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Preface

In PDF format, this guide provides information about managing the supported storage subsystems (RAID arrays) attached to the server/cluster. Includes information about tiered storage, storage pools, system drives (SDs), SD groups, and other storage device related configuration and management features and functions.

Contacting Hitachi Data Systems

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U.S.A.
https://portal.hds.com
North America: 1-800-446-0744

Related Documentation

Release Notes provide the most up-to-date information about the system, including new feature summaries, upgrade instructions, and fixed and known defects.

Administration Guides

- System Access Guide (MK-92HNAS014)—In PDF format, this guide explains how to log in to the system, provides information about accessing the NAS server/cluster CLI and the SMU CLI, and provides information about the documentation, help, and search capabilities available in the system.
- Server and Cluster Administration Guide (MK-92HNAS010)—In PDF format, this guide provides information about administering servers, clusters, and server farms. Includes information about licensing, name spaces, upgrading firmware, monitoring servers and clusters, the backing up and restoring configurations.
- Storage System User Administration Guide (MK-92HNAS013)—In PDF format, this guide explains user management, including the different types of system administrator, their roles, and how to create and manage these users.
- Network Administration Guide (MK-92HNAS008)—In PDF format, this guide provides information about the server's network usage, and explains how to configure network interfaces, IP addressing, name and directory services.
• **File Services Administration Guide** (MK-92HNAS006)—In PDF format, this guide explains about file system formats, and provides information about creating and managing file systems, and enabling and configuring file services (file service protocols).

• **Data Migrator Administration Guide** (MK-92HNAS005) —In PDF format, this guide provides information about the Data Migrator feature, including how to set up migration policies and schedules.

• **Storage Subsystem Administration Guide** (MK-92HNAS012)—In PDF format, this guide provides information about managing the supported storage sub-systems (RAID arrays) attached to the server/cluster. Includes information about tiered storage, storage pools, system drives (SDs), SD groups, and other storage device related configuration and management features and functions.

• **Snapshot Administration Guide** (MK-92HNAS011)—In PDF format, this guide provides information about configuring the server to take and manage snapshots.

• **Replication and Disaster Recovery Administration Guide** (MK-92HNAS009) —In PDF format, this guide provides information about replicating data using file-based replication and object-based replication, provides information on setting up replication policies and schedules, and using replication features for disaster recovery purposes.

• **Antivirus Administration Guide** (MK-92HNAS004)—In PDF format, this guide describes the supported antivirus engines, provides information about how to enable them, and how to configure the system to use them.

• **Backup Administration Guide** (MK-92HNAS007)—In PDF format, this guide provides information about configuring the server to work with NDMP, and making and managing NDMP backups. Also includes information about Hitachi NAS Synchronous Image Backup.

• **Command Line Reference**—Opens in a browser, and describes the commands used to administer the system.

---

**Note:** For a complete list of Hitachi NAS open source software copyrights and licenses, see the **System Access Guide**.

**Hardware References**

• **Hitachi NAS Platform 3080 and 3090 G1 Hardware Reference** (MK-92HNAS016)—Provides an overview of the second-generation server hardware, describes how to resolve any problems, and replace potentially faulty parts.

• **Hitachi NAS Platform 3080 and 3090 G2 Hardware Reference** (MK-92HNAS017)—Provides an overview of the second-generation server hardware, describes how to resolve any problems, and replace potentially faulty parts.

• **Hitachi NAS Platform Series 4000 Hardware Reference** (MK-92HNAS030) (MK-92HNAS030)—Provides an overview of the Hitachi NAS Platform.
Series 4000 server hardware, describes how to resolve any problems, and how to replace potentially faulty components.

- **Hitachi High-performance NAS Platform** (MK-99BA012-13)—Provides an overview of the NAS Platform 3100/NAS Platform 3200 server hardware, and describes how to resolve any problems, and replace potentially faulty parts.

### Best Practices

- **Hitachi USP-V/VSP Best Practice Guide for HNAS Solutions** (MK-92HNAS025)—The HNAS practices outlined in this document describe how to configure the HNAS system to achieve the best results.

- **Hitachi Unified Storage VM Best Practices Guide for HNAS Solutions** (MK-92HNAS026)—The HNAS system is capable of heavily driving a storage array and disks. The HNAS practices outlined in this document describe how to configure the HNAS system to achieve the best results.

- **Hitachi NAS Platform Best Practices Guide for NFS with VMware vSphere** (MK-92HNAS028)—This document covers VMware best practices specific to HDS HNAS storage.

- **Hitachi NAS Platform Deduplication Best Practice** (MK-92HNAS031)—This document provides best practices and guidelines for using HNAS Deduplication.

- **Hitachi NAS Platform Best Practices for Tiered File Systems** (MK-92HNAS038)—This document describes the Hitachi NAS Platform feature that automatically and intelligently separates data and metadata onto different Tiers of storage called Tiered File Systems (TFS).

- **Hitachi NAS Platform Data Migrator to Cloud Best Practices Guide** (MK-92HNAS045)—Data Migrator to Cloud allows files hosted on the HNAS server to be transparently migrated to cloud storage, providing the benefits associated with both local and cloud storage.

- **Brocade VDX 6730 Switch Configuration for use in an HNAS Cluster Configuration Guide** (MK-92HNAS046)—This document describes how to configure a Brocade VDX 6730 switch for use as an ISL (inter-switch link) or an ICC (inter-cluster communication) switch.

- **Best Practices for Hitachi NAS Universal Migrator** (MK-92HNAS047)—The Hitachi NAS Universal Migrator (UM) feature provides customers with a convenient and minimally disruptive method to migrate from their existing NAS system to the Hitachi NAS Platform. The practices and recommendations outlined in this document describe how to best use this feature.

- **Hitachi NAS Platform Storage Pool and HDP Best Practices** (MK-92HNAS048)—This document details the best practices for configuring and using HNAS storage pools, related features, and Hitachi Dynamic Provisioning (HDP).

Understanding storage and tiering

- Understanding tiered storage
- Storage management components
Understanding tiered storage

Tiered storage allows you to connect multiple diverse storage subsystems behind a single server (or cluster). Using tiered storage, you can match application storage requirements (in terms of performance and scaling) to your storage subsystems. This section describes the concept of tiered storage, and explains how to configure the storage server to work with your storage subsystems to create a tiered storage architecture.

Based on a storage subsystem’s performance characteristics, it is classified as belonging to a certain tier, and each tier is used differently in the enterprise storage architecture. The currently supported storage subsystems are fit into the tiered storage model as follows:

<table>
<thead>
<tr>
<th>Tier</th>
<th>Performance</th>
<th>Disk Type</th>
<th>Disk RPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Extremely high</td>
<td>Not disk, flash or solid state memory (SSD)</td>
<td>N/A</td>
</tr>
<tr>
<td>1</td>
<td>Very high</td>
<td>SAS</td>
<td>15,000</td>
</tr>
<tr>
<td>2</td>
<td>High</td>
<td>SAS</td>
<td>10,000</td>
</tr>
<tr>
<td>3</td>
<td>Nearline</td>
<td>NL SAS</td>
<td>7,200</td>
</tr>
<tr>
<td>4</td>
<td>Archival</td>
<td>NL SAS</td>
<td>7,200</td>
</tr>
<tr>
<td>5</td>
<td>Long-term storage N/A (Tape)</td>
<td>N/A (Tape)</td>
<td>NA</td>
</tr>
</tbody>
</table>

The NAS server supports tiers of storage, where each tier is made up of devices with different performance characteristics or technologies. The NAS server also supports storage virtualization through Hitachi Universal Storage Platform VSP, USP-V, USP-VM, and HUS-VM technology.

Tiers of storage and storage virtualization are fully supported by Data Migrator, an optional feature which allows you to optimize the usage of tiered storage and remote NFSv3 servers (note, however that Data Migrator does not support migration to or from tape storage devices or tape library systems). For detailed information about Data Migrator, refer to the Data Migrator Administration Guide.

Storage management components

The storage server architecture includes system drives, storage pools, file systems and virtual servers (EVSs), supplemented by a flexible quota management system for managing utilization, and the Data Migrator, which optimizes available storage. This section describes each of these storage components and functions in detail.
System drives

System drives (SDs) are the basic logical storage element used by the server. Storage subsystems use RAID controllers to aggregate multiple physical disks into SDs (also known as LUNs). An SD is a logical unit made up of a group of physical disks or flash/SSD drives. The size of the SD depends on factors such as the RAID level, the number of drives, and their capacity.

With some legacy storage subsystems, system drives (SDs) are limited to 2 TB each, and some Hitachi Data Systems RAID arrays, such as HUS VM, have a limit of 3TB for standard LUNs or 4TB for virtualized LUNs. When using legacy storage arrays, it is a common practice for system administrators to build large RAID arrays (often called RAID groups or volume groups) and then divide them into LUNs and SDs of 2 TB or less. However, with today's large physical disks, RAID arrays must be considerably larger than 2 TB in order to make efficient use of space.

Storage pools

A storage pool (known as a "span" in the command line interface) is the logical container for a collection of one or more system drives (SDs). There are two types of storage pools:

- An untiered storage pool is made up system drives (SDs) created on one or more storage subsystems (RAID arrays) within the same tier of storage (storage subsystems with comparable performance characteristics). To create an untiered storage pool, there must be at least one available and unused system drive on the storage subsystem from which the SDs in the storage pool will be taken.

