

Introduction and Implementation of Data Reduction Pools and Deduplication

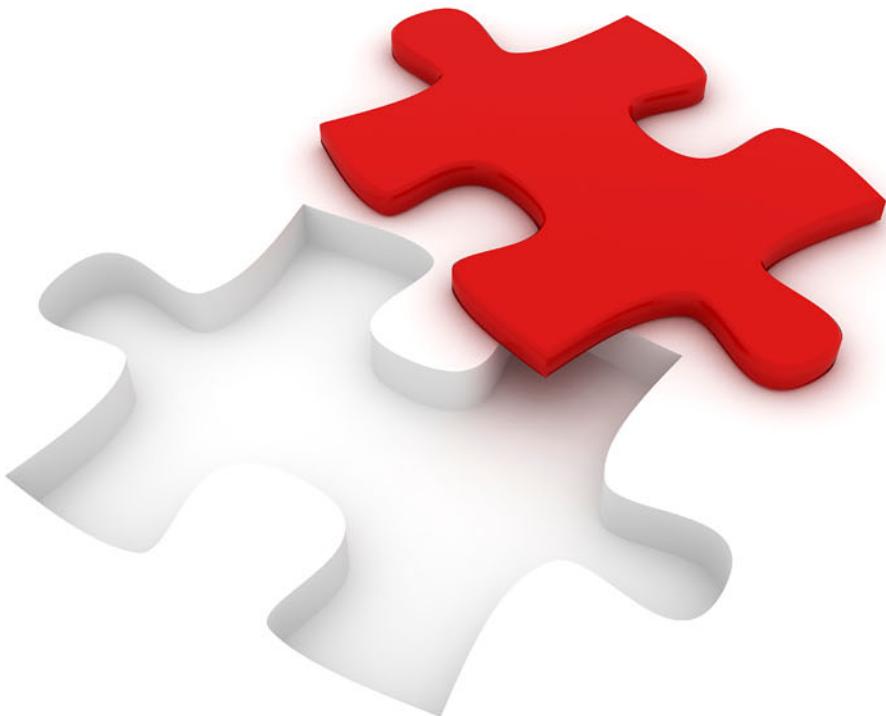
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Storage



International Technical Support Organization

**Introduction and Implementation of Data Reduction
Pools and Deduplication**

August 2018

Note: Before using this information and the product it supports, read the information in "Notices" on page ix.

First Edition (August 2018)

This edition applies to IBM Spectrum Virtualize V8.1.3.2 (minimum recommended software level) and the associated hardware and software detailed within. Note that the screen captures included within this book might differ from the generally available (GA) version, because parts of this book were written with pre-GA code.

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Preface

Continuing its commitment to developing and delivering industry-leading storage technologies, IBM® introduces Data Reduction Pools (DRP) and Deduplication powered by IBM Spectrum™ Virtualize, which are innovative storage features that deliver essential storage efficiency technologies and exceptional ease of use and performance, all integrated into a proven design.

This IBM Redbook discusses Data Reduction Pools (DRP) and Deduplication and is intended for experienced storage administrators who are fully familiar with IBM Spectrum Virtualize, SAN Volume Controller, and the Storwize family of products. For more information on those and to supplement your understanding of this book we suggest you refer to:

Implementing the IBM System Storage SAN Volume Controller with IBM Spectrum Virtualize V8.1, SG24-7933

Implementing the IBM Storwize V7000 with IBM Spectrum Virtualize V8.1, SG24-7938

IBM System Storage SAN Volume Controller and Storwize V7000 Best Practices and Performance Guidelines, SG24-7521

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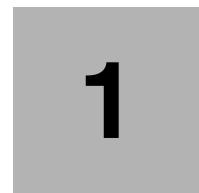
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Architecture

This section offers a high level description of Data Reduction Pools and deduplication architecture.

1.1 What are Data Reduction Pools

Data Reduction Pools (DRP) represent a significant enhancement to the storage pool concept. This is because the virtualization layer is primarily a simple layer that executes the task of lookups between virtual and physical extents. Now with the introduction of data reduction technology, compression and deduplication, it has become more of a requirement to have an uncomplicated way to stay thin.

Data Reduction Pools increase existing infrastructure capacity utilization by leveraging new efficiency functions and reducing storage costs. The pools enable you to automatically de-allocate (not to be confused with deduplication) and reclaim capacity of thin-provisioned volumes containing deleted data and, for the first time, enable this reclaimed capacity to be reused by other volumes. With a new log-structured pool implementation, data reduction pools help deliver more consistent performance from compressed volumes. Data reduction pools also support compression of all volumes in a system, potentially extending the benefits of compression to all data in a system.

Traditional storage pools have a fixed allocation unit of an extent, and that itself will not be changing with Data Reduction Pools, however features like Thin Provisioning and Real-time Compression (RtC) use smaller allocation units and manage this allocation with their own meta-data structures. These are described as the Binary Trees or Log Structured Arrays (LSA).

In order to 'stay thin' you need to be able to reclaim capacity that is no longer used, or in the case of an LSA (where all writes go to new capacity) garbage collect the old overwritten data blocks. This also needs to be done at the smaller allocation unit size (KB) per extents.

Figure 1-1 shows the DRP mirroring structure.

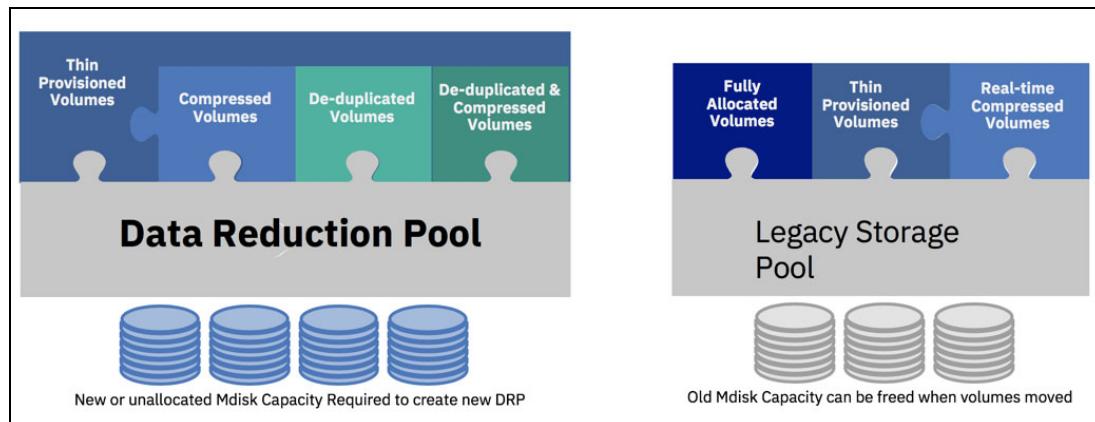


Figure 1-1 New Data Reduction Pool Volume Mirroring Structure

Note: Use volume mirroring to clone data to a new DRP as DRP does not support `migrate` commands.

1.1.1 DRP Volume types

DRP technology allows you to create five types of volumes

- ▶ Fully allocated

This type provides no storage efficiency but the best performance and is available for migration

- ▶ Thin

This type provides storage efficiency but no compression or deduplication

- ▶ Thin and Compressed

This type provides storage efficiency with compression and this combination will provide the best performance numbers

- ▶ Thin and Deduplication

This type provides storage efficiency but without compression

- ▶ Thin, Compressed and Deduplication

This type provides storage efficiency with maximum capacity savings

With storage efficiency, DRP thin and compressed volumes provide the best performance numbers. This is due to the new compression implementation. This implementation provides better load balancing and consistent performance when compared to the RACE implementation. This feature is also the second best performer to fully allocated volumes, followed by thin, compressed and deduplication volumes when it comes to storage efficiency.

Figure 1-2 shows the types of volumes in the DRP pools.

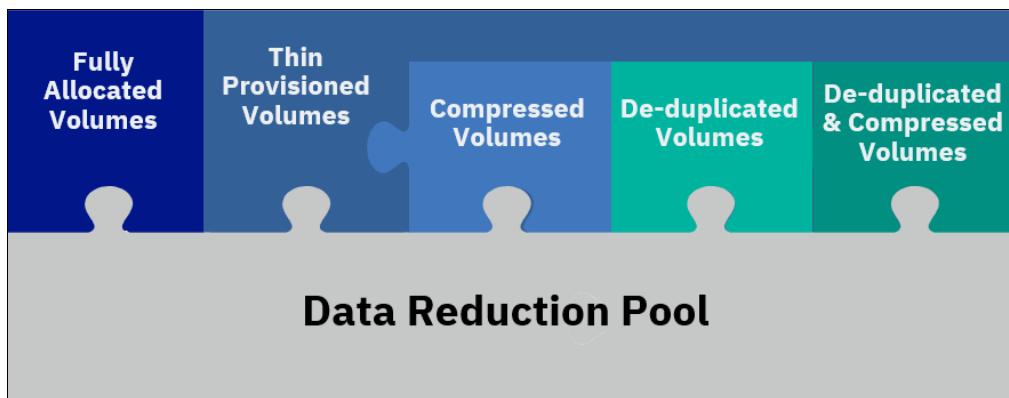


Figure 1-2 Volume types

There are four main characteristics that make up the IBM Data Reduction Pool design:

- ▶ Fine Grained allocation of data blocks
- ▶ The ability to free back unused (unmapped, or overwritten) capacity at a fine grain
- ▶ Give consistent, predictable performance
- ▶ Optimize performance for Solid State storage, such as Flash

A data reduction pool, at its core, uses an LSA to allocate capacity. Therefore, the volume you create from the pool to present to a host application consists of a directory that stores the allocation of blocks within the capacity of the pool.

All writes for data reduction pools take place at the upper cache layer to the host. Reads will have to go through the lower cache layer. The heart of the new DRP functionality is in the new implementation of the Log Structured Array. This includes lower cache, virtualization, Easy Tier, and RAID. LSA understands what works best for each of these components.

A log structured array allows a “tree” like directory to be used to define the physical placement of data blocks independent of size and logical location. Each logical block device has a range of LBAs – Logical Block Address. Starting from 0 and ending with the block address that fills the capacity. When written an LSA allows you to allocate data sequentially and provide a directory that provides a lookup to match LBA with physical address within the array.

Note: LSA will always append new data to the end of the array, when data is overwritten, the old location and capacity utilized needs to be marked as ‘free’. UNMAP functions can also request you ‘free’ no longer needed capacity. Compression overwrites may result in different capacity being used. Deduplication may find new duplicates when data is re-written.

Figure 1-3 shows Spectrum Virtualize IO stack structure.

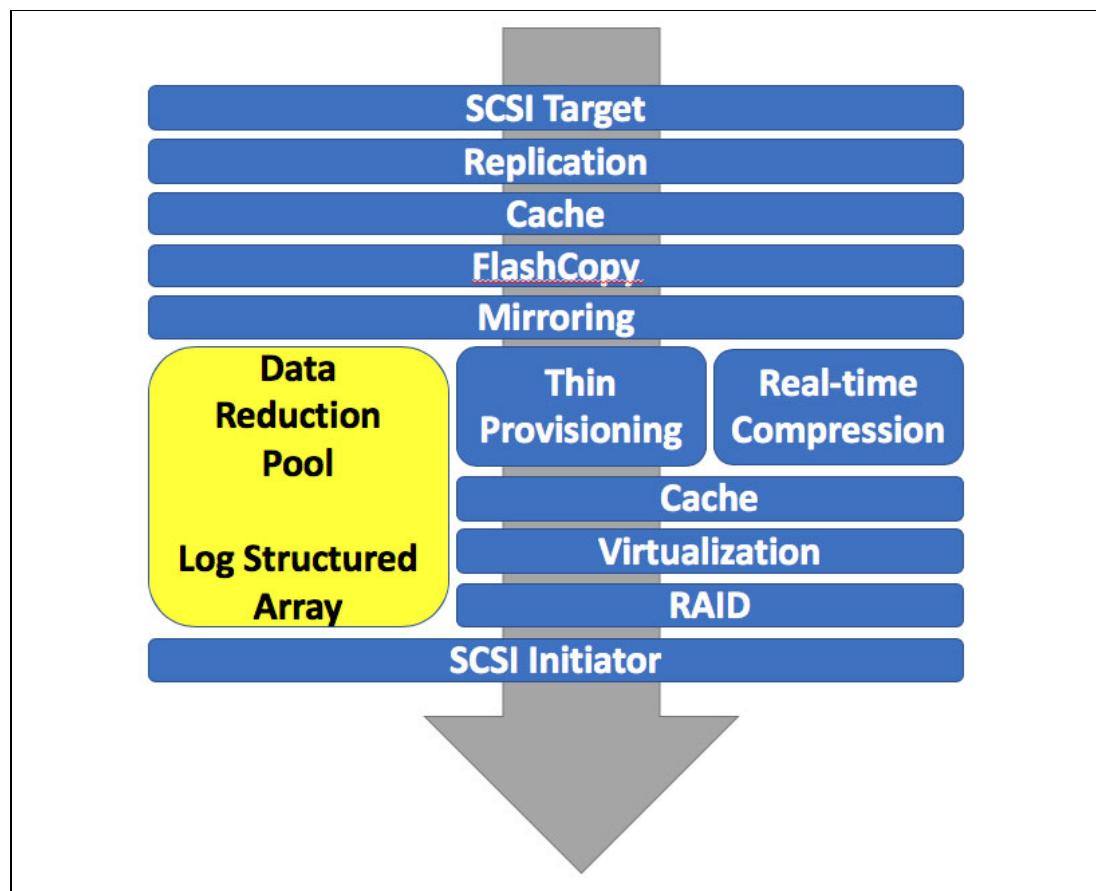


Figure 1-3 Data Reduction Pools/LSA is located in the Spectrum Virtualize IO stack

1.1.2 What is in a Data Reduction Pool

As shown in Figure 1-4 on page 5 the user will see a sample of four volumes in a Data Reduction Pool. Internally, there will be four directory volumes, one customer data volume (per I/O Group), and one Journal Volume (per I/O Group).

Figure 1-4 on page 5 shows the view of DRP.

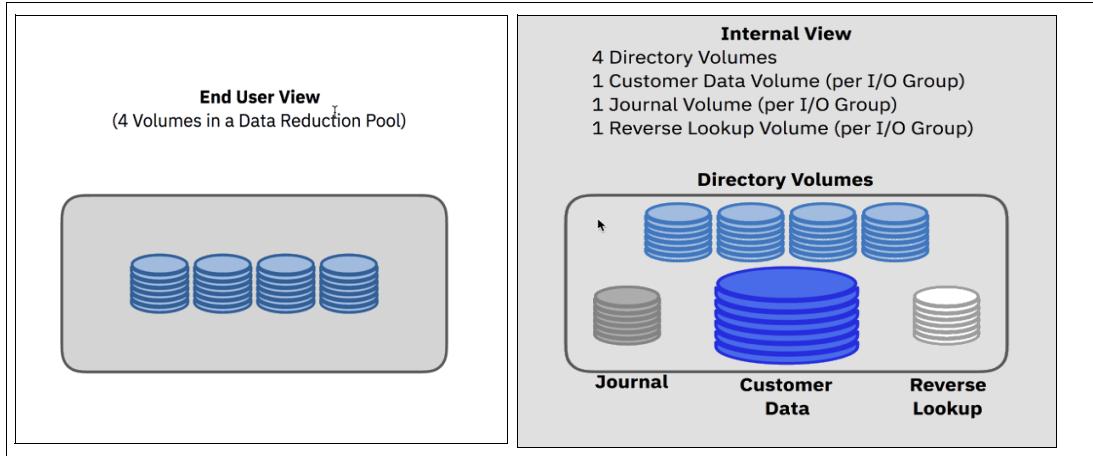


Figure 1-4 Both the front-end and back-end view of DRP

Each Internal volume type has very specific I/O patterns with its own percentage used of the total capacity of the pool shown in Table 1-1.

Table 1-1 I/O Patterns per Internal Volumes

Customer Data Volumes	Directory Volumes	Journal Volumes	Reverse Lookup
98% of Pool Capacity	1% of Pool Capacity	Less than 1% of Pool Capacity	Less than 1% of Pool Capacity
Large sequential write pattern & Short random read pattern	Short 4KB random read and write pattern	Large sequential write I/O & Only read for recovery scenarios (i.e. T3 etc.)	Short, semi-random read write pattern

1.1.3 Allocation block size

The allocation size of these blocks is now 8 KB - previously thin provisioned volumes used 32 KB and RACE Compression write of 32 KB of compressed data. Here are some key reasons behind the 8 KB allocation:

- ▶ UNMAP requests as small as 8 KB can be catered for
- ▶ The addressability of data in the pool is at an 8 KB (uncompressed) boundary - compared to 32 KB compressed with previous RACE compression.
- ▶ All random read requests are of 8 KB size (or less if compressed) which is ideal for Flash Storage
- ▶ With a common meta-data access size served by lower cache, performance is much more consistent.
- ▶ Figure 1-5 shows the DRP Compression I/O Amplification.

I/O Type	Space Allocated	I/O Amplification including Size
8K Read	Unallocated	0.50 (1x4K metadata + no data I/O)
	Allocated	1.00 (1x4K metadata + 1x4K data read)
32k Read	Unallocated	0.125 (1x4K metadata + no data I/O)
	Allocated	0.625 (1x4K metadata + 1x16K data read)
8K Write	Unallocated	1.50 (2x4K metadata + 1x4K data write)
	Allocated	1.50 (2x4K metadata + 1x4K data write)
32k Write	Unallocated	0.75 (2x4K metadata + 1x16K data write)
	Allocated	0.75 (2x4K metadata + 1x16K data write)

Figure 1-5 I/O Amplification of space allocated (assumes 50% Compression rate)

Note: Writes to already allocated space will drive the need for Garbage Collection (GC). The cost of GC depends on the amount of valid data in the extent that has not been over-written.

1.2 RACE versus DRP

RACE used variable input/fixed output. Intermittently having to wait or pause to see if more I/O is coming for a volume, see Figure 1-6 on page 6. The RACE minimum block size to read from backend = 32KB, and RACE pushes at least 4-8 times more data through decompress hardware than DRP for true random workload. Whereas, DRP Compression uses fixed input/variable output. In Figure 1-7, the DRP maximum block size to read from the backend is 8 KB (typically 4 KB or less though). With the use of 8 KB input sizes there is a small loss in compression ratio but a gain in lower latency when all workload is put into the same predictable small block size. Host IO that is put in these small grain block size in DRP allows for Fine grained allocation of block data, ability to free back unused capacity at a fine grain, give consistent, predictable performance, and optimize performance for Flash storage.

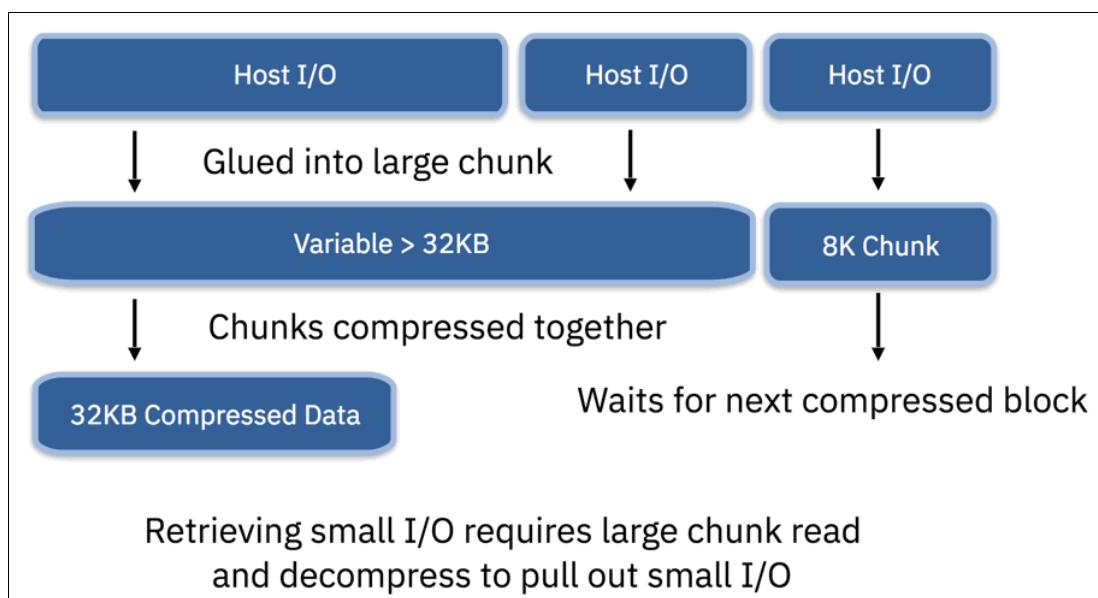


Figure 1-6 RACE compression IO stack

Figure 1-7 shows the DRP compression IO stack

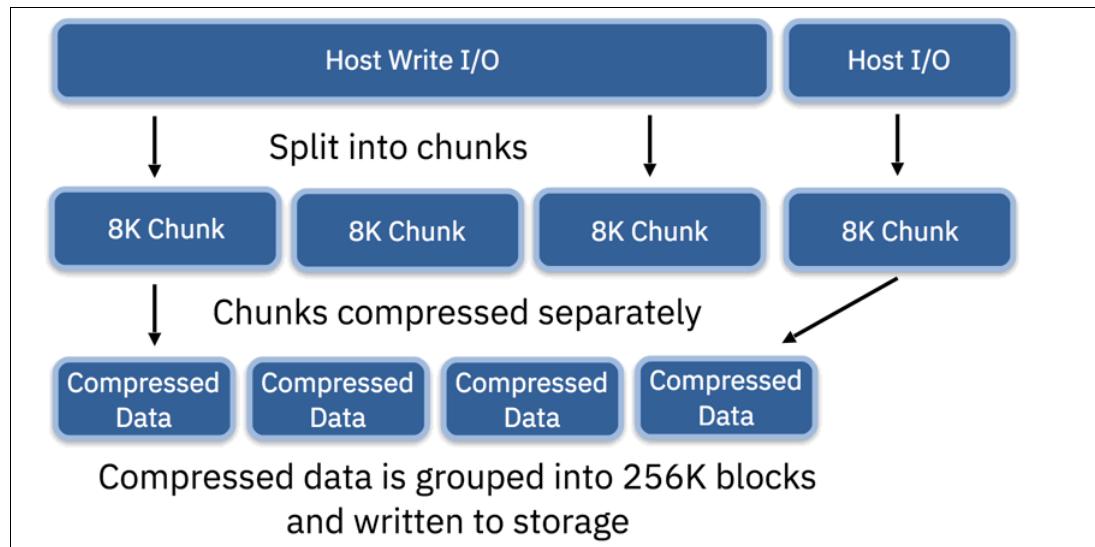


Figure 1-7 DRP compression IO stack

Here are some of the key differences in DRP when compared to RACE.

- ▶ CPU
 - Data reduction uses the same threads as the main I/O process
 - No separate compression CPU utilization
 - No dedicated CPU cores for compression
- ▶ Memory
 - Data reduction shares memory with the main I/O process
 - 1GB memory taken from cache when data reduction is enabled
- ▶ Compression Hardware
 - Shared with existing RtC compression and compression for IP replication
 - New DRP compression achieves up to 4.8 GB/s per node (compression card limit)

1.2.1 Benefits

There are many advantages to data reduction pools, including:

- ▶ Designed to be highly scalable to support hardware with more cores and more memory
- ▶ Tightly integrated compression shares available cores with other processes for greater efficiency
- ▶ Optimization for flash storage through conversion of random write I/Os into larger sequential writes
- ▶ No limit on the number of compressed volumes enables greater use of compression (up to 5X as many volumes) and so more compression benefit and reduced storage cost
- ▶ Up to 3x better throughput for compressed data, enabling its use with a wider range of data types.
- ▶ Ability to release and reuse storage in response to server needs, reducing overall storage required
- ▶ Designed for future data reduction technologies

- ▶ Separation of metadata and user data improves cache effectiveness
- ▶ Compression integrated within I/O stack
- ▶ Shared resource design
- ▶ Active/Active – Mirrored non-volatile metadata means significantly improved failover/failback response times due to no revalidation of metadata
- ▶ No limit on the number of compressed volumes
- ▶ Space reclamation – Unmap
- ▶ Designed for de-duplication
- ▶ Smaller 8k chunk means less compression bandwidth for small I/Os Metadata and User data separated, better use of cache prefetch/destage
- ▶ On average 1.8x I/O amplification on host I/O – much more predictable latency compared to RACE
- ▶ Able to use maximum compression bandwidth
- ▶ Comprestimator support

Table 1-2 on page 8 shows DRP disk limitations.

Table 1-2 DRP Disk Limitations

Extent Size	Volume size	4 IO groups
1GB	128TB	512TB
2GB	256TB	1PB
4GB	512TB	2PB
8GB	1PB	4PB

1.3 Data Reduction Pools and Unmap

DRP's support end to end unmap functionality. Space that is freed from the host(s) is a process called unmap. A host can issue a small file unmap (or a large chunk of unmap space if you are deleting a volume that is part of a data store on a host) and these will result in the freeing of all the capacity allocated within that unmap. Similarly, deleting a volume at the DRP level will free all the capacity back to the pool.

When a data reduction pool is created, the system monitors the pool for reclaimable capacity from host unmap operations. This capacity can be reclaimed by the system and redistributed into the pool. Create volumes that use thin provisioning or compression within the data reduction pool to maximize space within the pool.

1.4 Data Reduction Pools with Easy Tier

A DRP uses an LSA as mentioned above. RACE Compression has used a form of LSA since its introduction in 2011, and this means that there is normal garbage collection that needs to be done all the time. An LSA will always append new writes to the end of the allocated space, even if data already exists, and the write is an over-write, the new data will not be written in place. Instead the new write is appended at the end and the old data is marked as needing garbage collected. This itself allows for::

- ▶ Writes to a DRP volume are always sequential — so we can build all the 8 KB chunks into a larger 256 KB chunk and destage the writes from cache, either as full stride writes, or as large 256 KB sequential stream of writes.
- ▶ This should give the best performance both in terms of RAID on backend systems, but also on Flash, where it is easier for the Flash device to also garbage collect on a larger boundary.
- ▶ We can start to record meta-data about how frequently certain areas of a volume are over-written.

We can then bin sort the chunks into a heat map in terms of re-write activity and then group commonly re-written data onto a single extent. This is so that EasyTier will operate correctly for not only read data, but write data when data reduction is in use. Previously writes to compressed volumes held lower value to the Easy Tier algorithms, because writes were always to a new extent, so the previous heat was lost. Now we can maintain the heat over time and ensure that frequently re-written data gets grouped together. This also aids the garbage collection at the virtualize level and also on Flash, where it is likely that large contiguous areas will end up being garbage collected together.

1.5 Garbage collection

DRP has built in services to enable garbage collection of unused blocks. This means that lots of smaller unmap's will end up allowing a much larger chunk (extent) to be freed back to the pool, and if the storage behind SVC supports unmap, we will pass an unmap command to the backend storage - again equally important with today's Flash backend systems - especially so when they themselves implement some form of data reduction.

Trying to fill small holes is very inefficient – too many I/O's would be needed to keep reading and re-writing the directory. So, GC waits until an extent has many small holes. Move the remaining data in the extent - compact and re-write. Once we have an empty extent it can be freed back to the virtualization layer (and backend with UNMAP) or start writing into the extent with new data (or re-writes).

The reverse lookup meta-data volumes tracks the extent usage, or more importantly the holes created by over-writes or unmaps. GC looks for extents with the most unused space. Once a whole extent has had all valid data moved elsewhere, it can be freed back to the set of unused extents in that pool or can be reused for new written data.

1.6 Data Reduction Pools with Deduplication

Deduplication can be configured with thin-provisioned and compressed volumes in data reduction pools for added capacity savings. The deduplication process identifies unique chunks of data, or byte patterns, and stores a signature of the chunk for reference when writing new data chunks. If the new chunks signature matches an existing signature the new chunk is replaced with a small reference that points to the stored chunk. The same byte pattern may occur many times resulting in the amount of data that must be stored being greatly reduced.

Duplicate matches are found using SHA1 hashes created for each 8 KB align region of client data to a deduplicated copy. The matches are detected when the data is written. For Data Reduction Pools, deduplication data can work in two separate ways. It can be grouped into 256KB blocks and written to storage, or can be passed as 8 KB chunks, and compressed first.

Deduplication has specific IO characteristics in the handling of data and data copies. When a matching fingerprint is found the metadata is updated to point to the metadata of the existing copy of the data. Each copy of the data can have up to 255 8KiB virtual chunks referring to it. Each virtual 8KiB chunk can track up to 3 versions of data. IO performance will take precedence over finding duplicate copies of data. Host IOs smaller than 8KiB will not attempt to find duplicates.



Planning

This chapter discusses general guidelines and important considerations for using the Data Reduction Pools (DRP) functionality available for the Spectrum Virtualize family of products.

This chapter assumes that the reader is already familiar with IBM Spectrum Virtualize Real-time Compression and Easy Tier. Information on these technologies can be found in many sources, including the following publications:

- ▶ *IBM Real-time Compression in IBM SAN Volume Controller and IBM Storwize V7000*, REDP-4859
- ▶ *Implementing the IBM Storwize V7000 with IBM Spectrum Virtualize V8.1*, SG24-7938
- ▶ *Implementing the IBM System Storage SAN Volume Controller with IBM Spectrum Virtualize V8.1*, SG24-7933
- ▶ *IBM System Storage SAN Volume Controller and Storwize V7000 Best Practices and Performance Guidelines*, SG24-7521

This chapter contains the following:

- ▶ 2.1, “Data Reduction Pools benefits” on page 12
- ▶ 2.2, “Planning considerations” on page 13

Recommended software level: The minimum recommended software level is V8.1.3.2 which is available from IBM Fix Central and contains a number of critical fixes.

2.1 Data Reduction Pools benefits

Data reduction pools are a new type of storage pool that implement techniques such as thin-provisioning, compression and deduplication to reduce the amount of physical capacity required to store data. Savings in storage capacity requirements translate into reduction in the cost of storing the data.

The cost reductions that are achieved through software can facilitate the transition to all Flash storage. Flash storage has lower operating costs, i.e. lower power consumption, cheaper to cool, and higher density. However, the cost of Flash storage is still higher than Nearline Disk. With technologies such as DRP, the cost difference can be reduced to a point where an all Flash solution is feasible.

The first benefit of DRP is in the form of storage savings due to deduplication. The deduplication process identifies unique data patterns, and stores a signature of the data for reference when writing new data. If the signature of the new data matches an existing signature the new data is not written to disk, but instead a reference to the stored data is written. The same byte pattern may occur many times resulting in the amount of data that must be stored being greatly reduced.

