not unlocked and enabled. • The firmware is an old version.	• Unlock and enable Hitachi Dynamic Provisioning. • Upgrade the firmware.
Cannot manage the DP tier.	• Update the license (see Installing Hitachi Dynamic Tiering on page 11-12). • Upgrade the version of Hitachi Storage Navigator Modular 2. • Enable Tier Mode (see Changing the Tier Mode of a DP pool on page 13-7).	• The license has expired. • Hitachi Storage Navigator Modular 2 is an old version. • Tier Mode is disabled.
Cannot change the Tier Mode.	When the disabled status cannot be changed to the enabled status: • Hitachi Dynamic Tiering is not unlocked and enabled. • The DP RAID group of SSDs/FMDs exists in the DP pool. When the enabled status cannot be changed to the disabled status: • An SSD/FMD tier exists. When the firmware version is less than 0945/A: • Different RAID levels and combinations coexist in the same pool. • Different types of drives coexist in the same pool.	When it cannot be changed from Disable to Enable: • Hitachi Dynamic Tiering is not unlocked/enabled (see Installing Hitachi Dynamic Tiering on page 11-12). • Reconfigure it to the configuration not including the DP RAID group of SSDs/FMDs. When it cannot be changed from Enable to Disable: • Different RAID levels, combinations and/or drive types cannot coexist in HDP pool. The configuration needs to be rebuilt. Rebuild a configuration or update the firmware to version 0945/A or later. • Rebuild the configuration without including SSD/FMD tier. • Due to differences in the way Hitachi Dynamic Provisioning and Hitachi Dynamic Tiering handle chunk sizes, a Hitachi Dynamic Provisioning pool consisting solely of SSDs/FMDs cannot be converted into a Hitachi Dynamic Tiering pool (see Tier Mode relationship between Hitachi Dynamic Provisioning and Tiering on page 10-5).

Table 14-1: Troubleshooting for Hitachi Dynamic Tiering

Problems	Causes	Solutions
Cannot create or extend the pool.	• Memory reconfiguration fails while reconfiguring the memory to change DP Capacity Mode from maximum capacity to regular capacity (when creating). • • Four or more types of drives are being added in the same pool. When the firmware version is less than 0945/A: • Multiple RAID levels and/or combinations exist in the tier. • Multiple types of drives are being added in the same pool with tier mode disabled. Solution: •	• See Reconfiguring memory on page 11-9. • Only three or less drive types can be used in the same pool. If the firmware is earlier than 0945/A: • Only the same RAID level and/or combination can be used in the tier. • Enable Tier Mode (see Changing the Tier Mode of a DP pool on page 13-7). • Update the firmware to version 0945/A or later.
Cannot delete the pool.	DP volume exists in the pool. (The same condition as DP pool deletion.)	Delete DP volume before deleting the pool (see Deleting DP-VOLs on page 13-20) (The same condition as DP pool deletion.)
Cannot change the monitoring or relocation periods.	• Tier Mode is disabled. • Auto Progress Mode is disabled.	• Enable Tier Mode (see Changing the Tier Mode of a DP pool on page 13-7). • Enable Auto Progress Mode (see Changing High Efficiency Relocation and Auto Progress Mode on page 13-37).
Cannot change the following settings: • Buffer Space for New Page Assignment • Buffer Space for Tier Relocation • Auto Progress Mode • High Efficiency Relocation Mode • Relocation Speed • Monitored I/O • New Page Assignment Tier • Promptly Promotion Mode • Disabling Tier Relocation	Tier Mode is disabled.	Enable Tier Mode (see Changing the Tier Mode of a DP pool on page 13-7).

Table 14-1: Troubleshooting for Hitachi Dynamic Tiering

Problems	Causes	Solutions
Cannot update the firmware.	Downgrading to the version that does not support Hitachi Dynamic Tiering is being attempted with Dynamic Tiering unlocked.	Lock Hitachi Dynamic Tiering before updating the firmware (see Enabling or disabling Hitachi Dynamic Tiering on page 11-21).
Page relocation fails.	Destage timeout of DP management information occurred.	• Stop the relocation to lower the I/O load. • If the problem persists, perform a storage system shutdown.
Performance does not improve.	• Insufficient application time caused the improper relocation. • Tier-related settings are incorrect. • The drive has reached its performance limitation.	• Depending on capacity in use, the proper relocation requires about eight hours. Wait for the relocation to complete. • Check the tier-related settings. • Add a drive to the tier that has reached its performance limitation. • If the problem persists, contact HDS Support at portal.hds.com.
Operation status does not update.	• One minute has not passed since starting the reference because update cycle is one minute. • Relocation stops due to a failure (status has a setting other than Relocating).	• Retry in one minute. • Isolate the failure to make the status become Relocating.
Amount relocation planned remains.	• Auto Progress Mode is disabled. • Disabling Tier Relocation is enabled. • Relocation failed.	• Enable Auto Progress Mode. • Disable Tier Relocation. • Destage timeout of the DP management information has occurred. Stop the relocation to lower the I/O load. If the problem persists, perform the following: • Perform a storage system shutdown.

Table 14-1: Troubleshooting for Hitachi Dynamic Tiering

Problems	Causes	Solutions
DP pool capacity is depleted (DP pool status is Capacity Deplete).	There is no capacity that can be used in the DP pool.	Increase the DP pool capacity (see Adding DP pool capacity on page 13-14) or reduce the capacity in the DP pool as follows. Note, however, that these steps delete all user data. • Confirm that the affected DP-VOL is not needed, and then continue with the steps below. • Select the option **Reclaim zero pages before optimizing DP** to optimize the DP for the DP-VOL in the depleted DP pool. (See section 5.5.1) • Delete, format, and reduce the DP-VOL in the DP pool and reduce the capacity. User data is lost. Notes: • The capacity reduction by performing DP optimization is not effective when there is no zero data in the relevant DP-VOL. • Since Hitachi Dynamic Provisioning is a function based on not depleting a DP pool, use a notice function such as trend information, e-mail, SNMP trap, or Windows Event Viewer without depleting the DP pool. If the DP pool is depleted, the application can end unexpectedly or a system failure can occur.
DP pool usage rate exceeds the threshold.	• There are too many DP-VOLs or the stored data is too large. • The DP pool capacity is too low. • The threshold value of the DP pool is too small.	• Increase the DP pool capacity (see Adding DP pool capacity on page 13-14). • Increase the threshold value of the DP pool (see Changing the Tier Mode of a DP pool on page 13-7). • You need free volumes to add as DP-VOLs. If there are no free volumes, delete unneeded volumes or add the drives.
The capacity of the DP-VOL exceeds the threshold value.	The capacity of setting the DP-VOL is large and can reach the DP pool capacity.	• If the free capacity of the DP pool is in the insufficient trend, copy the data of the DP-VOL to the normal volume and delete the affected DP-VOL. • Increase DP pool capacity (see Adding DP pool capacity on page 13-14). • Increase the threshold value of the DP pool (see Changing the Tier Mode of a DP pool on page 13-7).

