



## **Manage Storage Nodes**

StorageGRID software

NetApp

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# Manage Storage Nodes

## Manage Storage Nodes

Storage Nodes provide disk storage capacity and services. Managing Storage Nodes entails the following:

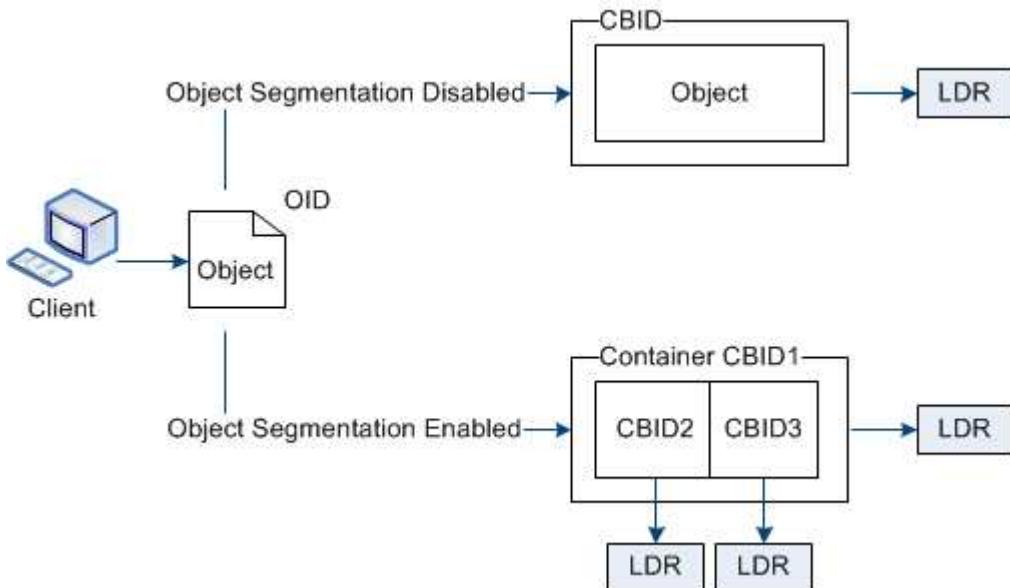
- Managing storage options
- Understanding what storage volume watermarks are and how you can use watermark overrides to control when Storage Nodes become read-only
- Monitoring and managing the space used for object metadata
- Configuring global settings for stored objects
- Applying Storage Node configuration settings
- Managing full Storage Nodes

## Use Storage options

### What is object segmentation?

Object segmentation is the process of splitting up an object into a collection of smaller fixed-size objects to optimize storage and resources usage for large objects. S3 multi-part upload also creates segmented objects, with an object representing each part.

When an object is ingested into the StorageGRID system, the LDR service splits the object into segments, and creates a segment container that lists the header information of all segments as content.



On retrieval of a segment container, the LDR service assembles the original object from its segments and returns the object to the client.

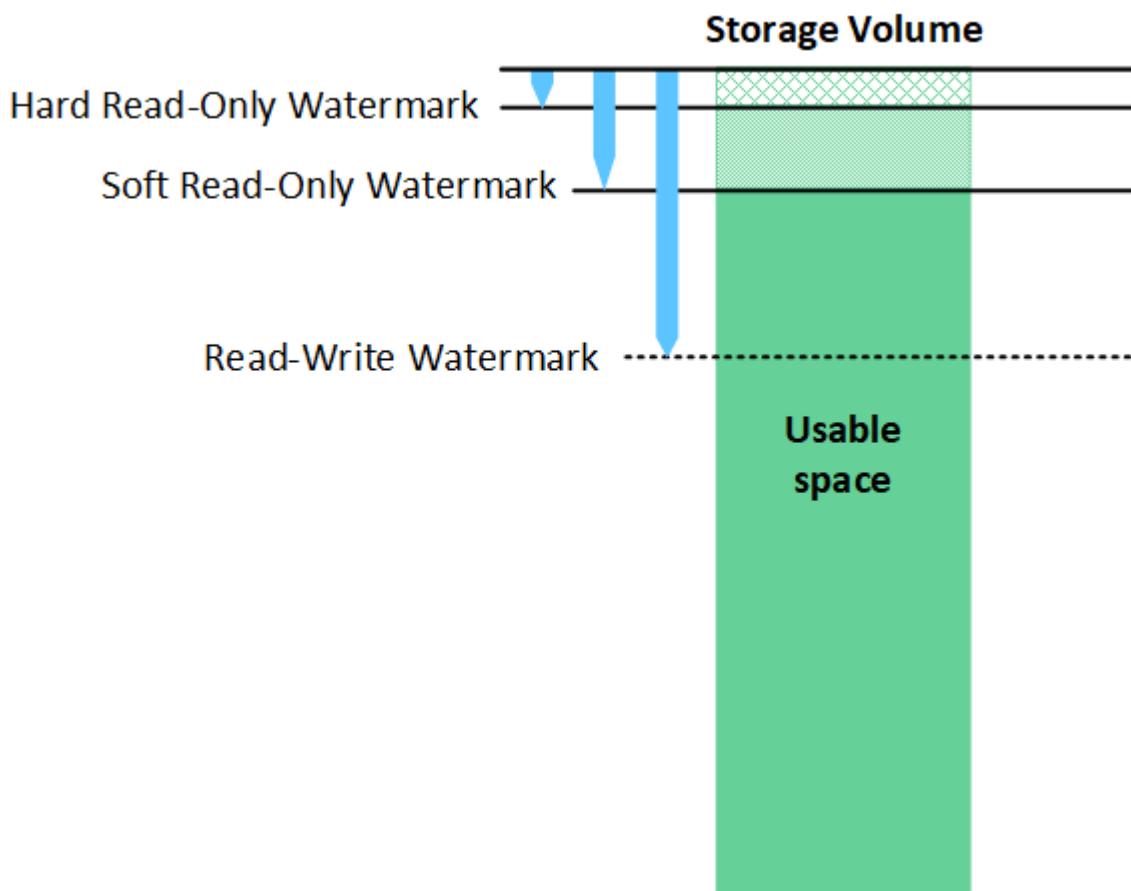
The container and segments aren't necessarily stored on the same Storage Node. Container and segments can be stored on any Storage Node within the storage pool specified in the ILM rule.