The second benefit of DRP comes in the form of performance improvements due to compression. While deduplication aims to identify the same data elsewhere in the storage pool and create references to the duplicate data instead of writing extra copies, compression is trying to reduce the size of the host data that is written. Compression and deduplication are not mutually exclusive, one or both or neither features may be enabled. If the volume is de-duplicated as well as compressed, data will be de-duplicated first, and then compressed. Therefore deduplication references are created on the compressed data stored on the physical domain.

DRP offers a new implementation of data compression that is integrated into the I/O stack. The new implementation makes better use of the resources of the system, and, similar to RACE, uses hardware accelerators for compression. As with RACE, the new implementation uses the same Lempel-Ziv (LZ) based real-time compression and decompression algorithm. However, in contrast to RACE compression, DRP compression operates on smaller block sizes resulting in additional performance gains. For more information on these performance gains see Chapter 5, “Best practices and guidelines” on page 41.

The third benefit of DRP comes in the form of performance improvements due to Easy Tier. The metadata of data reduction pools do not fit in RAM, hence they are stored on disk, in metadata volumes which are separate from data volumes. The metadata volumes of data reduction pools are small and frequently accessed. They are very good candidates for promotion through Easy Tier. In contrast, data volumes are large, but since metadata are stored separately, Easy Tier is able to accurately identify frequently used data. Performance gains are expected as Easy Tier promotes metadata and customer data to the fastest available storage tier.

2.2 Planning considerations

In this section we detail considerations directly related to DRP.

2.2.1 Data Reduction Pool characteristics

Data reduction pools can contain generic (thick) volumes. The space for these volumes is claimed at creation time. Thin-provisioned volumes on the other hand delay allocating storage until it is first written. This means that unused space in volumes presented to host servers does not actually consume any physical storage capacity. To create a thin-provisioned volume the user specifies both the real and virtual capacity of the volume when it is created. The real capacity defines how much physical storage is initially associated with the volume, the virtual capacity defines how large the volume will appear to the host server.

A data reduction pool makes use of metadata, labeled as overhead in Figure 2-1. Even when there are no volumes in the pool, some of the space of the pool is used to store the metadata. The space allocated to metadata is relatively small. Regardless of the type of volumes the pool contains, metadata are always stored separate from customer data.

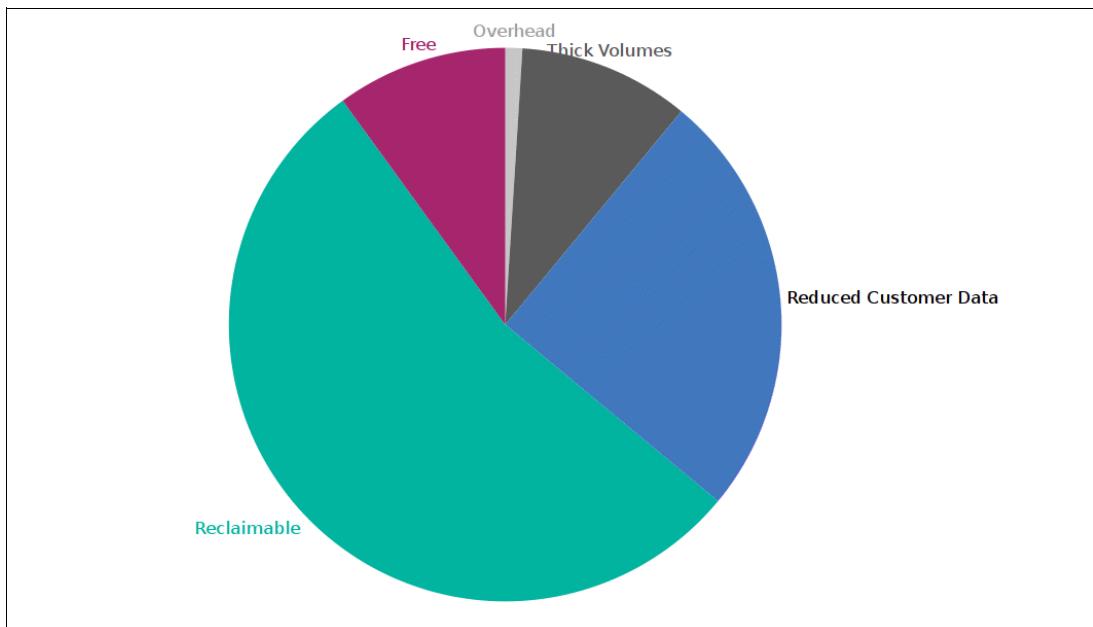


Figure 2-1 Example of capacity use in a data reduction pool

In data reduction pools, the maintenance of the metadata results in I/O amplification. I/O amplification occurs when a single host generated read or write I/O results in more than one back end storage I/O requests due to advanced functions. A read request from the host results in two I/O requests, a directory lookup and a data read. A write request from the host results in three I/O requests, a directory lookup, a directory update, and a data write.

The reclaimable space refers to garbage collection. As a result of compression and deduplication, overwriting host writes do not always consume the same amount of space that the previous data was using. This leads to these writes always having to occupy new space on back-end storage while the old data is still in its original location. The primary task of Garbage Collection is to track all the regions that have been invalidated and make this capacity usable for new writes.

For garbage collection stored data are divided into regions. As data are overwritten, a record is kept of which areas of those regions have been invalidated. Regions that have large number of invalidated parts, are potential candidates for garbage collection. When the majority of a region has invalidated data, it is fairly inexpensive to move the remaining data to another location hence freeing the whole region. Since garbage collection needs to move data in order to free regions, it is recommended that pools are sized so that the occupied capacity is 85% of the size of the pool. That will ensure that there will always be some free space for garbage collection. For more information see Chapter 5, “Best practices and guidelines” on page 41.

2.2.2 Migration

A data reduction pool is a new type of pool that supports thin-provisioning, compression, and deduplication. Any or all of these features can be enabled. A volume created in a data reduction pool can be either fully allocated or thin provisioned. It can be compressed or uncompressed. Deduplication can be enabled or not.

Even though data can be migrated regardless of the nature of the new volumes, the type of these volumes determines the migration strategy used. RACE and DRP compression cannot co-exist within the same MDisk group, or some systems do not have enough hardware resources to run RACE and DRP compression at the same I/O group. As such additional resources (storage and/or hardware) are required to migrate the data to data reduction pools.

Migration strategy for uncompressed volumes

This approach works on all platforms as there is no restriction to using thin volumes in data reduction pools. In this case, the recommended migration strategy is:

1. Create a new data reduction pool and add storage to it.
2. Add a volume copy from the volume whose data are migrated, to the data reduction pool.

Migration strategy for hardware compression

Data reduction compression can not be used at the same time as RACE compression within the same MDisk group, but it can be used in the same I/O group provided there are hardware compression capabilities. In this case, the recommended migration strategy is:

1. Create a new data reduction pool and add storage to it.
2. Add a volume copy from the volume whose data are migrated, to the data reduction pool with compression enabled.

Migration strategy for software compression for Storwize V5030

Storwize V5030 does not support hardware compression. The platform is limited to two I/O groups and it cannot be clustered with another node type that supports hardware compression.

This is the only platform that supports data reduction pools with software compression. However, the platform does not have the CPU resources to run RACE and DRP compression within the same I/O group at the same time. Hence, in this case a two step migration approach is required.

Decompress and recompress

The first approach is to use a thin data reduction pool, or a regular pool to migrate the data, in detail:

1. Create a new data reduction pool or a regular pool.

2. Add a thin copy in the new pool, and use the autodelete flag.
3. Add a compressed copy within the new pool, and use the auto delete flag.
4. Delete the original MDisk group.

The downside of this approach is that volumes cannot be migrated one at a time, as all RACE volumes need to be removed before a compressed volume in a data reduction pool is created. Hence for this approach the available storage to decompress all the RACE volumes needs to be available.

Migrate data across I/O groups

For this approach two I/O groups are needed, one containing the RACE volumes, and the other the DRP volumes, in detail:

1. Move all the RACE volumes under a single I/O group.
2. Create a data reduction pool under the I/O group that has no RACE volumes.
3. Use intra cluster Global Mirror or Metro Mirror to mirror the compressed volumes from the I/O group with RACE to the I/O group with DRP.
4. Use intra cluster Global Mirror or Metro Mirror to mirror any uncompressed volumes that need migration.

The downside of this approach is that it requires the hardware to setup a second I/O group.

Migration strategy for copy services

These are the migration strategies for copy services.

Volume mirroring

Systems that already make use of volume mirroring need to have the replication broken during the migration process. Once the migration process is complete the replication can be re-established. This is particularly important for systems with stretched clusters.

Global Mirror/Metro Mirror/Hyperswap

Systems with dual site replication do not have to break the replication during the migration. The exception is Storwize V5030 systems. Storwize V5030 systems that make use of global mirror, metro mirror, or hyperswap will have to break the replication during the migration process. Once the migration is complete, replication can be re-established.

2.2.3 Limits

Maximum number of volumes

As of IBM Spectrum Virtualize version 8.1.3 twelve internal copy volume IDs are allocated to each data reduction pool. Table 2-1 lists the maximum number of (compressed) volumes per data reduction pool.

Table 2-1 Maximum number of compressed volumes per DRP

Product	Platforms	Volume Copies	Volumes
SVC	ALL	10000	9988
V9000	ALL	10000	9988
V7000	ALL	10000	9988

Product	Platforms	Volume Copies	Volumes
V5000	V5030	8192	8180
	V5020	8192	8180
	V5010	4096	4084
	V5000	8192	8180

Maximum number of DRPs

The maximum number of data reduction pools that can be created in a cluster is 4.

Maximum volume copy size

There is a limit on the maximum size of a customer data volume at 128K extents per I/O group. This places a limit on the maximum physical capacity in a pool before data reduction, see Table 2-2 (note that it includes garbage (reclaimable capacity) as well).

Table 2-2 Maximum physical capacity in a pool before data reduction

Extend Size	1 DRP - 1 I/O group	1 DRP - 4 I/O groups	4 DRP - 4 I/O groups
1 GB	128 TB	512 TB	2 PB
2 GB	256 TB	1 PB	4 PB
4 GB	512 TB	2 PB	8 PB
8 GB	1 PB	4 PB	16 PB

If the pool reaches out of space, the whole pool goes offline.

2.2.4 Compression support

Table 2-3 summarises the hardware types that support RACE compression, DRP compression, and RACE plus DRP compression at the same time.

Table 2-3 Hardware that supports RACE compression

Hardware type	RACE compression support	DRP compression support	RACE plus DRP compression support
Storwize V5000, V5010, V5020	No	No	No
Storwize V5030 (16GB)	No	No	No
Storwize V7000 Gen2, V7000 Gen 3, All SVC nodes (DH8 and SV1 require compression hardware)	Yes	Yes	Yes
Storwize V5030 (32GB)	Yes	Yes	No
Storwize V3500, V3700, V7000 Gen 1, CF8, CG8	Not supported	Not supported	Not supported
SVCasSW	Dual CPU only	Dual CPU only	No



3

Implementation

In this chapter we discuss the following Data Reduction Pool (DRP) topics:

- ▶ About data reduction
- ▶ Requirements
- ▶ Data Reduction Pool creation
- ▶ Volume creation
- ▶ Volume migration
- ▶ Limitations

Recommended software level: The minimum recommended software level is V8.1.3.2 which is available from IBM Fix Central and contains a number of critical fixes.

3.1 About data reduction

Using data reduction reduces the amount of physical storage required and therefore saves money. Although the price of flash storage is decreasing there is still a 10x difference in cost between flash and nearline disk.

Using compression and deduplication it is very common to achieve 3x to 5x data reduction ratios. With the addition of thin provisioning the data reduction ratio is often up to 10x.

In addition flash storage has lower operating costs – lower power, cheaper to cool, higher density. Data reduction can therefore be used to facilitate a transition to all flash storage.

Data reduction with IBM Spectrum Virtualize family of products includes the following techniques:

- ▶ Thin provisioning
 - Capacity is allocated on demand as storage is first written to
- ▶ Compression
 - Data is compressed before being written to storage
- ▶ Deduplication
 - Duplicates of data are detected and are replaced with references to the first copy

Data Reduction Pools

Data Reduction Pools increase existing infrastructure capacity utilization by leveraging new efficiency functions. Data Reduction Pools enable you to automatically de-allocate and reclaim capacity of thin-provisioned volumes containing deleted data and enable this reclaimed capacity to be reused by other volumes. With the new log-structured pool implementation, data reduction pools help deliver more consistent performance from compressed volumes. Data Reduction Pools also support compressing all volumes in a system, potentially extending the benefits of compression to all data in a system.

Requirements

The following software and hardware requirements are needed for compression and deduplication:

- ▶ Enabled Compression license
- ▶ Code level V8.1.3.2 or higher is needed for data reduction pools
- ▶ Code level V8.1.3.2 or higher is needed for deduplication
- ▶ Nodes must have at least 32 GB memory to support deduplication
- ▶ Nodes that have more than 64 GB memory can use a bigger deduplication fingerprint database, which might lead to better deduplication

Random Access Compression Engine (RACE) compression and DRP compressed volumes can coexist in the same I/O group, however deduplication is not supported in the same I/O group as RACE compressed volumes.

Review or enable the compression license

The compression license can be reviewed and enabled from the menu **Settings** → **System** → **Licensed Functions** as shown in Figure 3-1 on page 19.

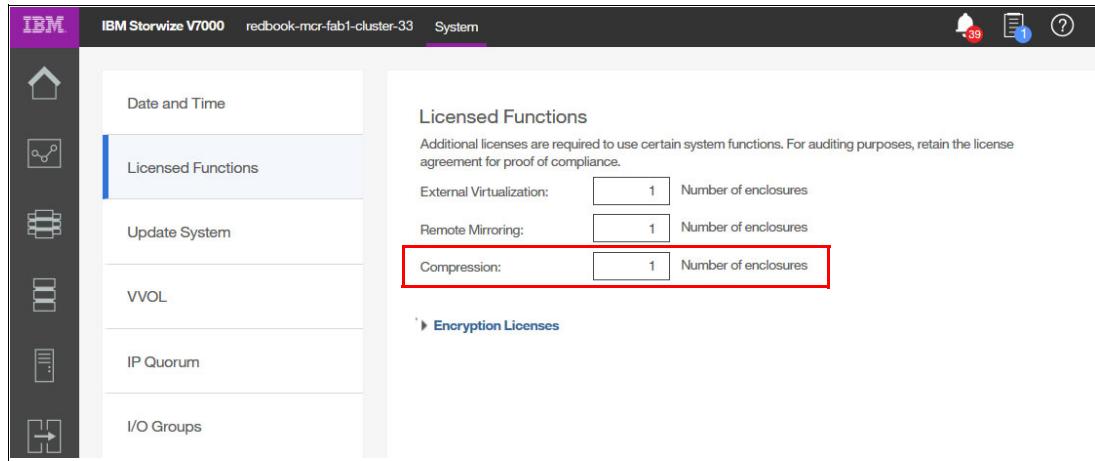


Figure 3-1 Review compression license

As shown above we have enabled a compression license for a system with a single enclosure. If adding enclosures to the system the compression license for additional enclosures must be added.

Volume compression

Volume compression with the Spectrum Virtualize family of products has traditionally been done with RACE software and compression acceleration cards. From V8.1.2 of Spectrum Virtualize software technology is moving away from RACE and towards Data Reduction Pools. Data Reduction Pools use the same hardware as RACE but the compression software has changed to reflect today's requirements for faster and more efficient storage.

Deduplicated volumes

A deduplicated volume or volume copy can be created in a data reduction pool. When you implement deduplication, you must consider your specific requirements in the storage environment.

Deduplication is a type of compression that eliminates duplicate copies of data. Deduplication of user data occurs within a storage pool and only between volumes or volume copies that are marked as deduplicated. However, there is no requirement for all nodes in a system, and therefore all I/O groups, to support deduplication. You can create deduplicated volumes in an I/O group when no compressed volumes or volume copies are in regular storage pools (that is, when RACE compression is in use on that I/O group). DRP compressed volumes can coexist with RACE compressed volumes in the same I/O group.

You can migrate any type of volume from a regular storage pool to a data reduction pool. You can also migrate any existing RACE compressed volume to a data reduction pool. After you migrate a volume to a data reduction pool, you can then create a deduplicated volume.

Note: RACE compression and DRP compressed volumes can coexist in the same I/O group, however deduplication is not supported in the same I/O group as RACE compressed volumes.

3.2 Creating data reduction pools

Data Reduction Pools has been available since V8.1.2 of the Spectrum Virtualize software. Deduplication was added in version V8.1.3.

Recommended software level: The recommended software level is V8.1.3.2 which is available from IBM Fix Central and contains a number of critical fixes.

In the following section we demonstrate how to create a data reduction pool and add storage to it.

Figure 3-2 shows a Storwize V7000 Storage Pools view where a single standard pool exists.

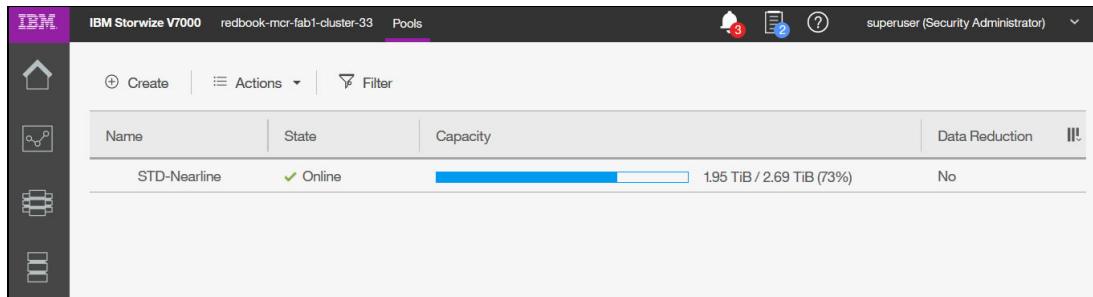


Figure 3-2 Storage pools view

Click Create to open the Create Pool wizard. We provide the name DRP-10KSAS to reflect that this is a data reduction pool containing SAS-drives 10K RPM speed. We also check the Data reduction enable checkbox.

Figure 3-3 shows the Create Pool wizard.

Name:	DRP-10KSAS
Encryption:	<input type="checkbox"/> Enable
Data reduction:	<input checked="" type="checkbox"/> Enable

Figure 3-3 Create Pool wizard

Click Create to create the new data reduction pool.

Figure 3-4 on page 21 shows the command for creating the data reduction pool.

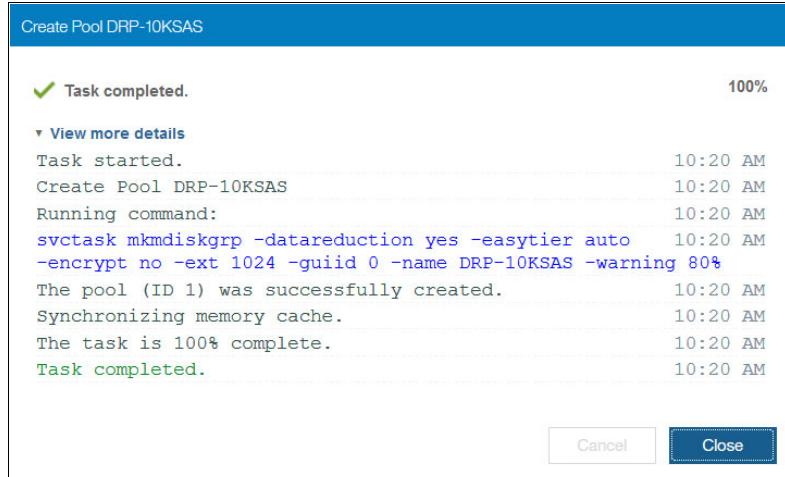


Figure 3-4 CLI command executes

We see that the extent size currently defaults to 1.00 GByte. If a different extent size is required then either the GUI or the CLI can be used to create the storage pool.

Figure 3-5 shows the storage pools view with the newly created data reduction pool. Currently no storage is allocated to the pool.

Name	State	Capacity	Data Reduction
STD-Nearline	✓ Online	1.95 TiB / 2.69 TiB (73%)	No
DRP-10KSAS	✓ Online	0 bytes	Yes

Figure 3-5 Storage pools view including a data reduction pool

Figure 3-6 on page 22 shows how to initiate the Assign Storage wizard. You either right-click the storage pool or click Actions and Add Storage.

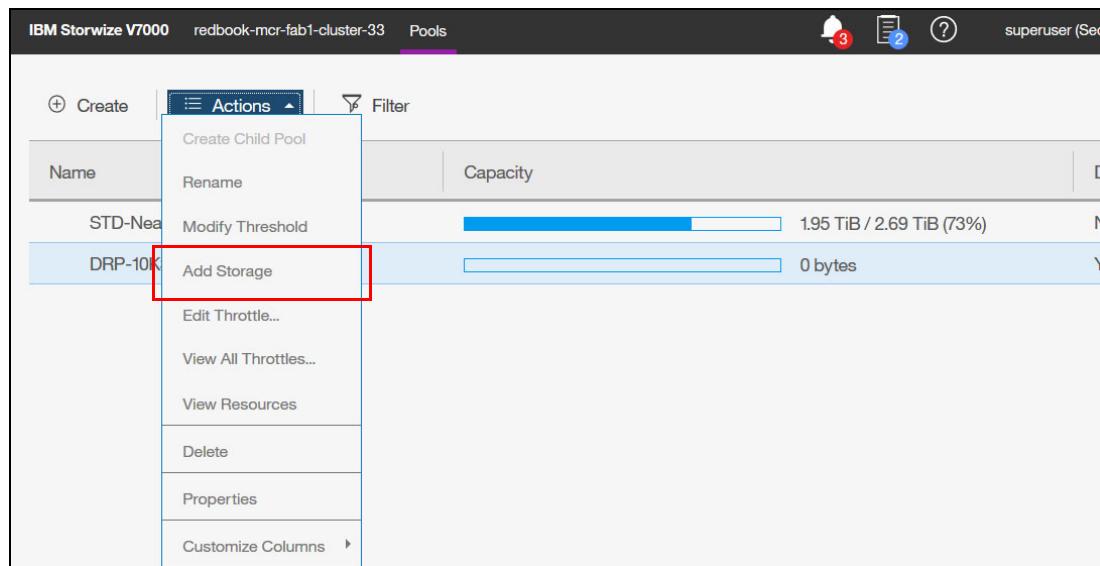


Figure 3-6 Initiate assign storage

Figure 3-7 shows the Assign Storage to pool window. In order to bypass defaults and to prevent volume format to initiate (only applicable for thick provisioned volumes) we click Internal Custom and Assign in the Advanced section.

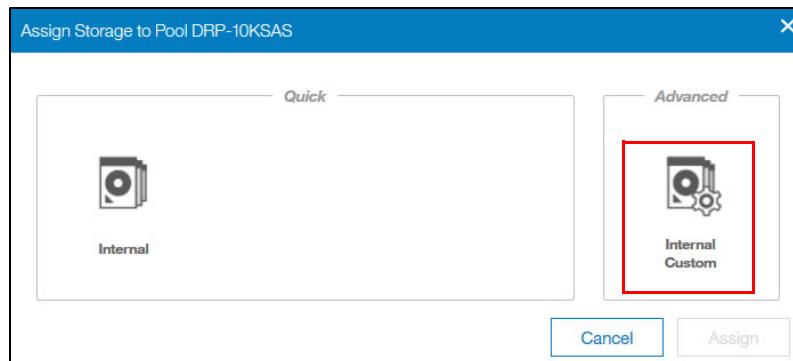


Figure 3-7 Assign storage

Figure 3-8 on page 23 shows the Drive Assignment window. We select Drive Class and the number of drives we want to assign and the preferred RAID-type. IBM recommends distributed RAID-6 (DRAID6) with at least one spare drive for redundancy and better performance.

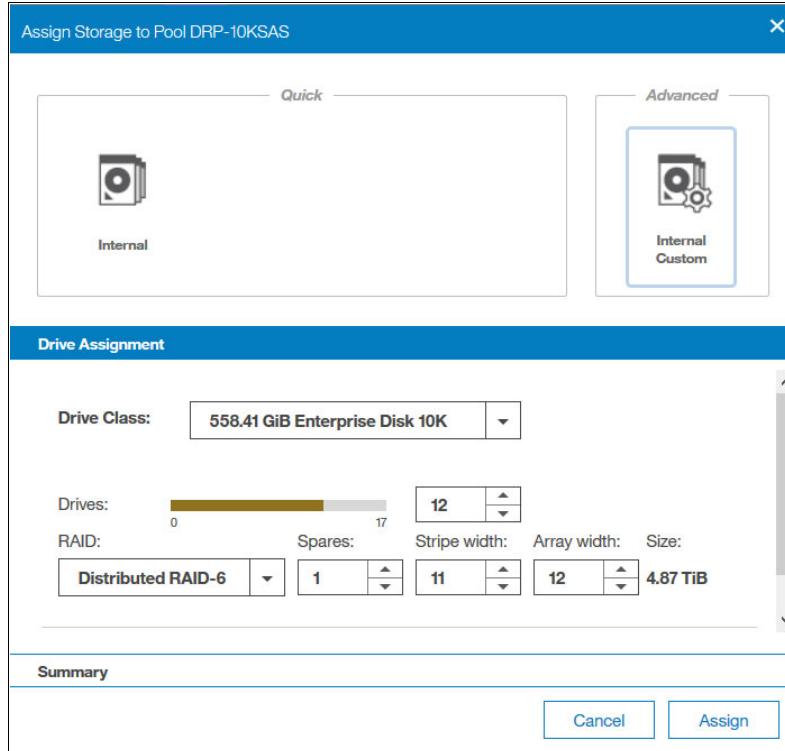


Figure 3-8 Drive assignment

Click Assign to create the new MDisk in the data reduction pool.

Figure 3-9 shows how the CLI executes the drive assignment command.

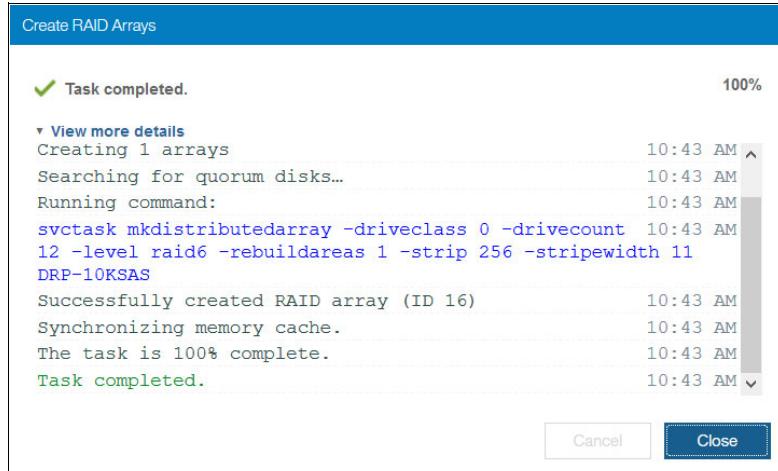


Figure 3-9 CLI executes drive assignment

Figure 3-10 on page 24 shows the Pools window after adding drives to the data reduction storage pool.

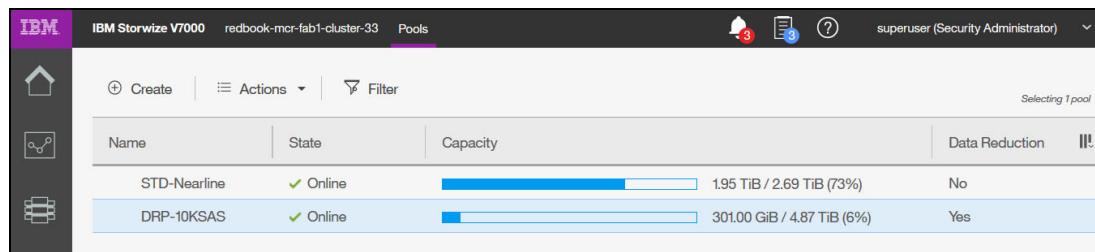


Figure 3-10 Capacity added

Data reduction pools require space for internal purposes, like garbage collection, which is used for cleaning up data extents which in turn frees up space and improves performance. In the example above six percent is allocated from the data reduction pool immediately after assigning storage and before any volumes are created within the pool.

Figure 3-11 shows the Pools → MDisks by Pools window from where storage pools also can be created and managed. This view gives the ability to view MDisks and properties for these including which drives are in the MDisks.

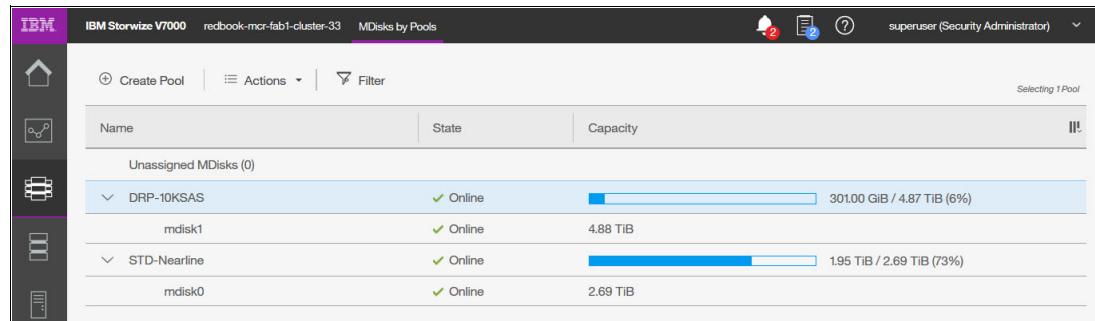


Figure 3-11 MDisks by Pools

Figure 3-12 shows properties for the data reduction pool. It shows that data reduction is enabled and the default extent size is 1.00 GB.

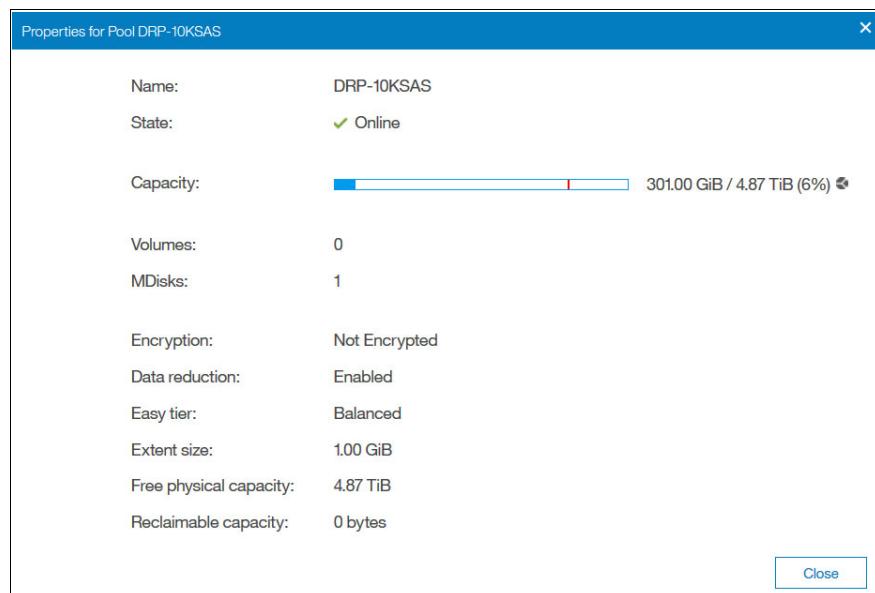


Figure 3-12 Data reduction pool properties

Extent size

A larger extent size increases the total amount of storage that the system can manage. A smaller extent size provides more fine-grained control of storage allocation. Extent size does not affect performance.