Table 14-1: Troubleshooting for Hitachi Dynamic Tiering

Problems	Causes	Solutions
Cannot create the DP-VOL.	• The total capacity of the DP-VOL exceeds the total capacity of the system support. • The over provisioning threshold value is exceeded. • Part of the DP pool is blocked or the DP pool capacity is depleted. • The DP-VOL deletion processing of the target DP-VOL number is running in the background.	• Create a DP-VOL so the total capacity of the DP-VOL is within the total capacity of the system support. • Reduce the DP-VOL capacity in the pool or change the over provisioning threshold value, and then create a DP-VOL. • Contact HDS Support at portal.hds.com. • See Reconfiguring memory on page 11-9 and reconfigure memory.
Cannot add a DP pool.	• The DP pool requirements have not been met. • Part of the DP pool is blocked.	• Check whether the DP pool meets the requirements of the DP RAID group (see Requirements of DP-VOLs and DP Pools on page 11-2). • Contact HDS Support at portal.hds.com.
Cannot shrink the DP pool.	• The requirements necessary for shrinking the DP pool are not met. • Part of the DP pool is blocked.	• Check whether the DP RAID group meets the shrinking requirements (see Shrinking DP pool capacity on page 10-7). • Contact HDS Support at portal.hds.com.
A DP pool is blocked.	A failure occurred in two or more HDUs.	Contact HDS Support at portal.hds.com.
A DP-VOL is blocked.		• Check whether the DP pool for which the DP-VOL is defined is blocked. • Contact HDS Support at portal.hds.com.
A DP pool cannot be recovered.	Causes: • It takes time because there is a blocked part in the array. • A DP pool is blocked.	• After waiting for a while, click **Refresh Information** at the top-right area of the Hitachi Storage Navigator Modular 2 screen, and then check the DP pool status in the DP Pool window. • Contact HDS Support at portal.hds.com.
An error occurs in the application for monitoring the volume installed in the host.	• There is insufficient free space for the DP pool. • Part of the DP pool is blocked. • The DP-VOL does not have enough capacity.	• Check the free capacity of a DP pool and grow the DP pool capacity. • Contact HDS Support at portal.hds.com.

Table 14-1: Troubleshooting for Hitachi Dynamic Tiering

Problems	Causes	Solutions
When the host computer tries to access the port, an error occurs and the host cannot access the port.	The following has occurred to the volume that is a DP-VOL: • The host has tried to write data onto the volume, but the data being written requires new pool capacity to be assigned and the pool did not have sufficient free space (pool utilization level was 100%). • Although capacity was added after a DP pool was completely depleted, the total capacity of a DP pool is 2 TB or more and the free capacity is less than 100 GB, or the total capacity of a DP pool is less than 2 TB and the free capacity is less than 5%. • The DP-VOL was prevented from accessing data because a portion of the DP pool is blocked. • A controller is blocked.	• Check the DP pool free capacity and lower the utilization level of a DP pool to at least 95% by adding a DP RAID group to the pool or deleting DP-VOLs to free up pool capacity. • After a DP pool is completely depleted once, normal access cannot be performed unless the free capacity of a DP pool is 5% or more or 100 GB or more. Grow a DP pool capacity and secure the free capacity of 100 GB or more for the consumed capacity when the total capacity of a DP pool is 2 TB or more. If the total capacity of a DP pool is less than 2 TB, secure the free capacity of 5% or more. • Contact HDS Support at portal.hds.com.
When operating Hitachi Storage Navigator Modular 2, a time-out occurs frequently.	• The load on the array is too heavy, so that Hitachi Storage Navigator Modular 2 computer cannot respond to the array. • The time-out time is set too short.	Wait a few minutes, and then try the operation again.
A DP-VOL capacity cannot be increased or shrunk.		• Retry the operation in approximately 10 minutes. • Contact HDS Support at portal.hds.com.
Backup and restore of a DP-VOL consumes capacity.	When using Hitachi Dynamic Provisioning, if a restore is performed from backup data, the actual capacity for the capacity defined as the DP-VOL is consumed. To use Dynamic Provisioning function effectively, perform the copy in file units from the application to the DP-VOL after restoring to the normal volume.	

Table 14-1: Troubleshooting for Hitachi Dynamic Tiering

Problems	Causes	Solutions
DP pool optimization was rejected by Hitachi Storage Navigator Modular 2.	• The status of the DP-VOL for optimization is Detached or Unformatted. • The forced parity correction status of the DP-VOL for optimization is Parity Correction, Restored, Waiting Parity Correction, Waiting Drive Reconstruction, Correction Skipped, Correction Aborted, Uncorrected, and Drive Detached. • The DP pool with the DP-VOL for optimization is conducting drive recovery. • The status of the DP-VOL for optimization or the DP pool with that DP-VOL is Detached. • PIN over is occurring on the DP-VOL for optimization or on the DP pool with that DP-VOL. • The DP-VOL for optimization is part of a Modular Volume Migration (MVM) pair. • The DP-VOL for optimization or the DP pool with that DP-VOL has write uncompleted area. • The DP-VOL for optimization is transitioning to the Full Capacity Mode. • The DP-VOL for optimization is a DMLU for replication. • The DP optimization status of the DP-VOL for optimization is Accepting, Pending, Optimizing, Suspended, or Canceling.	
DP pool cannot be optimized (expected capacity cannot be reclaimed).	• Competing with host I/Os • The processing to reclaim the capacity cannot be performed. • Conflict with relocation.	• Perform the optimization when host I/O load is light. • If there is no host I/O, the capacity is reclaimed according to the following times: 10 GB: about 20 seconds 100 GB: about 3 minutes • Schedule relocation and perform DP optimization when relocation stops.