Each segment is treated by the StorageGRID system independently and contributes to the count of attributes such as Managed Objects and Stored Objects. For example, if an object stored to the StorageGRID system is split into two segments, the value of Managed Objects increases by three after the ingest is complete, as follows:

segment container + segment 1 + segment 2 = three stored objects

## What are storage volume watermarks?

StorageGRID uses three storage volume watermarks to ensure that Storage Nodes are safely transitioned to a read-only state before they run critically low on space and to allow Storage Nodes that have been transitioned to a read-only state to become read-write again.



i Storage volume watermarks only apply to the space used for replicated and erasure-coded object data. To learn about the space reserved for object metadata on volume 0, go to [Manage object metadata storage](#).

## What is the soft read-only watermark?

The **storage volume soft read-only watermark** is the first watermark to indicate that a Storage Node's usable space for object data is becoming full.

If each volume in a Storage Node has less free space than that volume's soft read-only watermark, the Storage Node transitions into *read-only mode*. Read-only mode means that the Storage Node advertises read-only

services to the rest of the StorageGRID system, but fulfills all pending write requests.

For example, suppose each volume in a Storage Node has a soft read-only watermark of 10 GB. As soon as each volume has less than 10 GB of free space, the Storage Node transitions to soft read-only mode.

### What is the hard read-only watermark?

The **storage volume hard read-only watermark** is the next watermark to indicate that a node's usable space for object data is becoming full.

If the free space on a volume is less than that volume's hard read-only watermark, writes to the volume will fail. However, writes to other volumes can continue until the free space on those volumes is less than their hard read-only watermarks.

For example, suppose each volume in a Storage Node has a hard read-only watermark of 5 GB. As soon as each volume has less than 5 GB of free space, the Storage Node no longer accepts any write requests.

The hard read-only watermark is always less than the soft read-only watermark.

### What is the read-write watermark?

The **storage volume read-write watermark** applies only to Storage Nodes that have transitioned to read-only mode. It determines when the node can become read-write again. When the free space on any one storage volume in a Storage Node is greater than that volume's read-write watermark, the node automatically transitions back to the read-write state.

For example, suppose the Storage Node has transitioned to read-only mode. Also suppose that each volume has a read-write watermark of 30 GB. As soon as the free space for any volume increases to 30 GB, the node becomes read-write again.

The read-write watermark is always larger than both the soft read-only watermark and the hard read-only watermark.

## View storage volume watermarks

You can view the current watermark settings and the system-optimized values. If optimized watermarks aren't being used, you can determine if you can or should adjust the settings.

### Before you begin

- You have completed the upgrade to StorageGRID 11.6 or higher.
- You are signed in to the Grid Manager using a [supported web browser](#).
- You have the [Root access permission](#).

### View current watermark settings

You can view the current storage watermark settings in the Grid Manager.

### Steps

1. Select **SUPPORT > Other > Storage watermarks**.
2. On the Storage watermarks page, look at the **Use optimized values** checkbox.
  - If the checkbox is selected, all three watermarks are optimized for every storage volume on every Storage Node, based on the size of the Storage Node and the relative capacity of the volume.

This is the default and recommended setting. Do not update these values. Optionally, you can [View optimized storage watermarks](#).

- If the Use optimized values checkbox is unselected, custom (non-optimized) watermarks are being used. Using custom watermark settings is not recommended. Use the instructions for [troubleshooting Low read-only watermark override alerts](#) to determine if you can or should adjust the settings.

