



## **Add storage capacity**

StorageGRID software

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# Add storage capacity

## Guidelines for adding object capacity

You can expand the object storage capacity of your StorageGRID system by adding storage volumes to existing Storage Nodes or by adding new Storage Nodes to existing sites. You must add storage capacity in a way that meets the requirements of your information lifecycle management (ILM) policy.

### Guidelines for adding storage volumes

Before adding storage volumes to existing Storage Nodes, review the following guidelines and limitations:

- You must examine your current ILM rules to determine where and when to [add storage volumes](#) to increase the storage available for [replicated objects](#) or [erasure-coded objects](#).
- You can't increase the metadata capacity of your system by adding storage volumes because object metadata is stored only on volume 0.
- Each software-based Storage Node can support a maximum of 48 storage volumes. If you need to add capacity beyond that, you must add new Storage Nodes.
- You can add one or two expansion shelves to each SG6060 appliance. Each expansion shelf adds 16 storage volumes. With both expansion shelves installed, the SG6060 can support a total of 48 storage volumes.
- You can add one or two expansion shelves to each SG6160 appliance. Each expansion shelf adds 60 storage volumes. With both expansion shelves installed, the SG6160 can support a total of 180 storage volumes.
- You can't add storage volumes to any other storage appliance.
- You can't increase the size of an existing storage volume.
- You can't add storage volumes to a Storage Node at the same time you are performing a system upgrade, recovery operation, or another expansion.

After you have decided to add storage volumes and have determined which Storage Nodes you must expand to satisfy your ILM policy, follow the instructions for your type of Storage Node:

- To add one or two expansion shelves to an SG6060 storage appliance, go to [Add expansion shelf to deployed SG6060](#).
- To add one or two expansion shelves to an SG6160 storage appliance, go to [Add expansion shelf to deployed SG6160](#)
- For a software-based node, follow the instructions for [adding storage volumes to Storage Nodes](#).

### Guidelines for adding Storage Nodes

Before adding Storage Nodes to existing sites, review the following guidelines and limitations:

- You must examine your current ILM rules to determine where and when to add Storage Nodes to increase the storage available for [replicated objects](#) or [erasure-coded objects](#).
- You should not add more than 10 Storage Nodes in a single expansion procedure.

- You can add Storage Nodes to more than one site in a single expansion procedure.
- You can add Storage Nodes and other types of nodes in a single expansion procedure.
- Before starting the expansion procedure, you must confirm that all data-repair operations performed as part of a recovery are complete. See [Check data repair jobs](#).
- If you need to remove Storage Nodes before or after performing an expansion, you should not decommission more than 10 Storage Nodes in a single Decommission Node procedure.

## Guidelines for ADC service on Storage Nodes

When configuring the expansion, you must choose whether to include the Administrative Domain Controller (ADC) service on each new Storage Node. The ADC service keeps track of the location and availability of grid services.

- The StorageGRID system requires a [quorum of ADC services](#) to be available at each site and at all times.
- At least three Storage Nodes at each site must include the ADC service.
- Adding the ADC service to every Storage Node is not recommended. Including too many ADC services can cause slowdowns due to the increased amount of communication between nodes.
- A single grid should not have more than 48 Storage Nodes with the ADC service. This is equivalent to 16 sites with three ADC services at each site.
- In general, when you select the **ADC Service** setting for a new node, you should select **Automatic**. Select **Yes** only if the new node will replace another Storage Node that includes the ADC service. Because you can't decommission a Storage Node if too few ADC services would remain, this ensures that a new ADC service is available before the old service is removed.
- You can't add the ADC service to a node after it is deployed.

## Add storage capacity for replicated objects

If the information lifecycle management (ILM) policy for your deployment includes a rule that creates replicated copies of objects, you must consider how much storage to add and where to add the new storage volumes or Storage Nodes.

For guidance on where to add additional storage, examine the ILM rules that create replicated copies. If ILM rules create two or more object copies, plan to add storage in each location where object copies are made. As a simple example, if you have a two-site grid and an ILM rule that creates one object copy at each site, you must [add storage](#) to each site to increase the overall object capacity of the grid. For information about object replication, see [What is replication](#).