- A tiered storage pool is made up system drives (SDs) created on storage subsystems (RAID arrays) with different performance characteristics. Typically, a tiered storage pool is made up of SDs from high-performance storage such as SSD/flash memory, and SDs from lower-performance storage such as SAS, or NL SAS (near line SAS). You can, however, create a tiered storage pool from SDs on storage subsystems using any storage technology.

Storage pools:

- Can be expanded as additional SDs are created in the storage subsystem, and an SD can grow to a maximum of 1 PB or 256 SDs. Expanding a storage pool does not interrupt network client access to storage resources. By allocating a shared pool of storage for multiple users and allocating space dynamically (thin provisioning), a server/cluster supports “over-subscription,” sharing space that accommodates the peak requirements of individual clients while saving the overhead associated with sustaining unnecessary storage. Refer to the File Services Administration Guide for more information on thin provisioning.
• Contain a single stripeset when created. Each time the storage pool is expanded, another stripeset is added, up to a maximum of 64 stripesets (meaning that, after creation, a storage pool can be expanded a maximum of 63 times).

• Can hold up to 128 file systems, centralizing and simplifying management of its component file systems. For example, the settings applied to a storage pool can either allow or constrain the expansion of all file systems in the storage pool.

Storage pool chunks

Storage pools are made up of multiple small allocations of storage called “chunks.” The size of the chunks in a storage pool is defined when the storage pool is created, guideline chunk sizes are between 1 GB and 18 GB. A storage pool can contain up to a maximum of 60,000 chunks. In turn, an individual file system can also contain up to a maximum of 60,000 chunks.

Chunk size is an important consideration when creating storage pools, for two reasons:

• Chunks define the increment by which file systems will grow when they expand. Smaller chunks increase storage efficiency and the predictability of expansions, smaller chunks also work better with tiered file systems, and they also enable the effective optimization of I/O patterns by spreading I/O across multiple stripesets.

• As a file system contains a finite number of chunks, the chunk size places a limit on the future growth of file systems in a storage pool.
  ○ A smaller chunk size will result in a storage pool that expands in a more granular fashion, but cannot expand to as large an overall size as a storage pool created using the a large default chunk size (for example, an 18GiB chunk size).
  ○ A larger chunk size will result in storage pools that can expand to a larger overall size than those created using a smaller chunk size, but the storage pool will expand in larger increments.

The default chunk size is specified when creating the storage pool:

• If you create a storage pool using the CLI, the server will calculate a default chunk size based on the initial size specified for the storage pool divided by 3750. The server-calculated default chunk size will probably be smaller than the Web Manager would use (Web Manager will always use a default chunk size of 18GiB).

• If you create a storage pool using Web Manager, the default chunk size will be 18GiB (the maximum allowable size). The default chunk size set by Web Manager may (and probably will) be larger than the default chunk size calculated and suggested by the server if you created the storage pool using the CLI.
When creating a storage pool using the HNAS server CLI, you can specify to use a default chunk size other than what the server calculates. When creating a storage pool using Web Manager, you cannot change the default 18GiB chunk size used when creating a storage pool.

**Tiered and untiered storage pools**

A storage pool (known as a "span" in the command line interface) is the logical container for a collection of two or more system drives (SDs).

There are two types of storage pools:

- **An untiered storage pool**: An untiered storage pool is made up system drives (SDs) created on one or more storage subsystems within the same tier of storage (storage arrays with comparably performance characteristics). To create an untiered storage pool, there must be at least one available and unused system drive on the storage subsystem from which the SDs in the storage pool will be taken.

- **A tiered storage pool**: A tiered storage pool is made up system drives (SDs) created on storage subsystems (RAID arrays) with different performance characteristics. Typically, a tiered storage pool is made up of SDs from high-performance storage such as SSD/flash memory, and SDs from lower-performance storage such as NLSAS. You can, however, create a tiered storage pool from SDs of storage subsystems using any storage technology.

**Tiered storage pools**

Currently, a tiered storage pool must have two tiers:

- Tier 0 is used for metadata, and the best-performing storage should be designated as Tier 0.
- Tier 1 is used for user data.

To create a tiered storage pool, there must be at least one available and unused SD on each of the storage subsystems from which the storage pool tiers will be made. When you create a tiered storage pool, you first create the user data tier (Tier 1), then you create the metadata tier (Tier 0).

During normal operation, one tier of a tiered storage pool might become filled before the other tier. In such a case, one tier of the storage pool can be expanded (by adding at least two SDs) without expanding the other tier. Note that, when expanding a tier, you must make certain that the SD being added to the tier has the same performance characteristics as the SDs already in the tier (for example, do not add NLSAS based SDs to a tier already made up of SSD/flash drives).
Dynamically provisioned volumes
A dynamically provisioned volume (DP-Vol) is a virtual logical unit (LU) that is used with Hitachi Dynamic Provisioning (HDP). You create DP-Vols in a dynamically provisioned pool.

Dynamically provisioned pools
A dynamically provisioned pool (DP pool) contains the DP-Vols. A DP pool is also sometimes referred to as an HDP pool.

On enterprise storage, a DP pool resides on the pool volumes. On modular storage, a DP pool resides on the parity groups (PGs), rather than on logical units (LUs).

Note: Real (non-virtual) LUs are referred to as pool volumes in enterprise storage. In modular storage, real LUs are referred to as parity groups.

File system types
A file system typically consists of files and directories. Data about the files and directories (as well as many other attributes) is the metadata. The data within the file system (both user data and metadata) is stored in a storage pool.

Like storage pools, file system data (metadata and user data) may be stored in a single tier, or in multiple tiers.
• When file system metadata and user data are stored on storage subsystems of a single storage tier, the file system is called an untiered file system. An untiered file system must be created in an untiered storage pool, it cannot be created in a tiered storage pool.

• When file system metadata and user data are stored on storage subsystems of different storage tiers, the file system is called a tiered file system.

In a tiered file system, metadata is stored on the highest performance tier of storage, and user data is stored on a lower-performance tier. Storing metadata on the higher-performance tier provides system performance benefits over storing both the metadata and user data on the same tier of storage.
A tiered file system must be created in a tiered storage pool, it cannot be created in an untiered storage pool.

Fibre Channel connections
Each server supports up to four independently configurable FC ports. Independent configuration allows you to connect to a range of storage subsystems, which allows you to choose the configuration that will best meet
application requirements. The server manages all back-end storage as a single system, through an integrated network management interface.

<table>
<thead>
<tr>
<th>Server model</th>
<th>Supported FC port operational speeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>3080, 3090, 3100, and 4040</td>
<td>1, 2, or 4 Gbps</td>
</tr>
<tr>
<td>4060, 4080, and 4100</td>
<td>2, 4, or 8 Gbps</td>
</tr>
</tbody>
</table>

The server supports connecting to storage arrays either through direct-attached FC connections to the storage array (also called DAS connections) or Fibre Channel switches connected to the storage array (also called SAN configurations):

- In direct-attached (DAS) configurations, you can connect up to two (2) storage arrays directly to a server or a two-node cluster. Clusters of more than two nodes must use a FC switch configuration.
- In configurations using FC switches (SAN configurations), the server must be configured for N_PORT operation. Several FC Switch options are available, contact your Hitachi Data Systems representative for more information.

You can manage the FC interface on the server/cluster through the command line interface (CLI), using the following commands:

- `fc-link` to enable or disable the FC link.
- `fc-link-type` to change the FC link type.
- `fc-link-speed` to change the FC interface speed.

For more information about these commands, refer to the Command Line Reference.

**About FC paths**

The NAS server accesses the storage subsystem through a minimum of two FC paths (at least one from each of the Fibre Channel switches). An FC path is made up of the server’s host port ID, the storage subsystem port WWN (worldwide name), and the SD identifier (ID). The following illustration shows a complete path from the server to each of the SDs on the storage subsystem:
You can display information about the FC paths on the server/cluster through the command line interface (CLI), using the `fc-host-port-load`, `fc-target-port-load`, and the `sdpath` commands.

**Load balancing and failure recovery**

Load balancing on a storage server is a matter of balancing the loads to the system drives (SDs) on the storage subsystems (RAID arrays) to which the storage server is connected. LUNs and SDs are a logical division of a group of the physical disks of the storage subsystem, and LUNs that are visible to the storage server are known as SDs, which are and the SD is the basic storage unit of the storage subsystem.

The server routes FC traffic to individual SDs over a single FC path, distributing the load across two FC switches and, when possible, across dual active/active or multi-port RAID controllers.

Following the failure of a preferred path, disk I/O is redistributed among other (non-preferred) paths. When the server detects reactivation of the preferred FC path, it once again redistributes disk I/O to use the preferred FC path.

Default load balancing (load balancing automatically performed by the storage server) is performed based on the following criteria:
• “Load” is defined as the number of open SDs, regardless of the level of I/O on each SD. SDs count towards load at the target if they are open to at least one cluster node; the number of nodes (normally all nodes in a cluster, after boot) is not considered.
• Balancing load on RAID controller target ports takes precedence over balancing load on server FC host ports.
• Balancing load among a subsystem’s RAID controllers takes precedence over balancing among ports on those controllers.
• In a cluster, choice of RAID controller target port is coordinated between cluster nodes, so that I/O requests for a given SD do not simultaneously go to multiple target ports on the same RAID controller.