When you specify custom watermark settings, you must enter values greater than 0.

#### **View optimized storage watermarks**

StorageGRID uses two Prometheus metrics to show the optimized values it has calculated for the storage volume soft read-only watermark. You can view the minimum and maximum optimized values for each Storage Node in your grid.

1. Select **SUPPORT > Tools > Metrics**.
2. In the Prometheus section, select the link to access the Prometheus user interface.
3. To see the recommended minimum soft read-only watermark, enter the following Prometheus metric, and select **Execute**:

```
storagegrid_storage_volume_minimum_optimized_soft_readonly_watermark
```

The last column shows the minimum optimized value of the soft read-only watermark for all storage volumes on each Storage Node. If this value is greater than the custom setting for the storage volume soft read-only watermark, the **Low read-only watermark override** alert is triggered for the Storage Node.

4. To see the recommended maximum soft read-only watermark, enter the following Prometheus metric, and select **Execute**:

```
storagegrid_storage_volume_maximum_optimized_soft_readonly_watermark
```

The last column shows the maximum optimized value of the soft read-only watermark for all storage volumes on each Storage Node.

## **Manage object metadata storage**

The object metadata capacity of a StorageGRID system controls the maximum number of objects that can be stored on that system. To ensure that your StorageGRID system has adequate space to store new objects, you must understand where and how StorageGRID stores object metadata.

### **What is object metadata?**

Object metadata is any information that describes an object. StorageGRID uses object metadata to track the locations of all objects across the grid and to manage each object's lifecycle over time.

For an object in StorageGRID, object metadata includes the following types of information:

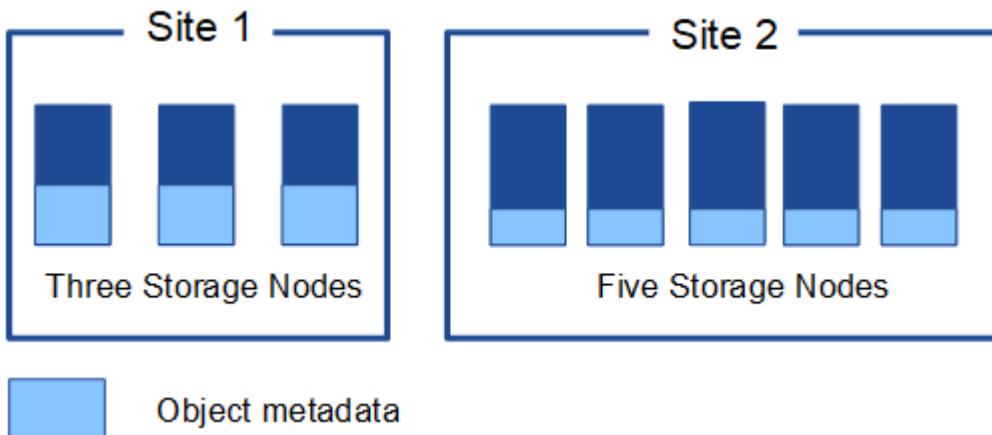
- System metadata, including a unique ID for each object (UUID), the object name, the name of the S3 bucket, the tenant account name or ID, the logical size of the object, the date and time the object was first created, and the date and time the object was last modified.

- Any custom user metadata key-value pairs associated with the object.
- For S3 objects, any object tag key-value pairs associated with the object.
- For replicated object copies, the current storage location of each copy.
- For erasure-coded object copies, the current storage location of each fragment.
- For object copies in a Cloud Storage Pool, the location of the object, including the name of the external bucket and the object's unique identifier.
- For segmented objects and multipart objects, segment identifiers and data sizes.