Note: For fully allocated volumes or migration between standard pools, volume migration between storage pools can only happen if storage pools have the same extent size.

You cannot migrate a thin-provisioned volume of any kind into/out-of a DRP regardless of extent size.

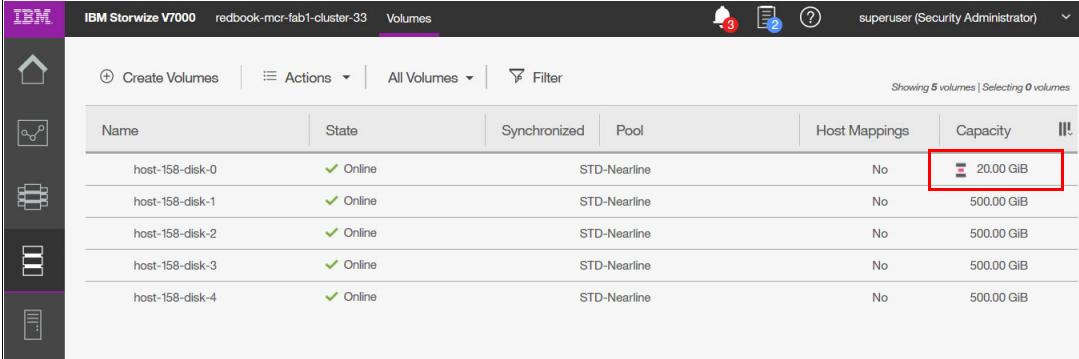
Capacity threshold

Data reduction pools are more sensitive to over-subscription than standard storage pools due to the fact that they use more advanced features. The default warning threshold is 80% just like the standard pool. This limit represents the best practice and leaves space for housekeeping purposes. A data reduction pool may experience performance degradation if it is filled with more than 85% of valid data (garbage is additional to this).

3.3 Creating volumes in data reduction pools

The main purpose of Data Reduction Pools is to be a fast and efficient container for volumes with data reduction capability. Data Reduction Pools can also contain standard thick provisioned volumes.

Figure 3-13 on page 25 shows the Volumes → Volumes view before adding volumes into data reduction pools.



Name	State	Synchronized	Pool	Host Mappings	Capacity
host-158-disk-0	✓ Online		STD-Nearline	No	20.00 GiB
host-158-disk-1	✓ Online		STD-Nearline	No	500.00 GiB
host-158-disk-2	✓ Online		STD-Nearline	No	500.00 GiB
host-158-disk-3	✓ Online		STD-Nearline	No	500.00 GiB
host-158-disk-4	✓ Online		STD-Nearline	No	500.00 GiB

Figure 3-13 Volumes view

So for a given IO group compressed volumes in a standard storage pool cannot coexist with deduplicated volumes in data reduction pools. Hence the compressed volume in the standard pool must be moved into the data reduction pool, or converted into a non-compressed volume before we can create deduplicated volumes in our newly created data reduction pool.

The reason for this limitation is a restriction in memory and compression adapters where two technology types cannot share the same hardware.

Reminder: Compressed volumes in a standard storage pool cannot coexist with deduplicated volumes in data reduction pools

Once the standard storage pool has no compressed volumes you will be able to create compressed/deduplicated volumes in the data reduction pool.

Figure 3-14 on page 26 shows the Create Volume wizard. Under the menu Capacity Savings we can select None, Thin Provisioned and Compressed. If selecting Compressed the Deduplicated checkbox also becomes highlighted and can then also be checked.

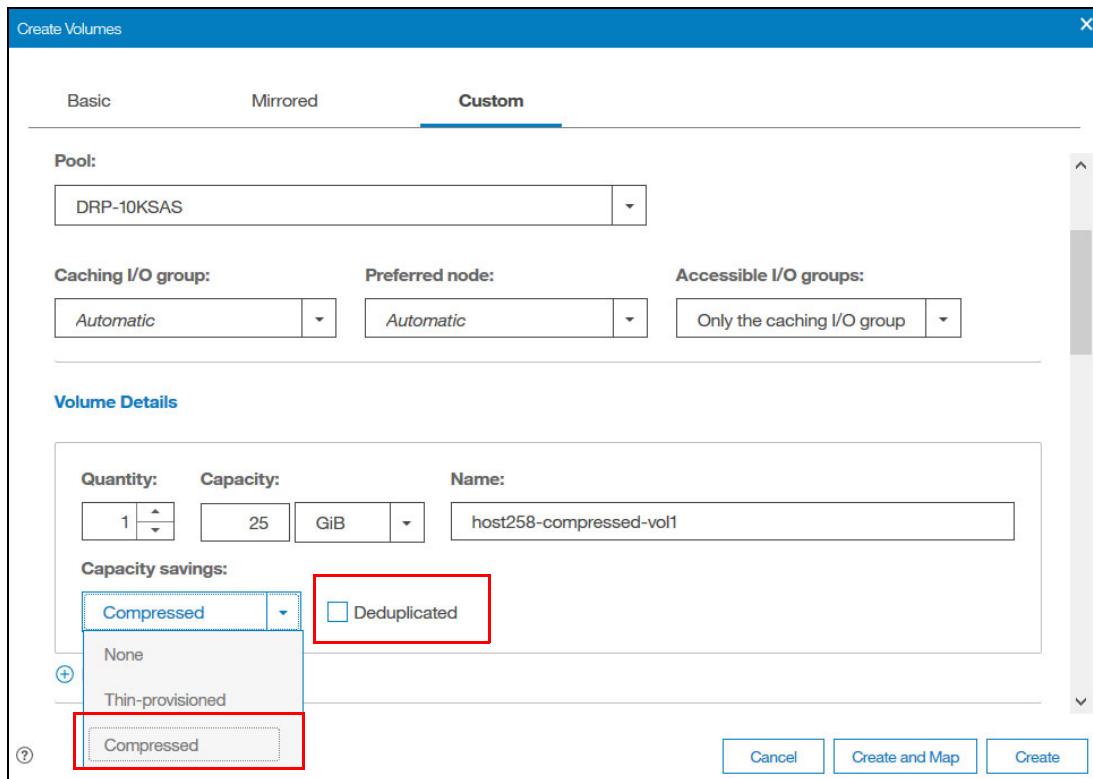


Figure 3-14 Create compressed volume

Figure 3-15 shows the Volumes window. Real capacity and Used capacity has been selected to be displayed also but shows “Not Applicable” for thin provisioned and compressed volumes. The reason for this is that this function is designed for RACE compression and at the current level of code is still not applicable for data reduction pools.

Name	State	Pool	Host Mappings	Capacity	Real Capacity	Used Capacity
host-158-disk-0	✓ Online	STD-Nearline	No	20.00 GiB	20.00 GiB	20.00 GiB
host-158-disk-1	✓ Online	STD-Nearline	No	500.00 GiB	500.00 GiB	500.00 GiB
host-158-disk-2	✓ Online	STD-Nearline	No	500.00 GiB	500.00 GiB	500.00 GiB
host-158-disk-3	✓ Online	STD-Nearline	No	500.00 GiB	500.00 GiB	500.00 GiB
host-158-disk-4	✓ Online	STD-Nearline	No	500.00 GiB	500.00 GiB	500.00 GiB
host238-vol0-thick	✓ Online	DRP-10KSAS	Yes	25.00 GiB	25.00 GiB	25.00 GiB
host238-vol2-thin	✓ Online	DRP-10KSAS	Yes	25.00 GiB	Not Applicable	Not Applicable
host238-vol3-comp	✓ Online	DRP-10KSAS	Yes	25.00 GiB	Not Applicable	Not Applicable
host238-vol4-comp-dedup	✓ Online	DRP-10KSAS	Yes	25.00 GiB	Not Applicable	Not Applicable

Figure 3-15 Volumes window

Easy Tier in Data Reduction Pools

IBM Easy Tier is a function that automatically and non disruptively moves frequently accessed data from slower drives to faster drives and vice-versa, thus placing hot and cold data in a faster or slower tier of storage depending on data activity.

Easy Tier can be managed at the storage pool level and it can be enabled and disabled at the volume level for traditional volumes. However, due to changed volume allocation in Data Reduction Pools, Easy Tier cannot be disabled on volumes in Data Reduction Pools.

3.4 Volume migration

In the following we give examples of migrating volumes from a standard storage pool to a data reduction pool. Reasons for such migration include compressing a non-compressed volume, or compressing and deduplication a non-compressed volume. Data reduction pools are more effective and better performing for data reduction purposes and migrating data away from standard storage pools would be common tasks of storage administrators if the goal is to reduce and improve performance for compressed data.

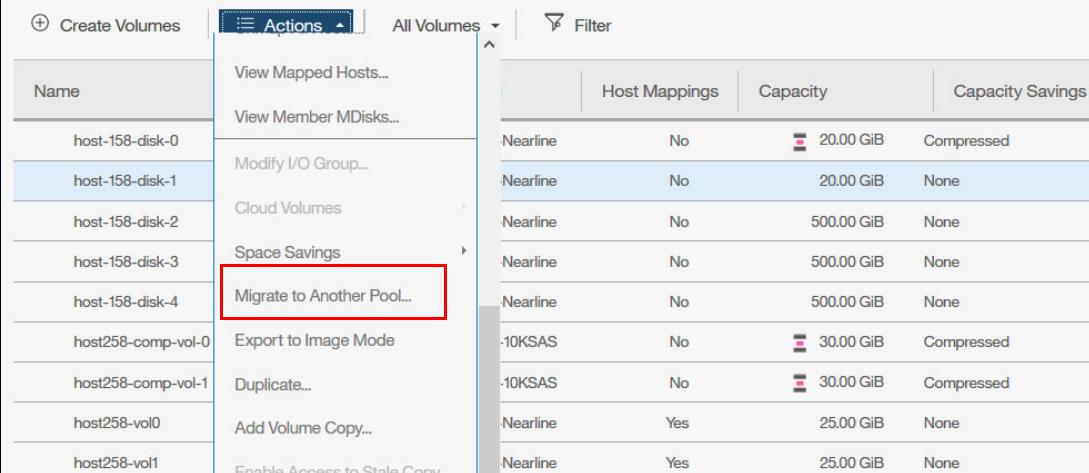
Migrating a standard volume to a DRP

Figure 3-16 shows the Volumes window. We see two volumes: one is compressed and one is a standard thick provisioned volume. Both volumes are placed in a standard pool.

Name	State	Pool	Host Mappings	Capacity	Capacity Savings
host-158-disk-0	✓ Online	STD-Nearline	No	20.00 GiB	Compressed
host-158-disk-1	✓ Online	STD-Nearline	No	20.00 GiB	None

Figure 3-16 Volumes view

Figure 3-17 shows the volume view where we initiate the migration process. Either click Actions or right-click on the volume and select Migrate to Another Pool.

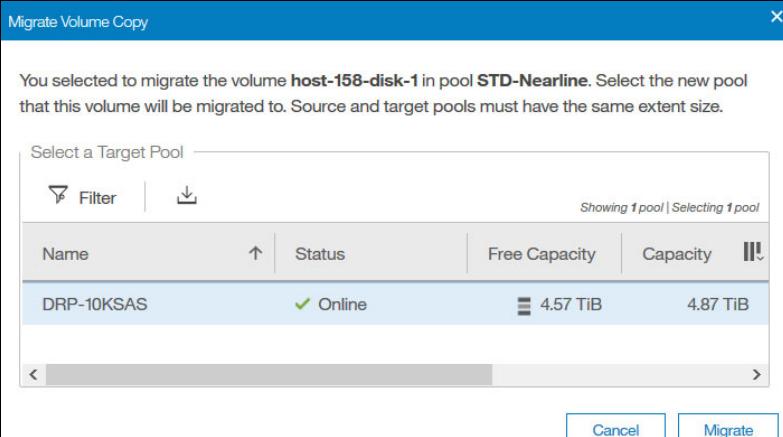


The screenshot shows a list of volumes on the left and a detailed view of 'host-158-disk-1' on the right. The 'Actions' menu for 'host-158-disk-1' is open, with 'Migrate to Another Pool...' highlighted.

	Host Mappings	Capacity	Capacity Savings
Nearline	No	20.00 GiB	Compressed
Nearline	No	20.00 GiB	None
Nearline	No	500.00 GiB	None
Nearline	No	500.00 GiB	None
Nearline	No	500.00 GiB	None
·10KSAS	No	30.00 GiB	Compressed
·10KSAS	No	30.00 GiB	Compressed
Nearline	Yes	25.00 GiB	None
Nearline	Yes	25.00 GiB	None

Figure 3-17 Migrate to another pool

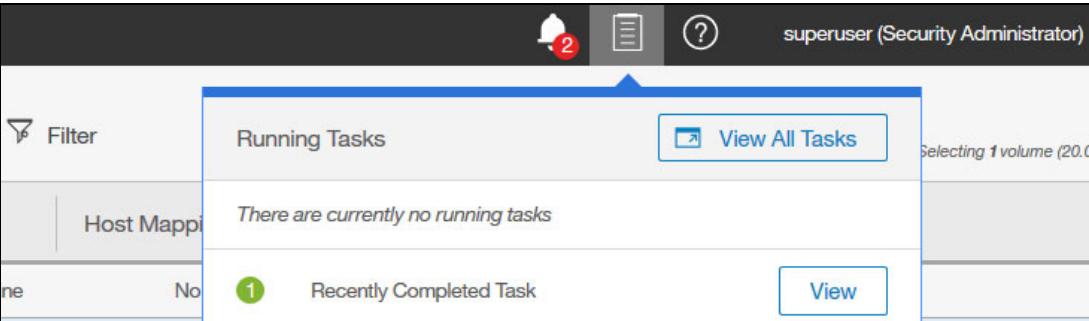
Figure 3-18 on page 28 shows the Migrate Volume Copy wizard. We select the new storage pool and click Migrate.



The screenshot shows the 'Migrate Volume Copy' wizard. It displays a list of storage pools: 'DRP-10KSAS' is selected and highlighted. The 'Migrate' button is visible at the bottom.

Figure 3-18 Select new storage pool

Migration progress can be viewed from the Running Tasks window as shown in Figure 3-19.



The screenshot shows the 'Running Tasks' window. It displays a table with one row: 'Recently Completed Task'. A 'View' button is located next to this row.

Figure 3-19 Running tasks

The migration task completed and can be viewed by clicking View as shown in Figure 3-20.

Select a running task to see its progress.		Recently Completed Task		
1 Recently Completed Task				
		Name	Completion Time	↓
		host-158-disk-1, copy 0 → Pool DRP-10KSAS	< 1 minute ago	

Figure 3-20 Show recently completed tasks

Figure 3-21 shows the Volumes window. The volume we migrated is now located in the data reduction pool.

Name	↑	State	Pool	Host Mappings	Capacity	Capacity Savings
host-158-disk-0		✓ Online	STD-Nearline	No	20.00 GiB	Compressed
host-158-disk-1		✓ Online	DRP-10KSAS	No	20.00 GiB	None

Figure 3-21 volumes window

It makes no sense to move a thick provisioned volume from a standard storage pool to a data reduction pool, unless the goal is to empty the standard storage pool so that the disks can be used for other purposes. However, one good reason may be to migrate the thick provisioned volume to a data reduction pool because we want to compress the volume. The procedure for doing so is to create a compressed volume copy, and then, when fully synchronized, delete the original and thick provisioned volume copy.

This action can be performed within the same storage pool and it can be performed between storage pools.

Migrating a standard volume to a compressed volume in a DRP

Given the example above, where we moved a volume from one storage pool to another, we will now demonstrate how to create a compressed volume copy while at the same time placing this in a data reduction pool.

Figure 3-22 shows the Volumes window.

Name	↑	State	Pool	Host Mappings	Capacity	Capacity Savings
host-158-disk-0		✓ Online	STD-Nearline	No	20.00 GiB	Compressed
host-158-disk-1		✓ Online	STD-Nearline	No	20.00 GiB	None

Figure 3-22 Volumes window

Figure 3-23 shows the Add Volume Copy window. Default for the original Copy 0 is the pool where the volume is currently located. We select the pool for Copy 1 which is DRP-10KSAS and under Capacity Savings we select Compressed. Deduplicated is not highlighted because, as we mentioned in 3.3, “Creating volumes in data reduction pools” on page 25, compressed volumes in standard pools cannot coexist with deduplicated volumes in data reduction pools.

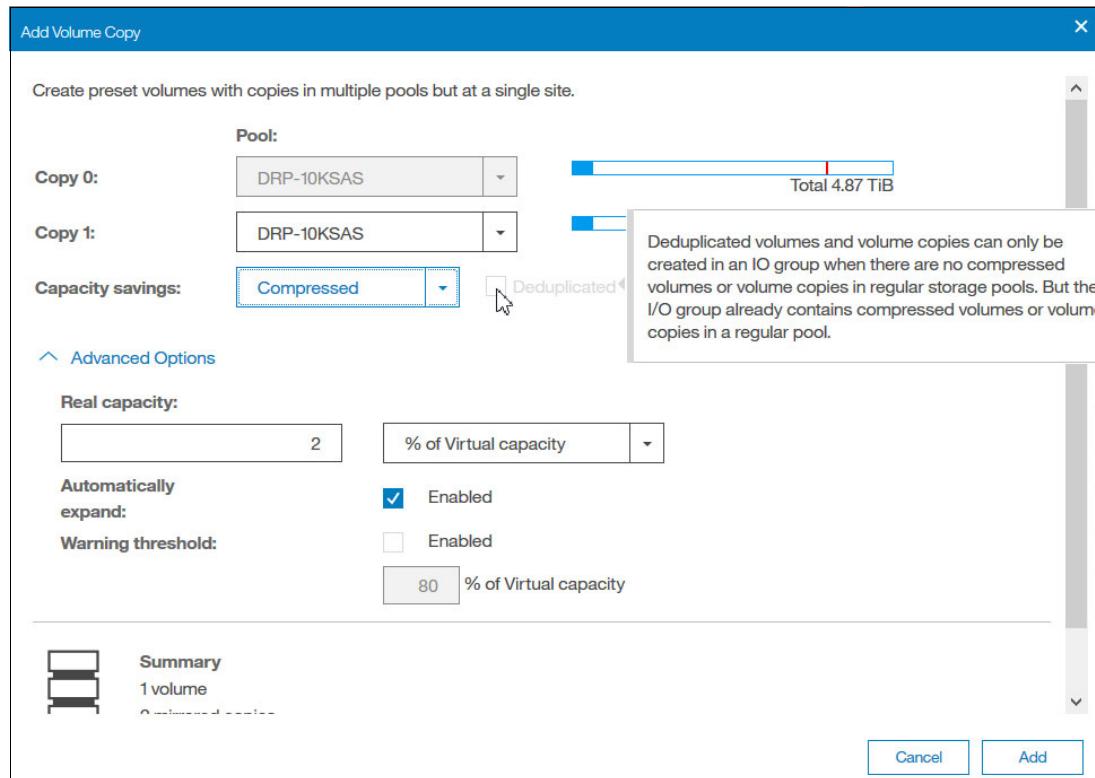


Figure 3-23 Add Volume Copy

Click Add to create the compressed volume copy.

Figure 3-24 shows the resulting volumes window. We now have two volume copies where one is compressed and in a data reduction pool. The volume copy creation may not have finished creation and its progress can be viewed in the Show Running Tasks window.

Name	↑	State	Pool	Host Mappings	Capacity	Capacity Savings
host-158-disk-0	✓	Online	STD-Nearline	No	20.00 GiB	Compressed
host-158-disk-1	✓	Online	STD-Nearline	No	20.00 GiB	Compressed
Copy 0*	✓	Online	STD-Nearline	No	20.00 GiB	None
Copy 1	✓	Online	DRP-10KSAS	No	20.00 GiB	Compressed

Figure 3-24 Volumes window

When the volume copy creation has finished the original volume copy can be deleted by right clicking Copy 0 and select Delete as shown in Figure 3-25.

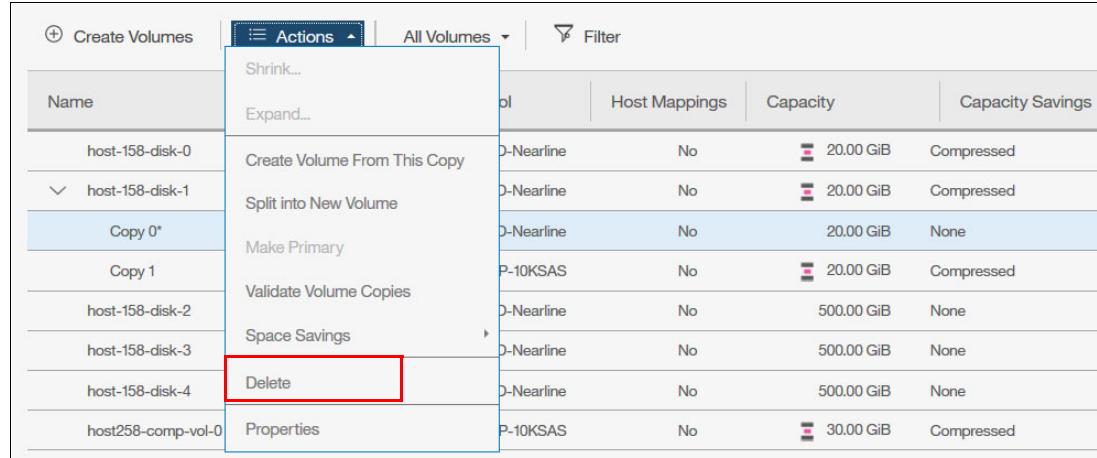


Figure 3-25 Delete volume copy

When this action has completed the volume has now been migrated to a compressed volume in the data reduction pool with the resulting Volumes window as shown in Figure 3-26.

Name	↑ State	Pool	Host Mappings	Capacity	Capacity Savings
host-158-disk-0	✓ Online	STD-Nearline	No	20.00 GiB	Compressed
host-158-disk-1	✓ Online	DRP-10KSAS	No	20.00 GiB	Compressed

Figure 3-26 Resulting Volumes window

Mirror sync rate

The parameter **mirror sync rate** controls the data copied per second in volume copy relationships. This setting affects the initial rate of formatting and the rate at which the volume copies resynchronize after loss of synchronization.

Table 3-1 Relationship between the sync rate value and the data copied per second

User-specified sync rate attribute value	Data copied/sec
1 - 10	128 KB
11 - 20	256 KB
21 - 30	512 KB
31 - 40	1 MB
41 - 50	2 MB
51 - 60	4 MB
61 - 70	8 MB
71 - 80	16 MB
81 - 90	32 MB
91 - 100	64 MB

The default mirror sync rate value is 50. For creating mirror copies in larger volumes it may be necessary to increase the mirror sync rate for the mirror copy to complete to a synchronized state within a reasonable time.

To review or change the mirror sync rate go to the menu Volumes → Volumes. Select the volume to be modified and either right-click or click Actions followed by Modify Mirror Sync Rate as shown in Figure 3-27.

Name	State	Pool	Host Mappings
host-158-disk-1	✓ Online	DRP-10KSAS	No
host-158-disk-0	✓ Online	DRP-10KSAS	No
host258-comp-vol-0	✓ Online	DRP-10KSAS	No
host258-comp-vol-1	✓ Online	DRP-10KSAS	No
host-158-disk-2	✓ Online	STD-Nearline	No
Copy 0*	✓ Online	STD-Nearline	No
Copy 1	✓ Online	DRP-10KSAS	No
host-158-disk-3	✓ Online	STD-Nearline	No
host-158-disk-4	✓ Online	STD-Nearline	No
host258-vol0	✓ Online	STD-Nearline	Yes
Copy 0*	✓ Online	STD-Nearline	No
Copy 1	✓ Online	DRP-10KSAS	No

Figure 3-27 Modify Mirror Sync Rate

Default mirror sync rate value is 50 and we change the value to 100 and click Modify as shown in Figure 3-28.

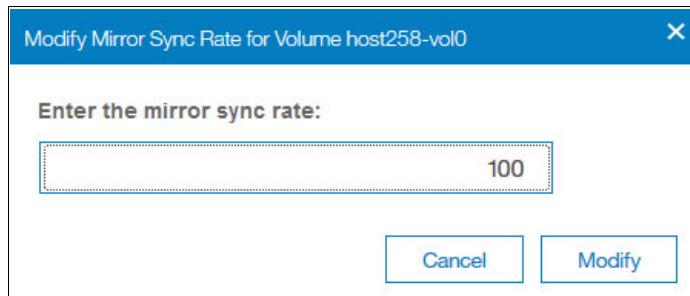


Figure 3-28 Select the new mirror sync rate value

The CLI executes as shown in Figure 3-29.

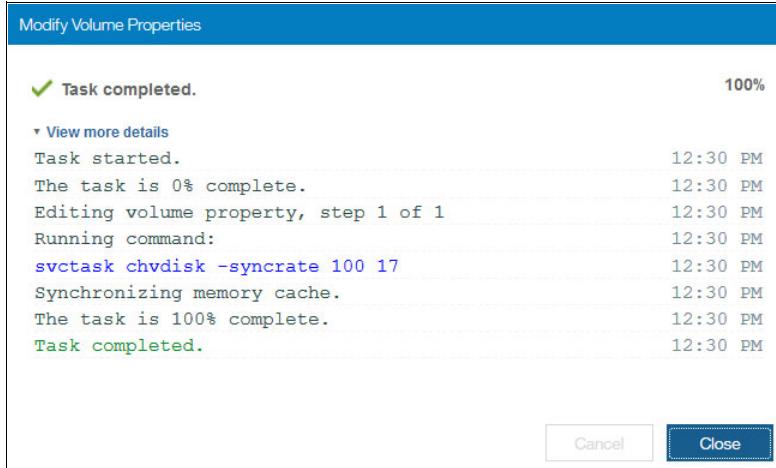


Figure 3-29 CLI executes

Figure 3-30 shows Running Tasks of a newly created volume mirror relationship where a 500 GB standard volume creates a mirror into a compressed volume. The volume uses default mirror sync rate of 50 which corresponds to 2 MB/sec. By viewing running tasks the remaining copy time to completion equals to more than 70 hours.

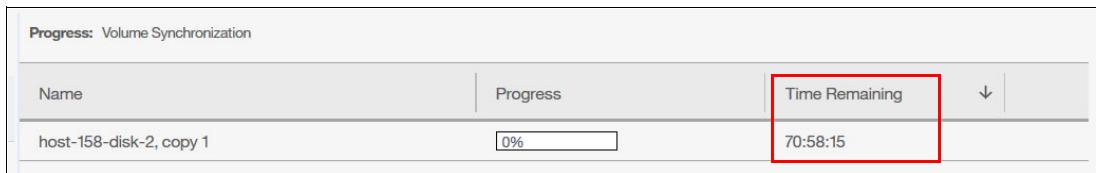


Figure 3-30 running tasks remaining time using default mirror sync rate

By changing the value of mirror sync rate value to maximum the mirror will complete much quicker.

Figure 3-31 shows the remaining copy time to completion is now only two hours with a mirror sync rate value of 100 which corresponds to 64 MB/sec.

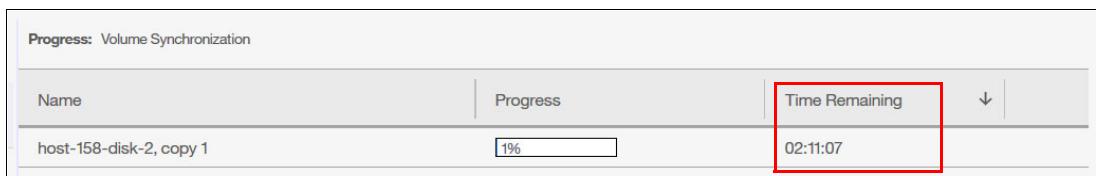


Figure 3-31 running tasks remaining time using mirror sync rate value 100

Considerations for modifying mirror sync rate

Obviously use a higher mirror sync rate for the volume copy if you want volume mirror to go quicker. The fastest speed is 64 MB/s. Volume mirror workload is sequential and it may not cause a performance problem if a higher rate is used. However, if many mirror copies are active doing an initial sync at the same time, or if resync is needed due to site or hardware problems, it may have a performance impact if all volumes are set to maximum mirror sync rate.

The default copy synchronization rate is set to 2 MB/sec. in order to avoid overloading the managed disks or backend storage system. Use the Spectrum Virtualize built in performance

monitor or Spectrum Control to monitor MDisk latency while building mirror relationships which may help to determine if a higher mirror sync rate can be chosen or if more copies can be active simultaneously.

One approach to create mirror copies into compressed copies may be to use the maximum mirror sync rate while building the mirror copies and then reduce to the default when synchronization is obtained.

For more information of the command **addvdiskcopy** and mirror sync rate see:

<https://ibm.co/2ztGdUu>

Migrating a compressed volume to a compressed volume in a DRP

When a RACE compressed volume is in a standard storage pool and you want to migrate this to a data reduction pool, the migration feature as shown in “Migrating a standard volume to a DRP” on page 27 is unavailable. The way to migrate such a volume is to first create a compressed mirror volume copy in the data reduction pool, and then delete the original volume copy following the same directions as shown in the section “Migrating a standard volume to a compressed volume in a DRP” on page 29.



4

Estimator and sizing tools

This chapter provides, information of specific tools used for sizing environment for data reduction pools and deduplication.

In this chapter we describe the tools and use of them as it pertains to Data Reduction Pools and Deduplication.

4.1 Evaluate compression savings using comprestimator

Comprestimator is a comprehensive tool that is used to monitor the performance of clusters, and to measure the level of compression and whether it is a good candidate for compression.

Before utilizing IBM Data Reduction Pools (DRP), it is important for storage administrators to analyze individual volumes or all volumes that are being considered for potential compression savings. This will help you determine if the workload that you are analyzing is a good candidate for DRP.

Note: Data Reduction Pools has metadata processing that takes place in the background. Some consideration should be taken into account when planning for sizing although the overhead is minimal.

IBM Comprestimator is an integrated GUI and CLI host-based utility that estimates the space savings achieved when using compressed volumes for block devices. This utility provides a quick and easy view of showing the benefits of using compression. The utility performs read only operations and therefore will have no effect on the data that is being stored on device.

If the compression savings prove to be beneficial in your environment, volume mirroring can be used to convert volumes to compressed volumes then added to the data reduction pools.