You can manually configure load distribution from the CLI (overriding the default load balancing performed by the server), using the sdpath command. When manually configuring load balancing using the sdpath command:
• You can configure a preferred server host port and/or a RAID controller target port for an SD. If both are set, the RAID controller target port preference takes precedence over the server host port preference. When a specified port preference cannot be satisfied, port selection falls back to automatic selection.
• For the SDs visible on the same target port of a RAID controller, you should either set a preferred RAID controller target port for all SDs or for none of the SDs. Setting the preferred RAID controller target port for only some of the SDs visible on any given RAID controller target port may create a situation where load distribution is suboptimal.

Note: For storage solutions such as the HUS1x0 and HUS VM, manually setting a preferred path is not necessary or recommended.

The sdpath command can also be used to query the current FC path being used to communicate with each SD. For more information on the sdpath command, enter man sdpath command.

To see information about the preferred path on HUS 1x0 arrays, navigate to Home > Storage Management > System Drives, then select the SD and click details to display the System Drive Details page.
### Field/Item Description

<table>
<thead>
<tr>
<th>Field/Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Information</strong></td>
<td></td>
</tr>
<tr>
<td>Comment</td>
<td>Additional descriptive information can be assigned to a SD to help make it more identifiable when viewed elsewhere in the UI.</td>
</tr>
<tr>
<td>System Drive ID</td>
<td>SD Identifier.</td>
</tr>
<tr>
<td>Rack Name</td>
<td>The name of the RAID rack hosting the SD.</td>
</tr>
<tr>
<td>Logical Unit ID (LUID)</td>
<td>A unique internal identifier of the SD, the LUID is created by the RAID controller.</td>
</tr>
<tr>
<td>Manufacturer (Model)</td>
<td>The manufacturer and model information of the RAID rack on which this SD resides.</td>
</tr>
<tr>
<td>Version</td>
<td>The firmware version number of the RAID controller on which the SD resides.</td>
</tr>
<tr>
<td>Capacity</td>
<td>The size of the SD.</td>
</tr>
<tr>
<td>Status</td>
<td>The status light is an indicator of the health of the SD. The following describes the possible states of the status indicator:</td>
</tr>
<tr>
<td></td>
<td>• Green: OK - The SD is operating normally.</td>
</tr>
<tr>
<td>Field/Item</td>
<td>Description</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Version</td>
<td>Shows the version number of the SD.</td>
</tr>
</tbody>
</table>
| Tier                 | Shows which Tier the SD is used for in a tiered storage pool.  
  - Tier 0 is used for metadata.  
  - Tier 1 is used for user data.                                                                                                                                                                               |
| apply                | Click this button to save any changes made to the SD.                                                                                                                                                       |
| Performance Settings | Controls the superflush settings used for the storage pool. Superflush is a technique that the server uses to optimize writing to all levels of RAID SDs. By writing a whole stripe line at a time, the server allows the RAID controller to generate parity more efficiently. Superflush Settings include the following two fields shown in this table: Width and Stripe Size.  
  - Stripe Size: Also referred to as the segment size, this setting defines the size of the data patterns written to individual disks in an SD. The value specified for the stripe size should always match the value configured at the RAID controller. The default stripe size is influenced by a number of factors, including the number of drives making up the SD. The default value presented for the stripe size is the optimum setting for a given storage configuration across a range of applications.  
  - Width: The number of data (non-parity) disks contained in the SD. This is the number of disks that can be written to in a single write request. The number reported here is different depending on your RAID level. A typical SD will contain a number of disks, plus the added space of a single disk to be used for parity in RAID 5, or two disks in RAID 6. These types of arrays are often referred to as n+1 and n+2, where a single write request can be made to n number of disks. In other words, the width will typically be set to the number of disks in the SD, minus one (for RAID 5) or minus two (for RAID 6). |
| FC Path              | The current path through which the server is communicating with the RAID controller is shown. If a preferred path has been configured, the preferred path will also be shown.                                          |
| Storage Pool Configuration | This section displays the Storage Pool Label and the Storage Pool Status. For the storage pool status:  
  - Green: The storage pool is healthy.  
  - Red: The server cannot currently perform I/O to the storage pool or its file systems.  
  - Gray: The storage pool is not accessible (it belongs to another cluster).                                                                 |
**Fibre channel statistics**

The server provides per-port and overall statistics, in real time, at 10-second intervals. Historical statistics cover the period since previous server start or statistics reset. The **Fibre Channel Statistics** page of the Web Manager displays a histogram showing the number of bytes/second received and transmitted during the past few minutes.

**RAID controllers**

The RAID controllers operate as an Active/Active (A/A) pair within the same rack. Both RAID controllers can actively process disk I/O requests. Should one of the two RAID controllers fail, the storage server reroutes the I/O transparently to the other controller, which starts processing disk I/O requests for both controllers.

**Hot spare disk**

For arrays that support CopyBack, when the failed disk is replaced, the RAID controller’s CopyBack process will automatically move the reconstructed data from the disk that was the hot spare to the replacement disk. The hot spare disk will then be made available for future use.

If it is necessary to remove and replace failed disks, it is possible to perform “hot swap” operations. In a hot swap, an offline or failed disk is removed and a replacement disk is inserted while the power is on and the system is operating.

---

**Note:** When replacing a disk drive or a hot spare disk, consult the maintenance manual for the particular array before replacing a drive.
Managing the storage subsystem

Hitachi NAS Platform storage arrays can be managed using Web Manager. Common operations are:
• Changing the rack name, password, or media scan period.
• Checking the status of media scan and other operations.
• Reviewing events logged by the RAID rack.
• Determining the status of physical disks.

- Supported Hitachi Data Systems storage subsystems
- System drives
- System drive groups
- Using Hitachi Dynamic Provisioning
Supported Hitachi Data Systems storage subsystems

All Series 3000 and Series 4000 NAS storage servers support storage arrays manufactured by Hitachi Data Systems. Supported storage arrays are dependent on server series and model:

<table>
<thead>
<tr>
<th>Server Series</th>
<th>Server Model</th>
<th>Current Offerings</th>
<th>Discontinued, but still supported</th>
</tr>
</thead>
<tbody>
<tr>
<td>4000</td>
<td>4040, 4060, 4080 and 4100</td>
<td>VSP, USP V, USP VM, HUS VM, HUS 110, HUS 130, HUS 150, and VSP G1000</td>
<td>AMS 2100, AMS 2300, AMS 2500, USP 100, USP 600, USP 1100, NSC</td>
</tr>
<tr>
<td>3000</td>
<td>3080 and 3090</td>
<td>VSP, USP V, USP VM, HUS VM, HUS 110, HUS 130, HUS 150, and VSP G1000</td>
<td>AMS 2100, AMS 2300, AMS 2500, USP 100, USP 600, USP 1100, SMS 100, SMS 110, 95XX, 99XX, NSC</td>
</tr>
</tbody>
</table>

Many arrays have several configurations, and may be suitable for use in several tiers in the tiered storage model, based on configuration of the individual storage array. Due to the specific capacity and performance characteristics of each storage subsystem, arrays will typically be used in the storage model tiers as follows:

<table>
<thead>
<tr>
<th>Array</th>
<th>Typically used in Tier(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMS 2100, AMS 2300, AMS 2500, HUS 110, HUS 130, HUS 150, and USP V</td>
<td>Tier 1, Tier 2, and Tier 3</td>
</tr>
<tr>
<td>HUS VM and NSC</td>
<td>Tier 1 and Tier 2</td>
</tr>
<tr>
<td>USP VM</td>
<td>Tier 1 and Tier 3</td>
</tr>
<tr>
<td>VSP and VSP G1000</td>
<td>Tier 1</td>
</tr>
<tr>
<td>95XX, 99XX, SMS 100, and SMS 110</td>
<td>Tier 2 and Tier 3</td>
</tr>
</tbody>
</table>

Note: All currently supported HDS storage subsystems support RAID levels 1, 5, 6, and 10.

System drives

System drives (SDs) are the basic logical storage element used by the server. Storage subsystems use RAID controllers to aggregate multiple physical disks into SDs (also known as LUNs). An SD is a logical unit made up of a group of physical disks or flash/SSD drives. The size of the SD depends on factors such as the RAID level, the number of drives, and their capacity.

With some legacy storage subsystems, system drives (SDs) are limited to 2 TB each, and some Hitachi Data Systems RAID arrays, such as HUS VM, have a limit of 3TB for standard LUNs or 4TB for virtualized LUNs. When using legacy storage arrays, it is a common practice for system administrators to
build large RAID arrays (often called RAID groups or volume groups) and then divide them into LUNs and SDs of 2 TB or less. However, with today’s large physical disks, RAID arrays must be considerably larger than 2 TB in order to make efficient use of space.

Creating system drives

SDs are created using Hitachi Storage Navigator Modular 2 (HSNM2) for modular systems (AMS/HUS 1x0), Hitachi Storage Navigator (HSN) for RAID systems (HUS VM, VSP) or Hitachi Command Suite (HCS for all arrays). You cannot create SDs using Web Manager or the NAS server command line. Refer to the Hitachi Storage Navigator Modular 2 documentation for information on accessing and logging in to the Storage Navigator Modular 2 application.

When creating SDs, you may need to specify array-specific settings in the Storage Navigator Modular 2 application. Also, depending on the firmware version of the array, there may be device-specific configuration settings. For example, on HUS 110, HUS 130, and HUS 150 arrays, if the HUS1x0 firmware code is base 0935A or greater, you should enable the HNAS Option Mode on the Options tab of the Edit Host Groups page.

For more information about what settings are required for each type of array, and for the firmware installed on the array, contact Hitachi Data Systems Support Center.