Table 14-1: Troubleshooting for Hitachi Dynamic Tiering

Problems	Causes	Solutions
DP pool optimization ends abnormally.	• DP pool is blocked. • DP pool capacity was consumed. • Destage timeout of the DP management information occurred. • DP pool tier was consumed.	• Check the DP pool status. If DP pool capacity is depleted, add the DP pool capacity. • Check the status of DP pool tier, and if the capacity of DP pool tier is depleted, add capacity to the depleted tier. • Perform the optimization when I/O load is low. • If the condition persists after performing the steps above, contact HDS Support at portal.hds.com.
DP pool optimization does not start (optimization status is Pending).	• DP pool formatting may not be completed. • Preparation for the optimization processing is taking time because the capacity on which optimization will be performed is large. • Optimization of the target volume that occurs after shrinking the capacity and the page formatting may not be complete.	• Check the DP pool status and confirm that DP pool formatting is complete. If not, wait until it completes. DP pool optimization starts automatically after formatting is completed. • DP pool optimization starts according to the following times: 100 GB: about 12 minutes 1 TB: about 2 hours • Confirm the status of the optimization target volume and check whether page formatting is complete. If not, wait for it to complete. DP pool optimization starts automatically after page formatting is completed.
DP pool optimization status (Suspended(100%) .	This is displayed when waiting for optimization to complete processing. This is not an error condition.	The status recovers in about 10 seconds. Check the status again waiting a few minutes.

Table 14-1: Troubleshooting for Hitachi Dynamic Tiering

Problems	Causes	Solutions
Cannot change the DP Capacity Mode	• The memory is not reconfigured or the array is not restarted. • If the array model is a Hitachi Unified Storage 110, it does not support the DP Capacity Mode. • The firmware version of the array is less than 0950/A.	• Reconfigure the memory or restart the array. • Check whether the array is a Hitachi Unified Storage 130 or 150, which supports the DP Capacity Mode. • Check whether the firmware version of the array is 0950/A or more. When changing the DP Capacity Mode by restarting the array, if "The setting change of the DP Capacity Mode has failed(Code-xx)" appears in the event log message (Event Log tab in the Alerts & Events window of Hitachi Storage Navigator Modular 2) of the array, follow the maintenance procedure according to the Code numbers shown below. (Code-01: Cache capacity is insufficient) 1. Check whether the cache memory is inserted correctly. 2. Check whether the cache capacity is correct (see Table 10-5 on page 10-11). 3. Add cache capacity. 4. Change the DP Capacity Mode again. 5. Reconfigure the memory or restart the array (it is possible to start the array after the array shutdown). (Code-02: Array shutdown is not completed) 1. Reconfigure the memory or restart the array (it is possible to start the array after the array shutdown). (Code-03: PIN over occurred) 1. Contact the service personnel and request for the PIN recovery. 2. If recovered, reconfigure the memory or restart the array (it is possible to start the array after the array shutdown).
The total capacity of the DP pools and the total value of the DP-VOL consumed capacity are mismatched.	• DP-VOL formatting is not performed after reinitializing the DP pool. • When formatting DP-VOLs whose Full Capacity Mode is enabled.	• Perform the DP-VOL formatting. • Wait for DP-VOL formatting to complete. • Contact HDS Support at portal.hds.com.
Windows 2012 or VMware, DP pool capacity is not reclaimed when a file is deleted (UNMAP command is issued internally)	• The length of the issued UNMAP command is less than 1 GB • (UNMAP Short Length Mode is enabled.) • The reclaiming process is delayed.	• Perform DP Optimization with **Reclaim zero pages before optimizing DP**. • If Windows 2012 is used, perform drive optimization. • Capacity is reclaimed based on the following approximate times: 10 GB = approximately 20 seconds 100 GB = approximately 3 minutes

If you cannot solve a problem using the above suggestions, or if you encounter a problem not listed, contact HDS Support at portal.hds.com.

15

Installing Hitachi Dynamic Tiering when Cache Partition Manager is used

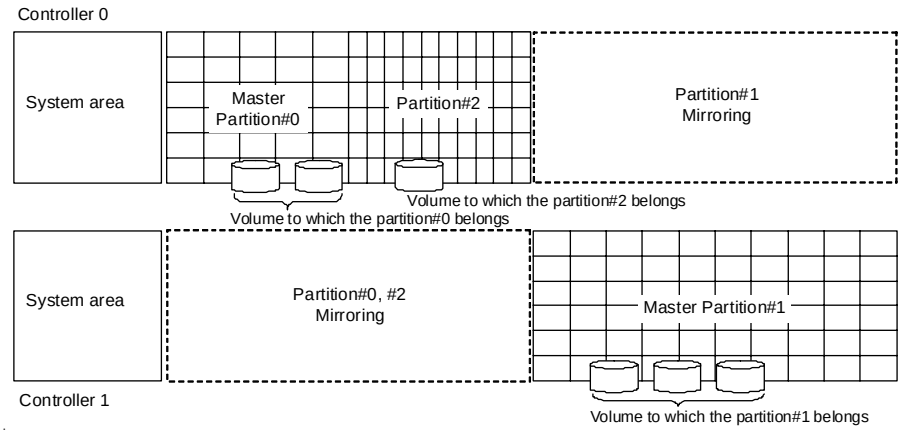
Hitachi Dynamic Tiering uses a part of the cache area to manage the inner resources. When this happens, the cache capacity that Cache Partition Manager can use decreases.

Ensure that the cache partition information is initialized as in the following figures, which show Hitachi Dynamic Tiering installed and Cache Partition Manager in use.

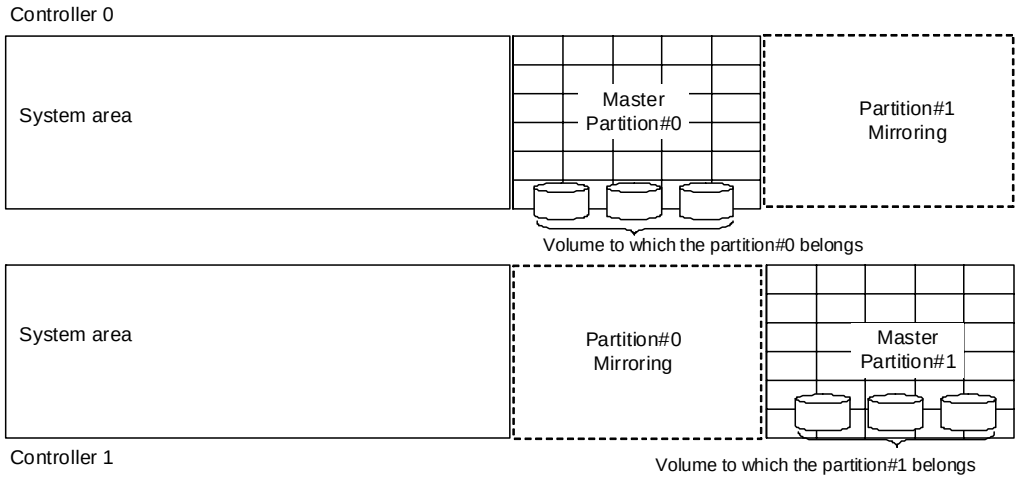
All the volumes are moved to the master partitions on the side of the default controller that controls them.