## How is object metadata stored?

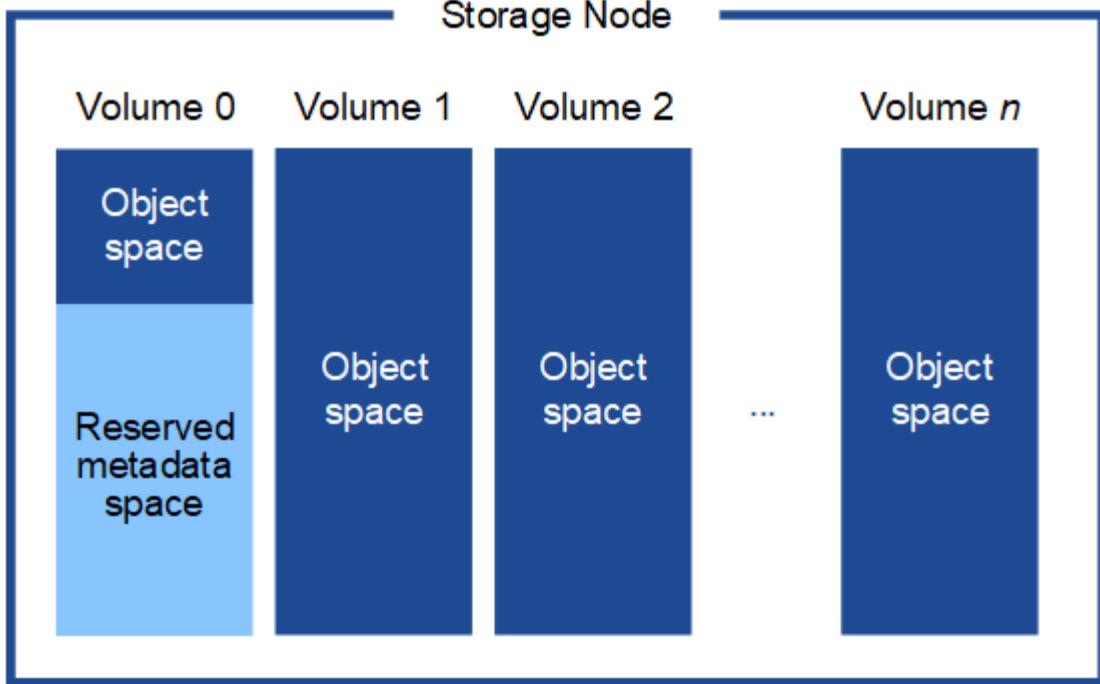
StorageGRID maintains object metadata in a Cassandra database, which is stored independently of object data. To provide redundancy and to protect object metadata from loss, StorageGRID stores three copies of the metadata for all objects in the system at each site.

This figure represents the Storage Nodes at two sites. Each site has the same amount of object metadata, and each site's metadata is subdivided among all Storage Nodes at that site.



## Where is object metadata stored?

This figure represents the storage volumes for a single Storage Node.



As shown in the figure, StorageGRID reserves space for object metadata on storage volume 0 of each Storage Node. It uses the reserved space to store object metadata and to perform essential database operations. Any remaining space on storage volume 0 and all other storage volumes in the Storage Node are used exclusively for object data (replicated copies and erasure-coded fragments).

The amount of space that is reserved for object metadata on a particular Storage Node depends on several factors, which are described below.

## Metadata reserved space setting

The *Metadata reserved space* is a system-wide setting that represents the amount of space that will be reserved for metadata on volume 0 of every Storage Node. As shown in the table, the default value of this setting is based on:

- The software version you were using when you initially installed StorageGRID.
- The amount of RAM on each Storage Node.

Version used for initial StorageGRID installation	Amount of RAM on Storage Nodes	Default Metadata reserved space setting
11.5 to 11.9	128 GB or more on each Storage Node in the grid	8 TB (8,000 GB)
	Less than 128 GB on any Storage Node in the grid	3 TB (3,000 GB)
11.1 to 11.4	128 GB or more on each Storage Node at any one site	4 TB (4,000 GB)

Version used for initial StorageGRID installation	Amount of RAM on Storage Nodes	Default Metadata reserved space setting
	Less than 128 GB on any Storage Node at each site	3 TB (3,000 GB)
11.0 or earlier	Any amount	2 TB (2,000 GB)

## View Metadata reserved space setting

Follow these steps to view the Metadata reserved space setting for your StorageGRID system.

### Steps

1. Select **CONFIGURATION > System > Storage settings**.
2. On the Storage settings page, expand the **Metadata reserved space** section.

For StorageGRID 11.8 or higher, the Metadata reserved space value must be at least 100 GB and no more than 1 PB.

The default setting for a new StorageGRID 11.6 or higher installation in which each Storage Node has 128 GB or more of RAM is 8,000 GB (8 TB).

## Actual reserved space for metadata

In contrast to the system-wide Metadata reserved space setting, the *actual reserved space* for object metadata is determined for each Storage Node. For any given Storage Node, the actual reserved space for metadata depends on the size of volume 0 for the node and the system-wide Metadata reserved space setting.