System drive groups

When performing write operations, if the server were to write simultaneously to multiple SDs in the same RAID group, it would increase head-movement, reducing both performance and the expected life of the disks. The NAS server has a mechanism to allow it to write to only one SD in a RAID group at any one time. This mechanism is called an SD group.

The NAS server uses SD groups in two basic ways:
1. To optimize writes across the devices in the SD group to improve write performance.
2. To place multiple copies of critical file system structures on different RAID groups for redundancy and file system resiliency. (Catastrophic failure of a RAID group may destroy all its SDs, not just one, so merely placing redundant copies of structures on different SDs is not true redundancy.)

System drives that are used in open storage pools cannot be grouped or ungrouped. A storage pool is open if it has any file system that is mounted or is being checked or fixed anywhere on the cluster.
A system drive that is not in any group is treated as if it were in a group of its own.

During EVS migration, the SMU automatically copies the groups from the source storage server or cluster and adds them to the target storage server or cluster.

**Types of SD groups**

Flash (SSD) drives and magnetic disks have very different performance and wear characteristics. In particular, flash drives have no heads to move and no concept of seek times.

There are two types of SD groups:

- **Serial SD groups** are for spinning media (traditional magnetic hard disks). Serial SD groups prevent parallel writes to their SDs. New SD groups are serial by default, unless HDP or SSD/flash with multiple LUNs per RAID group are involved. See the information on parallel SD groups, below, for more details.

  When performing write operations on spinning media, if the server were to write simultaneously to multiple SDs in the same RAID group, it would increase head-movement, reducing both performance and the expected life of the spinning media. To prevent simultaneous writes to multiple SDs in the same RAID group, the server can write to only one SD in a serial RAID group at any one time. By defining serial SD groups, you tell the server which SDs are in each RAID group, and give it the information it needs to optimize write performance for SD groups.

  - **Parallel SD groups**, which optimize the NAS server’s use of flash drives. Beginning with release SU 11.2, parallel SD groups are created by default for LUNs based on Parity Groups made up of SSD disks (flash drives) on AMS2000, HUS1x0, or HUS/VM storage arrays and for LUNs from an HDP pool (made up of any storage type).

    Parallel SD groups will allow parallel writes but will give the server enough information to place redundant structures correctly, if redundant copies of data structures are needed. Redundant copies of data structures were used only on storage arrays that were less reliable than HDS arrays. As an example, when parallel SD groups are used on an HDP pool (all LUNs from same pool number), the NAS server does not need or attempt to make redundant copies of data structures.

Configuration of SD groups is typically performed just once: SDs are not in any sense assigned to physical servers or EVSs, and configuration need not be repeated. Beginning with SU 11.2, the NAS server automatically detects the storage media type and the LUN type (regular RAID group or HDP pool). There is no longer a need to manually create SD groups. Simply, license the SDs and allow the NAS server access to them, at which point the user can proceed to create storage pools (spans). The process of creating the storage pool causes the SD groups to be configured automatically. Alternatively, you could use the CLI command `sd-group-auto` to configure the SDs, but this is
no longer required, because creating the storage pool automatically causes the SD groups to be configured.

All SDs in an SD group will be forcibly utilized in the same tier in a tiered storage pool.

**Managing system drive groups**

After system drives (SDs) are created, they are placed into system drive groups to optimize system performance. Beginning with SU 11.2, the NAS server automatically configures System Drive Groups (SD groups) on Hitachi arrays: you do not have to manually configure or manage SD groups, and you can create storage pools without first creating SD groups because the NAS server creates the SD groups as needed.

If auto-configuration makes a mistake, you can edit SD groups manually after the storage pool has been created or expanded. Once created, automatically configured SD groups are indistinguishable from SD groups created manually.

Note that all the `sd-group`-related commands are still available, and supported.

**System drive groups and dynamic write balancing**

Dynamic write balancing (DWB) maximizes performance by ensuring that the NAS server writes to as many SDs as possible. Dynamic write balancing also improves flexibility by letting the server reflect the physical characteristics of the storage without the need to reconfigure spans.

Dynamic write balancing is enabled by default.

In previous releases, during a write operation, the writing the NAS server could write to a single stripeset at any time. The stripeset being written to may contain only a small fraction of all the SDs in the storage pool. This produced three performance problems during write operations:

1. A storage bottleneck is created because all writes are going to a single stripeset, regardless of the number of SDs in the storage pool.
2. If the stripesets vary in performance (for example, some SDs may be on higher performance storage or may contain more SDs), the write performance of the file system will vary over time, depending on the stripeset characteristics.
3. If more storage is added to the storage pool, the file system’s write performance does not immediately improve; it will improve only after new chunks have been added to the file system. However, write performance will fall again when writing to older chunks.

Dynamic Write Balancing (DWB) solves these problems by writing to all SDs in parallel.
To implement Dynamic Write Balancing, the NAS server requires some knowledge of the physical configuration of the storage. SDs must be assigned to SD groups, with each SD group typically corresponding to one RAID group. After SD groups have been configured, write operations are associated with SD groups rather than with SDs; within each SD group, the NAS server will scan the whole of one SD for free space before moving on to the next SD.

**Optimizing dynamic write balancing performance**

Although dynamic write balancing removes many of the restrictions of previous allocation schemes, a few important guidelines still apply:

- Make SDs as large as possible, and use multiples of four (4) SDs whenever possible.
- Never divide storage into dozens of tiny SDs, and then create a storage pool from the many small SDs.

All the SDs in a RAID group or an HDP pool should be used in the same storage pool. If multiple SDs in an SD group are shared between storage pools, the SD group mechanism will not prevent the server from writing to several of the shared SDs at once. Writing to several of the shared SDs at once can cause a performance reduction, because one HDP pool may be driving the storage pool very hard, causing a slow-down on the other storage pools using the same resources.

Beginning with HNAS OS v 11.3, several enhancements have been made in order to help with server to storage troubleshooting.

1. The server will now log an event when the system drive becomes degraded on an HUS 1x0 array. For example:
   
   Warning: Device 0 (span "SPAN" ID 5B95587A30A2A328) : Device reporting : SD 0: SCSI Lan Sense LU status reports DEGRADED

2. A new trouble reporter has been created for any SD that is not in an optimal state. This reporter helps you to resolve performance issues by identifying an SD that may have higher than average response times.

3. The output of the `scsi-devices` command has been enhanced to include the internal LUN value of any SD.

4. For solutions with HUR and TrueCopy, the `sd-mirror-remotely` command has been optimized so that it tells the span management software about secondary SD's that already exist in the internal database.

5. The NAS server has been optimized to set a larger port command queue depth on HUS 1x0 arrays only when the Command Queue Expansion Mode is enabled. This restriction prevents the server from inadvertently enabling a larger port queue depth and potentially overloading the port with excessive amounts of IO.
Read balancing utility considerations

Read balancing helps to redistribute static datasets. Running the file system data redistribution utility causes data to be re-written to a new location, which will be the least utilized SD groups (the new storage) resulting in more balanced utilization of SD groups.

**Note:** The file system data redistribution utility can be run only after expanding a file system so that it uses newly added storage (chunks from a new stripeset on SDs from new SD groups). The file system data redistribution utility should be run immediately and it may be run only once per file system expansion. If you run the data redistribution utility more than once, or after an application has written a significant amount of data into the expanded file system, the utility will either refuse to run or produce unpredictable results.

For the utility to be run effectively, file system should under-utilize the SDs of the most recently added stripeset (the closer to 0%, the better) and the file system should over-utilize the SDs of the older stripesets (the closer to 100%, the better). Use the command `fs-sdg-utilization` to obtain this information.

**Note:** Each time a stripeset is added, you must expand file system and then run the file system data redistribution utility. In other words, you cannot add three new stripesets, expand the file system to use chunks from all three stripesets, and then run the utility. When adding more than one stripeset, for every stripeset you add, you must:

1. Add the stripeset.
2. Expand all file systems in the storage pool by the same proportion as you expanded the storage pool.
   
   For example, if you double the capacity of a storage pool, the size of all file systems in that storage pool should also be doubled. If you expand the storage pool capacity by 33% then the file systems in that storage pool should also be expanded by 33%.
3. Run the file system data redistribution utility.

Some use cases for using the read balancing utility after adding SDs to a storage pool would be:

- The customer is expecting to double the amount of data in the file system, but access to the existing data is largely read-only.

   Immediately doubling the file system size and re-balancing would make sense, because then the file system’s free space should be distributed roughly equally across both the original SDs and the new SDs of the storage pool. In this case, re-balancing allows the file system to use all the storage devices in all the SDs as the data grows. If the file system size is
increased little by little, the media of the new SDs of the storage pool will be used as the file system expands.

- The customer is not expecting the amount data to grow, it is largely static, and the current SDs are a bottleneck in the READ path. Doubling the file system size and re-balancing should move half the READ load onto the new SDs.

The file system data redistribution utility is designed to operate when a file system is expanded into new storage after SDs have been added to a storage pool when the file system is nearly full. However, storage may also be added to a storage pool for other reasons:
- To increase performance.
- To prevent the file system from becoming completely full.

To achieve the desired results in either of these situations:
- If your server/cluster is using SU11.2 or later, use the following process:
  1. Add the stripeset.
  2. Issue the CLI command `filesystem-expand (--by <GiB> | --to <GiB>) --on-stripeset X <filesystem-instance-name>` command, where $X$ is the number of the stripeset you just added (note that stripeset numbering begins with 0, so if your storage pool has three stripesets, the newest is stripeset number 2).