When using the CLI use the command shown in Example 5-1 to run volume analysis against a single volume.

Example 4-1 shows the command **analyzevdisk**.

Example 4-1 analyzevdisk command

```
IBM_Storwize:redbook-mcr-fab1-cluster-33:superuser>svctask analyzevdisk -h
```

analyzevdisk

Syntax

```
>>- analyzevdisk -- --+-----+-- ---+ vdisk_id ---+----->
          ' - -cancel-'      ' - vdisk_name - '
```

For more details type 'help analyzevdisk'.

```
IBM_Storwize:redbook-mcr-fab1-cluster-33:superuser>svctask analyzevdisk vol1
IBM_Storwize:redbook-mcr-fab1-cluster-33:superuser>
```

When using the CLI use the command shown in Example 5-2 to run volume analysis against the entire system.

Example 4-2 shows the command **analyzevdiskbysystem**.

Example 4-2 analyzevdiskbysystem

```
M_Storwize:redbook-mcr-fab1-cluster-33:superuser>svctask analyzevdiskbysystem -h
```

```
analyzevdiskbysystem
```

Syntax

```
>>> analyzevdiskbysystem -- --+-----+-----><
          '- -cancel-'
```

For more details type 'help analyzevdiskbysystem'.

```
IBM_Storwize:redbook-mcr-fab1-cluster-33:superuser>svctask analyzevdiskbysystem
vol1
IBM_Storwize:redbook-mcr-fab1-cluster-33:superuser>
```

Note: Commands **analyzevdisk** and **analyzevdiskbysystem** return back to the command prompt.

If you want to see the results of the volumes that you are analyzing, run the command shown in Example 4-3.

Example 4-3 lsvdiskanalysis and lsvdiskanalysis progress commands

```
IBM_Storwize:redbook-mcr-fab1-cluster-33:superuser>lsvdiskanalysisprogress
vdisk_count pending_analysis estimated_completion_time
12          12          180622091300
IBM_Storwize:redbook-mcr-fab1-cluster-33:superuser>
```

As stated previously, the utility can be used from the IBM Spectrum Virtualize V8.1 GUI. Figure 5-1 shows how to start a complete system analysis on compression estimates, go to **Volumes** → **Actions** → **Space Savings** → **Estimate Compression Savings**.

A window prompt will appear with the estimated time of completing the estimate on compression savings. This process can be monitored by adding the volumes that show compression savings in the volume table as shown in Figure 4-1 on page 38.

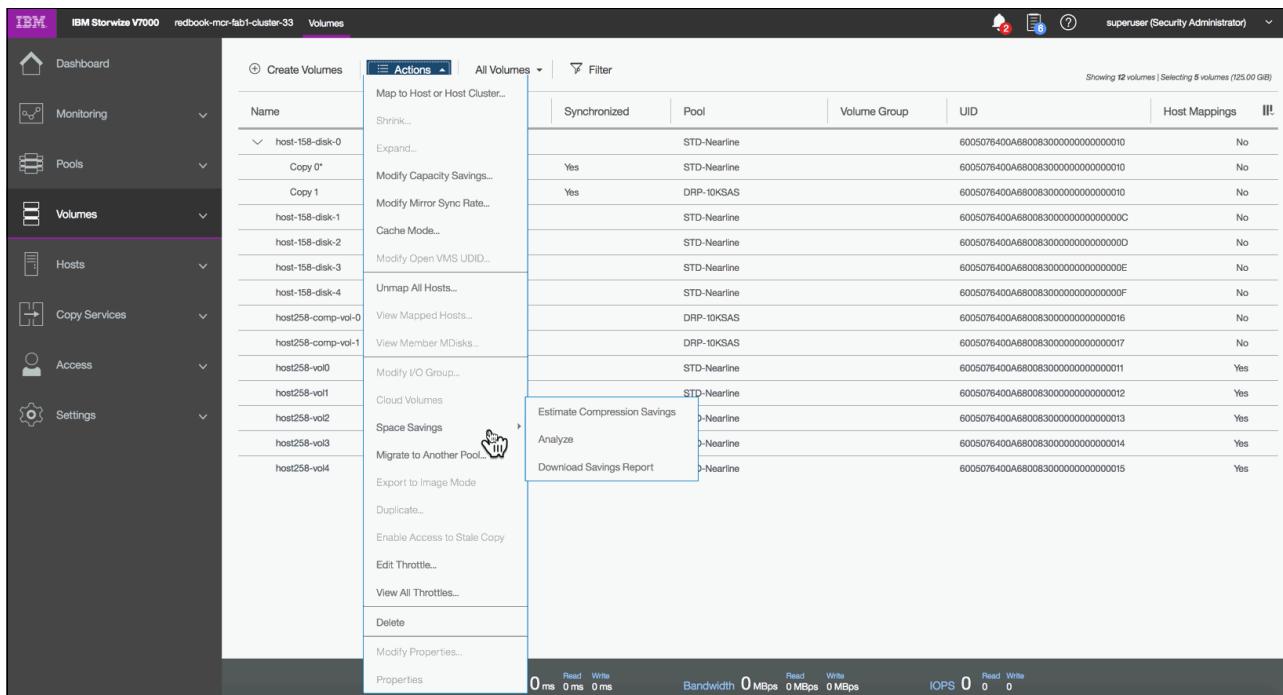


Figure 4-1 Estimate compression savings

If you are using a version of IBM Spectrum Virtualize that is before V7.6 or if you would like to estimate the compression savings of a different device, the IBM Comprestimator Utility can be installed on a host that is connected to the device that needs to be analyzed. More information and the latest version of this utility can be found at this website:

<http://www-304.ibm.com/support/customercare/sas/f/comprestimator/home.html>

There are a few recommended best practices for using Comprestimator:

- ▶ Run the Comprestimator utility before implementing an IBM Spectrum Virtualize solution and before implementing the IBM Data Reduction Pools technology.
- ▶ Download the latest version of the Comprestimator utility if you are not using one that is included in your IBM Spectrum Virtualize solution.
- ▶ Use Comprestimator to analyze volumes that contain as much active data as possible rather than volumes that are nearly empty or newly created. This will ensure more accuracy when sizing your environment for compression and data reduction pools.

Note: Comprestimator can run for a long period (a few hours) when it is scanning a relatively empty device. The utility randomly selects and reads 256 KB samples from the device. If the sample is empty (that is, full of null values), it is skipped. A minimum number of samples with actual data are required to provide an accurate estimation. When a device is mostly empty, many random samples are empty. As a result, the utility runs for a longer time as it tries to gather enough non-empty samples that are required for an accurate estimate. If the number of empty samples is over 95%, the scan is stopped.

4.2 Evaluating workload using Data Reduction Estimator Tool

Data Reduction Estimator Tool (DRET) is a CLI operated execution file that runs from the host to analyze a given block device. It provides a report of what it would expect the deduplication savings to be from data written to the disk. There are no additional adjustments or requirements to run this tool on your IBM Spectrum Virtualize solution.

DRET displays its accuracy best with sequential workloads and with volumes that contain the most active data in a storage environment. DRET is accurate at analyzing a range of workloads to identify the range at which the capacity a volume can be used. Furthermore, it is able to complete these tasks within a reasonable amount of time as shown in Table 4-1.

Table 4-1 Estimated time per block size

Volume Size	Time Taken (minutes)
15GB	1
35GB	1
100GB	41
1TB	32

When using DRET to analyze a block device used by a file system, all underlying data in the device is analyzed, regardless of whether this data belongs to files that were already deleted from the file system. For example, you can fill a 100GB file system and make it 100% used, then delete all the files in the file system making it 0% used. When scanning the block device used for storing the file system in this example, Data Reduction Estimator will access the data that belongs to the files that are already deleted.

Important: The preferred method of using Data Reduction Estimator is to analyze volumes that contain as much active data as possible rather than volumes that are mostly empty of data. This increases the accuracy level and reduces the risk of analyzing old data that is already deleted, but may still have traces on the device.

More information and the latest version of this utility can be found at this website:

<http://www14.software.ibm.com/webapp/set2/sas/f/dretool/home.html>

4.3 Evaluating workload using Disk Magic

Disk Magic for IBM is a performance analysis and hardware configuration planning tool for IBM storage disk subsystems that runs on MS Windows. It is licensed by IBM from IntelliMagic for exclusive use by IBMers and IBM Business Partners in the selling of new or upgraded IBM disk storage solutions.

Proper initial sizing greatly helps to avoid future sizing problems. Disk Magic is one such tool that is used for sizing and modeling storage subsystems for various open systems environments and various IBM platforms. It provides accurate performance and capacity analysis and planning for IBM Spectrum Virtualize products, other IBM storage solutions, and other vendors' storage subsystems. Disk Magic provides in-depth environment analysis, and is an excellent tool to estimate the performance of a system that is running (DRP) Data Reduction Pools.

For IBM Business Partners that would like more information about Disk Magic, and the latest version, can be found at this website:

<http://www.ibm.com/partnerworld/wps/servlet/ContentHandler/SSPQ048068H83479I86>



Best practices and guidelines

This chapter describes the preferred practice and guidelines for using IBM Spectrum Virtualize Data Reduction Pool (DRP) technology. The suggestions are based on the newly revised architecture of the product.

In this chapter we provide use cases and preferred practices for the DRP technology and its performance and efficiency gains.

This chapter is intended for experienced SVC and Storwize administrators and consultants. This book requires advanced knowledge of the SVC and Storwize products.

This chapter discusses the following:

- ▶ DRP performance
- ▶ Use Cases

Recommended software level: The minimum recommended software level is V8.1.3.2 which is available from IBM Fix Central and contains a number of critical fixes.

5.1 RACE and DRP overview

Flash and solid state drive (SSD) technology are improving constantly in performance and this technology provides low latency for application workloads.

Although Flash technology is cheaper than before, it has also reduced TCO as it requires less cooling and rack space, although it is currently still more expensive than traditional spinning disks. For this reason, storage administrators will optimize the amount of data stored on Flash storage to drive the TCO even lower.

IBM Data Reduction Pool technology is developed to optimize the Flash workload to provide cost savings by storing less data but at the same time providing stable and predictable performance.

5.1.1 DRP performance benefits

The SVC and Storwize first RACE implementation was software only. Later on dedicated hardware compression was introduced. The RACE implementation was created at a time when spinning disks were implemented in the majority of storage infrastructures. Today, SSD/Flash technology use is more widespread and data storage and capacity optimization are one of the key goals in the industry.

Initially, the original RACE implementation was done using a software only approach on the Storwize platform. As the product matured we were able to use hardware accelerators and Flash/SSD back-end technology to increase performance.

Data Reduction Pool technology is targeted to leverage the hardware accelerator and Flash technology. The architecture of DRP compression does not dedicate any hardware to compression software as significantly improved load balancing and Flash optimized IO paths provide an optimal performance for a compressed workload.

5.1.2 DRP performance improvements

These are some of the major DRP improvements:

- ▶ Multi threaded approach improved latency and throughput
- ▶ All memory and cores available to all function, no dedicated cores/memory.
- ▶ Up to 3x throughput can be achieved for system with hardware accelerators
- ▶ New compression and deduplication implementation to leverage new hardware

Note: Storwize V5030 does not have a dedicated compression accelerator card and it uses software compression only.

Data Reduction Pool IO handling

Data Reduction Pool technology uses a fixed block size (also known as grain size) of 8 KB. This block size was chosen specifically to optimize the workload for Flash storage where small block IO leverages low latency flash performance. Host IO is acknowledged by the upper cache layer and then processed in 8 KB chunks.

Figure 5-1 shows DRP Compression.

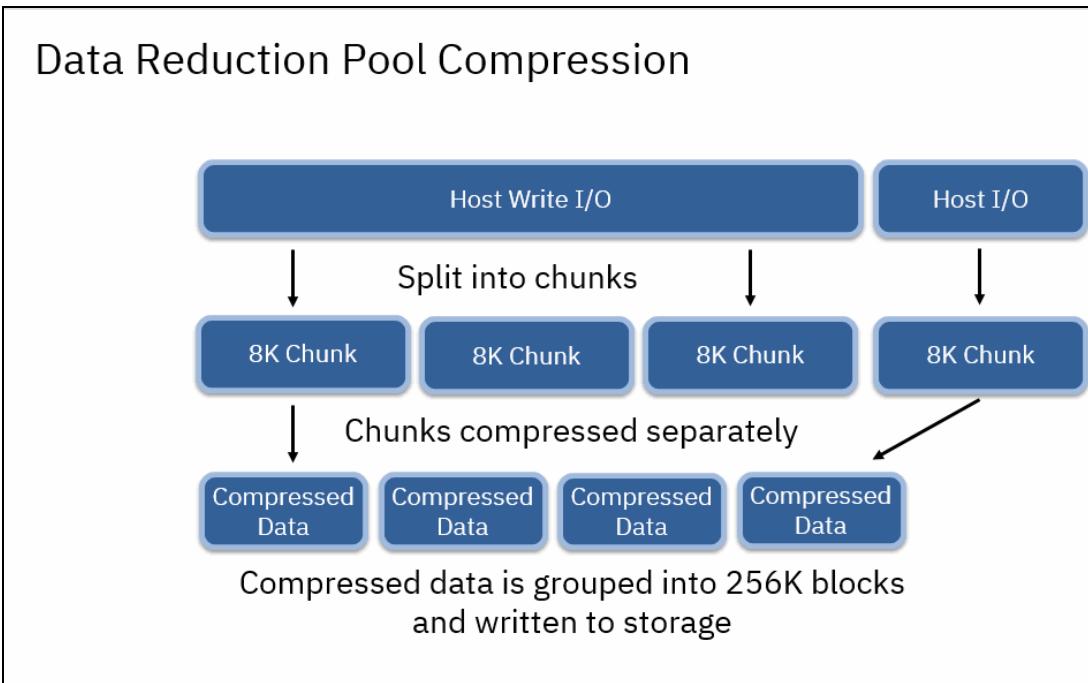


Figure 5-1 DRP Compression

DRP technology introduces an implementation of compression which will provide a stable performance irrespective of the IO size and workload pattern compared to the RACE implementation where certain workload types may have reduced performance. The compression workload will get a predictable performance no matter what the workload type is. This consistent performance will encourage users to compress workloads on Flash and it provides efficient cost saving and better performance.

DRP technology is ideal for Flash storage with compression. For example, with a compression pattern of 2:1 or higher, host IO will be sliced up into 8KB equal chunks, plus each 8KB chunk will be compressed to 4 KB or less, and is the optimal block size for leveraging flash performance.

The new compression implementation may lead up to 4x throughput for compressed workload with consistent performance.

DRP deduplication with compression provides the best storage efficiency. This combination will deduplicate and then compress the data reducing the storage capacity usage. It is recommended to use this option when the workload is compressible and it has a high duplicate ratio identified by the DRET tool, see 4.2, “Evaluating workload using Data Reduction Estimator Tool” on page 39.

DRP Deduplication IO handling

Host IO is processed in 8 KB chunks and then an in-memory calculation is performed for deduplication.

Host write IO for the deduplication volume is acknowledged back to the host by the upper cache layer, deduplication is performed after acknowledging the write to the host so the host performance is not impacted by deduplication.

The host read may be a cache hit and/or a read from the back-end depending upon the workload type.

Figure 5-2 shows DRP deduplication.

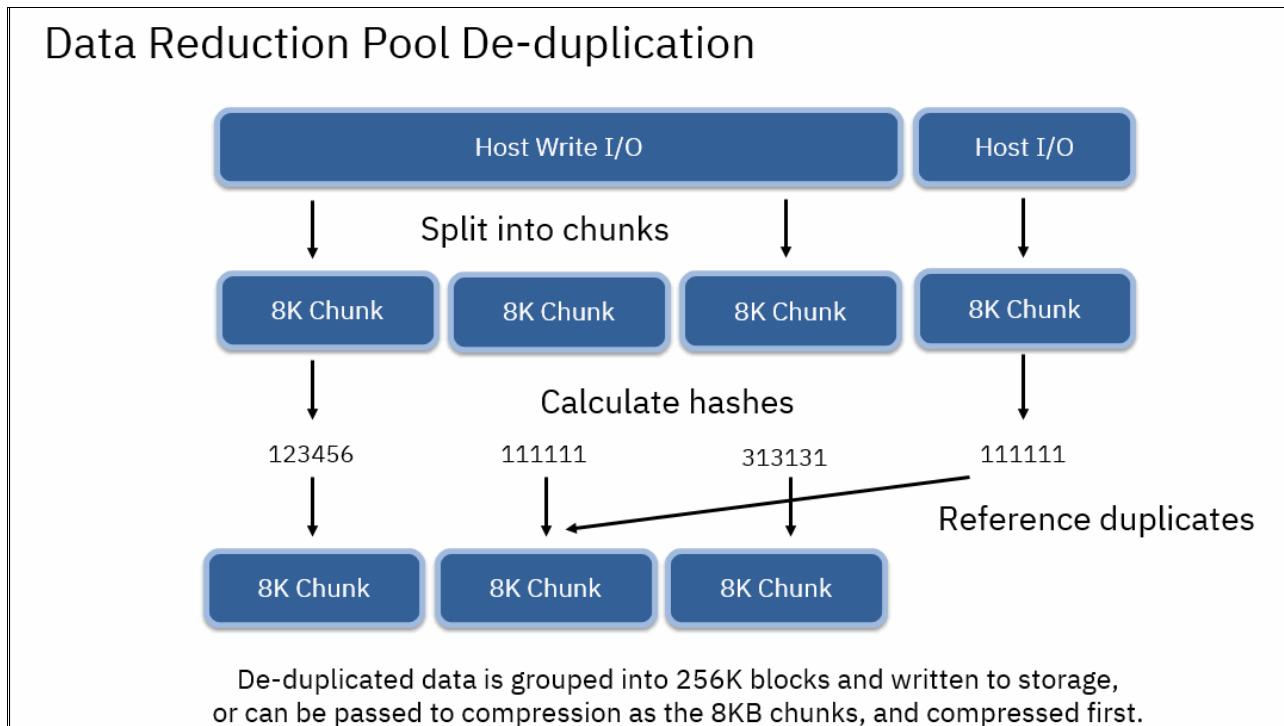


Figure 5-2 DRP deduplication

DRP Volume types

As a reminder from previously, DRP technology allows you to create five types of volumes

- ▶ Fully allocated
This type provides no storage efficiency but the best performance and is available for migration
- ▶ Thin
This type provides storage efficiency but no compression or deduplication
- ▶ Thin and Compressed
This type provides storage efficiency with compression and this combination will provide the best performance numbers
- ▶ Thin and Deduplication
This type provides storage efficiency but without compression
- ▶ Thin, Compressed and Deduplication
This type provides storage efficiency with maximum capacity savings

With storage efficiency, DRP thin and compressed volumes provide the best performance numbers. This is due to the new compression implementation. This implementation provides better load balancing and consistent performance when compared to the RACE implementation. This feature is also the second best performer to fully allocated volumes, followed by thin, compressed and deduplication volumes when it comes to storage efficiency.

Figure 5-3 on page 45 shows the types of volumes in the DRP pools.

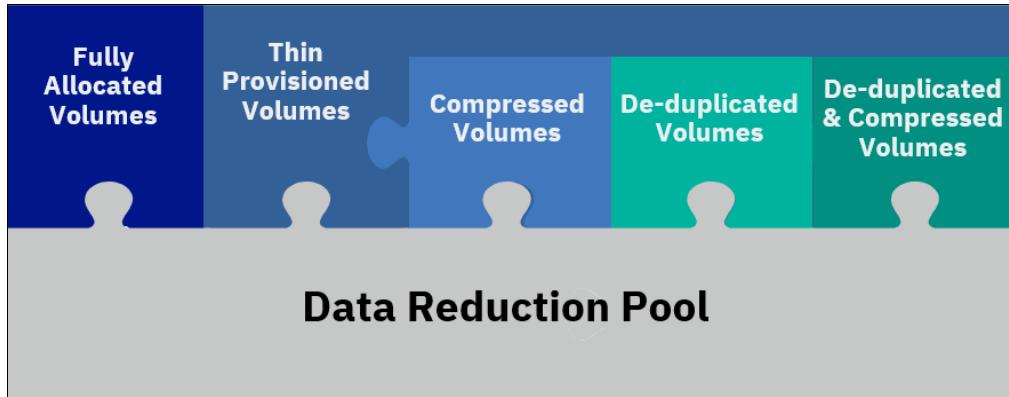


Figure 5-3 Volume types

We will discuss these volume combinations from a performance perspective.

Users should select the volume type which meets the business objectives and leverages good performance from DRP technology. Each of the above volume combinations provides certain benefits for storage efficiency and have different performance characteristics.

DRP technology allows the user to create a fully allocated volume. Fully allocated volumes provide the best performance but does not provide the best storage efficiency. This option is allowed for migrations, and also for applications which require maximum performance with lowest possible latency.

The current recommendation is to use DRP compressed volumes. There are two exceptions to this; first exception, if the workload has higher than a 30% deduplication ratio, use DRP deduplicated volumes instead. The second exception is if the hardware platform is Storwize V5030, when you would size for compressibility and performance. For more details, see Chapter 4., “Estimator and sizing tools” on page 35.

Configuring your system for best DRP performance

The purpose of SVC/Storwize storage pools are designed to separate workload or to mitigate against hardware failures using a failure domain. Standard pools can get similar performance numbers whether they are using single or multiple pools, however DRP performance gets a boost by increasing the numbers of pools in the system. Storage infrastructure should be designed in such a way where the workload is separated by workload type in different failure domains to achieve maximum DRP performance.

SVC/Storwize system are multi-core machines where the system will load balance the workload utilizing all the available resources to provide better performance. With DRP technology, the best performance numbers can be achieved using four data reduction pools. Four DRP storage pools allows the optimal use of node canister hardware resources such as CPU cores.

Using standard pools (non-DRP), the storage administrator has to cater for the performance of each volume at an application level. However, using DRP technology, storage administration is simplified where the storage administrator only monitors the storage pool for capacity and performance, and the volumes no longer require monitoring for capacity. More DRP pools allow the system to load balance the resource more evenly which provides good performance.

Size your workload and capacity using the tools described in Chapter 4, “Estimator and sizing tools” on page 35.

An application workload with a 2:1 or higher compression ratio will leverage the performance benefits from DRP compression, but to enhance the performance further using up to four pools will provide best performance numbers.

5.1.3 Garbage collection

DRP technology is built to leverage SSD/Flash technology. DRP technology is based on log structured array (LSA), where nothing is ever overwritten. Storage is allocated on demand and if a host/application re-writes a region of a disk, the new write is stored in a new location on the back-end. DRP technology invalidates the old data on the back-end disk to be garbage collected. For more information, see Chapter 1, "Architecture" on page 1.

Garbage collection keep track of extent usage in pools, and extents with the most unused space are garbage collected. Under normal circumstances, garbage collection works in a trickle mode, clearing up space and optimizing the back-end storage allocation. In a case where the pool is over provisioned and close to getting full, 85 - 100% of physical capacity, garbage collection will have to work harder and it will choose the least used storage pool extents and clear up space.

The entire environment should be sized for performance and capacity before implementing DRP technology. DRP compression will allow the user to compress the data and it will save and lower storage costs. This could also lead to the user over-provisioning and in some cases potentially an out of space condition. If a system runs out of space on the back-end disks, the DRP pool will go offline.

A DRP storage pool over-provisioning condition could create a performance issue when the physical space in the pool is between 85-100%. In this scenario, host IO and garbage collection may lead to disk IO contention, which could potentially overload the back-end or running out of space completely.

Another use case where garbage collection may have to work harder is when a user deletes a large amount of data from the host, or one or more volumes are deleted. If this happens, the reclaimable capacity in the DRP pool will go up, and garbage collection would need to run and reclaim space. If the storage system is not back-end disk limited, garbage collection should not impact performance of the system.

Users can check and monitor the amount of data that needs garbage collection. Monitor a data reduction pool using the **1smdiskgrp** CLI command or the GUI. Check for the new DRP attribute called **reclaimable_capacity**. This can be viewed using CLI or the GUI view.

When using the CLI issue the following command:

```
svcinfo 1smdiskgrp pool_id
```

Where **pool_id** is the numeric id of the data reduction pool, and check the amount of data that needs garbage collection in **reclaimable_capacity** output.

Example 5-1 on page 46 shows the out put from the **svcinfo 1smdiskgrp 0** command, with the reclaimable capacity in bold.

Example 5-1 svcinfo 1smdiskgrp 0

```
svcinfo 1smdiskgrp 0
id 0
name Group0
status online
mdisk_count 16
```

```
vdisk_count 64
capacity 208.00TB
extent_size 1024
free_capacity 203.81TB
virtual_capacity 5.00TB
used_capacity 3.91TB
real_capacity 3.91TB
overalllocation 2
warning 0
easy_tier auto
easy_tier_status balanced
tier tier0_flash
tier_mdisk_count 16
tier_capacity 208.00TB
tier_free_capacity 204.06TB
tier tier1_flash
tier_mdisk_count 0
tier_capacity 0.00MB
tier_free_capacity 0.00MB
tier tier_enterprise
tier_mdisk_count 0
tier_capacity 0.00MB
tier_free_capacity 0.00MB
tier tier_nearline
tier_mdisk_count 0
tier_capacity 0.00MB
tier_free_capacity 0.00MB
compression_active no
compression_virtual_capacity 0.00MB
compression_compressed_capacity 0.00MB
compression_uncompressed_capacity 0.00MB
site_id
site_name
parent_mdisk_grp_id 0
parent_mdisk_grp_name Group0
child_mdisk_grp_count 0
child_mdisk_grp_capacity 0.00MB
type parent
encrypt no
owner_type none
owner_id
owner_name
data_reduction yes
used_capacity_before_reduction 5.00TB
used_capacity_after_reduction 1.83TB
overhead_capacity 2.08TB
deduplication_capacity_saving 0.00MB
reclaimable_capacity 1.04GB
physical_capacity 93.13TB
physical_free_capacity 85.33TB
shared_resources no
```

This can also be achieved using the GUI by using:

Pool View → Select DRP Pool → Action -> Properties -> View More Details and Reclaimable capacity is shown in Figure 5-4. shows using the GUI.

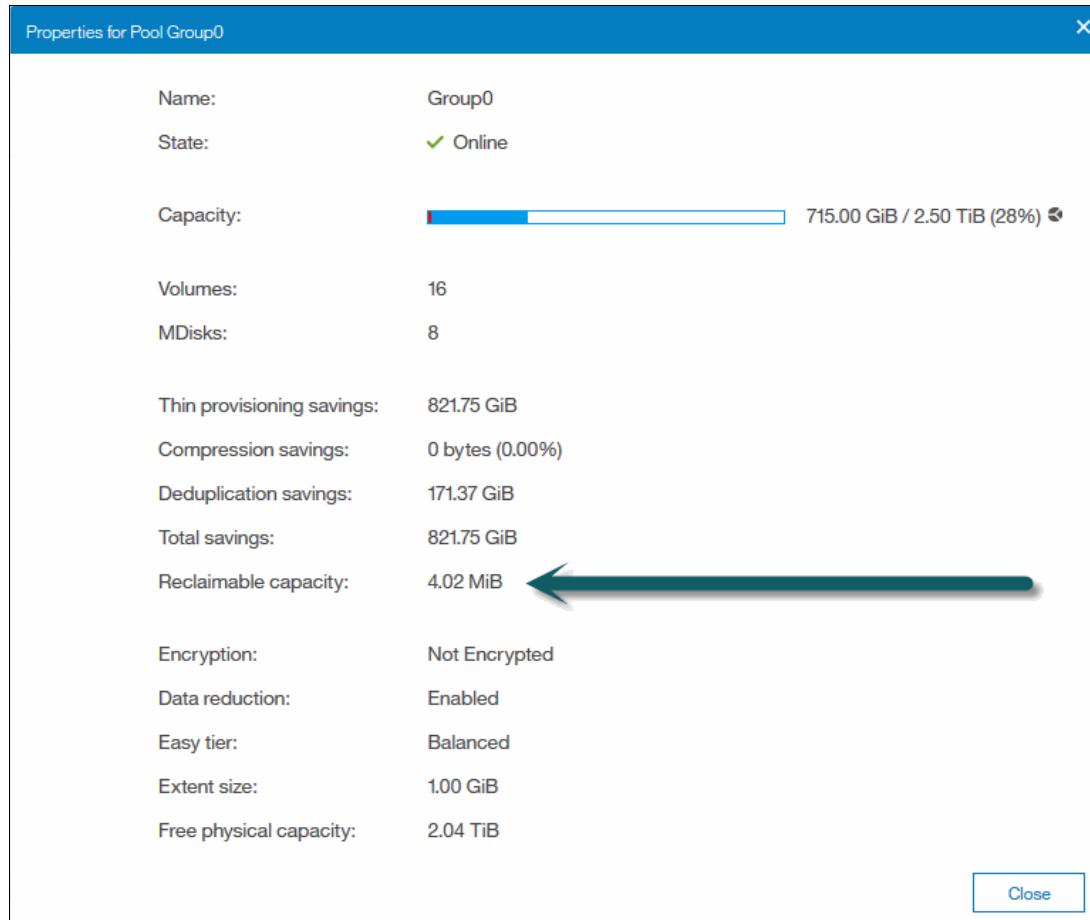


Figure 5-4 Reclaimable capacity

This is the amount of data which will be garbage collected. As long as there is more than 15% of the total capacity free, the user should not experience any problems.

5.1.4 Inter-node ports

IBM Spectrum Virtualize SVC/Storwize hardware platforms consist of at least two, up to a maximum of 8 nodes in a clustered system. The performance of the system relies on the timely communication of nodes in the cluster to provide good performance.

The Storwize family uses a dedicated inter-connect to communicate to the partner node canister in the same enclosure. In a single IO group configuration, the Storwize family code only uses the dedicated link unless the link (hardware) is broken, and FC ports are not used for inter-node connectivity. For a cluster with two or more control enclosures, inter-node communication between two control enclosures is done on FC ports as it is with the SVC.

SVC nodes use FC ports for connectivity. Prior to the DRP/Deduplication release, the recommendation was to use at least two FC ports for inter-node communication.

The two FC port inter-node recommendation remains the same for DRP users unless the host/application using DRP has a high write throughput (above 2 GBps host write workload)

or high write IOPS workload. Specifically, for deduplication users with a high write workload (above 1 GB/s host workload) we suggest using four FC ports dedicated to inter-node traffic.

Refer to the following for more information about the original two FC port recommendation:

IBM System Storage SAN Volume Controller and Storwize V7000 Best Practices and Performance Guidelines, SG24-7521

5.1.5 SVC with Storwize family back-end controllers

Since both systems will be running the same code, there is no performance or functionality gain available by using DRP compression or deduplication on both systems together. Therefore, it is recommended to use DRP technology at the SVC layer.