All sub-partitions are eliminated and the size of the each master partition is reduced to half of the user data area after the installing Hitachi Dynamic Tiering.

When Cache Partition Manager is used



Where Hitachi Dynamic Tiering is installed while Cache Partition Manager is used



16

Capacity of Hitachi Dynamic Tiering RAID Group

Table 16-1 and Table 16-2 on page 16-4 show the actual capacities of Hitachi Dynamic Tiering RAID groups.

NOTE: When adding two or more DP RAID groups to a DP pool, estimate the DP pool capacity by adding the appropriate values.

Table 16-1: Actual capacities of Hitachi Dynamic Tiering RAID groups chunk size: 1 GB, stripe size: 256 kB (unit: GB)

		SAS				SSD		SAS 7.2K			FMD
RAID level	**Drive type**	**300**	**600**	**900**	**1200**	**200**	**400**	**2000**	**3000**	**4000**	**1600**
RAID 1	1D+D	264	532	816	1090	179	362	1819	2731	3643	1634
RAID 1+0	2D+D	532	1068	1636	2183	361	728	3642	5465	7289	3271
	3D+D	800	1603	2454	3274	543	1093	5461	8195	10930	4906
	4D+D	1068	2140	3275	4369	726	1460	7287	10934	14581	6546
	5D+D	1335	2673	4090	5357	907	1824	9100	13655	18209	8175
	6D+D	1603	3210	4911	6552	1090	2190	10926	16394	21863	9816
	7D+D	1869	3742	5725	7637	1271	2553	12736	19109	25482	11441
	8D+D	2140	4283	6553	8741	1455	2923	14577	21871	29166	13096

Table 16-1: Actual capacities of Hitachi Dynamic Tiering RAID groups chunk size: 1 GB, stripe size: 256 kB (unit: GB) (Continued)

		SAS				SSD		SAS 7.2K			FMD
RAID level	**Drive type**	**300**	**600**	**900**	**1200**	**200**	**400**	**2000**	**3000**	**4000**	**1600**
RAID 5	2D+1P	532	1068	1636	2183	361	728	3642	5465	7289	3271
	3D+1P	800	1603	2454	3274	543	1093	5461	8195	10930	4906
	4D+1P	1068	2140	3275	4369	726	1460	7287	10934	14581	6546
	5D+1P	1335	2673	4090	5457	907	1824	9100	13655	18209	8175
	6D+1P	1603	3210	4911	6552	1090	2190	10926	16394	21863	9816
	7D+1P	1869	3742	5725	7637	1271	2553	12736	19109	25482	11441
	8D+1P	2140	4283	6553	8741	1455	2923	14577	21871	29166	13096
	9D+1P	2043	4809	7358	9815	1635	3282	16367	24557	32748	14704
	10D+1P	2673	5349	8184	10917	1818	3651	18204	27313	36422	16354
	11D+1P	2938	5880	8996	12000	1999	4013	20010	30023	40036	17977
	12D+1P	3205	6413	9812	13088	2181	4377	21824	32744	43665	19607
	13D+1P	3469	6941	10619	14165	2360	4738	23620	35439	47258	21220
	14D+1P	3741	7487	11453	15278	2546	5110	25475	38221	50968	22886
	15D+1P	4001	8006	12248	16337	2723	5464	27242	40872	54502	24474

Table 16-1: Actual capacities of Hitachi Dynamic Tiering RAID groups chunk size: 1 GB, stripe size: 256 kB (unit: GB) (Continued)

		SAS				SSD		SAS 7.2K			FMD
RAID level	**Drive type**	**300**	**600**	**900**	**1200**	**200**	**400**	**2000**	**3000**	**4000**	**1600**
RAID 6	2D+2P	532	1068	1636	2183	361	728	3642	5465	7289	3271
	3D+2P	800	1603	2454	3274	543	1093	5461	8195	10930	4906
	4D+2P	1068	2140	3275	4369	726	1460	7287	10934	14581	6546
	5D+2P	1335	2673	4090	5457	907	1824	9100	13655	18209	8175
	6D+2P	1603	3210	4911	6552	1090	2190	10926	16394	21863	9816
	7D+2P	1869	3742	5725	7637	1271	2553	12736	19109	25482	11441
	8D+2P	2140	4283	6553	8741	1455	2923	14577	21871	29166	13096
	9D+2P	2403	4809	7358	9815	1635	3282	16367	24557	32748	14704
	10D+2P	2673	5349	8184	10917	1818	3651	18204	27313	36422	16354
	11D+2P	2938	5880	8996	12000	1999	4013	20010	30023	40036	17977
	12D+2P	3205	6413	9812	13088	2181	4377	21824	32744	43665	19607
	13D+2P	3469	6941	10619	14165	2360	4738	23620	35439	47258	21220
	14D+2P	3741	7487	11453	15278	2546	5110	25475	38221	50968	22886
	15D+2P	4001	8006	12248	16337	2723	5464	27242	40872	54502	24474
	16D+2P	4283	8659	13109	17486	2914	5849	29157	43746	58835	26195
	17D+2P	4549	9103	13925	18575	3096	6213	30972	46469	61966	27825
	18D+2P	4809	9622	14720	19634	3273	6567	32738	49118	65499	29412
	19D+2P	5076	10157	15538	20725	3455	6933	34557	51847	69138	31046
	20D+2P	5349	10702	16371	21837	3640	7305	36412	54630	72848	32712
	21D+2P	5595	11193	17123	22840	3808	7640	38084	57138	76193	34214
	22D+2P	5864	11732	17948	23940	3891	8008	39917	59889	79861	35861
	23D+2P	6126	12257	18750	25010	4170	8366	41701	62565	83430	37464
	24D+2P	6413	12830	19627	26180	4365	8758	43652	65492	87333	39217
	25D+2P	6687	13378	20465	27298	4551	9132	45516	68288	91061	40891
	26D+2P	6941	13886	21242	28334	4724	9479	47244	70881	94519	42444
	27D+2P	7215	14435	22081	29453	4911	9853	49109	73679	98250	44120
	28D+2P	7461	14926	22832	30455	5078	10188	50780	76186	101592	45620

Table 16-2: Actual capacities of Hitachi Dynamic Tiering RAID groups chunk size: 1 GB, stripe size: 64 kB (unit: GB)