  **Note:** Expand all file systems in that storage pool by the same proportion as you expanded the storage pool. For example, if you double the capacity of a storage pool, the size of all file systems in that storage pool should also be doubled. If you expand the storage pool capacity by 33% then the file systems in that storage pool should also be expanded by 33%.

  3. Run the file system data redistribution utility.
  4. Repeat steps 2 and 3 for each file system in the storage pool.

- If your server/cluster is using SU11.1 or earlier, use the following process:
  1. Create a dummy file system, using all available space. (Creating the dummy file system uses any remaining capacity on the storage pool, preventing any use or expansion onto those chunks, and allowing the redistribution to occur.)
  2. Add the stripeset.
  3. Expand the almost full target file system to use some (or all) of the space added to the storage pool. Note that the expansion should be at least 50% of the added storage capacity.

  **Note:** Expand all file systems in that storage pool by the same proportion as you expanded the storage pool. For example, if you
double the capacity of a storage pool, the size of all file systems in that storage pool should also be doubled. If you expand the storage pool capacity by 33% then the file systems in that storage pool should also be expanded by 33%.

4. Run the file system data redistribution utility.
5. Repeat steps 3 and 4 for each file system in the storage pool.
6. Delete the dummy file system.

Note: To add several new stripesets of SDs to the storage pool, the process must be carried out each time a stripeset is added.

**Snapshots and the file system data redistribution utility**

When the file system data redistribution utility is run and snapshots are enabled, the old data is preserved, because the data redistribution utility cannot balance snapshot allocations. As a result, snapshots will grow, consuming a lot of disk space. The space used by these snapshots is not freed until all snapshots present when the file system data redistribution utility was started have been deleted.

There are four options available to recover the space used by snapshots:

1. Allow the snapshots to be deleted according to the snapshot configuration.
   This is the slowest option for recovering space, but it can be used in scenarios where the space won’t be required immediately after the file system data redistribution utility completes.
2. Manually delete snapshots after running the file system data redistribution utility.
   This option recovers space more quickly than option 1.
3. Manually kill snapshots after running the file system data redistribution utility.
   This option also recovers space more quickly than options 1 or 2, but it requires that the file system is taken offline.
4. Disable snapshots (and therefore backups) and kill/delete existent snapshots before running the file system data redistribution utility.
   This option avoids the snapshot space usage problem altogether.

**Using Hitachi Dynamic Provisioning**

You can use Hitachi Dynamic Provisioning (HDP) software to improve your storage utilization. The HDP software uses storage-based virtualization layered on top of RAID technology (RAID on RAID) to enable virtual LUNs (dynamically provisioned volumes, DP-Vols) to draw space from multiple pool volumes. This aggregated space widens the storage bottleneck by distributing
the I/O to more disks. The greater distribution insulates the server from the realities of the pool volumes (small capacities of individual disks).

If you are using HDP, see the *Hitachi NAS Platform Storage Pool and HDP Best Practices* (MK-92HNAS048) for recommendations.

**HDP high-level process**

The following flow chart shows the high-level process for provisioning storage with HDP:

![Flow chart](image)

**Figure 2-1 High-level process for HDP provisioning**

**Understanding HDP thin provisioning**

Dynamic provisioning allows storage to be allocated to an application without it actually being physically mapped until it is used. It also decouples the provisioning of storage to an application from the physical addition of storage capacity to the storage system. Thin provisioned HDP allows the total capacity of the DP-Vols in a pool to exceed the capacity of the volumes in the pool. For example, the pool volumes can total 30TiB, and the DP-Vols can total 80TiB. The server interprets the capacity as 80TiB of storage.
**Note:** Hitachi Data Systems strongly recommends that you always use thin provisioning with HDP.

The HDP software reads the real space in a pool. When you create or expand file systems using thin-provisioning with HDP, the server uses no more space than the space the pool vols provide. This also allows for file system creation and expansion to now fail safely.

HDP allocates pages of real disk space as the server writes data. The server can write anywhere on any DP-Vol, but not everywhere, meaning that you cannot exceed the amount of real disk space provided by the pool volumes.

---

**Understanding how HDP works with HNAS**

Using HDP with HNAS provides many benefits.

HDP with HNAS provides the following benefits:

- Improves performance by striping I/O across all available disks
- Supports scalability of larger LUs (typically up to 64TiB)
- Eliminates *span-expand* and dynamic read balancing (DRB), and their limitations. When HDP thin provisioning is used, a pool can be expanded in small increments any number of times. However, if you expand a storage pool, make the increments as large as the initial size of the storage pool to avoid performance problems.
- File system creation or expansion still fails safely, even in the presence of thinly provisioned pools

To fully realize those benefits, see the HDP configuration guidelines in the *Storage Subsystem User Administrator Guide*.

Some limitations with HDP thin provisioning and HNAS exist. Consider the following:

- Some storage arrays and systems do not over-commit by more than a factor of ten to one.
- The amount of memory the storage needs for HDP is proportional to the size of the (large, virtual) DP-Vols, not the (smaller, real) pool volumes. Therefore, massive over-commitment causes the storage to prematurely run out of memory.
- Enterprise storage uses separate boards called *shared memory*, so consider over-committing by 2:1 or 3:1, rather than 100:1.
Using a storage pool

Storage pools contain one or more file systems, which consume space from the storage pool upon creation or expansion. A storage pool can also be used to control the auto-expansion policy for all of the file systems created in the storage pool. The following procedures describe how to create, delete, expand, remove from service, and rename a storage pool.

Once access is allowed to one system drive (SD) in a storage pool, that storage pool becomes visible in the Web Manager. If access is denied to all SDs in a storage pool, the storage pool is not visible in the Web Manager.

- Creating storage pools
- Adding the metadata tier
- Deleting a storage pool
- Expanding storage pools
- Reducing the size of a storage pool
- Denying access to a storage pool
- Allowing access to a storage pool
- Renaming a storage pool
- Configuring automatic file system expansion for an entire storage pool
Creating storage pools

You can create storage pools from either the GUI or CLI.

Creating a storage pool using the GUI

With available SDs, administrators can create a storage pool at any time. After being created, a storage pool can be expanded until it contains up to 256 SDs.

With available SDs, administrators can create a storage pool at any time. After being created, a storage pool can be expanded until it contains up to 256 SDs.

When creating a tiered storage pool, to attain optimal performance, make sure that the SDs of the metadata tier (Tier 0) are on the highest performance storage type.

After the storage pool has been created, smaller file systems can be created in the pool for more granular storage provisioning.

Procedure

1. Navigate to Home > Storage Management > Storage Pools, and click create to launch the Storage Pool Wizard.

2. Select the SDs for either the storage pool (for an untiered storage pool), or the user data tier (Tier 1) of a tiered storage pool.

3. From the list of available SDs, select the SDs for the storage pool/tier, and specify the storage pool label.

   Select one or more SDs for use in building the new storage pool/tier. To select an SD, fill the check box next to the ID (Label).

   An untiered storage pool cannot contain SDs on RAID arrays with different manufacturers, disk types, or RAID levels. Any attempt to create a storage pool from such dissimilar SDs will be refused.
A tiered storage pool can contain SDs on RAID arrays with different manufacturers, or disk types, as long as they are in different tiers. A tiered storage pool cannot, however, contain SDs with different RAID levels. Any attempt to create a storage pool with SDs that have different RAID levels will be refused.

For the highest level of performance and resiliency in an untiered storage pool or in a tier of a tiered storage pool, Hitachi Data Systems Support Center strongly recommends that all SDs be of the same capacity, width, and stripe size, and disks size; however, after first acknowledging a warning prompt, you can create a storage pool with SDs that are not identically configured.

4. Verify your settings, and click next to display a summary page.

The summary page displays the settings that will be used to create the storage pool/tier.

If you have already set up mirrored SDs for disaster preparedness or replication purposes, and you want the server to try to reestablish the mirror relationship, fill the Look For Mirrored System Drives check box.

**Note:** Before filling the Look For Mirrored System Drives check box, you must have finished configuring the mirrored SDs using the RAID tools appropriate for the array hosting the mirrored SDs. For example, for Hitachi Data Systems storage arrays, you would use True Copy to create the mirrored SDs.

The default chunk size is specified when creating the storage pool. For more information about chunk size, see Storage pools on page 13.

5. After you have reviewed the information, click create to create the storage pool/tier.

- If you are creating an untiered storage pool, you can now either:
  - Click yes to create file systems (refer to the File Services Administration Guide for information on creating file systems).
  - Click no return to the Storage Pools page.
- If you are creating the user data tier of a tiered file system, you can now either:
  - Click yes to display the next page of the wizard, which you use to create the user data tier.
    1. Specify which SDs to use in the tier by filling the check box next to the SD label of each of the SDs you want to use in the tier.
    2. Click next to display the next page of the wizard, which is a summary page.
    3. If you have mirrored SDs, for disaster preparedness or replication purposes, and you want the server to try to
reestablish the mirror relationship, fill the Look For Mirrored System Drives check box.

4. After you have reviewed the information, click add to create the user data tier of the storage pool.

A confirmation dialog will appear, and you can now choose to add the metadata tier of the storage pool, or you can return to the Storage Pools page:

- Click add to display the next page of the wizard, which allows you to select the SDs to be used in the metadata tier.
  1. Specify which SDs to use in the tier by filling the check box next to the SD label of each of the SDs you want to use in the tier.
  2. Click next to display the next page of the wizard, which is a summary page.
  3. After you have reviewed the information, click add to create the metadata tier of the storage pool.