5.1.6 SVC with external back-end controllers

If external back-end controllers are used and virtualized behind SVC, again the recommendation is to use DRP compression on the front-end SVC layer. Careful planning is required for the back-end controller which also can compress or deduplicate, and you should consider using a 1:1 compression and deduplication ratio. This is to avoid running out of physical capacity.

5.1.7 Storwize family with external back-end controllers

If Storwize is used to virtualize any other back-end controller behind it, use DRP at the Storwize layer. This combination will provide storage efficiency and good stable performance.

5.2 When to use DRP Compression

DRP pools utilize a new compression algorithm implementation. The suggestion for optimal performance is to use compression on all platforms, on all workloads (except Storwize V5030 as noted previously).

There is no performance penalty for writing non-compressible data, and for application workloads with a 2:1 or higher compression ratio there is significant capacity saving with no performance overhead. This will cut down on a lot of planning work and simplify capacity savings for any storage solution.

Storwize V5030 does not have hardware accelerator cards and it uses only software compression on the six core hardware platform. To use compression on Storwize V5030, use the same RACE guidance for compressibility, nodes CPU usage. Refer to the following for guidelines on using compression on Storwize V5030:

IBM Real-time Compression in IBM SAN Volume Controller and IBM Storwize V7000, REDP-4859

Implementing the IBM Storwize V5000 Gen2 (including the Storwize V5010, V5020, and V5030) with IBM Spectrum Virtualize V8.1, SG24-8162

5.2.1 When to use DRP deduplication

Application workloads with more than a 30% deduplication ratio should consider using the DRP deduplication feature. A workload with a 2:1 or higher deduplication ratio will benefit from capacity savings. In addition, the deduplication feature is recommended to be used with compression, which provides the best capacity savings.

To identify the deduplication ratio use the DRET tool. For more details refer to 4.2, “Evaluating workload using Data Reduction Estimator Tool” on page 39.

5.3 Performance monitoring

IBM recommends performance monitoring of the system which allows the system administrator to monitor the production workload and storage solution performance. IBM provides Spectrum Control which is an enterprise class performance monitoring solution for SVC, Storwize and other storage products.

There is another alternative IBM Cloud offering known as Storage Insights which can be used for performance monitoring of SVC and Storwize solution. For more detail, contact your IBM sales representative or Business Partner. Alternatively, visit the following link for more information

<https://www.ibm.com/us-en/marketplace/analytics-driven-data-management/resources>

5.3.1 Total Port Data Rate By Port

Users should monitor the port data rates using the following guidelines:

- ▶ Although FC ports are full duplex, setting a warning level near the “single direction line speed” is recommended to prevent ports from becoming saturated. Specifically, we recommend a warning level of 1200MB/s for 8Gb ports, and 2100 MB/s for 16Gb ports.
- ▶ Exceeding this limit requires further review. Workload may be balanced/moved to other available resources (ports, nodes, IOGroups) or additional resources may be needed to accommodate additional growth.

5.3.2 Total SVC Node Data Rate

The recommended monitoring limit for front-end data rate is 1800MB/sec per node. This number is based on 75% utilization of 8Gb ports shared for host and backend traffic.

CPU Utilization Percentage – maximum per SVC node

Users should monitor CPU usage using the following guidelines:

- ▶ While a weighted average CPU utilization for the cluster (subsystem) is available, it's best to monitor utilization per node.
- ▶ Exceeding the node average of 70% may be impacting I/O performance for some workloads.
- ▶ CPU utilization per core should also be monitored to ensure no single core exceeds 90%.

Port to Local Node Send Response Time – maximum per node

Users should monitor port to local node send response time using the following guidelines:

- ▶ The port to local node response time is critical to ensuring stable performance of the cluster. Values greater than .5ms will impact the overall performance of the cluster to varying degrees.
- ▶ Poor Port to Local Node Send Response time is generally only an issue when the ports utilized for local node traffic are shared with other traffic (host/storage or replication). But even with dedicated ports, elevated Port to Local Node Send Response time can still be an issue for other conditions such as port saturation or degraded link quality due to hardware conditions.

Buffer Credit Depletion – maximum per SVC port

Users should monitor buffer credit depletion using the following guidelines:

- ▶ Buffer Credit Depletion exceeding 20% that is sustained for longer than 20 minutes can negatively impact performance for all workloads that are sharing that port.
- ▶ Short duration spikes in credit depletion that occur because of spikes in workload are normal FC flow control events and are not indicative of a problem.
- ▶ 16 Gbps adapters do not support buffer credit counters. A replacement metric called “Port Send Delay ms/op” is available in SVC 7.8.1 and supported in Spectrum Control 5.2.14.

Volume and Back-end Response Times

Each environment may have a unique workload pattern and will require a certain desired performance from the given workload. For example, a video streaming storage solution may require a 10 ms response time from volumes and 5-10 ms latency is not an issue. Another environment which hosts financial software, for example an OLTP database, may require <1ms response times. In these sorts of environments we recommend that clients engage with IBM Professional Services.



Troubleshooting

We advise the reader to consult the following publications for common procedures to maintain the IBM Spectrum Virtualize environment and ensure that all the necessary logs are kept should they need to be analyzed by IBM Support:

- ▶ *IBM System Storage SAN Volume Controller and Storwize V7000 Best Practices and Performance Guidelines*, SG24-7521
- ▶ *Implementing the IBM System Storage SAN Volume Controller with IBM Spectrum Virtualize V8.1*, SG24-7933
- ▶ *Implementing the IBM Storwize V7000 with IBM Spectrum Virtualize V8.1*, SG24-7938

This chapter contains the following:

- ▶ 6.1, “Troubleshooting and fix procedures” on page 54
- ▶ 6.2, “SVC Event Log Definitions for DRP” on page 63
- ▶ 6.3, “Monitoring” on page 70
- ▶ 6.4, “Audit log” on page 84
- ▶ 6.5, “Collecting support information using the GUI and the CLI” on page 86
- ▶ 6.6, “Error codes” on page 93

6.1 Troubleshooting and fix procedures

The management GUI of IBM Spectrum Virtualize is a browser-based GUI for configuring and managing all aspects of your system. It provides extensive facilities to help troubleshoot and correct problems. This section explains how to effectively use its features to avoid service disruption of your system.

Figure 6-1 shows the menu to start the **Monitoring** menu for **System** information, viewing **Events**, or seeing real-time **Performance** statistics.

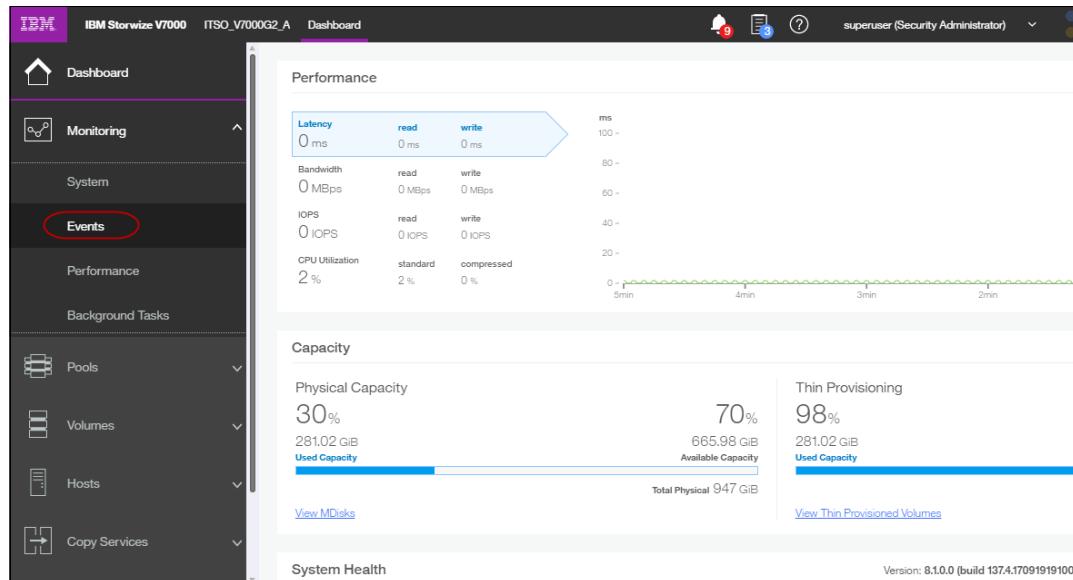


Figure 6-1 Monitoring options

Use the management GUI to manage and service your system. Select **Monitoring** → **Events** to list events that should be addressed and maintenance procedures that walk you through the process of correcting problems. Information in the Events window can be filtered in three ways:

- ▶ Recommended Actions

Shows only the alerts that require attention. Alerts are listed in priority order and should be resolved sequentially by using the available fix procedures. For each problem that is selected, you can do these tasks:

 - Run a fix procedure
 - View the properties
- ▶ Unfixed Messages and Alerts

Displays only the alerts and messages that are not fixed. For each entry that is selected, you can perform these tasks:

 - Run a fix procedure
 - Mark an event as fixed
 - Filter the entries to show them by specific minutes, hours, or dates
 - Reset the date filter
 - View the properties
- ▶ Show All

Displays all event types whether they are fixed or unfixed. For each entry that is selected, you can perform these tasks:

- Run a fix procedure
- Mark an event as fixed
- Filter the entries to show them by specific minutes, hours, or dates
- Reset the date filter
- View the properties

Some events require a certain number of occurrences in 25 hours before they are displayed as unfixed. If they do not reach this threshold in 25 hours, they are flagged as *expired*. Monitoring events are below the coalesce threshold, and are usually transient.

Important: The management GUI is the primary tool that is used to *operate* and *service* your system. Real-time *monitoring* should be established by using SNMP traps, email notifications, or syslog messaging on an automatic manner.

6.1.1 Managing event log

Regularly check the status of the system using the management GUI. If you suspect a problem, first use the management GUI to diagnose and resolve the problem.

Use the views that are available in the management GUI to verify the status of the system, the hardware devices, the physical storage, and the available volumes by completing these steps:

1. Click **Monitoring** → **Events** to see all problems that exist on the system (Figure 6-2).

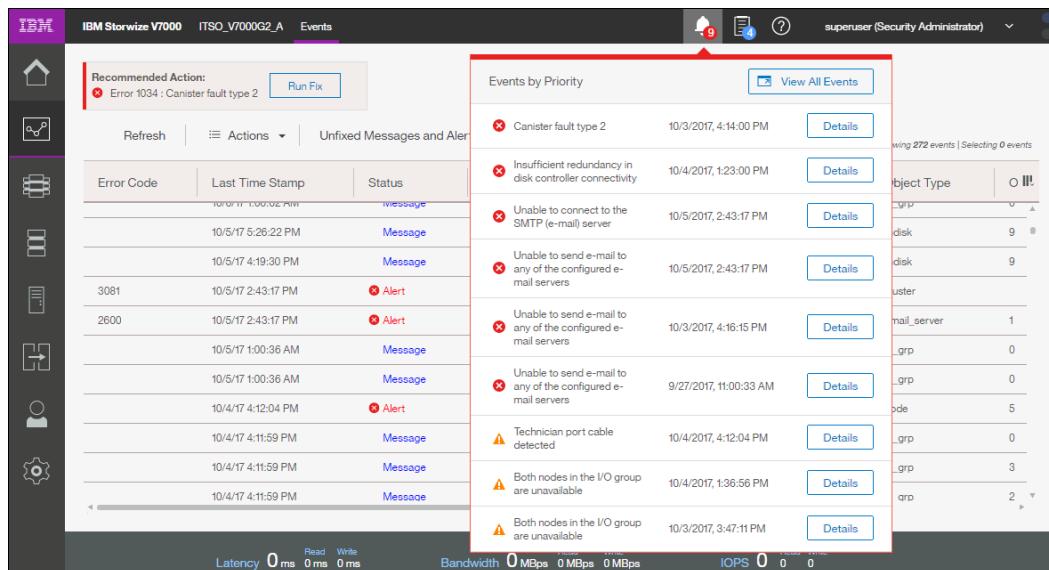
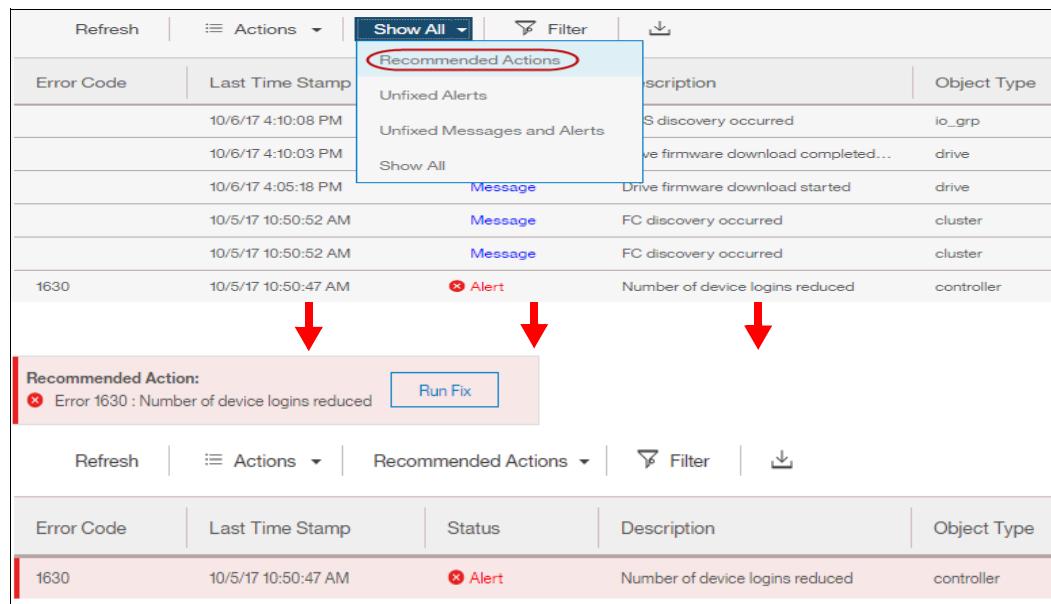


Figure 6-2 Messages in the event log

2. Select **Show All** → **Recommended Actions** to display the most important events to be resolved (Figure 6-3). The Recommended Actions tab shows the highest priority maintenance procedure that must be run. Use the troubleshooting wizard so that the system can determine the proper order of maintenance procedures.



The screenshot shows a management interface with a table of logs and alerts. A context menu is open over an alert row for error code 1630. The menu is titled 'Recommended Actions' and includes options: 'Unfixed Alerts', 'Unfixed Messages and Alerts', and 'Show All'. Below the menu, the alert row is highlighted with a red border. Three red arrows point from the bottom of the menu down to the 'Run Fix' button in a 'Recommended Action' box, and then down to the alert row in the table. The table has columns: Error Code, Last Time Stamp, Status, Description, and Object Type. The alert row for error 1630 shows 'Alert' in the Status column and 'Number of device logins reduced' in the Description column.

Figure 6-3 Recommended Actions

In this example, the *number of device logins reduced* is listed (service error code 1630). Review the physical FC cabling to determine the issue and then click **Run Fix**. At any time and from any GUI window, you can directly go to this menu by clicking the **Status Alerts** icon at the top of the GUI (Figure 6-4).



The screenshot shows a management interface with a header bar featuring a bell icon with '1', a document icon with '2', and a question mark icon. The title bar says 'superuser (Se...'. Below the header is a 'Events by Priority' section with a 'View All Events' button. A specific alert is highlighted with a red border: 'Number of device logins reduced' with a red 'X' icon, timestamp '10/5/2017, 10:50:47 AM', and a 'Details' button.

Figure 6-4 Status alerts

6.1.2 Running a fix procedure

If there is an error code for the alert, you should run the fix procedure to assist you in resolving the problem. These fix procedures analyze the system and provide more information about the problem. They suggest actions to take and walk you through the actions that automatically manage the system where necessary, while ensuring availability. Finally, they verify that the problem is resolved.

If an error is reported, always use the fix procedures from the management GUI to resolve the problem. Always use the fix procedures for both software configuration problems and hardware failures. The fix procedures analyze the system to ensure that the required changes will not cause volumes to become inaccessible to the hosts. The fix procedures automatically perform configuration changes that are required to return the system to its optimum state.

The fix procedure displays information that is relevant to the problem, and provides various options to correct the problem. Where possible, the fix procedure runs the commands that are required to reconfigure the system.

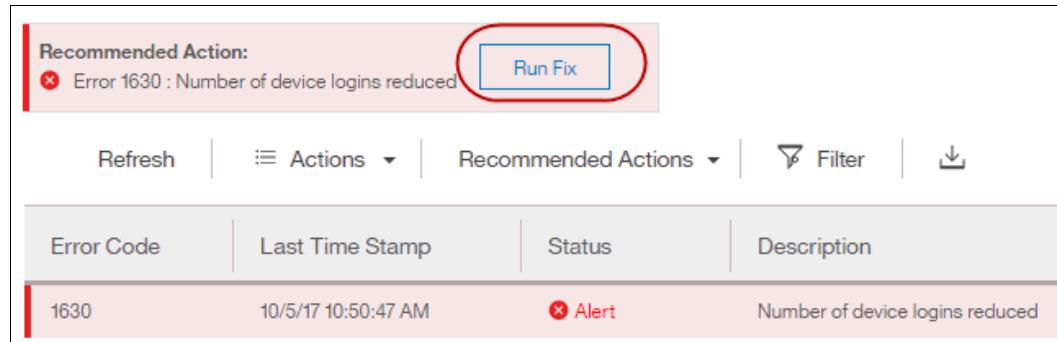
Note: After V7.4, you are no longer required to run the fix procedure for a failed drive. Hot plugging of a replacement drive will automatically trigger the validation processes.

The fix procedure also checks that any other existing problem will not result in volume access being lost. For example, if a power supply unit in a node enclosure must be replaced, the fix procedure checks and warns you if the integrated battery in the other power supply unit is not sufficiently charged to protect the system.

Hint: Always use the **Run Fix** button, which will resolve the most serious issues first. Often, other alerts will be corrected automatically because they were the result of a more serious issue.

The following example demonstrates how to clear the error that is related to a SAN Fabric zoning error to a backend disk controller:

1. From the GUI menu on the left, click **Monitoring** → **Events**, and list only the recommended actions by using the **Actions** menu (Figure 6-5). Click **Run Fix**.



The screenshot shows a management interface for monitoring events. At the top, a red box highlights the 'Run Fix' button in a 'Recommended Action' section for an error entry. The error entry is for 'Error 1630 : Number of device logins reduced'. Below this, there is a table with columns: Error Code, Last Time Stamp, Status, and Description. The first row of the table corresponds to the error entry above. The 'Status' column for this row shows an 'Alert' icon. The 'Description' column states 'Number of device logins reduced'.

Error Code	Last Time Stamp	Status	Description
1630	10/5/17 10:50:47 AM	Alert	Number of device logins reduced

Figure 6-5 Initiate Run Fix procedure from the management GUI

2. The pop-up window prompts you to indicate whether the issue was caused by a planned change or maintenance task, or whether it appeared in an uncontrolled manner (Figure 6-6).

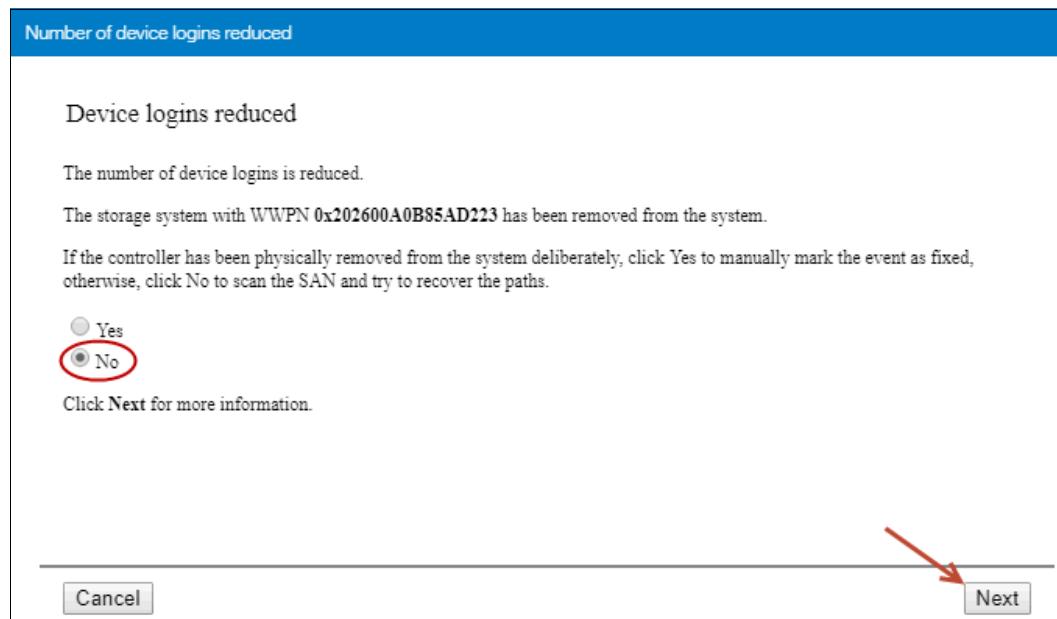


Figure 6-6 Determination of planned action

3. If you answer **Yes**, the fix procedure finishes, assuming that all changes in the system are expected and no other action is necessary, perhaps because you are decommissioning an old disk controller. However, our example simulates a zoning error and we continue to follow the fix procedure. Select **No** and click **Next**.
4. In the next window (Figure 6-7), IBM Spectrum Virtualize lists suggested actions and which components must be checked to fix and close the error. When you are sure that all possible technical requirements are met (in our case, we resolved our SAN zoning config), click **Next**.

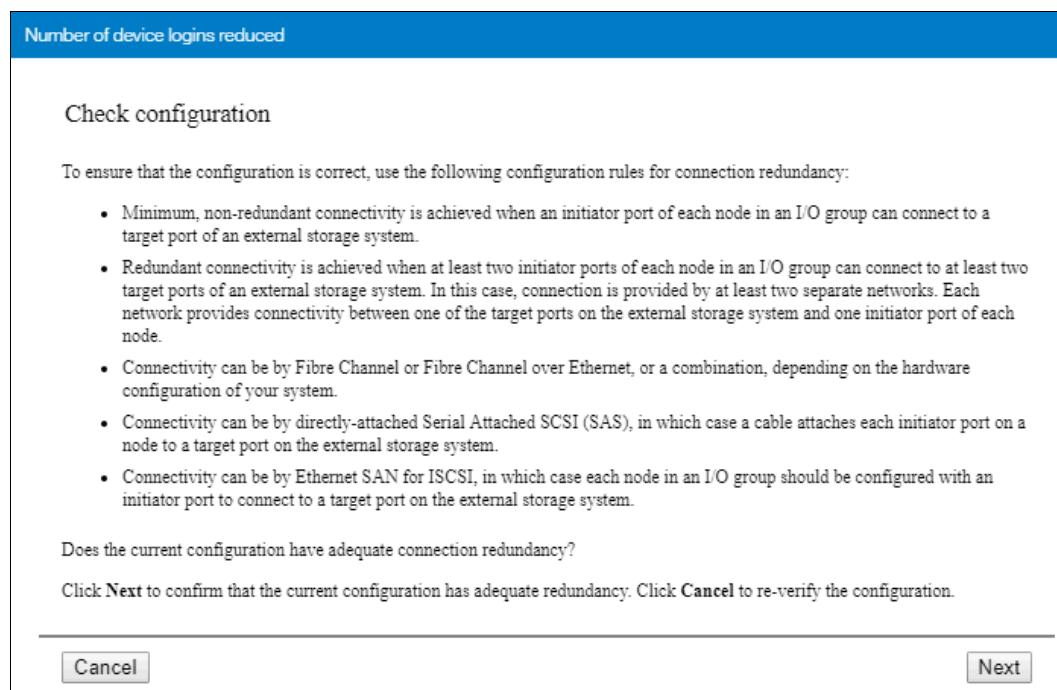


Figure 6-7 Verification steps to eliminate single point of failure

The discovery of managed disks starts (Figure 6-8).

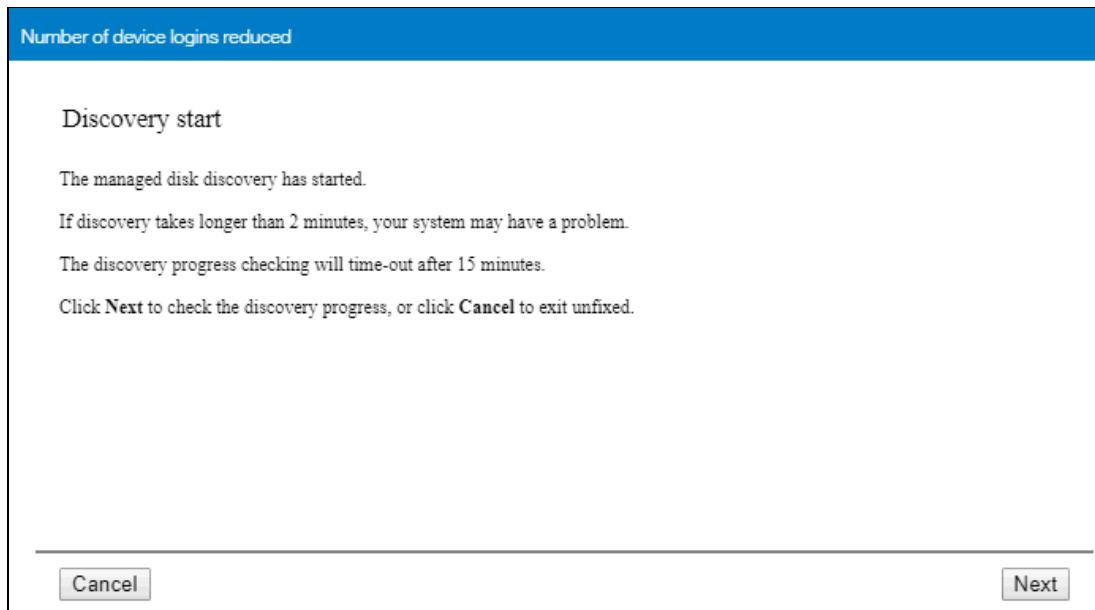


Figure 6-8 Starting the discovery of managed disks

If no other important issue exists, the discovery should finish within 2 minutes, depending on the number of enclosures and installed disk drives (Figure 6-9).

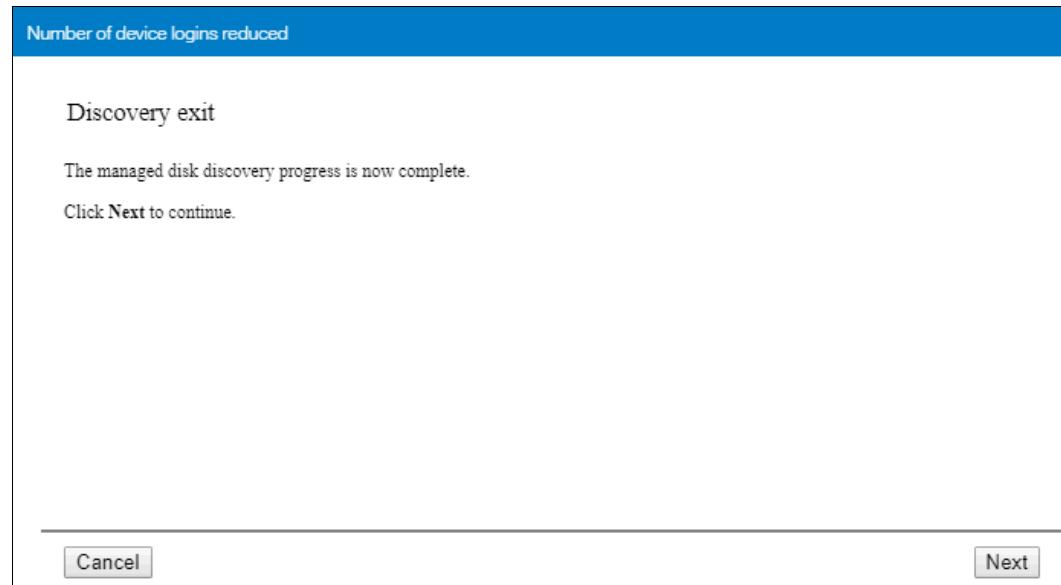


Figure 6-9 Discovery complete

5. The event has been marked as fixed, and you can safely finish the fix procedure. Click **Close** and the event is removed from the list of events (Figure 6-10).

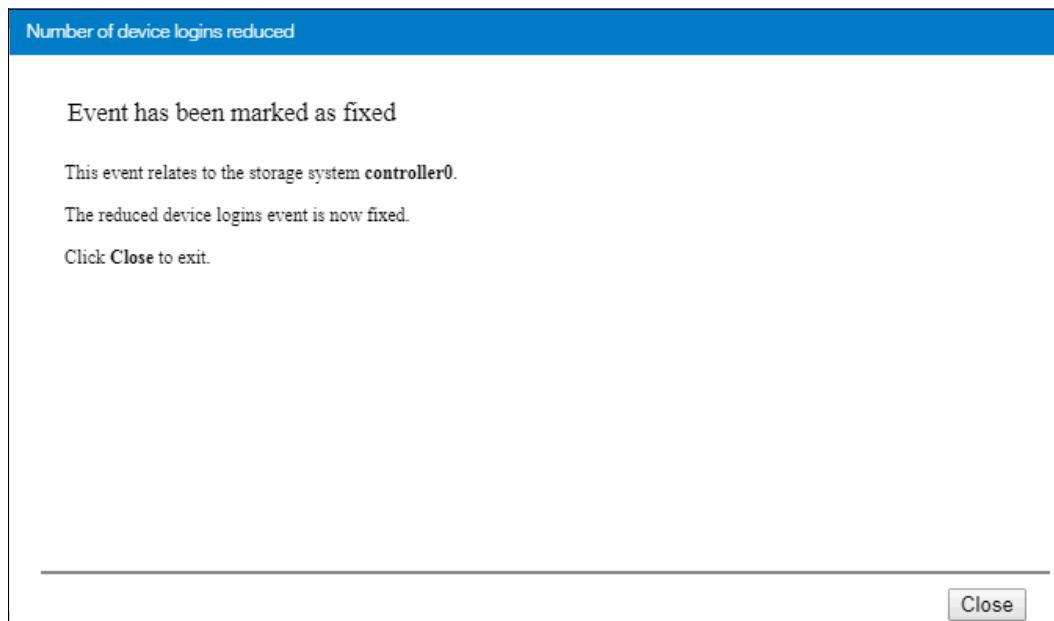


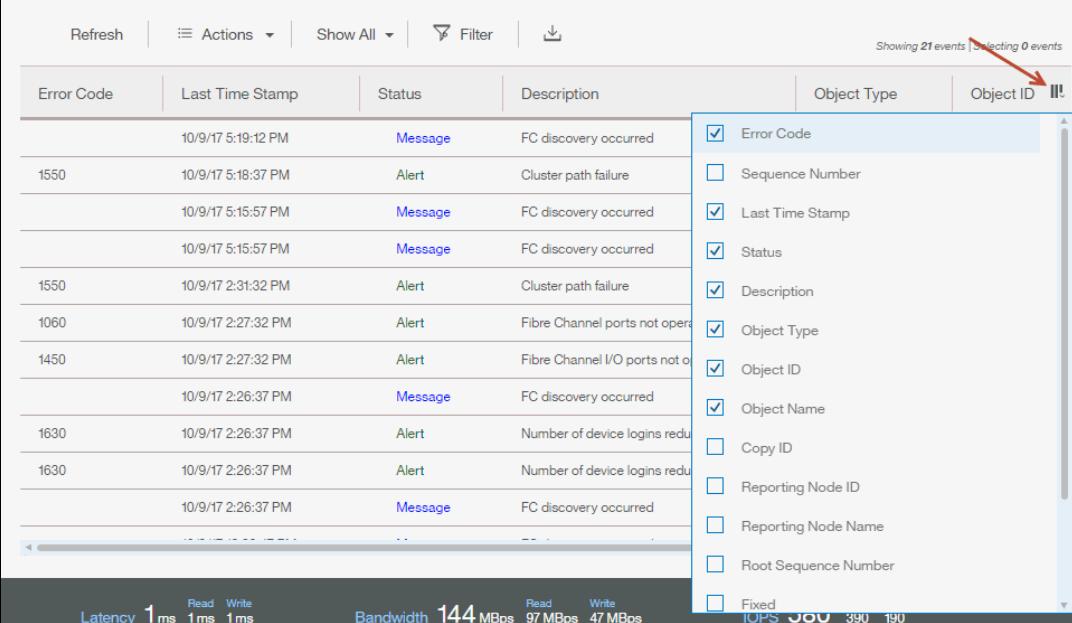
Figure 6-10 Correctly finished fix procedure

Resolve alerts in a timely manner

To minimize any impact to your host systems, always perform the recommended actions as quickly as possible after a problem is reported. Your system is designed to be resilient to most single hardware failures. However, if it operates for any period of time with a hardware failure, the possibility increases that a second hardware failure can result in some volume data that is unavailable. If several unfixed alerts exist, fixing any one alert might become more difficult because of the effects of the others.