		SAS				SSD		SAS 7.2K			FMD
RAID level	**Drive type**	**300**	**600**	**900**	**1200**	**200**	**400**	**2000**	**3000**	**4000**	**1600**
RAID 1	1D+D	264	532	816	1090	179	362	1819	2731	3643	1634
RAID 1+0	2D+D	532	1068	1636	2183	361	728	3642	5465	7289	3271
	3D+D	800	1603	2455	3275	544	1094	5463	8198	10934	4908
	4D+D	1068	2140	3275	4369	726	1460	7287	10934	14581	6546
	5D+D	1336	2675	4094	5462	908	1825	9109	13667	18226	8183
	6D+D	1604	3211	4913	6554	1091	2191	10930	16400	21871	9820
	7D+D	1871	3746	5732	7647	1273	2556	12752	19133	25515	11456
	8D+D	2140	4283	6553	8741	1455	2923	14577	21871	29166	13096
RAID 5	2D+1P	532	1068	1636	2183	361	728	3642	5465	7289	3271
	3D+1P	800	1604	2455	3275	544	1094	5463	8198	10934	4908
	4D+1P	1068	2140	3275	4369	726	1460	7287	10934	14581	6546
	5D+1P	1336	2675	4094	5462	908	1825	9109	13667	18226	8183
	6D+1P	1604	3211	4913	6554	1091	2191	10930	16400	21871	9820
	7D+1P	1871	3746	5732	7647	1273	2556	12752	19133	25515	11456
	8D+1P	2140	4283	6553	8741	1455	2923	14577	21871	29166	13096
	9D+1P	2047	4817	7370	9831	1637	3287	16394	24598	32802	14728
	10D+1P	2674	5352	8189	10924	1820	3653	18215	27330	36445	16364
	11D+1P	2942	5888	9008	12016	2002	4018	20037	30063	40089	18001
	12D+1P	3209	6423	9826	13107	2184	4384	21856	32792	43729	19636
	13D+1P	3477	6958	10645	14199	2366	4749	23677	35523	47370	21271
	14D+1P	3744	7493	11463	15291	2548	5114	25497	38254	51011	22906
	15D+1P	4012	8028	12281	16382	2730	5479	27216	40984	54652	24541

Table 16-2: Actual capacities of Hitachi Dynamic Tiering RAID groups chunk size: 1 GB, stripe size: 64 kB (unit: GB) (Continued)

		SAS				SSD		SAS 7.2K			FMD
RAID level	**Drive type**	**300**	**600**	**900**	**1200**	**200**	**400**	**2000**	**3000**	**4000**	**1600**
RAID 6	2D+2P	532	1068	1636	2183	361	728	3642	5465	7289	3271
	3D+2P	800	1604	2455	3275	544	1094	5463	8198	10934	4908
	4D+2P	1068	2140	3275	4369	726	1460	7287	10934	14581	6546
	5D+2P	1336	2675	4094	5462	908	1825	9109	13667	18226	8183
	6D+2P	1604	3211	4913	6554	1091	2191	10930	16400	21871	9820
	7D+2P	1871	3746	5732	7647	1273	2556	12752	19133	25515	11456
	8D+2P	2140	4283	6553	8741	1455	2923	14577	21871	29166	13096
	9D+2P	2407	4817	7370	9831	1637	3287	16394	24598	32802	14728
	10D+2P	2674	5352	8189	10924	1820	3653	18215	27330	36445	16364
	11D+2P	2942	5888	9008	12016	2002	4018	20037	30063	40089	18001
	12D+2P	3209	6423	9826	13107	2184	4384	21856	32792	43729	19636
	13D+2P	3477	6958	10645	14199	2366	4749	23677	35523	47370	21271
	14D+2P	3744	7493	11463	15291	2548	5114	25497	38254	51011	22906
	15D+2P	4012	8028	12281	16382	2730	5479	27316	40984	54652	24541
	16D+2P	4283	8659	13109	17486	2914	5849	29157	43746	58335	26195
	17D+2P	4549	9103	13925	18575	3096	6213	30972	46469	61966	27825
	18D+2P	4814	9633	14736	19656	3276	6575	32774	49172	3643	29444
	19D+2P	5082	10168	15556	20749	3459	6941	34597	51908	7289	31082
	20D+2P	5349	10702	16371	21837	3640	7305	36412	54630	10934	32712
	21D+2P	5616	11236	17189	22928	3822	7670	38230	57538	14581	34346
	22D+2P	5888	11780	18020	24036	4007	8040	40078	60130	18226	36006
	23D+2P	6152	12308	18829	25115	4187	8401	41877	62829	21871	37622
	24D+2P	6422	12849	19656	26218	4371	8771	43716	65588	25515	39275
	25D+2P	6687	13378	20465	27298	4551	9132	45516	68288	29166	40891
	26D+2P	6952	13908	21276	28379	4732	9494	47319	70994	7289	42511
	27D+2P	7227	14458	22118	29501	4919	9869	49190	73801	10934	44192
	28D+2P	7486	14977	22910	30559	5096	10233	50953	76446	14581	45776

Table 16-3: Actual capacities of Hitachi Dynamic Tiering RAID groups chunk size: 32MB, stripe size: 256 kB (unit: GB)

		2.5-inch SSD		FMD
RAID level	**Drive type**	**200**	**400**	**1600**
RAID 1	1D+D	179.3	362.7	1634.3
RAID 1+0	2D+D	361.7	728.5	3271.7
	3D+D	539.8	1085.7	4871.0
	4D+D	726.4	1460.0	6546.5
	5D+D	894.8	1797.6	8057.9
	6D+D	1058.0	2125.0	9523.5
	7D+D	1225.6	2451.0	11027.7
	8D+D	1455.9	2923.1	13096.0
RAID 5	2D+1P	361.7	728.5	3271.7
	3D+1P	539.8	1085.7	4871.0
	4D+1P	726.4	1460.0	6546.5
	5D+1P	894.8	1797.6	8057.9
	6D+1P	1058.0	2125.0	9523.5
	7D+1P	1225.6	2461.0	11027.7
	8D+1P	1455.9	2923.1	13096.0
	9D+1P	1553.2	3118.1	13369.3
	10D+1P	1792.6	3598.3	16118.9
	11D+1P	1942.3	3898.5	17462.4
	12D+1P	2119.1	4253.1	19050.1
	13D+1P	2331.3	4678.7	20955.5
	14D+1P	2331.3	4678.7	20955.5
	15D+1P	2590.7	5119.0	23284.2

Table 16-3: Actual capacities of Hitachi Dynamic Tiering RAID groups chunk size: 32MB, stripe size: 256 kB (unit: GB) (Continued)