A confirmation dialog will appear, and you can now choose to create file systems in the storage pool, or you can return to the Storage Pools page:

- Click yes to create file systems (refer to the File Services Administration Guide for information on creating file systems).
- Click no return to the Storage Pools page.
- Click cancel to return to the Storage Pools page.
  - If you are creating the metadata tier of a tiered file system, you can now either:
    - Click yes to create file systems (refer to the File Services Administration Guide for information on creating file systems).
    - Click no return to the Storage Pools page. If you choose not to create the second tier now, you can add it at a later time, but you cannot create file systems in this storage pool until the second tier has been added.

---

**Note:** After the storage pool has been created, it can be filled with file systems. For more information, see the File Services Administration Guide.

---

**Creating a storage pool using the CLI**

When you are using HDP, you can use the CLI to create storage pools.

---

**Note:** For detailed information about the `span-create` command, see the CLI man pages.
Procedure

1. On the HNAS system, use the `span-create` command to create a storage pool using the SDs from the DP-Vols (on storage).

Options and parameters:

```
```

Alias: mkspan

Examples:

```
server:$ span-create Accounts 0-3
The span has been created

Permanent ID:            0xa9f7c549a8320327
Capacity:               10715GiB (10TiB)
Span expandable to:     171433GiB (167TiB)
Each fs expandable to:  171433GiB (167TiB)
Chunksize:             2926MiB
```

```
server:$
Creates or corrects SD groups on SDs 0 to 3, if necessary, and then creates a span called 'Accounts' on them. If any of these SDs are secondaries, the command configures mirror relationships into the server:
server:$ span-create Accounts 0-3
The span has been created

Permanent ID:            0xa9f7c5608958e68e
Capacity:               5357GiB (5TiB)
Span expandable to:     85716GiB (84TiB)
Each fs expandable to:  85716GiB (84TiB)
Chunksize:             1463MiB
```

```
server:$ span-list -s Accounts
Span instance name     OK?  Free  Cap/GiB
Chunks                 Con
---------------------  ---  ----  -------
Accounts               Yes  100%     5357   3750 x
1533956517  90%
Set 0: 2 x 2679GiB = 5357GiB
   SD 0 (on rack '91250490') = SD 2 (on rack '91250490')
   SD 1 (on rack '91250490') = SD 3 (on rack '91250490')
```

```
server:$
```

Adding the metadata tier

If you created a tiered storage pool, but only defined the SDs for the user data tier (Tier 1), you must now create the metadata tier (Tier 0).

---

**Note:** You cannot add a tier to a storage pool that was created as an untiered storage pool.

---
To add a tier to a storage pool:

**Procedure**

1. Navigate to **Home > Storage Management > Storage Pools**.

![Storage Pools](image)

2. Select the storage pool to which you want to add the tier. Click **details** to display the **Storage Pool Details** page.

3. Click the **Add a Tier** link, to display the **Storage Pool Wizard** page, to create the user data tier.

4. Select the SDs to make up the metadata tier.
   Using the **Storage Pool Wizard** page, above, select the SDs for the second (user data) tier from the list of available SDs on the page. To select an SD for the tier, fill the check box next to the SD **ID Label** in the first column. Verify your settings, then click **next** to display a summary page.

5. Review and apply settings.
   The summary page displays the settings that will be used to create the storage pool/tier.

   If you have already created mirrored SDs for disaster preparedness or replication purposes, and you want the server to try to reestablish the mirror relationship, fill the **Look For Mirrored System Drives** checkbox.

---

**Note:** Before filling the **Look For Mirrored System Drives** check box, you must have finished configuring the mirrored SDs using the RAID tools appropriate for the array hosting the mirrored SDs. For example, for Hitachi Data Systems storage arrays, you would use True Copy to create the mirrored SDs.

---

Once you have reviewed the information, click **add** to create the second tier of the storage pool.
Note: After the storage pool has been created, it can be filled with file systems.

6. Complete the creation of the storage pool or tier.
   After clicking add (in the last step), you will see a confirmation dialog.

   You can now click yes to create a file system, or click no to return to the 
   Storage Pools page. If you click yes to create a file system, the Create 
   File System page will appear.

Deleting a storage pool

A storage pool that does not contain file systems can be deleted at any time; otherwise, delete the file systems first. After the pool has been deleted, its SDs become free and available for use by new or existing storage pools.

Note: For detailed information about specific commands, see the CLI man pages.

If you are using HDP, consider the following:

- Before deleting DP-Vols, use the `span-delete` command as usual.
- If you plan to reuse the DP-Vols, use `span-delete --reuse-dp-vols` to avoid space-leakage. This command unmaps the COD area, instead of just wiping a signature, and will not run unless the vacated-chunks-list is empty. See also the `chunk` CLI man page for detailed information about this command and related commands.
- Deleting the storage pool destroys the vacated-chunks-list and recycle bin. Creating a new storage pool with an empty vacated-chunks-list results in leak space.

Note: Failure to run `span-unmap-vacated-chunks --exhaustive` on the new storage seriously impacts performance and availability.
Procedure

1. Navigate to **Home > Storage Management > Storage Pools** to display the **Storage Pools** page.

   ![Storage Pool Page](image)

2. Click **details** for the storage pool you want to delete. The **Storage Pool Details** page will be displayed.

3. Click **delete**, then click **OK** to confirm.

### Expanding storage pools

The NAS server automatically configures System Drive Groups (SD groups) on Hitachi arrays. You do not have to manually configure or manage SD groups, and you can create or expand storage pools without first creating SD groups, because the NAS server creates and manages SD groups as needed.

---

**Note:** When expanding a storage pool with newly added SDs located in an HDP (Hitachi Dynamically Provisioned) pool, the NAS server automatically adds the SDs to the appropriate Parallel SD group.

---

**Note:** If SDs from an HDP pool are used in a tiered file system or storage pool, you cannot use other SDs from that pool in a non-tiered file system or storage pool. In other words, once a tiered file system or storage pool is created using SDs from HDP pool 0, any SD that has been exposed to the NAS server from HDP pool 0 can only be used in the original tier of the original storage pool or a new tiered file system. If you attempt to create a new non-tiered storage pool or non-tiered file system using new SDs from HDP pool 0 via the CLI (as opposed to SMU) the NAS server creates a tiered storage pool or file system.

If you are using Hitachi Dynamic Provisioning, see the *Hitachi NAS Platform Storage Pool and HDP Best Practices* (MK-92HNAS048) for recommendations.

---

**Why use HDP to expand DP-Vols**

Expanding DP-Vols without using HDP does *not* have the benefits HDP provides.
Using HDP to add space provides the following benefits:

- Once again, you can add disks in small increments, even just a single pool volume.
- Data gets restriped.
- Span gets faster and performance remains almost even.

Consider the following use case for using HDP for expanding DP-Vols:

If you originally created a pool containing 10TiB of real storage and eight DP-Vols of 2.5TiB each, totalling 20TiB, the pool is over-committed by a ratio of 2:1. As always, a storage pool (span on the CLI) resides on the DP-Vols. As time goes by, you make a series of expansions of 4TiB each by adding new parity groups or pool volumes. The first expansion increases the amount of real storage in the pool to 14TiB and the second expansion takes it to 18TiB.

After each of these expansions, no further action is necessary. However, after a third 4TiB expansion, the pool contains 22TiB of real storage, but its DP-Vols total only 20TiB. As a result, 2TiB of the disk space that you have installed are inaccessible to the server.

More DP-Vols are needed, but any expansion should always add at least as many DP-Vols as were provided when the span was created. You must therefore create a further eight DP-Vols, preferably of the same 2.5TiB as the original ones, and add them to the storage pool, using `span-expand' or GUI equivalent. This addition brings the total DP-Vol capacity to 40TiB. No further DP-Vols will be necessary until and unless the real disk space in the pool is expanded beyond 40TiB.

**Expanding a non-HDP storage pool or tier**

**Procedure**

1. Navigate to Home > Storage Management > Storage Pools to display the Storage Pools page.
2. Fill the check box next to the label of the storage pool you want to expand, and click **details**.

If the storage pool is an untiered storage pool, the **Storage Pool Details** page looks like the following:

![Storage Pool Details](image)

To display the available system drives to add to the storage pool, click **expand**. The **Storage Pool Wizard** page is displayed.

If the storage pool is a tiered storage pool, the **Storage Pool Details** page looks like the following:
3. To display the available system drives to add to a tier, select the tier you want to expand, and click expand to display the Storage Pool Wizard page.

4. Fill the check box next to the label of the system drive you want to add, then click next to display the next Storage Pool Wizard page.

5. Click expand to add the SDs to the storage pool/tier.

**Expanding space in a thinly provisioned HDP storage pool**

You can easily add space to a storage pool that uses thin-provisioned HDP. The pool formatting process is non-disruptive, so the file systems stay mounted during the process.

---

**Note:** For detailed information about specific commands and how they are used, see the CLI man pages.

---

**Procedure**

1. On the HNAS system, use the span-create command to create a storage pool using the SDs from the DP-Vols (on storage).
See [Creating a storage pool using the CLI on page 37](#).

2. Create the necessary file systems, format them, mount them, and share and/or export them.

   See the *File Services Administrator Guide* for more information.

3. Add space to a storage pool that uses HDP pools:
   a. Create the pool volumes.
   b. Use the `span-confine` command to confine the span.
   c. Add the pool volumes to the HDP pool.
   d. Wait for the pool to finish formatting.

   **Note:** If you fail to wait for the pool to finish formatting, the storage prematurely reports to the server that the new space as available before it is truly usable.