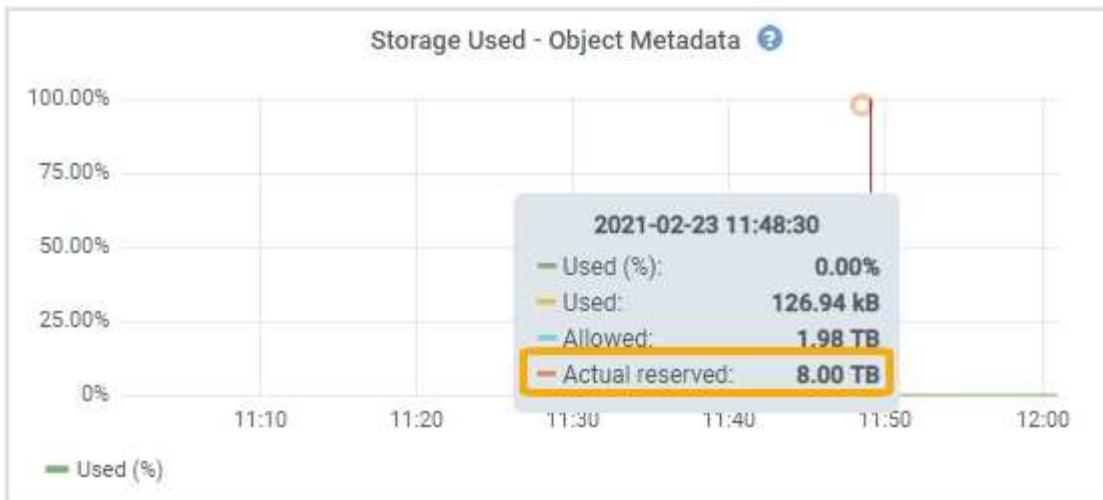
Size of volume 0 for the node	Actual reserved space for metadata
Less than 500 GB (non-production use)	10% of volume 0
500 GB or more or Metadata-only Storage Nodes	<p>The smaller of these values:</p> <ul style="list-style-type: none"> <li>• Volume 0</li> <li>• Metadata reserved space setting</li> </ul> <p><b>Note:</b> Only one rangedb is required for metadata-only Storage Nodes.</p>

## View actual reserved space for metadata

Follow these steps to view the actual reserved space for metadata on a particular Storage Node.

### Steps

1. From the Grid Manager, select **NODES > Storage Node**.
2. Select the **Storage** tab.
3. Position your cursor over the Storage Used - Object Metadata chart and locate the **Actual reserved** value.



In the screenshot, the **Actual reserved** value is 8 TB. This screenshot is for a large Storage Node in a new StorageGRID 11.6 installation. Because the system-wide Metadata reserved space setting is smaller than volume 0 for this Storage Node, the actual reserved space for this node equals the Metadata reserved space setting.

## Example for actual reserved metadata space

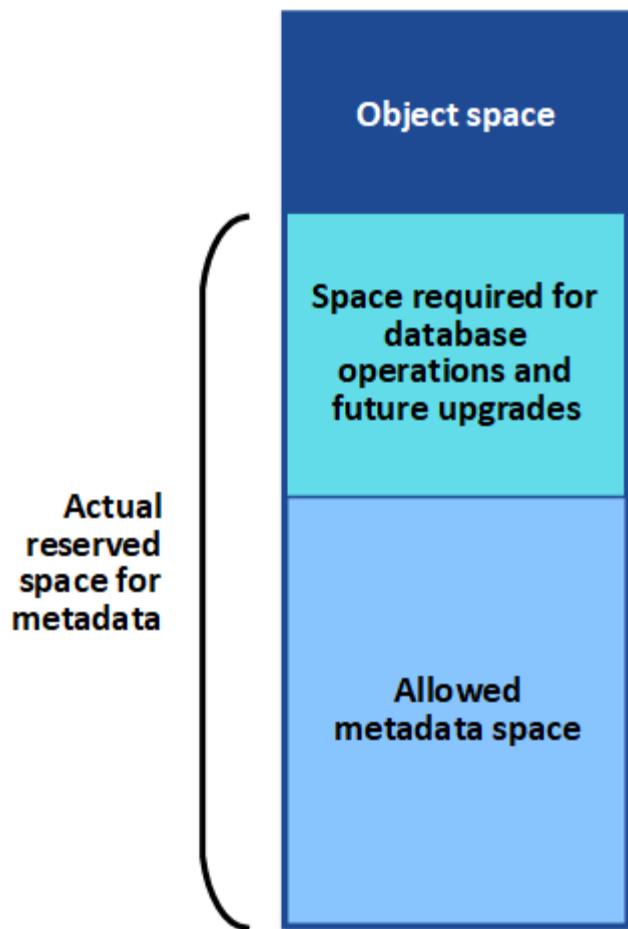
Suppose you install a new StorageGRID system using version 11.7 or later. For this example, assume that each Storage Node has more than 128 GB of RAM and that volume 0 of Storage Node 1 (SN1) is 6 TB. Based on these values:

- The system-wide **Metadata reserved space** is set to 8 TB. (This is the default value for a new StorageGRID 11.6 or higher installation if each Storage Node has more than 128 GB RAM.)
- The actual reserved space for metadata for SN1 is 6 TB. (The entire volume is reserved because volume 0 is smaller than the **Metadata reserved space** setting.)

## Allowed metadata space

Each Storage Node's actual reserved space for metadata is subdivided into the space available for object metadata (the *allowed metadata space*) and the space required for essential database operations (such as compaction and repair) and future hardware and software upgrades. The allowed metadata space governs overall object capacity.