For performance reasons, you should attempt to keep storage capacity and compute power balanced across sites. So, for this example, you should add the same number of Storage Nodes to each site or additional storage volumes at each site.

If you have a more complex ILM policy that includes rules that place objects in different locations based on criteria such as bucket name, or rules that change object locations over time, your analysis of where storage is required for the expansion will be similar, but more complex.

Charting how quickly overall storage capacity is being consumed can help you understand how much storage to add in the expansion, and when the additional storage space will be required. You can use the Grid Manager to [monitor and chart storage capacity](#).

When planning the timing of an expansion, remember to consider how long it might take to procure and install additional storage.

## Add storage capacity for erasure-coded objects

If your ILM policy includes a rule that makes erasure-coded copies, you must plan where to add new storage and when to add new storage. The amount of storage you add and the timing of the addition can affect the grid's usable storage capacity.

The first step in planning a storage expansion is to examine the rules in your ILM policy that create erasure-coded objects. Because StorageGRID creates  $k+m$  fragments for every erasure-coded object and stores each fragment on a different Storage Node, you must ensure that at least  $k+m$  Storage Nodes have space for new erasure-coded data after the expansion. If the erasure-coding profile provides site-loss protection, you must add storage to each site. See [What are erasure-coding schemes](#) for information about erasure-coding profiles.

The number of nodes you need to add also depends on how full the existing nodes are when you perform the expansion.

### General recommendation for adding storage capacity for erasure-coded objects

If you want to avoid detailed calculations, you can add two Storage Nodes per site when existing Storage Nodes reach 70% capacity.

This general recommendation provides reasonable results across a wide range of erasure-coding schemes for both single-site grids and for grids where erasure coding provides site-loss protection.

To better understand the factors that led to this recommendation or to develop a more precise plan for your site, see [Considerations for rebalancing erasure-coded data](#). For a custom recommendation optimized for your situation, contact your NetApp Professional Services consultant.

## Considerations for rebalancing erasure-coded data

If you are performing an expansion to add Storage Nodes and you use ILM rules to erasure code data, you might need to perform the erasure coding (EC) rebalance procedure if you can't add enough Storage Nodes for the erasure-coding scheme you are using.

After reviewing these considerations, perform the expansion, and then go to [Rebalance erasure-coded data after adding Storage Nodes](#) to run the procedure.

### What is EC rebalancing?

EC rebalancing is a StorageGRID procedure that might be required after a Storage Node expansion. The procedure is run as a command-line script from the primary Admin Node. When you run the EC rebalance procedure, StorageGRID redistributes erasure-coded fragments among the existing and the newly added Storage Nodes at a site.

The EC rebalance procedure:

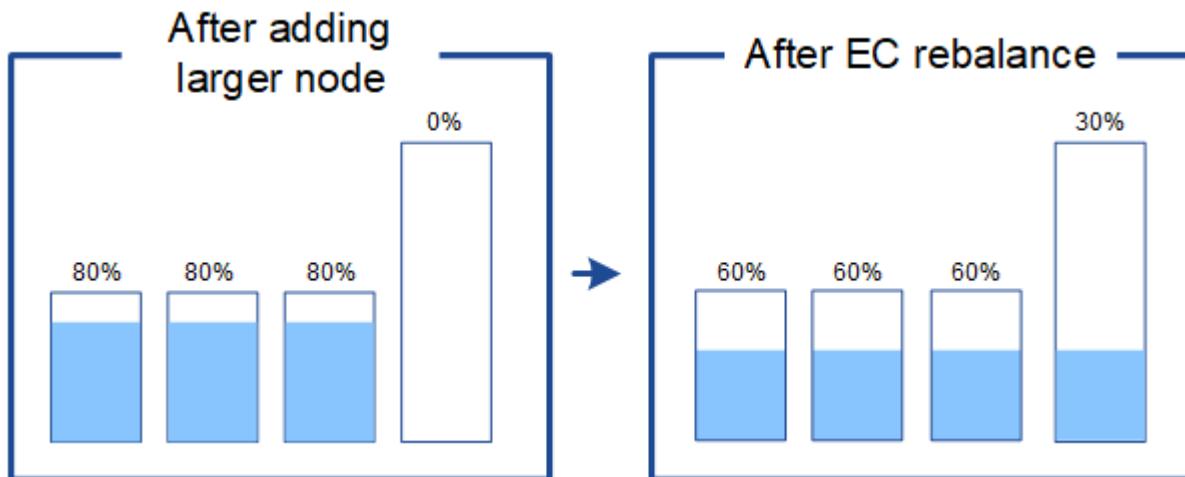
- Only moves erasure-coded object data. It does not move replicated object data.
- Redistributions the data within a site. It does not move data between sites.