4. If required, release the span on the HNAS system.

   The HNAS system auto-detects the new space and lets you use it in new or existing file systems.

5. Check that the real disk space in the pool still does not exceed the total capacity of the pool's DP-Vols. If it does, see [Expanding storage space with DP-Vols on page 45](#) for information about how to add more space.

**Expanding storage space using DP-Vols**

Eventually, the total size of the pool volumes reaches the total size of the DP-Vols. If the span needs more space, you can add space to it.

You can add as many pool volumes as you want; however, you typically only need to add a small amount of space.

**Note:** See the CLI man pages for detailed information about commands.

**Procedure**

1. Add the new pool volumes to the original pool.
2. Add more DP-vols to the same HDP pool.

   **Note:** Make the new DP-Vols the same size and number as you originally created. All stripesets must the same.

3. Wait for formatting to finish.

   Otherwise, the file systems may auto-expand onto the new storage and find it so slow that the entire span fails.

4. Use the `span-expand` command to expand the span on to the new DP-Vols.
Reducing the size of a storage pool

The size of a storage pool cannot be reduced.

Denying access to a storage pool

Procedure

1. Navigate to Home > Storage Management > File Systems to display the File Systems page.

2. Select every file system in the storage pool to which you want to deny access. To select a file system, fill the check box next to the file system label.

3. Unmount every file system in the storage pool. Click unmount, and in the confirmation dialog, click OK.

4. Click the Storage Pools shortcut to display a list of all pools, select a particular storage pool, and click Deny Access; in the confirmation dialog, click OK.

Note: This will also remove the pool from the storage pools list, but it will not be deleted.
Allowing access to a storage pool

This procedure restores access to a storage pool, but can also be used when a storage array previously owned by another server has been physically relocated to be served by another server. The process restores access to the SDs that belong to the storage pool, then restores access to the pool itself.

To allow access to a storage pool:

Procedure

1. Navigate to **Home > Storage Management > System Drives**.
2. Select one of the SDs belonging to the storage pool, and click **Allow Access**.
3. Select a pool, and click **details**. In the **Details** page for that storage pool, click **Allow Access**; then, in the **Confirmation** page, click **OK**.

**Note:** To become accessible, each file system in the storage pool must be associated with an EVS. To do this, navigate to the **Details** page for each file system in the storage pool and assign it to an EVS.

Renaming a storage pool

The name for a storage pool can be changed at any time, without affecting any clients.

Procedure

1. Navigate to **Home > Storage Management > Storage Pools** to display the **Storage Pools** page.
2. Select a storage pool, and click **details**.
3. Enter a new name in the **Label** text box, and click **rename**.
Storage pool labels are not case sensitive, but they do preserve case (labels will be kept as entered, in any combination of upper and lower case characters). Also, storage pool labels may not contain spaces or any of the following special characters: "&'*/;:<=>\.

⚠️ Note: Storage pool labels must be unique within a server or cluster. Also, a storage pool cannot have the same label as a file system.

**Configuring automatic file system expansion for an entire storage pool**

Use this procedure to allow or prohibit automatic expansion of all file systems in the specified storage pool. This setting only affects auto-expansion; manual expansion of file systems in the storage pool is not affected by this setting.

**Procedure**

1. Navigate to **Home > Storage Management > Storage Pools**.
2. Select a storage pool, and click **details** to display the **Storage Pools Details** page.
3. Configure auto-expansion.
You can configure file system auto-expansion at the storage pool level as follows:

- **Enable auto-expansion**
  Even if the storage pool is configured to allow its file systems to automatically expand, the file systems must also be configured to support automatic expansion. After a file system has expanded, its size cannot be reduced. If file system auto-expansion is currently disabled, you can enable it by clicking enable auto-expansion in the **FS Auto-Expansion** option box. After a file system has expanded, its size cannot be reduced.
  If file system auto-expansion is currently disabled, you can enable it by clicking **enable auto-expansion** in the **FS Auto-Expansion** option box.

- **Disable auto-expansion**
  When automatic expansion of a file system is disabled, manual expansion of file systems in the storage pool is still possible.
  If file system auto-expansion is currently enabled, you can disable it by clicking **disable auto-expansion** in the **FS Auto-Expansion** option box.
Configuring a system to use HDP

When you configure your system to work with HDP, you have to configure both the storage and the HNAS.

See the *Hitachi NAS Platform Storage Pool and HDP Best Practices* (MK-92HNAS048) for configuration recommendations.

- Deciding how far to over-provision storage
- Configuring storage for HDP and HNAS
- Configuring HNAS for HDP and HNAS
- Configuring storage to use HDP
- Configuring HNAS to use HDP
- Using HDP storage
Deciding how far to over-provision storage

When using HDP, you must over-commit the storage for a DP pool to a reasonable point. This section can help you decide what makes sense of your situation.

The total capacity of the DP-Vols should exceed the total capacity of the parity groups or pool volumes by a factor of 2:1 or 3:1, depending on how far you expect the storage pool to expand. The total capacity of the DP-Vols created when the storage pool was initially set up does not constrain the eventual size of the storage pool.

For example, if you have 20TiB of storage and the storage pool may need to expand to 50TiB later on, you should set up 50TB of DP-Vols. If you ever need to grow the storage pool beyond 50TiB, you can add further DP-Vols.

Limits on thin provisioning:

- You can make the storage pool capacity larger than the total capacity of the DP-Vols that you created at the outset by adding more DP-Vols later.
- For HDP, the storage requires a proportional amount of memory equal to that of the large, virtual DP-Vols, not to that of the smaller, real pool volumes. Therefore, consider the following:
  - Massive over-commitment causes storage to run out of memory prematurely.
  - Enterprise storage uses separate boards called shared memory, so consider over-committing by 2:1 or 3:1, rather than 100:1.

Configuring storage for HDP and HNAS

You must configure the storage so the HDP software and the HNAS system can work together.

See the Configuration guidelines for HNAS with HDP on page 54 for configuration details.

Procedure

1. Make every new HDP pool thinly provisioned.
2. Create enough DP-Vols to meet the expected size of the span and provide enough queue depth.
3. Wait for the pool to finish formatting.
   - If the formatting has not completed, the pool may be so slow that the server thinks it has failed.
Configuring HNAS for HDP and HNAS

You must configure the HNAS system so that the HNAS software and HDP software can work together.

Important: See Configuration guidelines for HNAS with HDP on page 54 for the Hitachi Data Systems recommended configuration guidelines.

Procedure

1. Create the storage pool with the `span-create` command. For example: `span-create Foo 0-15`
2. Use the following CLI commands or the GUI equivalent to create, and format and mount file system on the storage pool.

Note: See the CLI man pages for detailed information about commands.

- `filesystem-create` command adds a new file system to a storage pool.

Note: If you use the `-block-size` (or `-b`) switch, `filesystem-create` additionally formats and, by default, mounts a file system. This switch avoids the need to run `format` and `mount` as separate operations.

- `format` command formats the file system.
- `mount` command mounts the file system.

Configuring storage to use HDP

When you configure storage to work with HDP, follow this section. You will also need to consult the HDP software documentation.

See Deciding how far to over-provision on page 51 for helpful over-provisioning information.

Procedure

1. Place several real LUs (pool volumes) in a DP Pool.
2. Create several virtual LUs (DP-Vols) on the HDP pool with storage configurator software. Perform this step with configurator software, such as Hitachi Storage Navigator Modular 2 (NM2) or Hitachi Command Suite (HCS).
3. Give the DP-Vols host LUNs, so the server recognizes them as SDs.
Before deleting DP-Vols

There are some steps you must take before you delete a DP-Vol.

⚠️ Note: See the CLI man pages for detailed information about commands.

⚠️ Important: The `span-delete --reuse-dp-vols` command imposes extra requirements. Hitachi Data Systems strongly recommends you read the man page before trying to use this command.

Procedure

1. Delete the file systems on the storage pool (span in the CLI) that covers the DP-Vols you want to delete.
2. Use the `span-delete` command to delete the storage pool that use the DP-Vol you plan to delete.
3. If you plan to reuse the DP-Vols, use `span-delete --reuse-dp-vols` to avoid space-leakage.

Disable zero page reclaim

HDP offers the ability to unmap individual pages within a file system. This capability is called zero page reclaim (ZPR).

Consult the Hitachi Dynamic Provisioning software documentation for more information about ZPR.

⚠️ Important: ZPR is always turned off with HNAS.

Procedure

1. Confirm that ZPR is turned off when you are using HDP with HNAS.

Configuring HNAS to use HDP

When you configure your system to work with HDP, you have to configure both the storage and the HNAS. Follow this section when you configure an HNAS server to work with HDP. You will also need to consult the HDP software documentation.

When using HDP Pools, consider the following:

- All current Hitachi Data Systems storage supports HDP as a licensed option.
- All HNAS servers support HDP without requiring a server-side license.
- From release 12.1, HNAS servers now support thinly provisioned DP pools.
- The HDP software has no effect on protocol clients, such as NFS, and CIFS.
• Each DP-Vol draws space from multiple pool volumes:
  ○ Widens the storage bottleneck by distributing I/O to more disks
  ○ Insulates the server from the pool volume problem with small capacities
• The server can write anywhere on any DP-Vol, but not everywhere.

**Note:** While Hitachi Data Systems recommends the use of thin provisioning, the total capacity of the file systems on a storage pool (span in the CLI) cannot exceed the total capacity of the real storage that underpins the pool.