## Volume 0



The following table shows how StorageGRID calculates the **allowed metadata space** for different Storage Nodes, based on the amount of memory for the node and the actual reserved space for metadata.

Amount of memory on Storage Node		
	< 128 GB	$\geq 128$ GB
Actual reserved space for metadata	60% of actual reserved space for metadata, up to a maximum of 1.32 TB	60% of actual reserved space for metadata, up to a maximum of 1.98 TB
	$(\text{Actual reserved space for metadata} - 1\text{ TB}) \times 60\%$ , up to a maximum of 1.32 TB	$(\text{Actual reserved space for metadata} - 1\text{ TB}) \times 60\%$ , up to a maximum of 3.96 TB

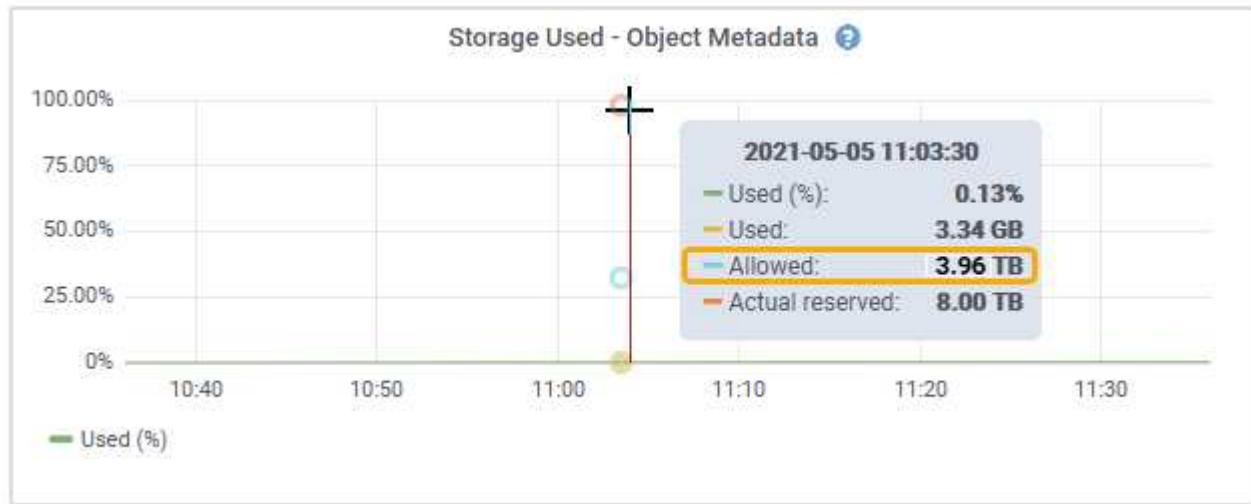
### View allowed metadata space

Follow these steps to view the allowed metadata space for a Storage Node.

#### Steps

1. From the Grid Manager, select **NODES**.

2. Select the Storage Node.
3. Select the **Storage** tab.
4. Position your cursor over the Storage used - object metadata chart and locate the **Allowed** value.



In the screenshot, the **Allowed** value is 3.96 TB, which is the maximum value for a Storage Node whose actual reserved space for metadata is more than 4 TB.

The **Allowed** value corresponds to this Prometheus metric:

```
storagegrid_storage_utilization_metadata_allowed_bytes
```

## Example for allowed metadata space

Suppose you install a StorageGRID system using version 11.6. For this example, assume that each Storage Node has more than 128 GB of RAM and that volume 0 of Storage Node 1 (SN1) is 6 TB. Based on these values:

- The system-wide **Metadata reserved space** is set to 8 TB. (This is the default value for StorageGRID 11.6 or higher when each Storage Node has more than 128 GB RAM.)
- The actual reserved space for metadata for SN1 is 6 TB. (The entire volume is reserved because volume 0 is smaller than the **Metadata reserved space** setting.)
- The allowed space for metadata on SN1 is 3 TB, based on the calculation shown in the [table for allowed space for metadata](#): (Actual reserved space for metadata – 1 TB) × 60%, up to a maximum of 3.96 TB.

## How Storage Nodes of different sizes affect object capacity

As described above, StorageGRID evenly distributes object metadata across the Storage Nodes at each site. For this reason, if a site contains Storage Nodes of different sizes, the smallest node at the site determines the site's metadata capacity.

Consider the following example:

- You have a single-site grid containing three Storage Nodes of different sizes.
- The **Metadata reserved space** setting is 4 TB.

- The Storage Nodes have the following values for the actual reserved metadata space and the allowed metadata space.

Storage Node	Size of volume 0	Actual reserved metadata space	Allowed metadata space
SN1	2.2 TB	2.2 TB	1.32 TB
SN2	5 TB	4 TB	1.98 TB
SN3	6 TB	4 TB	1.98 TB

Because object metadata is evenly distributed across the Storage Nodes at a site, each node in this example can only hold 1.32 TB of metadata. The additional 0.66 TB of allowed metadata space for SN2 and SN3 can't be used.