- Redistributions data among all Storage Nodes at a site. It does not redistribute data within storage volumes.
- Does not consider the replicated data usage on each Storage Node when determining where to move erasure-coded data.
- Redistributions erasure-coded data evenly between Storage Nodes without considering the relative capacities of each node.
- Will not distribute erasure-coded data to Storage Nodes that are more than 80% full.
- Might decrease the performance of ILM operations and S3 client operations when it runs—additional resources are required to redistribute the erasure-coding fragments.

When the EC rebalance procedure is complete:

- Erasure-coded data will have moved from Storage Nodes with less available space to Storage Nodes with more available space.
- The data protection of erasure-coded objects will be unchanged.
- Used (%) values might be different between Storage Nodes for two reasons:
  - Replicated object copies will continue to consume space on the existing nodes—the EC rebalance procedure does not move replicated data.
  - Larger-capacity nodes will be relatively less full than smaller-capacity nodes, even though all nodes will end up with approximately the same amount of erasure-coded data.

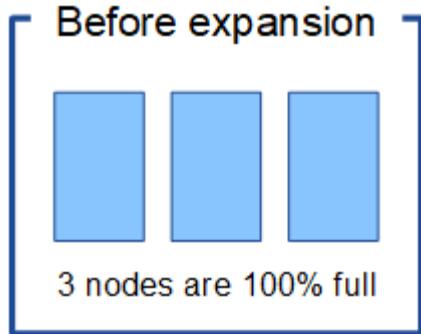
For example, suppose three 200-TB nodes are each filled to 80% ( $200 \times 0.8 = 160$  TB on each node, or 480 TB for the site). If you add a 400-TB node and run the rebalance procedure, all nodes will now have approximately the same amount of erasure-code data ( $480/4 = 120$  TB). However, the Used (%) for the larger node will be less than the Used (%) for the smaller nodes.



## When to rebalance erasure-coded data

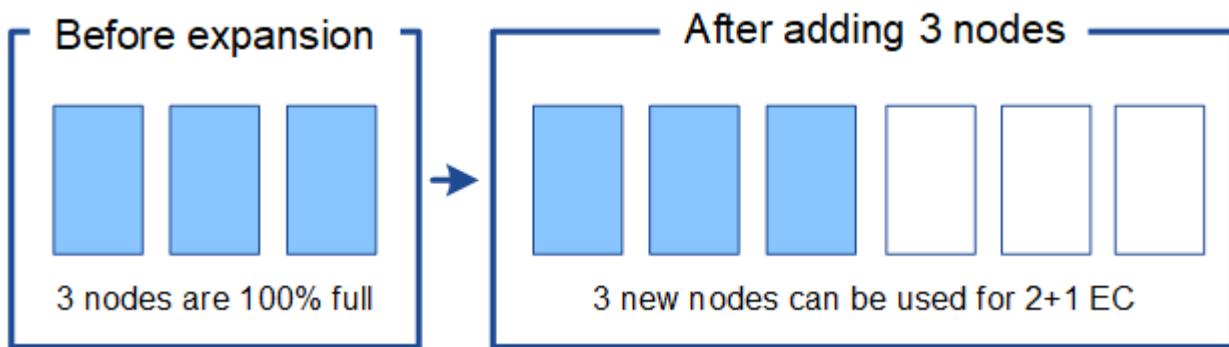
Consider the following scenario:

- StorageGRID is running at a single site, which contains three Storage Nodes.
- The ILM policy uses a 2+1 erasure-coding rule for all objects larger than 1.0 MB and a 2-copy replication rule for smaller objects.
- All Storage Nodes have become completely full. The **Low Object Storage** alert has been triggered at the major severity level.