		2.5-inch SSD		FMD
RAID level	**Drive type**	**200**	**400**	**1600**
RAID 6	2D+2P	361.7	728.5	3271.7
	3D+2P	539.8	1085.7	4871.0
	4D+2P	726.4	1460.0	6546.5
	5D+2P	894.8	1797.6	8057.9
	6D+2P	1058.0	2125.0	9523.5
	7D+2P	1225.6	2461.0	11027.7
	8D+2P	1455.9	2923.1	13096.0
	9D+2P	1553.2	3118.1	13969.3
	10D+2P	1792.6	3598.3	16118.9
	11D+2P	1942.3	3898.5	17462.4
	12D+2P	2119.1	4253.1	19050.1
	13D+2P	2331.3	4678.7	20955.5
	14D+2P	2331.3	467.87	20955.5
	15D+2P	2590.7	5199.0	23284.2
	16D+2P	2914.9	5849.2	26195.1
	17D+2P	2914.9	5849.2	26195.1
	18D+2P	2914.9	5849.2	26195.1
	19D+2P	3331.8	6685.2	29937.6
	20D+2P	3331.8	6685.2	29937.6
	21D+2P	3331.8	6685.2	29937.6
	22D+2P	3387.6	7800.0	34927.8
	23D+2P	3387.6	7800.0	34927.8
	24D+2P	3387.6	7800.0	34927.8
	25D+2P	3387.6	7800.0	34927.8
	26D+2P	4665.7	9360.5	41914.0
	27D+2P	4665.7	9360.5	41914.0
	28D+2P	4665.7	9360.5	41914.0

Table 16-4: Actual capacities of Hitachi Dynamic Tiering RAID groups chunk size: 32MB, stripe size: 64 kB (unit: GB)

		2.5-inch SSD		FMD
RAID level	**Drive type**	**200**	**400**	**1600**
RAID 1	1D+D	179.3	362.7	1634.3
RAID 1+0	2D+D	361.7	728.5	3271.7
	3D+D	543.0	1092.1	4899.5
	4D+D	726.4	1460.0	6546.5
	5D+D	903.5	1815.1	8136.2
	6D+D	1082.7	2174.5	9745.1
	7D+D	1258.8	2527.6	11325.9
	8D+D	1455.9	2923.1	13096.0
RAID 5	2D+1P	361.7	728.5	3271.7
	3D+1P	543.0	1092.1	4899.5
	4D+1P	726.4	1460.0	6546.5
	5D+1P	903.5	1815.1	8136.2
	6D+1P	1082.7	2174.5	9745.1
	7D+1P	1258.8	2527.6	11325.9
	8D+1P	1455.9	2923.1	13096.0
	9D+1P	1635.1	3282.4	14704.7
	10D+1P	1792.6	3598.3	16118.9
	11D+1P	1983.6	3981.5	17834.0
	12D+1P	2168.5	4352.1	19493.2
	13D+1P	2331.3	4678.7	20955.5
	14D+1P	2520.6	5058.3	22654.8
	15D+1P	2664.8	5347.6	23949.5

Table 16-4: Actual capacities of Hitachi Dynamic Tiering RAID groups chunk size: 32MB, stripe size: 64 kB (unit: GB) (Continued)

		2.5-inch SSD		FMD
RAID level	**Drive type**	**200**	**400**	**1600**
RAID 6	2D+2P	361.7	728.5	3271.7
	3D+2P	543.0	1092.1	4899.5
	4D+2P	726.4	1460.0	6546.5
	5D+2P	903.5	1815.1	8136.2
	6D+2P	1082.7	2174.5	9745.1
	7D+2P	1258.8	2527.6	11325.9
	8D+2P	1455.9	2923.1	13096.0
	9D+2P	1635.1	3284.4	14704.7
	10D+2P	1792.6	3598.3	16118.9
	11D+2P	1983.6	3981.5	17834.0
	12D+2P	2168.5	4352.1	19493.2
	13D+2P	2331.3	4678.7	20955.5
	14D+2P	2520.6	5053.8	22654.8
	15D+2P	2664,8	5347.6	23949.5
	16D+2P	2914.9	5849.2	26195.1
	17D+2P	3009.0	6038.0	27040.2
	18D+2P	3216.8	6456.6	28905.2
	19D+2P	3455.3	6933.0	31046.6
	20D+2P	3588.3	7199.7	32240.8
	21D+2P	3732,0	7487.8	33530.5
	22D+2P	3887.6	7800.0	34927.8
	23D+2P	4956.7	8139.2	36446.5
	24D+2P	4241.3	8509.3	38103.3
	25D+2P	4443.4	8914.6	39917.9
	26D+2P	4665.7	9360.5	41914.0
	27D+2P	4911.5	9853.4	44121.0
	28D+2P	4911.5	9853.4	44121.0

Glossary

This glossary provides definitions for replication terms as well as terms related to the technology that supports your Hitachi storage system. Click the letter of the glossary section to display the related page.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z

A

array

A set of hard disks mounted in a single enclosure and grouped logically together to function as one contiguous storage space.

asynchronous

Asynchronous data communications operate between a computer and various devices. Data transfers occur intermittently rather than in a steady stream. Asynchronous replication does not depend on acknowledging the remote write, but it does write to a local log file. Synchronous replication depends on receiving an acknowledgement code (ACK) from the remote system and the remote system also keeps a log file.

B

background copy

A physical copy of all tracks from the source volume to the target volume.

Bits per second, the standard measure of data transmission speeds.

C

cache

A temporary, high-speed storage mechanism. It is a reserved section of main memory or an independent high-speed storage device. Two types of caching are found in computers: memory caching and disk caching. Memory caches are built into the architecture of microprocessors and often computers have external cache memory. Disk caching works like memory caching; however, it uses slower, conventional main memory that on some devices is called a memory buffer.

capacity

The amount of information (usually expressed in megabytes) that can be stored on a disk drive. It is the measure of the potential contents of a device; the volume it can contain or hold. In communications, capacity refers to the maximum possible data transfer rate of a communications channel under ideal conditions.

CCI

See command control interface.

CLI

See command line interface.

cluster

A group of disk sectors. The operating system assigns a unique number to each cluster and then keeps track of files according to which clusters they use.

cluster capacity

The total amount of disk space in a cluster, excluding the space required for system overhead and the operating system. Cluster capacity is the amount of space available for all archive data, including original file data, metadata, and redundant data.

command control interface (CCI)

Hitachi's Command Control Interface software provides command line control of Hitachi array and software operations through the use of commands issued from a system host. Hitachi's CCI also provides a scripting function for defining multiple operations.

command devices

Dedicated logical volumes that are used only by management software such as CCI, to interface with the storage systems. Command devices are not used by ordinary applications. Command devices can be shared between several hosts.

command line interface (CLI)

A method of interacting with an operating system or software using a command line interpreter. With Hitachi's Storage Navigator Modular Command Line Interface, CLI is used to interact with and manage Hitachi storage and replication systems.