Similarly, because StorageGRID maintains all object metadata for a StorageGRID system at each site, the overall metadata capacity of a StorageGRID system is determined by the object metadata capacity of the smallest site.

And because object metadata capacity controls the maximum object count, when one node runs out of metadata capacity, the grid is effectively full.

#### Related information

- To learn how to monitor the object metadata capacity for each Storage Node, see the instructions for [Monitoring StorageGRID](#).
- To increase the object metadata capacity for your system, [expand a grid](#) by adding new Storage Nodes.

## Increase Metadata Reserved Space setting

You might be able to increase the Metadata Reserved Space system setting if your Storage Nodes meet specific requirements for RAM and available space.

#### What you'll need

- You are signed in to the Grid Manager using a [supported web browser](#).
- You have the [Root Access](#) permission or the [Grid Topology Page Configuration and Other Grid Configuration](#) permissions.



The Grid topology page has been deprecated and will be removed in a future release.

## About this task

You might be able to manually increase the system-wide Metadata Reserved Space setting up to 8 TB.

You can only increase the value of the system-wide Metadata Reserved Space setting if both of these statements are true:

- The Storage Nodes at any site in your system each have 128 GB or more RAM.
- The Storage Nodes at any site in your system each have sufficient available space on storage volume 0.

Be aware that if you increase this setting, you will simultaneously reduce the space available for object storage on storage volume 0 of all Storage Nodes. For this reason, you might prefer to set the Metadata Reserved Space to a value smaller than 8 TB, based on your expected object metadata requirements.



In general, it is better to use a higher value instead of a lower value. If the Metadata Reserved Space setting is too large, you can decrease it later. In contrast, if you increase the value later, the system might need to move object data to free up space.

For a detailed explanation of how the Metadata Reserved Space setting affects the allowed space for object metadata storage on a particular Storage Node, see [Manage object metadata storage](#).

## Steps

1. Determine the current Metadata Reserved Space setting.
  - a. Select **CONFIGURATION > System > Storage options**.
  - b. In the Storage watermarks section, note the value of **Metadata Reserved Space**.
2. Ensure you have enough available space on storage volume 0 of each Storage Node to increase this value.
  - a. Select **NODES**.
  - b. Select the first Storage Node in the grid.
  - c. Select the Storage tab.
  - d. In the Volumes section, locate the **/var/local/rangedb/0** entry.
  - e. Confirm that the Available value is equal to or greater than difference between the new value you want to use and the current Metadata Reserved Space value.

For example, if the Metadata Reserved Space setting is currently 4 TB and you want to increase it to 6 TB, the Available value must be 2 TB or greater.

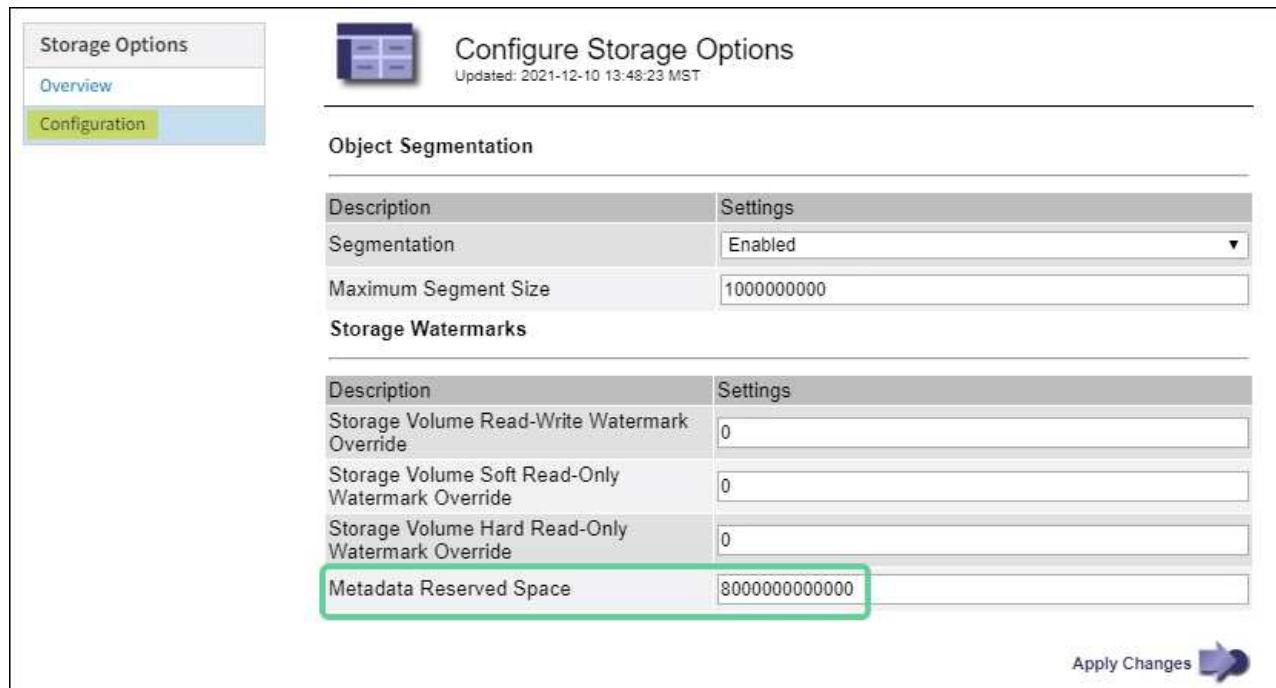
- f. Repeat these steps for all Storage Nodes.
    - If one or more Storage Nodes do not have enough available space, the Metadata Reserved Space value cannot be increased. Do not continue with this procedure.
    - If each Storage Node has enough available space on volume 0, go to the next step.
3. Ensure you have at least 128 GB of RAM on each Storage Node.
  - a. Select **NODES**.
  - b. Select the first Storage Node in the grid.
  - c. Select the **Hardware** tab.
  - d. Hover your cursor over the Memory Usage chart. Ensure that **Total Memory** is at least 128 GB.
  - e. Repeat these steps for all Storage Nodes.