6.1.3 Event log details

Multiple views of the events and recommended actions are available. The GUI works like a typical Microsoft Windows pop-up menu, so the event log grid is manipulated through the row that contains the column headings (Figure 6-11). When you click the column icon at the right end of the table heading, a menu for the column choices opens.



Error Code	Last Time Stamp	Status	Description	Object Type	Object ID
	10/9/17 5:19:12 PM	Message	FC discovery occurred		
1550	10/9/17 5:18:37 PM	Alert	Cluster path failure		
	10/9/17 5:15:57 PM	Message	FC discovery occurred		
	10/9/17 5:15:57 PM	Message	FC discovery occurred		
1550	10/9/17 2:31:32 PM	Alert	Cluster path failure		
1060	10/9/17 2:27:32 PM	Alert	Fibre Channel ports not oper		
1450	10/9/17 2:27:32 PM	Alert	Fibre Channel I/O ports not o		
	10/9/17 2:26:37 PM	Message	FC discovery occurred		
1630	10/9/17 2:26:37 PM	Alert	Number of device logins redu		
1630	10/9/17 2:26:37 PM	Alert	Number of device logins redu		
	10/9/17 2:26:37 PM	Message	FC discovery occurred		

Figure 6-11 Grid options of the event log

Select or remove columns as needed. You can then also extend or shrink the width of the column to fit your screen resolution and size. This is the way to manipulate it for most grids in the management GUI of IBM Spectrum Virtualize, not just the events pane.

Every field of the event log is available as a column in the event log grid. Several fields are useful when you work with IBM Support. The preferred method in this case is to use the **Show All** filter, with events sorted by time stamp. All fields have the sequence number, event count, and the fixed state. Using **Restore Default View** sets the grid back to the defaults.

You might want to see more details about each critical event. Some details are not shown in the main grid. To access properties and sense data of a specific event, double-click the specific event anywhere in its row.

The properties window opens (Figure 6-12) with all the relevant sense data. This data includes the first and last time of an event occurrence, worldwide port name (WWPN), and worldwide node name (WWNN), enabled or disabled automatic fix, and so on.

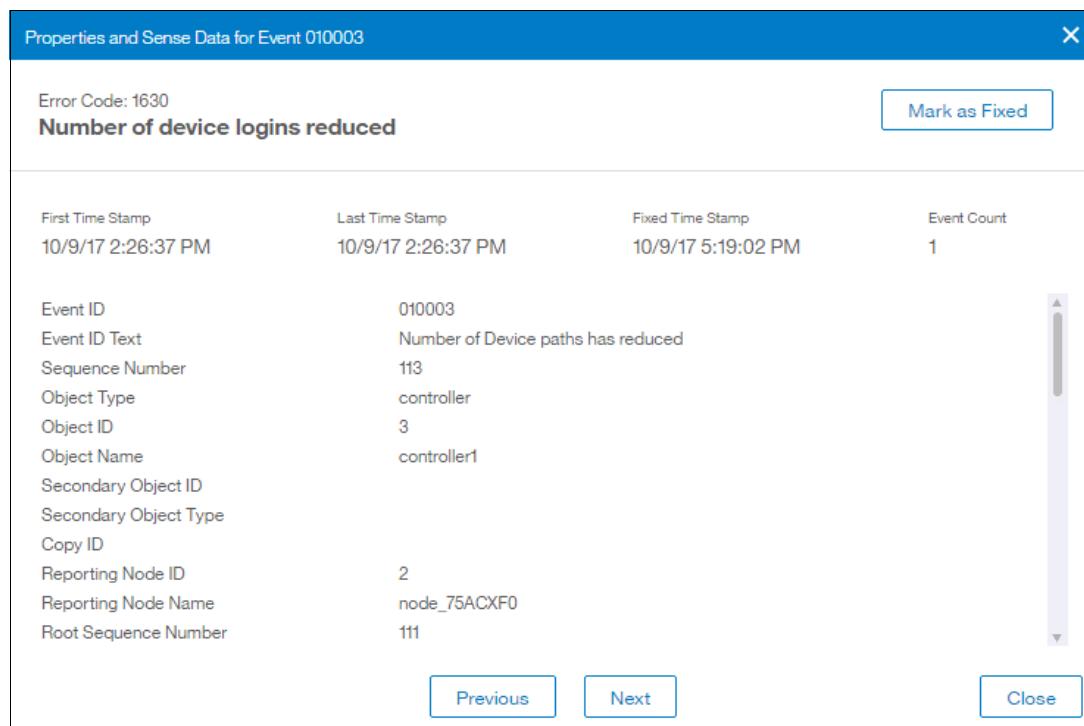


Figure 6-12 Event sense data and properties

For more information about troubleshooting options, see the Troubleshooting section in IBM Knowledge Center, which is available at:

<https://ibm.biz/BdjmgY>

6.2 SVC Event Log Definitions for DRP

This section lists the event IDs related to data reduction pools. For more information about troubleshooting options and events, see the Troubleshooting section in IBM Knowledge Center, which is available at:

<https://ibm.biz/Bdjmzg>

6.2.1 Event ID 060001

Example 6-1 Event ID 060001

Space-efficient VDisk Copy offline due to insufficient space

A space-efficient VDisk has been taken offline because there is insufficient allocated real capacity available on the VDisk for the used space to increase further. If the space-efficient VDisk is auto expand enabled, then the managed disk group it is in also has no free space.

6.2.2 Event ID 060002

Example 6-2 Event ID 060002

Space-efficient VDisk Copy offline due to corrupt metadata

A space-efficient VDisk Copy has been taken offline because there is an inconsistency in the SAN Volume Controller metadata that describes the disk contents. This may occur because of corruption of data on the physical disk (e.g. medium error or data miscompare), the loss of cached metadata (because of a T3 recovery) or because of a software error. The event data gives information on the reason.

The SAN Volume Controller maintains backup copies of the metadata and it may be possible to repair the space-efficient VDisk using this data. Run the repair VDisk option to start the repair process. This repair process can however take some time. In some situations it may be more appropriate to delete the space-efficient VDisk and reconstruct a new one from a backup or mirror copy. If the repair procedure completes successfully this error is automatically marked as fixed otherwise another error event (error code 1860) is logged to indicate the repair failed.

6.2.3 Event ID 060003

Example 6-3 Event ID 060003

Space-efficient VDisk Copy offline due to failed repair

The attempt to repair a space-efficient volume's metadata, that describes the disk contents, has failed because of problems with the automatically maintained backup copy of this data. The error event data describes the problem. Delete the space-efficient VDisk and reconstruct a new one from a backup or mirror copy. Then mark the error fixed. Also mark and the original 1862 error fixed.

6.2.4 Event ID 060004

Example 6-4 Event ID 060004

Compressed Virtual Disk Copy offline due to insufficient space

The VDisk copy is offline because it needs more real capacity to perform host IO and there is no available real capacity: either the copy does not have autoexpand set and it is full, or it does have autoexpand set but there is no free space left in the mdisk group.

6.2.5 Event ID 060005

Example 6-5 Event ID 060005

Compressed Virtual Disk Copy offline due to corrupt metadata

Compressed VDisk cannot be accessed because of a CRC error in data or metadata on disk and has been taken offline.

6.2.6 Event ID 060006

Example 6-6 Event ID 060006

Compressed Virtual Disk Copy offline due to failed repair

Disk was corrupt, repair issued, and didn't work.

6.2.7 Event ID 060007

Example 6-7 Event ID 060007

Compressed Virtual Disk Copy has bad blocks

At least one of the blocks on the VDisk copy is unreadable. This is caused by either:

- ▶ A replication task such as FlashCopy or VDisk Mirroring encountering a medium error on their read and using a virtual medium error to replicate this state; or
- ▶ RtC receiving a medium error failure on a data block read and so marking the block as being exempt from optimization.

6.2.8 Event ID 060008

Example 6-8 Event ID 060008

Data reduction pool meta data corrupt

Some aspect of a volume's metadata that is part of a data reduction pool, is corrupt. All volume copies data are part of the data reduction pool are offline as a result.

The SAN Volume Controller maintains backup copies of the metadata and it may be possible to repair the space-efficient VDisk using this data. Run the repair VDisk option to start the repair process. This repair process can however take some time. In some situations it may be more appropriate to delete the space-efficient VDisk and reconstruct a new one from a backup or mirror copy. If the repair procedure completes successfully this error is

automatically marked as fixed otherwise another error event (error code 1860) is logged to indicate the repair failed.

6.2.9 Event ID 060009

Example 6-9 Event ID 060009

Pool's virtual disk copies offline due to failed data reduction pool repair

The data reduction pool repair process has encountered an error that prevents the recovery process from completing.

6.2.10 Event ID 060010

Example 6-10 Event ID 060010

Virtual Disk Copies offline due to insufficient space in Data Reduction Pool

A data reduction pool has insufficient space that prevents thin or compressed virtual disk copies from expanding. In this case the pool is taken offline. The pool can be brought online through any of the following methods:

- ▶ Add extra capacity to the storage pool (i.e. add extra mdisks to the pool).
- ▶ Delete some of the volumes in the storage pool and wait for Garbage Collection to reclaim some of the deleted capacity.
- ▶ If the pool is offline but has a large amount of reclaimable capacity then wait for Garbage Collection to reclaim and free some storage.

Once a method has been followed, the system administrator needs to manually mark the event as fixed to bring the pool online.

6.2.11 Event ID 060011

Example 6-11 Event ID 060011

Virtual Disk Copies offline due to insufficient Journal space in Data Reduction Pool

A data reduction pool has insufficient journal space that prevents metadata modification of thin or compressed virtual disk copies.

6.2.12 Event ID 986001

Example 6-12 Event ID 986001

Space-efficient VDisk Copy data in a node is pinned

A node in an I/O group has been unable to write a space-efficient VDisk Copy's metadata to MDisk. This may be because a MDisk has gone offline. The metadata will remain in the node's cache until it can be written to MDisk. The space-efficient VDisk Copy is offline.

6.2.13 Event ID 986002

Example 6-13 Event ID 986002

All space-efficient VDisk Copy data in a node is now unpinned

After a period when the space-efficient VDisk Copy's metadata has been pinned, the node has been able to write all the metadata it holds for a space-efficient VDisk to a MDisk.

6.2.14 Event ID 986010

Example 6-14 Event ID 986010

Space-efficient Virtual Disk Copy import failure

The creation of a new, space-efficient, image mode VDisk copy has been attempted. SAN Volume Controller has determined that it cannot interpret the space-efficient VDisk Copy's control metadata. This is because the image mode disk that is being imported was created by a cluster running a newer version of SAN Volume Controller.

The VDisk Copy is created, but it is offline. To bring the VDisk Copy online the cluster software version must be upgraded to at least the version that created the image mode VDisk Copy. The import will restart automatically after the software version is upgraded. Alternatively the VDisk Copy can be deleted.

6.2.15 Event ID 986011

Example 6-15 Event ID 986011

Space-efficient VDisk Copy import successful

The creation of an image mode space-efficient VDisk Copy, through the import of an existing space-efficient image mode disk, completed successfully.

6.2.16 Event ID 986020

Example 6-16 Event ID 986020

Space-efficient VDisk Copy space warning

The used capacity of the space-efficient VDisk has exceeded the warning threshold for the VDisk. (The threshold is configurable).

Action should be taken to ensure the space-efficient VDisk's requirements do not continue to grow so they exceed to real disk capacity available.

If the space-efficient VDisk copy has auto expand enabled, the warning threshold may have been set to indicate that the used capacity of the VDisk Copy is approaching the virtual size of the VDisk Copy. The actions that can be taken depend on whether the space-efficient virtual disk has auto expand enabled.

If auto expand is enabled:

1. Ignore the event and increase the value of the warning threshold.
2. Expand the virtual capacity of the VDisk to provide more storage to the host application.

3. If the VDisk is expanding rapidly you should check for an application error. The auto expand option can be turned off, or in an extreme case the VDisk can be forced offline by moving it to the recovery I/O group.

If auto expand is not enabled this event indicates that the allocated space is filling up. You can take one or more of the following actions:

1. Ignore the event and increase the value of the warning threshold
2. Expand the real capacity of the VDisk to provide more storage for the space-efficient virtual disk.
3. Enable the auto expand option to allow the cluster to automatically expand the volume when required.

If the used space of the space-efficient VDisk Copy is close to the virtual size of the disk, and the virtual size is not going to be increased, then you should consider migrating the space-efficient VDisk Copy to a fully allocated VDisk Copy which will provide more efficient access to the data.

6.2.17 Event ID 986030

Example 6-17 Event ID 986030

Space-efficient VDisk Copy repair started

An attempt to repair a space-efficient VDisk copy has started.

6.2.18 Event ID 986031

Example 6-18 Event ID 986031

Space-efficient VDisk Copy repair successful

SAN Volume Controller has successfully repaired a space-efficient VDisk copy. The VDisk Copy is online and the 1862 error is marked fixed.

6.2.19 Event ID 986032

Example 6-19 Event ID 986032

Space-efficient VDisk Copy validation started

A space-efficient VDisk copy validation has started.

6.2.20 Event ID 986033

Example 6-20 Event ID 986033

Space-efficient VDisk Copy validate successful

SAN Volume Controller has completed a validation of a space-efficient VDisk copy and found no problems. The VDisk Copy is online.

6.2.21 Event ID 986034

Example 6-21 Event ID 986034

Compressed Virtual Disk Copy import successful

Compressed image-mode VDisk copy has been imported successfully.

6.2.22 Event ID 986035

Example 6-22 Event ID 986035

Compressed Virtual Disk Copy space warning

Used capacity has exceeded warning capacity.

6.2.23 Event ID 986036

Example 6-23 Event ID 986036

Compressed Virtual Disk Copy repair started

A compressed VDisk copy repair has started.

6.2.24 Event ID 986037

Example 6-24 Event ID 986037

Compressed Virtual Disk Copy repair successful

A repair that was started by e.g. **recovervdisk** has completed successfully and the VDisk is online again.

6.2.25 Event ID 986038

Example 6-25 Event ID 986038

Compressed Virtual Disk Copy has too many bad blocks.

A bad block has been requested. The VDisk Copy has so many bad blocks on it that it cannot create another one.

The VDisk Copy is not directly taken offline when this happens. However the operation that is writing the data will also respond to the failed write: FlashCopy stops the mapping and VDisk Mirroring holds the VDisk copy offline.

6.2.26 Event ID 986039

Example 6-26 Event ID 986039

A data reduction pool repair process has begun.

This event is raised to inform the system administrator that the repair process has begun.

6.2.27 Event ID 986040

Example 6-27 Event ID 986040

A data reduction pool repair process has completed successfully.

This event is raised to inform the system administrator that the repair process has completed successfully.

6.2.28 Event ID 986105

Example 6-28 Event ID 986105

Compressed volume copy may require repair due to possible data loss

The system has detected this volume copy could be affected by a data loss issue, APAR HU00898. Refer to the following webpage, which explains how to verify whether the volume copy is affected, and how to repair it:

<http://www-01.ibm.com/support/docview.wss?uid=ssg1S1005361>

6.2.29 Event ID 986106

Example 6-29 Event ID 986106

Compressed volume virtual size limitation breached

Compressed volume size was reduced and previously created volumes are in breach of new size.

6.2.30 Event ID 986107

Example 6-30 Event ID 986107

Compressed volume real capacity size limitation breached

Cluster has at least one compressed volume that uses more real capacity than allowed.

6.3 Monitoring

An important step is to correct any issues that are reported by your IBM Spectrum Virtualize system as soon as possible. Configure your system to send automatic notifications when a new event is reported. To avoid having to monitor the management GUI for new events, select the type of event for which you want to be notified. For example, restrict notifications to just events that require action. Several event notification mechanisms exist:

Email	An event notification can be sent to one or more email addresses. This mechanism notifies individuals of problems. Individuals can receive notifications wherever they have email access, including mobile devices.
SNMP	An SNMP traps report can be sent to a data center management system, such as IBM Systems Director, that consolidates SNMP reports from multiple systems. With this mechanism, you can monitor your data center from a single workstation.
Syslog	A syslog report can be sent to a data center management system that consolidates syslog reports from multiple systems. With this option, you can monitor your data center from a single location.

If your system is within warranty or if you have a hardware maintenance agreement, configure your IBM Spectrum Virtualize system to send email events directly to IBM if an issue that requires hardware replacement is detected. This mechanism is known as *Call Home*. When this event is received, IBM automatically opens a problem report and, if appropriate, contacts you to help resolve the reported problem.

Important: If you set up Call Home to IBM, ensure that the contact details that you configure are correct and kept up to date. Personnel changes can cause delays in IBM making contact.

6.3.1 Email notifications and the Call Home function

The Call Home function of IBM Spectrum Virtualize uses the email notification being sent to the specific IBM support center. Therefore, the configuration is similar as to sending emails to the specific person or system owner. The following procedure summarizes how to configure email notifications and emphasizes what is specific to Call Home:

1. Prepare your contact information that you want to use for the email notification and verify the accuracy of the data. From the GUI menu, click **Settings** → **Notifications** (Figure 6-13).

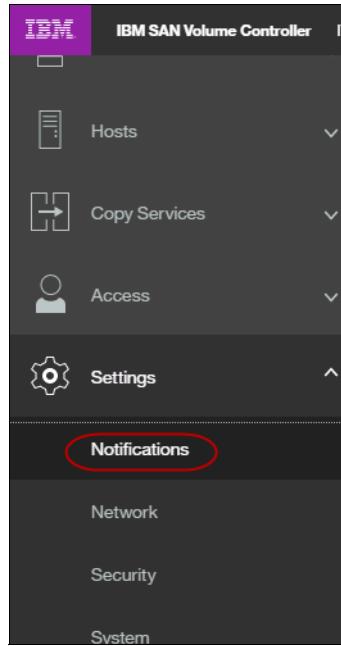


Figure 6-13 Notifications menu

2. Select **Email** and then click **Enable Notifications** (Figure 6-14). You can also access the IBM eLearning movie for more technical details:

<http://www.ibm.com/support/knowledgecenter/ST3FR7/welcome?cp=ST3FR7%2F0&lang=en>

For the correct functionality of email notifications, ask your network administrator if Simple Mail Transfer Protocol (SMTP) is enabled on the management network and is not, for example, blocked by firewalls. Be sure to test the accessibility to the SMTP server using the **telnet** command (port 25 for a non-secured connection, port 465 for Secure Sockets Layer (SSL)-encrypted communication) using any server in the same network segment.

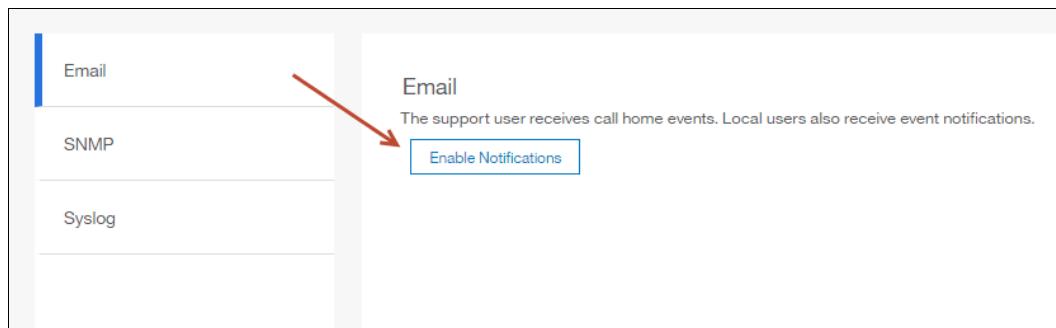


Figure 6-14 Configuration of email notifications

3. After clicking **Next** on the welcome window, provide the information about the location of the system (Figure 6-15) and contact information of IBM Spectrum Virtualize administrator (Figure 6-16 on page 72) to be contactable by IBM Support. *Always* keep this information current.

System Location

Service parts should be shipped to the same physical location as the system.

Company name: IBM ITSO

System address: 120 Holger way

City: San Jose

State or province: CA

Postal code: 95134

Country or region: United States

Machine location: Bld#3 2ndFloor Back Room ITSO racks

Cancel < Back Next >

Figure 6-15 Location of the device

Figure 6-16 shows the contact information of the owner.

Contact

The support center contacts this person to resolve issues on the system.

Name: System Administrator

Email: name@company.com

Phone (primary): +1234 567 8900

Phone (alternate):

Cancel < Back Apply and Next >

Figure 6-16 Contact information

4. Configure the SMTP server according to the instruction in Figure 6-17. When the correct SMTP server is provided, you can test the connectivity using **Ping** to verify it can be contacted. Then, click **Apply and Next**.

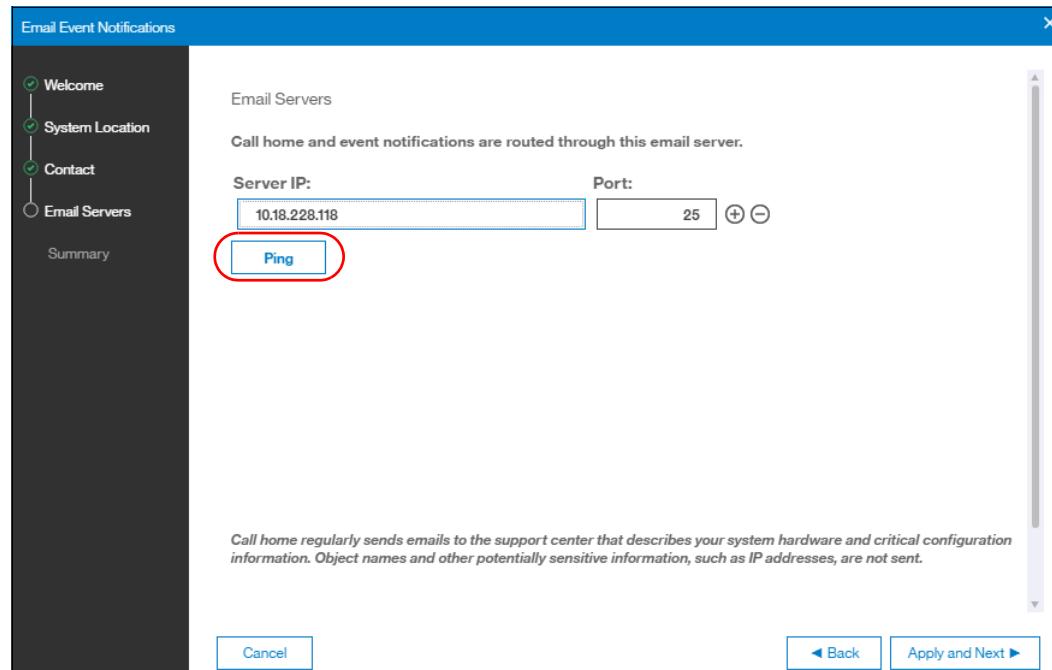


Figure 6-17 Configure email servers and inventory reporting

5. A summary window is displayed. Verify all of the information, then click **Finish**. We are then returned to the Email Settings window where you can verify email addresses of IBM Support (callhome0@de.ibm.com) and optionally add local users who also need to receive notifications. See Figure 6-18 for details.

The default support email address callhome0@de.ibm.com is predefined by the system to receive Error Events and Inventory. Do not change these settings or disable the 7 day reporting interval at the bottom of the Settings window.

You can modify or add local users using **Edit** mode after the initial configuration is saved.

The **Inventory Reporting** function is enabled by default for Call Home. Rather than reporting a problem, an email is sent to IBM that describes your system hardware and critical configuration information. Object names and other information, such as IP addresses, are not included. By default the inventory email is sent weekly, allowing an IBM Cloud™ service to analyze and inform you if the hardware or software that you are using requires an update because of any known issue.

Figure 6-18 shows the configured email notification and Call Home settings.

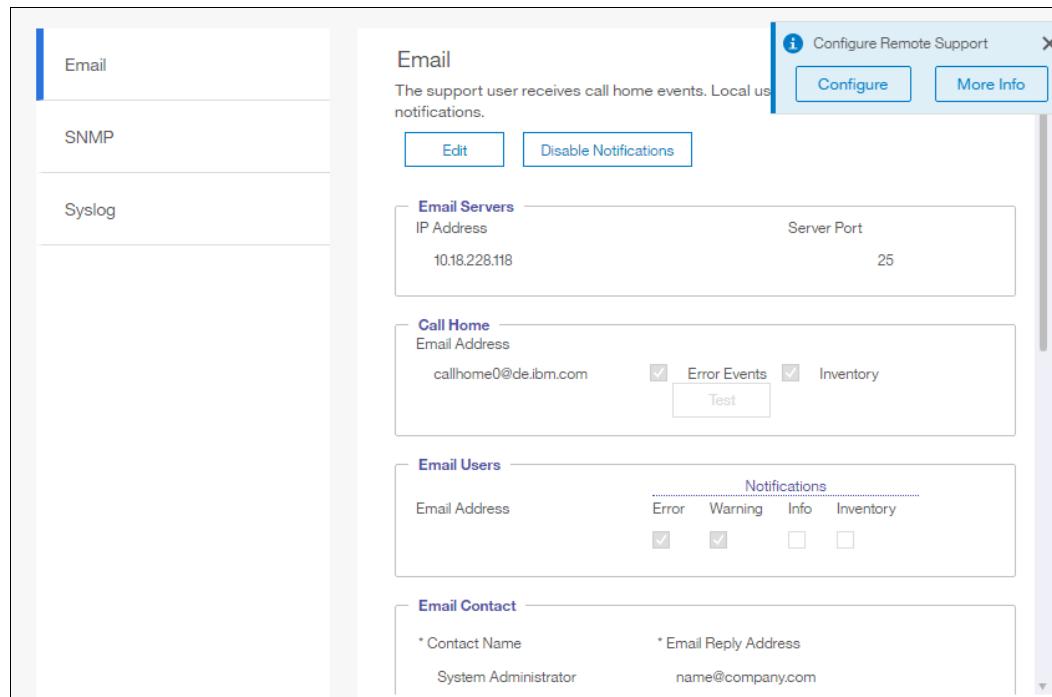


Figure 6-18 Setting email recipients and alert types

6. After completing the configuration wizard, test the email function. To do so, enter **Edit** mode, as illustrated in Figure 6-19. In the same window, you can define additional email recipients or alter any contact and location details as needed.

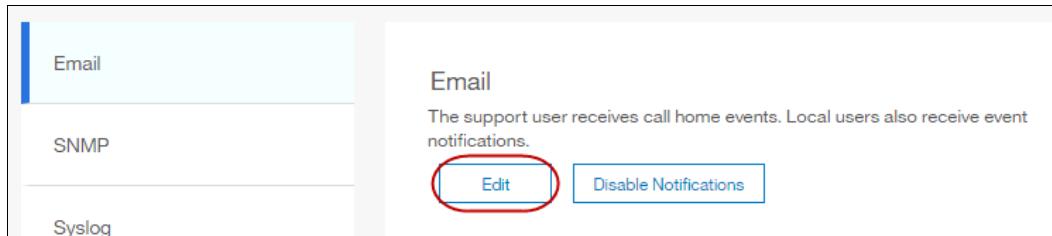


Figure 6-19 Entering edit mode

We strongly suggest that you keep the sending inventory option enabled to IBM support. However, it might not be of interest to local users, although inventory content can serve as a basis for inventory and asset management.

7. In Edit mode, you can change any of the previously configured settings. After you are finished editing these parameters, adding more recipients, or just testing the connection, save the configuration to make the changes take effect (Figure 6-20).

The screenshot shows the 'Email' configuration page. At the top, there is a message: 'The support user receives call home events. Local users also receive event notifications.' Below this are two buttons: 'Save' (highlighted with a red arrow) and 'Cancel'. The page is divided into sections: 'Email Servers', 'Call Home', and 'Email Users'. In the 'Email Servers' section, there is an 'IP Address' field containing '10.18.228.118' and a 'Server Port' field containing '25' with a '+' and '-' button. In the 'Call Home' section, there is an 'Email Address' field containing 'callhome0@de.ibm.com', a 'Test' button (circled in red), and checkboxes for 'Error Events' and 'Inventory'. In the 'Email Users' section, there is an 'Email Address' field containing 'DaniR@teach.com', a 'Notifications' section with checkboxes for 'Error', 'Warning', 'Info', and 'Inventory' (where 'Error' and 'Warning' are checked), and a '+' and '-' button.

Figure 6-20 Saving modified configuration

Note: The **Test** button will appear for new email users after first saving and then editing again.

Disabling and enabling notifications

At any time, you can temporarily or permanently disable email notifications, as shown in Figure 6-21. This is good practice when performing activities in your environment that might generate errors on your IBM Spectrum Virtualize system, such as SAN reconfiguration/replacement activities. After the planned activities, remember to re-enable the email notification function. The same results can be achieved with the CLI **svctask stopmail** and **svctask startmail** commands.