concurrency of S-VOL

Occurs when an S-VOL is synchronized by simultaneously updating an S-VOL with P-VOL data AND data cached in the primary host memory. Discrepancies in S-VOL data may occur if data is cached in the primary host memory between two write operations. This data, which is not available on the P-VOL, is not reflected on to the S-VOL. To ensure concurrency of the S-VOL, cached data is written onto the P-VOL before subsequent remote copy operations take place.

concurrent copy

A management solution that creates data dumps, or copies, while other applications are updating that data. This allows end-user processing to continue. Concurrent copy allows you to update the data in the files being copied, however, the copy or dump of the data it secures does not contain any of the intervening updates.

configuration definition file

The configuration definition file describes the system configuration for making CCI operational in a TrueCopy Extended Distance Software environment. The configuration definition file is a text file created and/or edited using any standard text editor, and can be defined from the PC where the CCI software is installed. The configuration definition file describes configuration of new TrueCopy Extended Distance pairs on the primary or remote storage system.

consistency group (CTG)

A group of two or more logical units in a file system or a logical volume. When a file system or a logical volume which stores application data, is configured from two or more logical units, these multiple logical units are managed as a consistency group (CTG) and treated as a single entity. A set of volume pairs can also be managed and operated as a consistency group.

consistency of S-VOL

A state in which a reliable copy of S-VOL data from a previous update cycle is available at all times on the remote storage system A consistent copy of S-VOL data is internally pre-determined during each update cycle and maintained in the remote data pool. When remote takeover operations are performed, this reliable copy is restored to the S-VOL, eliminating any data discrepancies. Data consistency at the remote site enables quicker restart of operations upon disaster recovery.

CRC

Cyclical Redundancy Checking, a scheme for checking the correctness of data that has been transmitted or stored and retrieved. A CRC consists of a fixed number of bits computed as a function of the data to be protected, and appended to the data. When the data is read or received, the function is recomputed, and the result is compared to that appended to the data.

CTG

See Consistency Group.

cycle time

A user specified time interval used to execute recurring data updates for remote copying. Cycle time updates are set for each storage system and are calculated based on the number of consistency groups CTG.

cycle update

Involves periodically transferring differential data updates from the P-VOL to the S-VOL. TrueCopy Extended Distance Software remote replication processes are implemented as recurring cycle update operations executed in specific time periods (cycles).

D

data path

See remote path.

data pool

One or more disk volumes designated to temporarily store un-transferred differential data (in the local storage system or snapshots of backup data in the remote storage system). The saved snapshots are useful for accurate data restoration (of the P-VOL) and faster remote takeover processing (using the S-VOL).

data volume

A volume that stores database information. Other files, such as index files and data dictionaries, store administrative information (metadata).

differential-data

The original data blocks replaced by writes to the primary volume. In Copy-on-Write, differential data is stored in the data pool to preserve the copy made of the P-VOL to the time of the snapshot.

differential data control

The process of continuously monitoring the differences between the data on two volumes and determining when to synchronize them.

Differential Management Logical Unit (DMLU)

An exclusive volume used for storing data when the array system is powered down.

differential-data

The original data blocks replaced by writes to the primary volume. In Copy-on-Write, differential data is stored in the data pool to preserve the copy made of the P-VOL to the time of the snapshot.

disaster recovery

A set of procedures to recover critical application data and processing after a disaster or other failure. Disaster recovery processes include failover and failback procedures.

disk array

An enterprise storage system containing multiple disk drives. Also referred to as “disk array device” or “disk storage system.”

DMLU

See Differential Management-Logical Unit.

dual copy

The process of simultaneously updating a P-VOL and S-VOL while using a single write operation.

duplex

The transmission of data in either one or two directions. Duplex modes are full-duplex and half-duplex. Full-duplex is the simultaneous transmission of data in two direction. For example, a telephone is a full-duplex device, because both parties can talk at once. In contrast, a walkie-talkie is a half-duplex device because only one party can transmit at a time.

E

entire copy

Copies all data in the primary volume to the secondary volume to make sure that both volumes are identical.

extent

A contiguous area of storage in a computer file system that is reserved for writing or storing a file.

F

failover

The automatic substitution of a functionally equivalent system component for a failed one. The term failover is most often applied to intelligent controllers connected to the same storage devices and host computers. If one of the controllers fails, failover occurs, and the survivor takes over its I/O load.

fallback

Refers to the process of restarting business operations at a local site using the P-VOL. It takes place after the storage systems have been recovered.

Fault tolerance

A system with the ability to continue operating, possibly at a reduced level, rather than failing completely, when some part of the system fails.

FC

See Fibre Channel.

Fibre Channel

A gigabit-speed network technology primarily used for storage networking.

firmware

Software embedded into a storage device. It may also be referred to as Microcode.

full duplex

The concurrent transmission and the reception of data on a single link.

G

G

Gigabit per second.

granularity of differential data

Refers to the size or amount of data transferred to the S-VOL during an update cycle. Since only the differential data in the P-VOL is transferred to the S-VOL, the size of data sent to S-VOL is often the same as that of data written to the P-VOL. The amount of differential data that can be managed per write command is limited by the difference between the number of incoming host write operations (inflow) and outgoing data transfers (outflow).

GUI

Graphical user interface.

I

I/O

Input/output.

initial copy

An initial copy operation involves copying all data in the primary volume to the secondary volume prior to any update processing. Initial copy is performed when a volume pair is created.

initiator ports

A port-type used for main control unit port of Fibre Remote Copy function.

IOPS

I/O per second.

iSCSI

Internet-Small Computer Systems Interface, a TCP/IP protocol for carrying SCSI commands over IP networks.

iSNS

Internet-Small Computer Systems Interface, a TCP/IP protocol for carrying SCSI commands over IP networks.

L

LAN

Local Area Network, a computer network that spans a relatively small area, such as a single building or group of buildings.

load

In UNIX computing, the system load is a measure of the amount of work that a computer system is doing.

logical

Describes a user's view of the way data or systems are organized. The opposite of logical is physical, which refers to the real organization of a system. A logical description of a file is that it is a quantity of data collected together in one place. The file appears this way to users. Physically, the elements of the file could live in segments across a disk.

logical unit

See logical unit number.

logical unit number (LUN)

An address for an individual disk drive, and by extension, the disk device itself. Used in the SCSI protocol as a way to differentiate individual disk drives within a common SCSI target device, like a disk array. LUNs are normally not entire disk drives but virtual partitions (or volumes) of a RAID set.

LU

Logical unit.

LUN

See logical unit number.

LUN Manager

This storage feature is operated through Storage Navigator Modular 2 software and manages access paths among host and logical units for each port in your array.

M

metadata

In sophisticated data systems, the metadata -- the contextual information surrounding the data -- will also be very sophisticated, capable of answering many questions that help understand the data.

microcode

The lowest-level instructions directly controlling a microprocessor. Microcode is generally hardwired and cannot be modified. It is also referred to as firmware embedded in a storage subsystem.