- If one or more Storage Nodes do not have enough available total memory, the Metadata Reserved Space value cannot be increased. Do not continue with this procedure.
- If each Storage Node has at least 128 GB of total memory, go to the next step.

4. Update the Metadata Reserved Space setting.

- Select **CONFIGURATION > System > Storage options**.
- Select the Configuration tab.
- In the Storage watermarks section, select **Metadata Reserved Space**.
- Enter the new value.

For example, to enter 8 TB, which is the maximum supported value, enter **8000000000000** (8, followed by 12 zeros)



Description	Settings
Segmentation	Enabled
Maximum Segment Size	1000000000
Storage Watermarks	
Storage Volume Read-Write Watermark Override	0
Storage Volume Soft Read-Only Watermark Override	0
Storage Volume Hard Read-Only Watermark Override	0
Metadata Reserved Space	8000000000000

- Select **Apply Changes**.

## Compress stored objects

You can enable object compression to reduce the size of objects stored in StorageGRID, so that objects consume less storage.

### Before you begin

- You are signed in to the Grid Manager using a [supported web browser](#).
- You have [specific access permissions](#).

### About this task

By default, object compression is disabled. If you enable compression, StorageGRID attempts to compress each object when saving it, using lossless compression.



If you change this setting, it will take about one minute for the new setting to be applied. The configured value is cached for performance and scaling.

Before enabling object compression, be aware of the following:

- You should not select **Compress stored objects** unless you know that the data being stored is compressible.
- Applications that save objects to StorageGRID might compress objects before saving them. If a client application has already compressed an object before saving it to StorageGRID, selecting this option will not further reduce an object's size.
- Don't select **Compress stored objects** if you are using NetApp FabricPool with StorageGRID.
- If **Compress stored objects** is selected, S3 client applications should avoid performing GetObject operations that specify a range of bytes be returned. These "range read" operations are inefficient because StorageGRID must effectively uncompress the objects to access the requested bytes. GetObject operations that request a small range of bytes from a very large object are especially inefficient; for example, it is inefficient to read a 10 MB range from a 50 GB compressed object.

If ranges are read from compressed objects, client requests can time out.



If you need to compress objects and your client application must use range reads, increase the read timeout for the application.

## Steps

1. Select **CONFIGURATION > System > Storage settings > Object compression**.
2. Select the **Compress stored objects** checkbox.
3. Select **Save**.

## Manage full Storage Nodes

As Storage Nodes reach capacity, you must expand the StorageGRID system through the addition of new storage. There are three options available: adding storage volumes, adding storage expansion shelves, and adding Storage Nodes.

### Add storage volumes

Each Storage Node supports a maximum number of storage volumes. The defined maximum varies by platform. If a Storage Node contains fewer than the maximum number of storage volumes, you can add volumes to increase its capacity. See the instructions for [expanding a StorageGRID system](#).

### Add storage expansion shelves

Some StorageGRID appliance Storage Nodes, such as the SG6060 or SG6160, can support additional storage shelves. If you have StorageGRID appliances with expansion capabilities that have not already been expanded to maximum capacity, you can add storage shelves to increase capacity. See the instructions for [expanding a StorageGRID system](#).

## Add Storage Nodes

You can increase storage capacity by adding Storage Nodes. Careful consideration of currently active ILM rules and capacity requirements must be taken when adding storage. See the instructions for [expanding a StorageGRID system](#).

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