• HDP can improve performance by striping I/O across all available disks.
• Recycling or deleting a file system frees up space. The chunks that the old file system used to occupy can eventually be reused in other file systems.

**Note:** When you recycle or delete a file system, the amount of free space shown in a storage configurator, such as Hitachi Command Suite or Hitachi Storage Navigator, does not reflect the new space until the file system expires from the recycle bin.

• Recycling a file system causes the chunks to be listed in a vacated-chunks-list, which contains records of which freed chunks were used by which file system.
• Creating or expanding a file system draws space from the vacated-chunks-list, if any is available, costing no space. Any further space is pre-allocated at once.
• Writing to a file system costs no space because that space was pre-allocated.
• When using HDP storage and you create (`span-create`) or expand (`span-expand`) a storage pool, you must use the DP-Vols from a single DP pool. This rule applies whether you are using the CLI or the GUI.

**Note:** Successive span-expansions can be used to spread a storage pool across multiple DP pools.

• Deleting a file system frees no space (The file system sits in the recycle bin for a period of time.)

**Configuration guidelines for HNAS with HDP**

Follow these guidelines for best results.

Hitachi Data Systems recommends the following configurations:
• Make every new HDP pool thinly provisioned.
• Create enough DP-Vols to meet the expected size of the storage pool and to provide enough queue depth (minimum of four).
• Wait for the pool to finish formatting to avoid server timeouts. You may need to run `scsi-refresh` on the server before it will detect the new DP-Vols.
• Limit each HDP pool to hosting only a single storage pool. With the exception of tiered file systems, if you need fifty storage pools, create fifty HDP pools.
• For tiered file systems, you must use two HDP pools.
• Do not share a pool between two or more clusters.
• Do not share a pool between an HNAS system and a foreign server.
• Do not mix HDP DP-Vols and plain parity groups in a single span. However, it is acceptable for some spans to use HDP DP-Vols while others use parity groups.
• For best performance, when creating a new storage pool on DP-Vols, specify all the DP-Vols in a single span-create command or GUI equivalent. Do not create the storage pool on just a few of the DP-Vols and then make a series of small expansions.
• Create as many file systems as needed and expand them as often as necessary (or allow them to auto-expand). For maximum flexibility and responsiveness, create file systems small and allow them to auto-expand as data is written to them.

Note: The maximum size of a newly created file system on an HDP pool is 1TiB, but repeated expansions can take the file system all the way to the 256TiB limit.

Upgrading from older HNAS systems

Any pre-existing storage pool (span in the CLI) should be left thickly provisioned after a recent upgrade.

Note: Run span-unmap-vacated-chunks --exhaustive to reclaim space from any deleted filesystems and wait for the zero initialization to finish. Wait until the total space used on the pool equals the total size of the filesystems on the storage pool, then thin provisioning can safely be used.

When upgrading from an older version of an HNAS system, be aware that certain conditions produce the results and restrictions described here.

The conditions:
• A storage pool (span in the CLI) that was created in an earlier release violates the SDs in each stripeset must come from one HDP pool restriction.
• A storage pool (span) contains a mixture of HDP DP-Vols and plain parity groups. This configuration is unsupported.

The following results are produced:
• Events will be logged at boot time.
• The span-list and trouble span will issue warnings.
• Some operations will fail cleanly, for example:
  ○ Cannot create a file system.
○ Cannot expand a file system.
○ Cannot delete a file system.

• You can still load Cod.
• You can still mount file systems.

Using HDP storage
When working with HNAS systems, the HDP software supports up to two levels of tiered storage (Tier 0 and Tier 1).

See the Hitachi NAS Platform Storage Pool and HDP Best Practices (MK-92HNAS048) for recommendations.

Considerations when using HDP pools
Consider the following when using the HDP pools:

• Deleting a file system is not always permanent. Sometimes file systems are recoverable from the recycle bin or by using the `filesystem-undelete` command.
• Recycle a file system is permanent.
• Freed chunks move to the vacated-chunks-list, which is stored in Cod.
• Vacated chunks are reused when you create or expand other storage pools
• By reusing the same chunks, the server avoids exhausting space prematurely. Reusing chunks from recycled file systems prevents HDP from continuing to back them up with real disk storage and leaking space.

Creating an HDP pool with untiered storage
Create the pool and volumes for the single tier.

With untiered storage, tiers are not used. The metadata and the data reside on the same level. The server has no real perception of tiering with untiered storage.

Procedure
1. Create a thinly provisioned pool and DP-Vols for the Tier 0 storage pool.

Creating HDP pools with tiered storage
Most storage pools reside on a single DP pool, but a tiered storage pool needs two DP pools, one for each tier. Create the pools and volumes for tiered storage.

Important: The HNAS systems support up to two levels of tiered storage (Tier 0 and Tier 1).

With tiered storage, the metadata is kept on Tier 0 and the data on Tier 1. Tier 0 should be smaller than Tier 1 but should consist of faster storage. The
metadata Tier 0 it will contain is more compact than user data but is accessed more often.

See the Configuration guidelines for HNAS with HDP on page 54 for configuration details.

**Procedure**

1. Create a thinly provisioned pool and DP-Vols for Tier 1 of the tiered storage pool.
2. Create a thinly provisioned pool and DP-Vols for Tier 0 of the tiered storage pool.

**Creating storage pools with DP pools from HDP storage**

After you have created an HDP pool with tiered or untiered storage, you can use them to create storage pools.

See Considerations when using HDP pools on page 56 for more information.

See the CLI man pages for detailed information about commands.

**Procedure**

1. Use the command `span-create` or the GUI equivalent to create the storage pool on the first HDP pool’s DP-Vols.
2. Use the command `span-expand` to expand the storage pool on to the HDP second pool’s DP-Vols.
   
   Expanding the storage pool at the outset avoids the disadvantages of expanding it on a mature span. This is the only recommended exception to the rule of one pool per storage pool and one storage pool per pool.
3. When necessary, add new pool volumes to whichever pool needs them. Use the following steps:

   **Note:** Do not use dynamic read balancing (DRB, the command `fs-read-balancer`) at this step.

   a. Add parity groups (PGs) or pool volumes.
   b. If the amount of storage in the affected pool exceeds the total size of its DP-Vols, add more DP-Vols and use `span-expand`.

**Moving free space between storage pools**

You can move free space between storage pools, but you should first thoughtfully consider the implications because of the strong performance impacts.

The `span-unmap-vacated-chunks` launches a background thread that may run for seconds, minutes, hours, days or even months, and which can be monitored and managing using commands mentioned in its man page.
The free space on the DP pool will keep increasing as long as this background thread runs.

On configurations where the storage has to zero-initialize (overwrite with zeros) HDP pages before they can be reused, the free space on the pool may well continue to increase even after the unmapping thread terminates.

The performance of all DP pools on the affected array will be lower than usual until free space has finished increasing, but DP pools on other storage arrays will be unaffected.

**Unmapper use and why to avoid it**

The Hitachi Data Systems recommended best practice is to dedicate each pool to a single storage pool (span on the CLI). However, although not recommended, should a situation arise where multiple storage pools (spans) exist on a single pool, you can use the unmapper feature to move space between the storage pools on that pool.

**Important:** Using the unmapper commands can have serious consequences. Hitachi Data Systems strongly recommends that you read the CLI man pages for each command.

**Considerations:**

- Unmapping vacated chunks does free space, but the performance impact is extreme. Never unmap chunks just to affect the appearance of available storage.
- You cannot boot HNAS version 12.0 or earlier into the cluster while any storage pool (span) has a non-empty vacated chunks list. Should you need to downgrade to 12.0 or earlier, use the `span-vacated-chunks` command to identify storage pools whose vacated-chunks-lists are not empty. Then, use the `span-unmap-vacated-chunks` command on each of those storage pools. Finally, wait for events to indicate that unmapping has finished on each storage pool. There is no need to wait for zero-initialization (overwriting to zeros) to take place inside the storage.
- You can unmap space on any number of spans at one time, but performance is further impacted.
- The server has no commands for monitoring or managing the HDP zero-init process. Once the process starts, you have to wait until it finishes. The time can exceed many hours, even weeks in some cases.

**Further reasons to avoid using the unmapper:**

- The `span-unmap-vacated-chunks` command launches a background process that takes a very long time to run.
- On most storage configurations, an HDP page cannot be reused immediately after being unmapped. For security reasons, the page must first be zero-initialized to overwrite the previous page with zeros. This process occurs inside the storage, and it cannot be monitored or managed by commands on the server.
• Until pages have been zeroed, they’re not available for reuse.
• Zero-initialize can impact the performance of the connected storage and also that of other HDP pools.

The mapper feature uses the following commands:
• **span-vacated-chunks** displays the number of vacated chunks in a storage pool and the progress of any unmapper.
• **span-stop-unmapping** cancels an unmapper without losing completed work.
• **span-throttle-unmapping** helps you avoid long queues of pages waiting to be zero-initialized.

The only tested way to minimize the unmapper performance impact is to change the format priority from Normal to Host Access. Doing so makes formatting slower but enables the server to keep running.

**Using the unmapper**

After thoughtfully considering the consequences associated with use of the unmapper, you decide it is worth the significant performance impact, you can use the following steps.

> **Note:** See the CLI man pages for detailed information about commands.

**Procedure**

1. Delete and recycle a file system from storage pool S (Span S).
2. Run **span-unmap-vacated-chunks** on Span S.
3. When running the **span-list --sds T** command shows that storage pool T (Span T) has enough free space, create a new filesystem on Span T and/or expand one or more file systems on that storage pool.