Microsoft Cluster Server

Microsoft Cluster Server is a clustering technology that supports clustering of two NT servers to provide a single fault-tolerant server.

mount

To mount a device or a system means to make a storage device available to a host or platform.

mount point

The location in your system where you mount your file systems or devices. For a volume that is attached to an empty folder on an NTFS file system volume, the empty folder is a mount point. In some systems a mount point is simply a directory.

P

pair

Refers to two logical volumes that are associated with each other for data management purposes (e.g., replication, migration). A pair is usually composed of a primary or source volume and a secondary or target volume as defined by the user.

pair splitting

The operation that splits a pair. When a pair is "Paired", all data written to the primary volume is also copied to the secondary volume. When the pair is "Split", the primary volume continues being updated, but data in the secondary volume remains as it was at the time of the split, until the pair is re-synchronized.

pair status

Internal status assigned to a volume pair before or after pair operations. Pair status transitions occur when pair operations are performed or as a result of failures. Pair statuses are used to monitor copy operations and detect system failures.

paired volume

Two volumes that are paired in a disk array.

parity

The technique of checking whether data has been lost or corrupted when it's transferred from one place to another, such as between storage units or between computers. It is an error detection scheme that uses an extra checking bit, called the parity bit, to allow the receiver to verify that the data is error free. Parity data in a RAID array is data stored on member disks that can be used for regenerating any user data that becomes inaccessible.

parity groups

RAID groups can contain single or multiple parity groups where the parity group acts as a partition of that container.

peer-to-peer remote copy (PPRC)

A hardware-based solution for mirroring logical volumes from a primary site (the application site) onto the volumes of a secondary site (the recovery site).

point-in-time logical copy

A logical copy or snapshot of a volume at a point in time. This enables a backup or mirroring application to run concurrently with the system.

pool volume

Used to store backup versions of files, archive copies of files, and files migrated from other storage.

primary or local site

The host computer where the primary volume of a remote copy pair (primary and secondary volume) resides. The term "primary site" is also used for host failover operations. In that case, the primary site is the host computer where the production applications are running, and the secondary site is where the backup applications run when the applications on the primary site fail, or where the primary site itself fails.

primary volume (P-VOL)

The storage volume in a volume pair. It is used as the source of a copy operation. In copy operations a copy source volume is called the P-VOL while the copy destination volume is called "S-VOL" (secondary volume).

P-VOL

See primary volume.

R

RAID

Redundant Array of Independent Disks, a disk array in which part of the physical storage capacity is used to store redundant information about user data stored on the remainder of the storage capacity. The redundant information enables regeneration of user data in the event that one of the array's member disks or the access path to it fails.

Recovery Point Objective (RPO)

After a recovery operation, the RPO is the maximum desired time period, prior to a disaster, in which changes to data may be lost. This measure determines up to what point in time data should be recovered. Data changes preceding the disaster are preserved by recovery.

Recovery Time Objective (RTO)

The maximum desired time period allowed to bring one or more applications, and associated data back to a correct operational state. It defines the time frame within which specific business operations or data must be restored to avoid any business disruption.

remote or target site

Maintains mirrored data from the primary site.

remote path

Also called the data path, the remote path is a link that connects ports on the local storage system and the remote storage system. Two remote paths must be set up for each AMS array (one path for each of the two controllers built in the storage system).

remote volume stem

In TrueCopy operations, the remote volume (R-VOL) is a volume located in a different subsystem from the primary host subsystem.

resynchronization

Refers to the data copy operations performed between two volumes in a pair to bring the volumes back into synchronization. The volumes in a pair are synchronized when the data on the primary and secondary volumes is identical.

RPO

See Recovery Point Objective.

RTO

See Recovery Time Objective.

S

SAS

Serial Attached SCSI, an evolution of parallel SCSI into a point-to-point serial peripheral interface in which controllers are linked directly to disk drives. SAS delivers improved performance over traditional SCSI because SAS enables up to 128 devices of different sizes and types to be connected simultaneously.

SATA

Serial ATA is a computer bus technology primarily designed for the transfer of data to and from hard disks and optical drives. SATA is the evolution of the legacy Advanced Technology Attachment (ATA) interface from a parallel bus to serial connection architecture.

secondary volume (S VOL)

A replica of the primary volume (P-VOL) at the time of a backup and is kept on a standby storage system. Recurring differential data updates are performed to keep the data in the S-VOL consistent with data in the P-VOL.

SMPL

Simplex.

snapshot

A term used to denote a copy of the data and data-file organization on a node in a disk file system. A snapshot is a replica of the data as it existed at a particular point in time.

SNM2

See Storage Navigator Modular 2.

Storage Navigator Modular 2

A multi-featured scalable storage management application that is used to configure and manage the storage functions of Hitachi arrays. Also referred to as “Navigator 2”.

suspended status

Occurs when the update operation is suspended while maintaining the pair status. During suspended status, the differential data control for the updated data is performed in the primary volume.

S-VOL

See secondary volume.

S-VOL determination

Independent of update operations, S-VOL determination replicates the S-VOL on the remote storage system. This process occurs at the end of each update cycle and a pre-determined copy of S-VOL data, consistent with P-VOL data, is maintained on the remote site at all times.

T

target copy

A file, device, or any type of location to which data is moved or copied.

V

virtual volume (V-VOL)

In Copy-on-Write, a secondary volume in which a view of the primary volume (P-VOL) is maintained as it existed at the time of the last snapshot. The V-VOL contains no data but is composed of pointers to data in the P-VOL and the data pool. The V-VOL appears as a full volume copy to any secondary host.

volume

A disk array object that most closely resembles a physical disk from the operating environment's viewpoint. The basic unit of storage as seen from the host.

volume copy

Copies all data from the P-VOL to the S-VOL.

volume pair

Formed by pairing two logical data volumes. It typically consists of one primary volume (P-VOL) on the local storage system and one secondary volume (S-VOL) on the remote storage systems.

V-VOL

See virtual volume.

V-VOLTL

Virtual Volume Tape Library.

W

WMS

Workgroup Modular Storage.

write order guarantee

Ensures that data is updated in an S-VOL, in the same order that it is updated in the P-VOL, particularly when there are multiple write operations in one update cycle. This feature is critical to maintain data consistency in the remote S-VOL and is implemented by inserting sequence numbers in each update record. Update records are then sorted in the cache within the remote system, to assure write sequencing.

write workload

The amount of data written to a volume over a specified period of time.

Index

D

E

F

G

H

I

J

L

M

N

O

P

R

S

T

U

V

W

X

Z

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