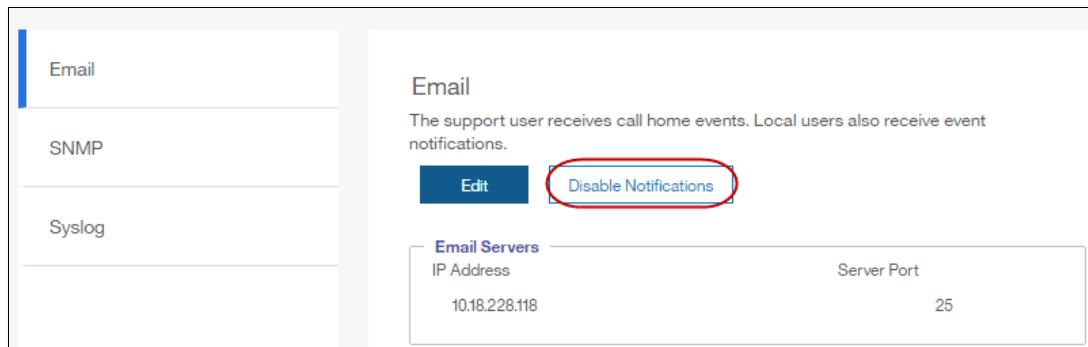


Figure 6-21 Disabling or enabling email notifications

6.3.2 Remote Support Assistance

Remote Support Assistance, introduced with V8.1, allows IBM support to remotely connect to the IBM Spectrum Virtualize system through a secure tunnel to perform analysis, log collection, and software updates. The tunnel can be enabled ad hoc by the client or enable a permanent connection if wanted.

Note: Clients who have purchased Enterprise Class Support (ECS) are entitled to IBM support using Remote Support Assistance to quickly connect and diagnose problems. However, IBM Support might choose to use this feature on non-ECS systems at their discretion. Therefore, configure and test the connection on all systems.

If you are enabling Remote Support Assistance, then ensure that the following prerequisites are met:

1. Ensure that call home is configured with a valid email server.
2. Ensure that a valid service IP address is configured on each node of the IBM Spectrum Virtualize storage system.
3. If your IBM Spectrum Virtualize storage system is behind a firewall or if you want to route traffic from multiple storage systems to the same place, you must configure a Remote Support Proxy server. Before you configure remote support assistance, the proxy server must be installed and configured separately. During the setup for support assistance, specify the IP address and the port number for the proxy server on the Remote Support Centers window.
4. If you do not have firewall restrictions and the nodes of the IBM Spectrum Virtualize storage system are directly connected to the internet, request your network administrator to allow connections to 129.33.206.139 and 204.146.30.139 on Port 22.
5. Both uploading support packages and downloading software require direct connections to the internet. A DNS server must be defined on your IBM Spectrum Virtualize storage system for both of these functions to work.

6. To ensure that support packages are uploaded correctly, configure the firewall to allow connections to the following IP addresses on port 443: 129.42.56.189, 129.42.54.189, and 129.42.60.189.
7. To ensure that software is downloaded correctly, configure the firewall to allow connections to the following IP addresses on port 22: 170.225.15.105, 170.225.15.104, 170.225.15.107, 129.35.224.105, 129.35.224.104, and 129.35.224.107.

Figure 6-22 shows a pop-up window that appears in the GUI after updating to V8.1. It prompt you to configure IBM Spectrum Virtualize for Remote Support. You can select to not enable it, open a tunnel when needed, or to open a permanent tunnel to IBM.

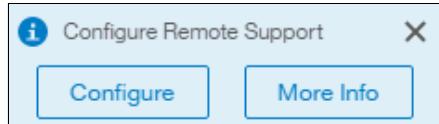


Figure 6-22 Prompt to configure Remote Support Assistance

You can choose to configure IBM Spectrum Virtualize, learn some more about the feature, or just close the window by clicking the X. Figure 6-23 shows how you can find the Setup Remote Support Assistance if you have closed the window.

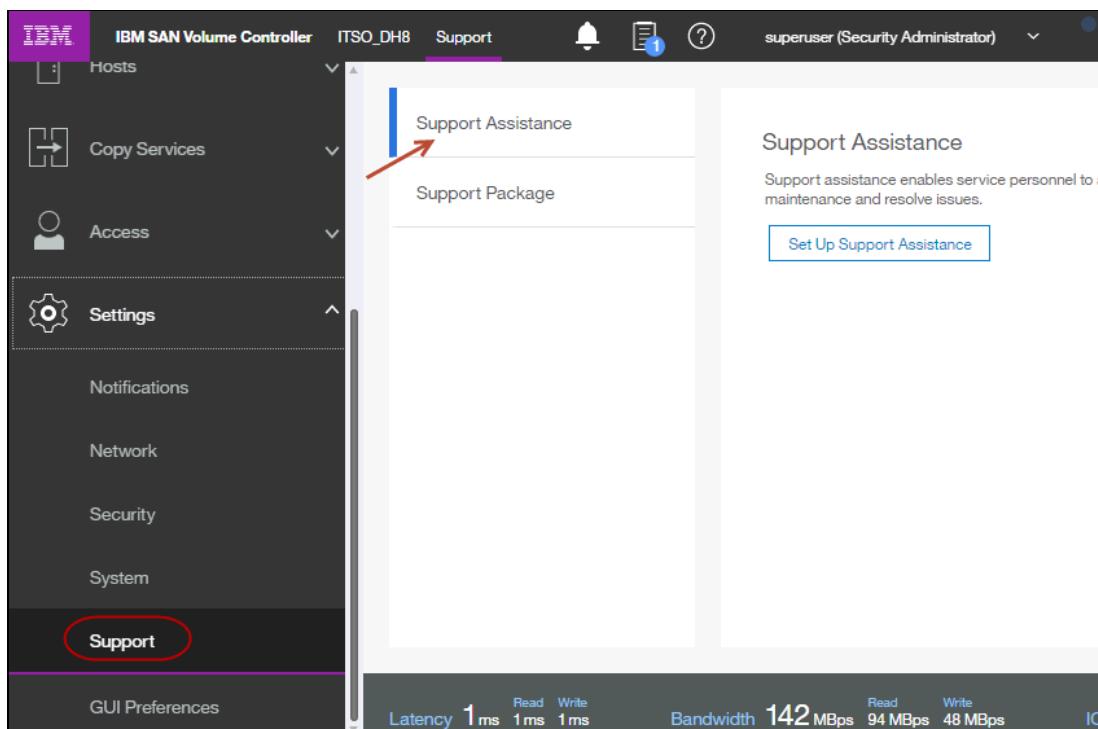


Figure 6-23 Remote Support Assistance menu

Choosing to set up support assistance opens a wizard to guide you through the configuration:

1. Figure 6-24 shows the first wizard window. Choose not to enable remote assistance by selecting **I want support personnel to work on-site only** or enable remote assistance by choosing **I want support personnel to access my system both on-site and remotely**. Click **Next**.

Note: Selecting **I want support personnel to work on-site only** does not entitle you to expect IBM support to attend on-site for all issues. Most maintenance contracts are for customer-replaceable units (CRU) support, where IBM diagnoses your problem and send a replacement component for you to replace if required. If you prefer to have IBM perform replacement tasks for you, then contact your local sales person to investigate an upgrade to your current maintenance contract.

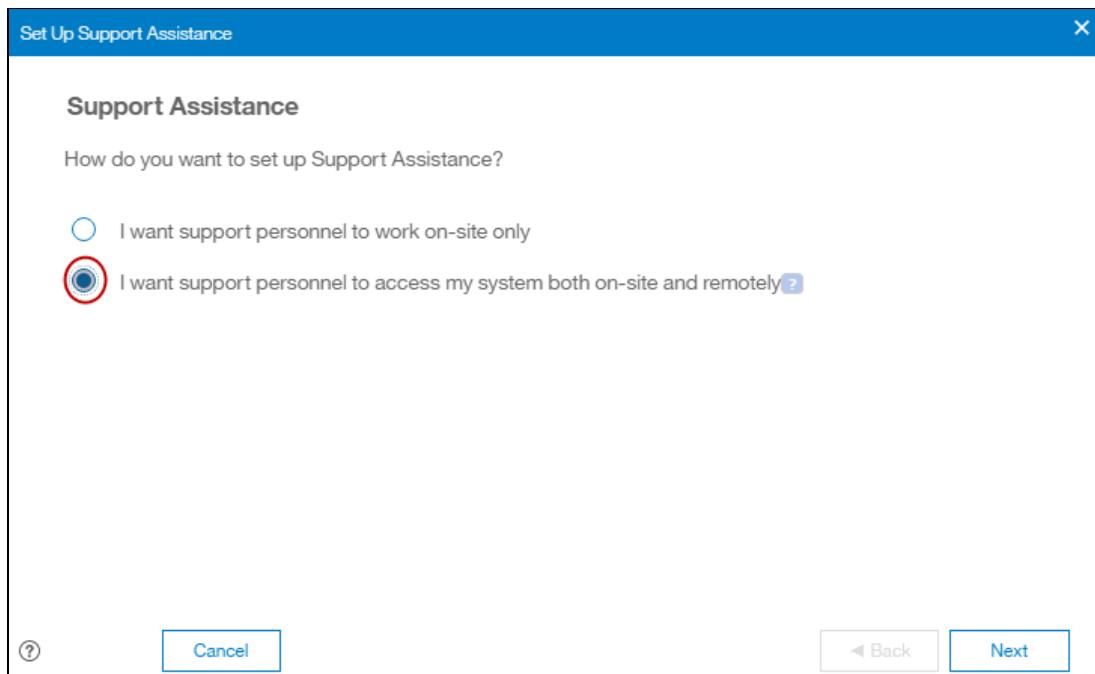


Figure 6-24 Remote Support wizard enable or disable

2. The next window, shown in Figure 6-25, lists the IBM Support center's IP addresses and SSH port that will need to be open in your firewall. You can also define a Remote Support Assistance Proxy if you have multiple IBM Spectrum Virtualize storage systems in the data center, allowing for firewall configuration only being required for the Proxy Server rather than every storage system. We do not have a proxy server and leave the field blank, then click **Next**.

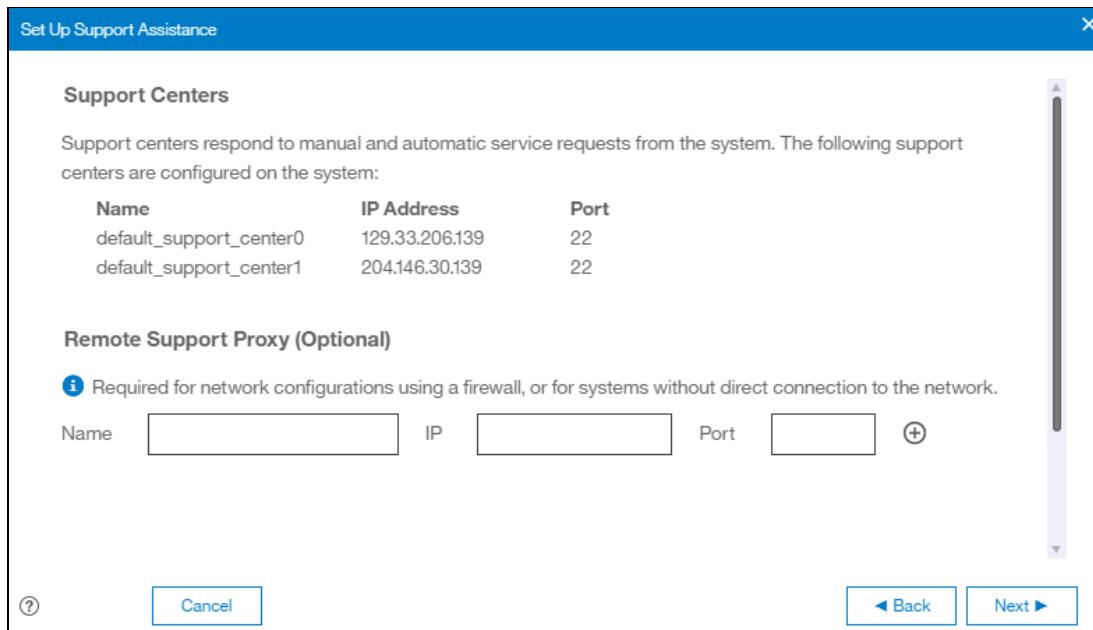


Figure 6-25 Remote Support wizard proxy setup

3. The next window asks if you want to open a tunnel to IBM permanently, allowing IBM to connect to your IBM Spectrum Virtualize storage system **At Any Time**, or **On Permission Only**, as shown in Figure 6-26. **On Permission Only** requires a storage administrator to log on to the GUI and enable the tunnel when required. Click **Finish**.

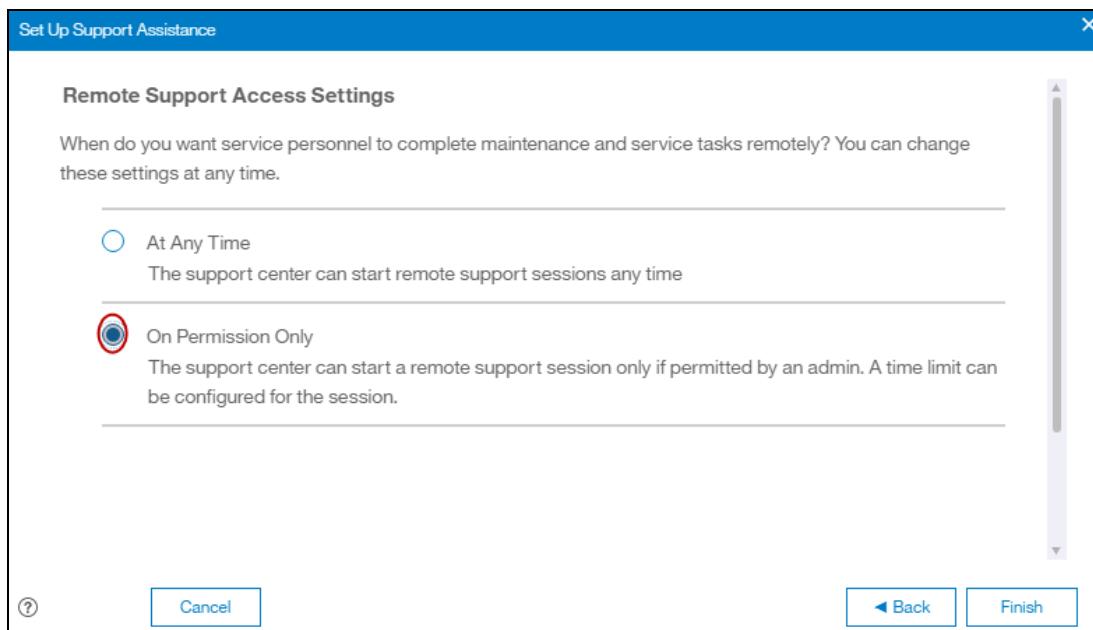


Figure 6-26 Remote Support wizard access choice

4. After completing the remote support setup, you can view the status of any remote connection, start a new session, test the connection to IBM, and reconfigure the setup. In Figure 6-27, we have successfully tested the connection. Click **Start New Session** to open a tunnel for IBM Support to connect through.

Support Assistance

Support assistance enables service personnel to access the system to perform maintenance and resolve issues.

Local Support: Session Ready

IBM Service Status: **Not Connected**

Remote Support

[Start New Session](#)

[Test Connection](#) Last test: **Successful Connection on 10/9/17 11:35:50 PM**

Support Users and History

Monitor Users: **0**

Privileged Users: **0**

Token Age: **0 days** [Generate New Token](#)

Remote Support Access Setting: **On Permission Only**

Proxy Servers Configured: **0**

[Reconfigure Settings](#)

Figure 6-27 Remote Support Status and session management

5. A pop-up window asks how long you would like the tunnel to remain open if there is no activity by setting a timeout value. As shown in Figure 6-28, the connection is established and waits for IBM Support to connect.

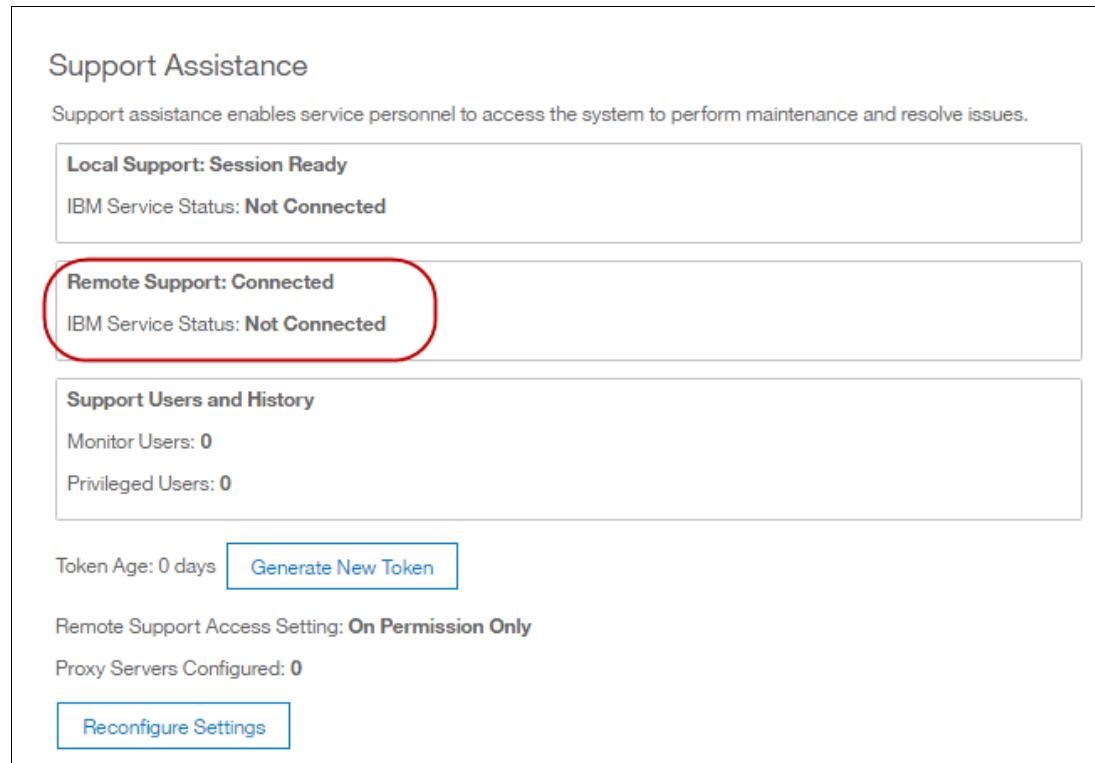


Figure 6-28 Remote Assistance tunnel connected

6.3.3 SNMP configuration

SNMP is a standard protocol for managing networks and exchanging messages. The system can send SNMP messages that notify personnel about an event. You can use an SNMP manager to view the SNMP messages that are sent by the IBM Spectrum Virtualize storage system.

You can configure an SNMP server to receive various informational, error, or warning notifications by entering the following information (Figure 6-29 on page 82):

- ▶ IP Address
The address for the SNMP server.
- ▶ Server Port
The remote port number for the SNMP server. The remote port number must be a value of 1 - 65535 where the default is port 162 for SNMP.
- ▶ Community
The SNMP community is the name of the group to which devices and management stations that run SNMP belong. Typically, the default of public is used.

► Event Notifications:

Consider the following points about event notifications:

- Select **Error** if you want the user to receive messages about problems, such as hardware failures, that require prompt action.

Important: Browse to **Recommended Actions** to run the fix procedures on these notifications.

- Select **Warning** if you want the user to receive messages about problems and unexpected conditions. Investigate the cause immediately to determine any corrective action such as a space efficient volume running out of space.

Important: Browse to **Recommended Actions** to run the fix procedures on these notifications.

- Select **Info** if you want the user to receive messages about expected events. No action is required for these events.

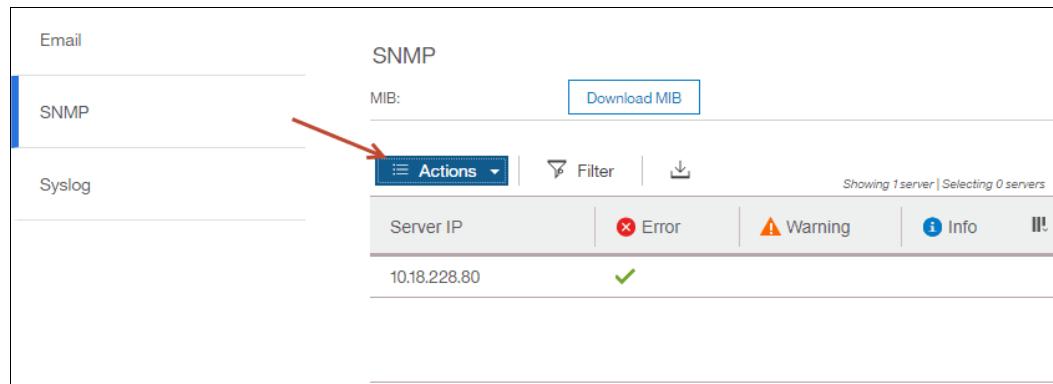


Figure 6-29 SNMP configuration

To add an SNMP server, click **Actions** → **Add** and fill out the Add SNMP Server window, as shown in Figure 6-30. To remove an SNMP server, click the line with the server you want to remove, and select **Actions** → **Remove**.

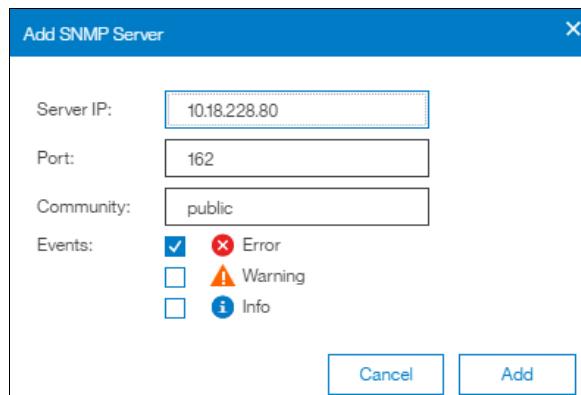


Figure 6-30 Add SNMP Server

6.3.4 Syslog notifications

The syslog protocol is a standard protocol for forwarding log messages from a sender to a receiver on an IP network. The IP network can be IPv4 or IPv6. The system can send syslog messages that notify personnel about an event.

You can configure a syslog server to receive log messages from various systems and store them in a central repository by entering the following information (Figure 6-31):

- ▶ IP Address

The IP address for the syslog server.
- ▶ Facility

The facility determines the format for the syslog messages. The facility can be used to determine the source of the message.
- ▶ Message Format

The message format depends on the facility. The system can transmit syslog messages in the following formats:

 - The concise message format provides standard detail about the event.
 - The expanded format provides more details about the event.
- ▶ Event Notifications

Consider the following points about event notifications:

 - Select **Error** if you want the user to receive messages about problems, such as hardware failures, that must be resolved immediately.

Important: Browse to **Recommended Actions** to run the fix procedures on these notifications.

- Select **Warning** if you want the user to receive messages about problems and unexpected conditions. Investigate the cause immediately to determine whether any corrective action is necessary.

Important: Browse to **Recommended Actions** to run the fix procedures on these notifications.

- Select **Info** if you want the user to receive messages about expected events. No action is required for these events.

Figure 6-31 Syslog configuration

To remove a syslog server, click the Minus sign (-).

To add another syslog server, click the Plus sign (+).

The syslog messages can be sent in concise message format or expanded message format.

Example 6-31 shows a compact format syslog message.

Example 6-31 Compact syslog message example

IBM2076 #NotificationType=Error #ErrorID=077102 #ErrorCode=1091 #Description=Node Double fan failed #ClusterName=V7000G2_1 #Timestamp=Wed Jul 02 08:00:00 2017 BST #ObjectType=Node #ObjectName=Node1 #CopyID=0 #ErrorSequenceNumber=120

Example 6-32 shows an expanded format syslog message.

Example 6-32 Full format syslog message example

6.4 Audit log

The audit log is useful when analyzing past configuration events, especially when trying to determine, for example, how a volume ended up being shared by two hosts, or why the volume was overwritten. The audit log is also included in the *svc_snap* support data to aid in problem determination.

The audit log tracks action commands that are issued through a Secure Shell (SSH) session, through the management GUI or Remote Support Assistance. It provides the following entries:

- ▶ Identity of the user who issued the action command.
- ▶ Name of the actionable command.
- ▶ Time stamp of when the actionable command was issued on the configuration node.
- ▶ Parameters that were issued with the actionable command.

The following items are not documented in the audit log:

- ▶ Commands that fail are not logged.
- ▶ A result code of 0 (success) or 1 (success in progress) is not logged.
- ▶ Result object ID of node type (for the **addnode** command) is not logged.
- ▶ Views are not logged.

Several specific service commands are not included in the audit log:

- ▶ **dumpconfig**
- ▶ **cpdumps**
- ▶ **cleardumps**
- ▶ **finderr**
- ▶ **dumperrlog**
- ▶ **dumpintervallog**
- ▶ **svcservicetak dumperrlog**
- ▶ **svcservicetask finderr**

Figure 6-32 shows the access to the audit log. Click **Audit Log** in the left menu to see which configuration CLI commands have been run on IBM Spectrum Virtualize storage system.

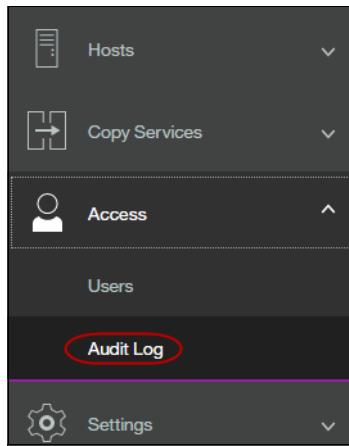


Figure 6-32 Audit Log from Access menu

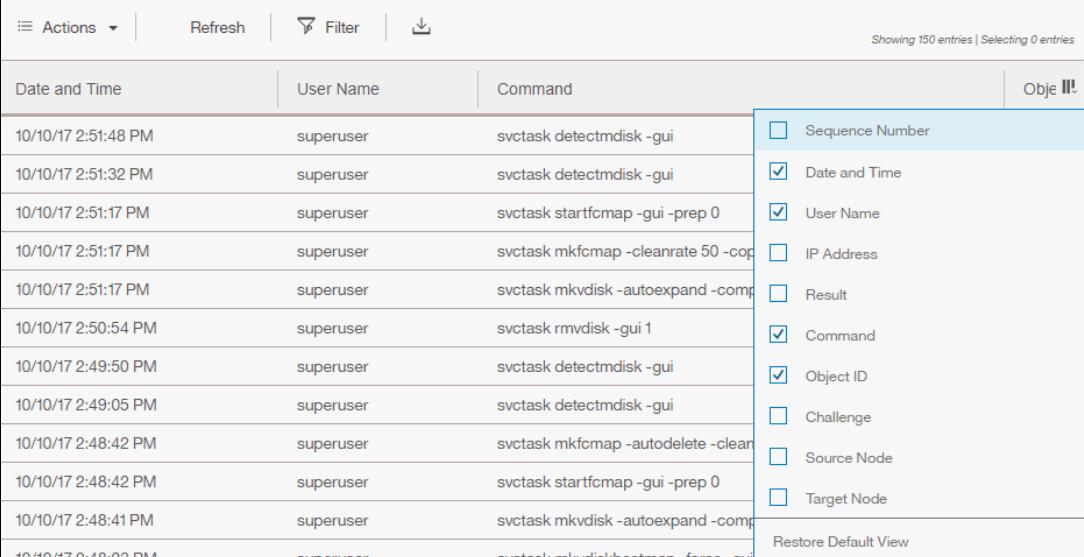
Figure 6-33 shows an example of the audit log after creating a FlashCopy® volume, with a command highlighted. The **Running Tasks** button is available at the top of the window in the status pane. If you click that button, the progress of the currently running tasks can be displayed by clicking the associated **View** button.

 A screenshot of the Audit Log window in the IBM Spectrum Virtualize interface. The window title is 'Audit Log'. The status bar shows 'superuser (Security Administrator)'. The 'Running Tasks' section lists the following tasks:

Date and Time	User Name	Task Description	View Button
10/10/17 2:51:48 PM	superuser	Array Initialization	View
10/10/17 2:51:32 PM	superuser	FlashCopy Operation (highlighted with a red oval)	View
10/10/17 2:51:17 PM	superuser	svctask startfcmap -gui -prep 0	
10/10/17 2:51:17 PM	superuser	svctask mkfcmap -cleanrate 50 -copyrate 50 -gui -incremental -so...	0
10/10/17 2:51:17 PM	superuser	svctask mkvdisk -autoexpand -compressed -gui -iogrp io_grp0 -m...	1

Figure 6-33 Audit log

Changing the view of the Audit Log grid is also possible by right-clicking column headings (Figure 6-34). The grid layout and sorting is completely under the user's control, so you can view everything in the audit log, sort different columns, and reset the default grid preferences.



The screenshot shows a table with three columns: Date and Time, User Name, and Command. A context menu is open over the 'Command' column, listing various audit log entries. The menu includes options for Sequence Number, Date and Time, User Name, IP Address, Result, Command, Object ID, Challenge, Source Node, and Target Node. At the bottom of the menu is a 'Restore Default View' option.

Date and Time	User Name	Command	Objet
10/10/17 2:51:48 PM	superuser	svctask detectmdisk -gui	<input type="checkbox"/> Sequence Number
10/10/17 2:51:32 PM	superuser	svctask detectmdisk -gui	<input checked="" type="checkbox"/> Date and Time
10/10/17 2:51:17 PM	superuser	svctask startfcmap -gui -prep 0	<input checked="" type="checkbox"/> User Name
10/10/17 2:51:17 PM	superuser	svctask mkfcmap -cleanrate 50 -comp	<input type="checkbox"/> IP Address
10/10/17 2:51:17 PM	superuser	svctask mkvdisk -autoexpand -comp	<input type="checkbox"/> Result
10/10/17 2:50:54 PM	superuser	svctask rmvdisk -gui 1	<input checked="" type="checkbox"/> Command
10/10/17 2:49:50 PM	superuser	svctask detectmdisk -gui	<input checked="" type="checkbox"/> Object ID
10/10/17 2:49:05 PM	superuser	svctask detectmdisk -gui	<input type="checkbox"/> Challenge
10/10/17 2:48:42 PM	superuser	svctask mkfcmap -autodelete -clean	<input type="checkbox"/> Source Node
10/10/17 2:48:42 PM	superuser	svctask startfcmap -gui -prep 0	<input type="checkbox"/> Target Node
10/10/17 2:48:41 PM	superuser	svctask mkvdisk -autoexpand -comp	
10/10/17 2:48:23 PM	superuser	svctask mkvdiskhostmap -force -gui	

Figure 6-34 Right-click audit log column headings

6.5 Collecting support information using the GUI and the CLI

Occasionally, if you have a problem and call the IBM Support Center, they will most likely ask you to provide a support package. You can collect and upload this package from the **Settings** → **Support** menu.

6.5.1 Collecting information using the GUI

To collect information using the GUI, complete the following steps:

1. Click **Settings** → **Support** and the Support Package tab (Figure 6-35).
2. Click the **Upload Support Package** button.

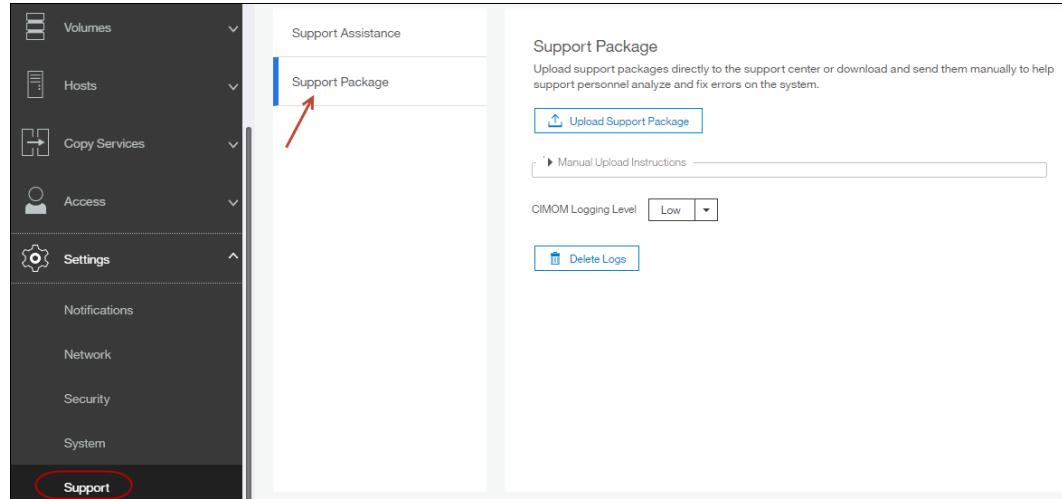


Figure 6-35 Support Package option

Assuming that the problem encountered was an unexpected node restart that has logged a 2030 error, we collect the default logs plus the most recent statesave from each node to capture the most relevant data for support.

Note: When a node unexpectedly reboots, it first dumps its current statesave information before it restarts to recover from an error condition. This statesave is critical for support to analyze what happened. Collecting a snap type 4 creates new statesaves at the time of the collection, which is not useful for understanding the restart event.

3. The Upload Support Package window provides four options for data collection. If you have been contacted by IBM Support due to your system calling home or you have manually opened a call with IBM Support, you will have been given a *PMR number*. Enter that PMR number into the **PMR** field and select the snap type, often referred to as an *option 1, 2, 3, 4 snap*, as requested by IBM Support (Figure 6-36). In our case, we enter our PMR number, select snap type 3 (option 3) because this will automatically collect the statesave created at the time the node restarted, and click **Upload**.

Tip: You can use <https://www.ibm.com/support/servicerequest> to open a service request online.

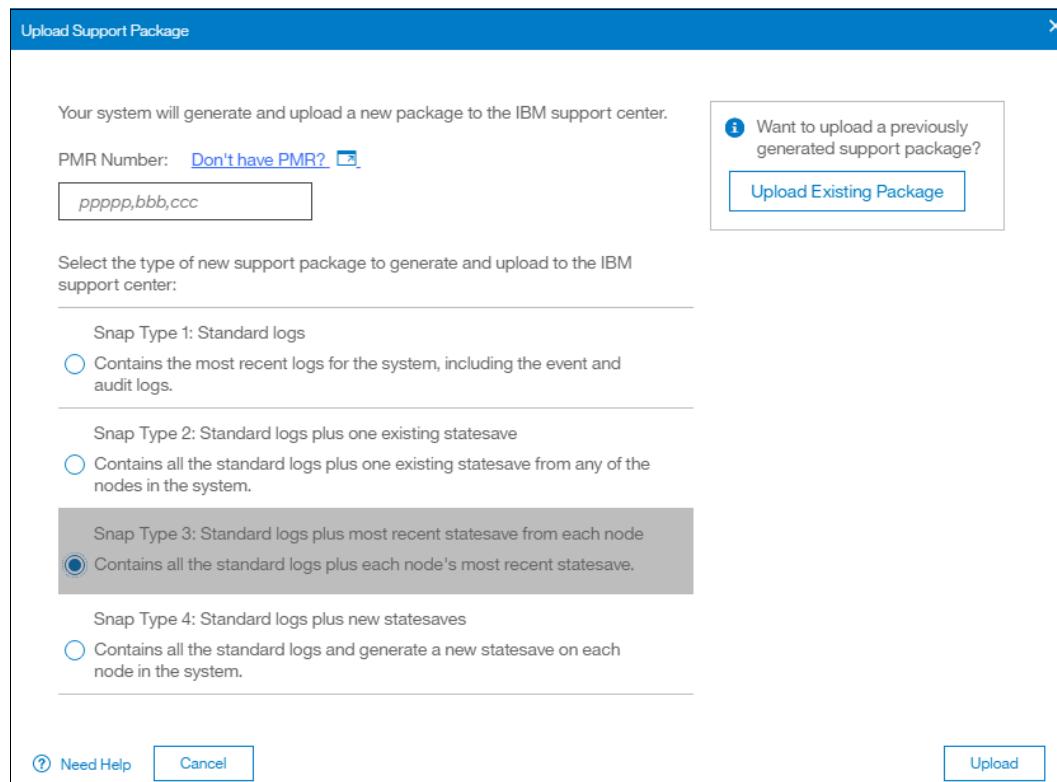


Figure 6-36 Upload Support Package window

4. The procedure to generate the snap on a IBM Spectrum Virtualize storage system, including the most recent statesave from each node canister, starts. This process might take a few minutes (Figure 6-37).

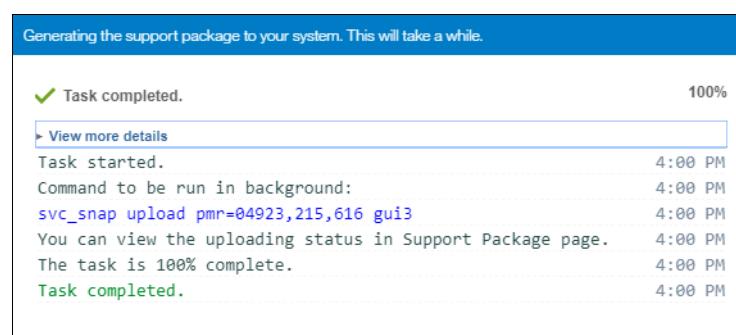


Figure 6-37 Task detail window

6.5.2 Collecting logs using the CLI

The CLI can be used to collect and upload a support package as requested by IBM Support by performing the following steps:

1. Log in to the CLI and issue the `svc_snap` command that matches the type of snap requested by IBM Support:
 - Standard logs (type 1):
`svc_snap upload pmr=ppppp,bbb,ccc gui1`
 - Standard logs plus one existing statesave (type 2):
`svc_snap upload pmr=ppppp,bbb,ccc gui2`
 - Standard logs plus most recent statesave from each node (type 3):
`svc_snap upload pmr=ppppp,bbb,ccc gui3`
 - Standard logs plus new statesaves:
`svc_livedump -nodes all -yes`
`svc_snap upload pmr=ppppp,bbb,ccc gui3`
2. We collect the type 3 (option 3) and have it automatically upload to the PMR number provided by IBM Support, as shown in Example 6-33.

Example 6-33 The `svc_snap` command

```
ssh superuser@10.18.228.71
Password:
IBM_Storwize:V7000G2:superuser>svc_snap upload pmr=04923,215,616 gui3
```

3. If you do not want to automatically upload the snap to IBM, do not specify the `upload pmr=ppppp,bbb,ccc` part of the commands. When the snap creation completes, it creates a file named using this format:
`/dumps/snap.<panel_id>.YYMMDD.hhmmss.tgz`
It takes a few minutes for the snap file to complete, and longer if including statesaves.
4. The generated file can then be retrieved from the GUI under **Settings** → **Support** → **Manual Upload Instructions** twisty → **Download Support Package** and then click **Download Existing Package**, as shown in Figure 6-38.

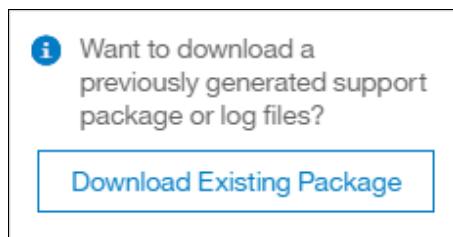


Figure 6-38 Downloaded Existing Package

5. Click in the **Filter** box and enter snap to see a list of snap files, as shown in Figure 6-39. Locate the exact name of the snap generated by the `svc_snap` command issued earlier, select that file, and click **Download**.

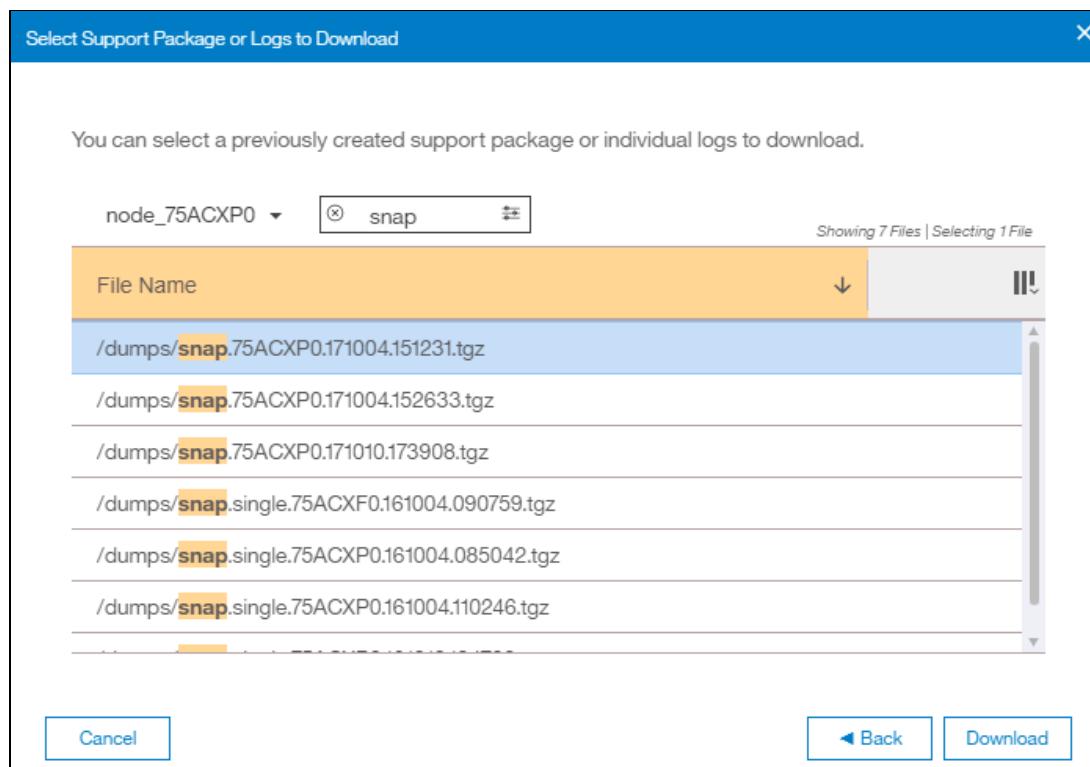


Figure 6-39 Filtering on snap to download

6. Save the file to a folder of your choice on your workstation.

6.5.3 Uploading files to the Support Center

If you have chosen to not have the IBM Spectrum Virtualize storage system upload the support package automatically, it can still be uploaded for analysis from the Enhanced Customer Data Repository (ECuRep). Any uploads should be associated with a specific problem management report (PMR). The PMR is also known as a *service request* and is a mandatory requirement when uploading.

To upload information, use the following procedure:

1. Using a web browser, navigate to ECuRep:

<https://www.secure.ecurep.ibm.com/app/upload>

This link takes you to the Secure Upload page (Figure 6-40).

The fields indicated with an asterisk (*) are required to complete this transaction; other fields are optional. If you do not want to provide us with the required information, please use the "Back" button on your browser to return to the previous page, or close the window or browser session that is displaying this page.

PMR number:^{*} 04923,215,616

Upload is for:^{*} Hardware

Email address: MattR@mecheng.org.

Usage information
Enter the PMR number you got from IBM support (e.g. 12345,789,002) and select the upload directory.
If you specify an email address, an email will be sent on failure or success.

Continue

Figure 6-40 ECuRep details

2. Complete the required fields:

- **PMR number** (mandatory) as provided by IBM support for your specific case. This number should be in the format of ppppp,bbb,ccc, for example, 04923,215,616, using a comma (,) as a separator.
- **Upload is for** (mandatory). Select **Hardware** from the drop-down menu.
- **Email address** (not mandatory). We recommend to input your email address in this field to be automatically notified of a successful or unsuccessful upload.

3. When the form is completed, click **Continue** to open the input window (Figure 6-41).

The fields indicated with an asterisk (*) are required to complete this transaction; other fields are optional. If you do not want to provide us with the required information, please use the "Back" button on your browser to return to the previous page, or close the window or browser session that is displaying this page.

Click to Select Files

snap.75ACXP0.171010.173908.tgz	257 MB
--------------------------------	--------

1 file selected

Upload

Back

Usage information
Select the files you want to upload to IBM and select the Upload button. Files are processed after a complete upload is successful. You have 24 hours to resume any paused uploads before they are removed from IBM. If a file upload fails or is cancelled, that file data will be removed.

NOTE: It is recommended to use the latest browser version to take advantage of the uploader features. Older browser versions have limits such as 2 GB file sizes and no ability to pause/resume uploads.

Figure 6-41 ECuRep File upload

Select one or more files, click **Upload** to continue, and follow the directions.

6.6 Error codes

This section lists the error codes related to data reduction pools. For more information about troubleshooting options and error codes, see the Troubleshooting section in IBM Knowledge Center, which is available at:

<https://ibm.biz/Bdjmzg>

6.6.1 Error code CMMVC7210E

Example 6-34 CMMVC7210E

CMMVC7210E The command failed because it would create too many compressed volume copies that are contained within regular pools in the I/O group.

There is a limitation depending on the hardware platform type on the number of compressed copies within regular pools in the I/O group. The limitation is either 200 or 512 compressed copies that are within regular pools within the I/O group, depending on the platform type. There is no such limitation for compressed copies in data reduction pools. The recommended approaches are to delete compressed copies that are within regular pools, or create compressed copies in data reduction pools or create the copies in other I/O groups.

6.6.2 Error code CMMVC8696E

Example 6-35 CMMVC8696E

CMMVC8696E The command failed because the volume or a volume copy is in the deleting state.

An action was requested on a volume or a volume copy that was in the process of being deleted. Make sure that you specified the correct volume. If so, the requested action is not supported on volumes or volume copies which are deleting.

6.6.3 Error code CMMVC9173E

Example 6-36 CMMVC9173E

CMMVC9173E The pool specified is a data reduction pool. Thin provisioned or compressed volume copies created from a data reduction pool must use **-autoexpand**.

A volume copy created from a data reduction pool must have **autoexpand** on. The command fails when a thin provisioned or compressed volume copy is created from a data reduction pool without specifying the **-autoexpand** parameter.

6.6.4 Error code CMMVC9175E

Example 6-37 CMMVC9175E

CMMVC9175E The pool specified is a data reduction pool. Volumes or volume copies which are thin provisioned or compressed and created from a data reduction pool can not be striped specifying an mdisk, sequential or image mode.

A volume or volume copy created from a data reduction pool must not be striped specifying an MDisk, sequential, or image mode. The command fails when a thin provisioned or compressed volume copy is created from a data reduction pool and these parameters are specified.

6.6.5 Error code CMMVC9176E

Example 6-38 CMMVC9176E

CMMVC9176E The pool specified is a data reduction pool. For volumes or volume copies which are thin provisioned or compressed and created from a data reduction pool, the volume cannot have a cache mode of none or readonly.

A volume or volume copy created from a data reduction pool must have a cache mode of readwrite. The command fails when a thin provisioned or compressed volume copy is created from a data reduction pool and the volume cache mode is not readwrite.

6.6.6 Error code CMMVC9235E

Example 6-39 CMMVC9235E

CMMVC9235E The pool specified is a data reduction pool. Volumes or volume copies which are thin provisioned and created from a data reduction pool can not use the -grainsize parameter.

A volume or volume copy created from a data reduction pool must not use the **-grainsize** parameter or the command fails. This type of volume or volume copy is created with a grainsize of 8 KB.

6.6.7 Error code CMMVC9236E

Example 6-40 CMMVC9236E

CMMVC9236E The pool specified is a data reduction pool. Volumes or volume copies which are thin provisioned and created from a data reduction pool can not use the -warning parameter.

A volume or volume copy created from a data reduction pool must not use the **-warning** parameter. This type of volume or volume copy will be created without a warning threshold.

6.6.8 Error code CMMVC9247E

Example 6-41 CMMVC9247E

CMMVC9247E The pool specified is a data reduction pool. Thin or compressed volumes or volume copies in data reduction pools cannot have the easytier status set or changed.

A volume or volume copy created from a data reduction pool cannot specify the easytier mode of the volume. The easytier mode is an attribute of the pool and must be set or changed at the pool level.

6.6.9 Error code CMMVC9245E

Example 6-42 CMMVC9245E

CMMVC9245E The pool specified is a data reduction pool and the I/O group selected already contains compressed volumes within a regular pool. An I/O group using software compression can not contain compressed volumes from regular and data reduction pools at the same time.

The I/O group selected supports only software compression and cannot contain compressed volumes or volume copies from regular and data reduction pools at the same time. Select a different I/O group or create the compressed volume or volume copy in a regular pool.

6.6.10 Error code CMMVC9246E

Example 6-43 CMMVC9246E

CMMVC9246E The pool specified is a regular pool and the I/O group selected already contains compressed volumes within a data reduction pool. An I/O group using software compression can not contain compressed volumes from regular and data reduction pools at the same time.

The I/O group selected supports only software compression and can not contain compressed volumes or volume copies from regular and data reduction pools at the same time. Select a different I/O group or create the compressed volume or volume copy in a data reduction pool.

6.6.11 Error code CMMVC9177E

Example 6-44 CMMVC9177E

CMMVC9177E The pool specified is a data reduction pool. Thin provisioned or compressed volume copies created from a data reduction pool can not use **-noautoexpand**.

A volume copy created from a data reduction pool must have **autoexpand** on. The command fails when a thin provisioned or compressed volume copy from a data reduction pool is created and the **-noautoexpand** parameter is specified.

6.6.12 Error code CMMVC9250E

Example 6-45 CMMVC9250E

CMMVC9250E The pool specified is a data reduction pool. Thin provisioned or compressed volume copies created from a data reduction pool can not use the **-buffersize** parameter.

A volume copy created from a data reduction pool cannot use the **-buffersize** parameter. The command fails when a thin provisioned or compressed volume copy is created from a data reduction pool and the **-buffersize** parameter is specified.

6.6.13 Error code CMMVC9248E

Example 6-46 CMMVC9248E

CMMVC9248E The volume or volume copy specified is a thin or compressed volume in a data reduction pool. The easytier status cannot be changed.

A volume or volume copy created from a data reduction pool cannot specify the easytier mode of the volume. The easytier mode is an attribute of the pool and must be set or changed at the pool level.

6.6.14 Error code CMMVC9184E

Example 6-47 CMMVC9184E

CMMVC9184E The volume specified is a thin or compressed volume in a data reduction pool. Autoexpand must be on and can not be changed.

Thin or compressed volumes in data reduction pools must have autoexpand on, this setting cannot be changed.

6.6.15 Error code CMMVC9237E

Example 6-48 CMMVC9237E

CMMVC9237E The volume specified is a thin or compressed volume in a data reduction pool. Cache can not be set to none or readonly.

Thin or compressed volumes in data reduction pools must have the cache enabled. This setting cannot be changed.

6.6.16 Error code CMMVC9238E

Example 6-49 CMMVC9238E

CMMVC9238E The volume specified is a thin or compressed volume in a data reduction pool. The -warning parameter can not be used.

Thin or compressed volumes in data reduction pools must not have a warning threshold.

6.6.17 Error code CMMVC9185E

Example 6-50 CMMVC9185E

CMMVC9185E The volume or volume copy specified is a thin or compressed volume in a data reduction pool and the action requested is not supported on volumes of this type.

It is not possible to run this command on a thin or compressed volume copy in a data reduction pool. This action can only be performed on fully allocated volumes or thin or compressed volume copies which are in a regular pool.

6.6.18 Error code CMMVC9186E

Example 6-51 CMMVC9186E

CMMVC9186E The pool specified is a data reduction pool. It is not possible to migrate thin or compressed volumes to a data reduction pool.

It is not possible to migrate thin or compressed volume copies to a data reduction pool. Use volume mirroring (**addvdiskcopy**) to migrate thin or compressed volumes to a data reduction pool. For more information see Chapter 2, “Planning” on page 11.

6.6.19 Error code CMMVC9179E

Example 6-52 CMMVC9179E

CMMVC9179E The command failed as the resource required for a data reduction pool could not be allocated.

There are not enough resources available. Each data reduction pool requires resources used for managing pools and volumes. Delete some volume copies, volumes or pools on the system to free enough resources then create a data reduction pool.

6.6.20 Error code CMMVC9180E

Example 6-53 CMMVC9180E

CMMVC9180E The data reduction pool can not be created as the maximum number of data reduction pools already exists.

There can be four data reduction pools in a cluster, once this limit is reached no further data reduction pools can be created.

6.6.21 Error code CMMVC9181E

Example 6-54 CMMVC9181E

CMMVC9181E Data reduction can only be set to on for a parent pool.

It is not allowed to change a child pool to a data reduction child pool.

6.6.22 Error code CMMVC9249E

Example 6-55 CMMVC9249E

CMMVC9249E Data reduction pools can not have child pools.

A data reduction pool is not allowed to have child pools.

6.6.23 Error code CMMVC9190E

Example 6-56 CMMVC9190E

CMMVC9190E The pool specified is a data reduction pool, creating thin or compressed volumes from this type of pool must have autoexpand on.

All thin or compressed volumes in data reduction pools must have autoexpand on, otherwise the command fails.

6.6.24 Error code CMMVC9253E

Example 6-57 CMMVC9253E

CMMVC9253E An I/O group using software compression can not contain compressed volumes from regular and data reduction pools at the same time.

The I/O group selected supports only software compression and a compressed volume can not be created with copies in both a regular and a data reduction pool. Select a different I/O group or create the compressed volume with both copies in either regular pools or data reduction pools.

6.6.25 Error code CMMVC9242E

Example 6-58 CMMVC9242E

CMMVC9242E The volume or volume copy specified is a thin or compressed volume in a data reduction pool. Thin provisioned or compressed volume copies created from a data reduction pool can not use the **-rszie** parameter.

A volume copy created from a data reduction pool cannot use the **-rszie** option as data reduction pools automatically manage the physical capacity used across the volumes in the pool. The command fails when the **-rszie** of a thin provisioned or compressed volume copy from a data reduction pool, is expanded or shrunk.

6.6.26 Error code CMMVC9241E

Example 6-59 CMMVC9241E

CMMVC9241E Action failed because Quorum device is unavailable.

The action failed due to issues communicating with the Quorum device. Check the event log and resolve any outstanding issues with the Quorum device.

6.6.27 Error code CMMVC9185E

Example 6-60 CMMVC9185E

CMMVC9185E The volume specified is a thin or compressed volume in a data reduction pool and the action requested is not supported on volumes of this type.

It is not possible to run this command on a thin or compressed volume copy in a data reduction pool. Only perform this action on fully allocated volumes or thin or compressed volumes or volume copies which are in a regular pool.

6.6.28 Error code CMMVC5772E

Example 6-61 CMMVC5772E

CMMVC5772E The operation requested could not be performed because software upgrade is in progress.

The operation failed because a software upgrade is in progress. Wait for the software upgrade to complete and then reissue the command.

6.6.29 Error code CMMVC9296E

Example 6-62 CMMVC9296E

CMMVC9296E The command has failed because the volume LBA address supplied is not recoverable and contains a virtual medium error.

The operation failed because the data at the supplied volume LBA cannot be recovered and the volume LBA cannot lookup the physical address. The data to the virtual LBA need to be restored from a backup or from a previously generated backup of the volume or the volume needs to be repaired from the host application.

6.6.30 Error code CMMVC9185E

Example 6-63 CMMVC9185E

CMMVC9185E The volume specified is a thin or compressed volume in a data reduction pool and the action requested is not supported on volumes of this type.

This command cannot be executed on a thin or compressed volume copy in a data reduction pool. Only perform this action on fully allocated volumes or thin or compressed volumes or volume copies which are in a regular pool.

6.6.31 Error code CMMVC9277E

Example 6-64 CMMVC9277E

CMMVC9277E The command failed because there are out of sync volume mirrors and some copies are in data reduction pools that may also be deleted.

There are volume mirrors that are out of synchronisation and at least one thin or compressed copy is in a data reduction pool. For the volume mirrors where there is at least one copy in a data reduction pool, bring the volume mirrors back into synchronisation before re-attempting the command.

6.6.32 Error code CMMVC9265E

Example 6-65 CMMVC9265E

CMMVC9265E The volume specified has a thin or compressed volume copy in a data reduction pool. Thin provisioned or compressed volumes created from a data reduction pool can not use -size parameter to reduce the size of the volume.

It is not possible to shrink thin provisioned or compressed volumes created from a data reduction pool, when **-size** parameter was used. Select a regular disk or a disk from a non data reduction pool to perform this action.

6.6.33 Error code CMMVC9262E

Example 6-66 CMMVC9262E

CMMVC9262E The pool specified is a data reduction pool. The action requested is not supported with pools of this type.

It is not possible to run this command if a data reduction pool is selected. Select a regular pool to perform this action.

6.6.34 Error code CMMVC9252E

Example 6-67 CMMVC9252E

CMMVC9252E The command failed because the I/O group contains compressed volumes. The new hardware configuration does not support compressed volumes.

The I/O group this node belongs to contains compressed volumes and the hardware configuration being submitted stops the node from supporting compressed volumes. Revert the change to the hardware configuration or remove all the compressed volumes from the I/O group.

6.6.35 Error code CMMVC9286E

Example 6-68 CMMVC9286E

CMMVC9286E The amount of memory configured for FlashCopy cannot be greater than 1.5 gigabytes (GB) because data reduction volumes exist in this I/O group.

For I/O groups containing 8GB node types, the flash copy bitmap cannot be increased beyond 1.5GByte if there are thin or compressed volumes created within that I/O group. Upgrade the node types within the I/O group to contain more than 8GByte of memory, do not use data reduction volumes within that I/O group or set the flash copy bitmap size under 1.5GByte, or select another I/O group to use for flash copies if you wish to have more than 1.5GByte of flash copy bitmap.

6.6.36 Error code CMMVC9285E

Example 6-69 CMMVC9285E

CMMVC9285E A thin or compressed volume in a data reduction pool cannot be created within this I/O group because the amount of memory configured for FlashCopy is

greater than 1.5 gigabytes (GB) and there is insufficient free memory in the I/O group.

For I/O groups containing 8 GByte node types, thin or compressed volumes cannot be created if the flash copy bitmap is set beyond 1.5GByte for the I/O group. Upgrade the node types within the I/O group to contain more than 8GByte of memory, do not use data reduction volumes within that I/O group, select another I/O group to create the thin or compressed volumes in a data reduction pool or reduce the amount of flash copy bitmap memory that is in use for the I/O group to below 1.5GByte.

6.6.37 Error code CMMVC9283E

Example 6-70 CMMVC9283E

CMMVC9283E The command failed because the pool specified is a data reduction pool that has insufficient capacity.

There is insufficient capacity within the pool specified to be able to create a thin or compressed volume within a data reduction pool. Add extra capacity to the specified storage pool and then re-attempt the command.

6.6.38 Error code CMMVC9284E

Example 6-71 CMMVC9284E

CMMVC9284E The command failed because the pool specified is a data reduction pool that contains offline volumes.

Volumes cannot be created in data reduction pools whilst there are other thin or compressed volumes in data reduction pools. Repair the offline volumes in the data reduction pool or bring online the mdisks or bring online the offline data reduction pool or add additional capacity to the pool.

6.6.39 Error code CMMVC8710E

Example 6-72 CMMVC8710E

CMMVC8710E The command failed because there were not enough extents in storage pool.

There is insufficient capacity within the pool specified to be able to create a fully allocated volume within a data reduction or regular storage pool. The user needs to add extra capacity to the specified storage pool and then re-attempt the command.

6.6.40 Error code CMMVC9185E

Example 6-73 CMMVC9185E

CMMVC9185E The volume specified is a thin or compressed volume in a data reduction pool and the action requested is not supported on volumes of this type.

This action is not supported on thin or compressed volumes in data reduction pools.

6.6.41 Error code CMMVC9186E

Example 6-74 CMMVC9186E

CMMVC9186E The pool specified is a data reduction pool. It is not possible to migrate thin or compressed volumes to a data reduction pool.

It is not possible to migrate thin or compressed volume copies to a data reduction pool. Use volume mirroring (**addvdiskcopy**) to migrate thin or compressed volumes to a data reduction pool.

6.6.42 Error code CMMVC9287E

Example 6-75 CMMVC9287E

CMMVC9287E The volume or volume copy cannot be deleted because the data reduction pool is corrupt.

Volumes cannot be deleted from data reduction pools.

6.6.43 Error code CMMVC9288E

Example 6-76 CMMVC9288E

CMMVC9288E The node could not be added as a data reduction pool containing a thin or compressed volume exists within this I/O group and the new node does not meet the minimum CPU requirements.

When the first thin or compressed volume in a data reduction pool is created for an I/O group, the I/O group sets CPU parameters based on the lowest number of CPU resources available based on the nodes in the I/O group. A new node with less CPU resources cannot be added to the I/O group. Delete all thin and compressed volumes in all data reduction pools for the specified I/O group then retry the addnode.

Related publications

The publications listed in this section are considered particularly suitable for a more detailed discussion of the topics covered in this book.

The following IBM Redbooks publications provide additional information about the topic in this document (note that some publications referenced in this list might be available in softcopy only):

- ▶ *Implementing the IBM System Storage SAN Volume Controller with IBM Spectrum Virtualize V8.1*, SG24-7933
- ▶ *Implementing the IBM Storwize V7000 with IBM Spectrum Virtualize V8.1*, SG24-7938
- ▶ *Implementing the IBM Storwize V5000 Gen2 (including the Storwize V5010, V5020, and V5030) with IBM Spectrum Virtualize V8.1*, SG24-8162

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