#### Rebalance is not required if you add enough nodes

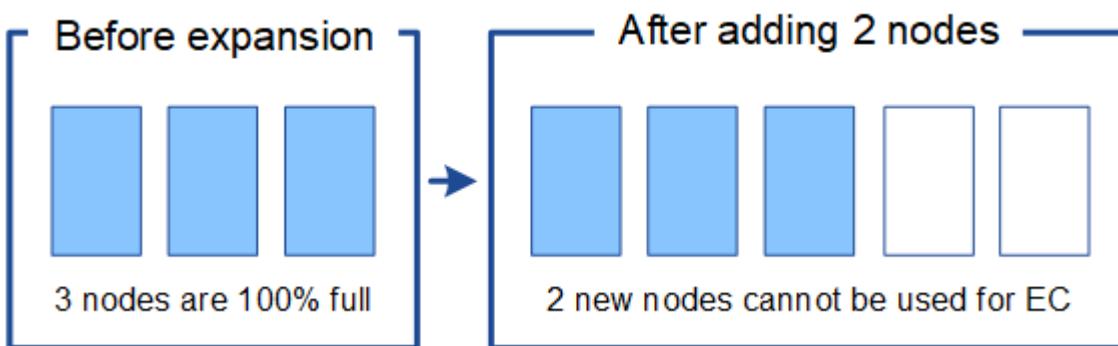
To understand when EC rebalance is not required, suppose you added three (or more) new Storage Nodes. In this case, you don't need to perform EC rebalance. The original Storage Nodes will remain full, but new objects will now use the three new nodes for 2+1 erasure coding—the two data fragments and the one parity fragment can each be stored on a different node.



While you can run the EC rebalance procedure in this case, moving the existing erasure-coded data will temporarily decrease the grid's performance, which might impact client operations.

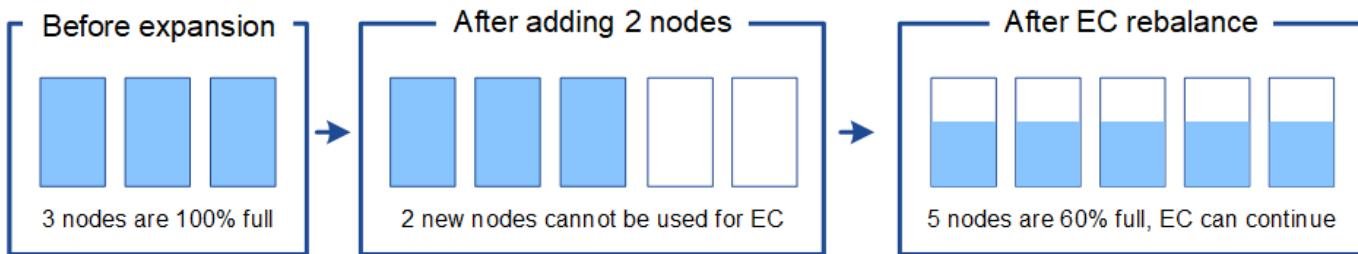
#### Rebalance is required if you can't add enough nodes

To understand when EC rebalance is required, suppose you can only add two Storage Nodes, instead of three. Because the 2+1 scheme requires at least three Storage Nodes to have space available, the empty nodes can't be used for new erasure-coded data.



To make use of the new Storage Nodes, you should run the EC rebalance procedure. When this procedure runs, StorageGRID redistributes existing erasure-coded data and parity fragments among all Storage Nodes at

the site. In this example, when the EC rebalance procedure is complete, all five nodes are now only 60% full, and objects can continue to be ingested into the 2+1 erasure-coding scheme on all Storage Nodes.



## Recommendations for EC rebalancing

NetApp requires EC rebalancing if *all* of the following statements are true:

- You use erasure coding for your object data.
- The **Low Object Storage** alert has been triggered for one or more Storage Nodes at a site, indicating that the nodes are 80% or more full.
- You are unable to add enough new Storage Nodes for the erasure-coding scheme in use. See [Add storage capacity for erasure-coded objects](#).
- Your S3 clients can tolerate lower performance for their write and read operations while the EC rebalance procedure is running.

You can optionally run the EC rebalance procedure if you prefer Storage Nodes to be filled to similar levels and your S3 clients can tolerate lower performance for their write and read operations while the EC rebalance procedure is running.

## How EC rebalance procedure interacts with other maintenance tasks

You can't perform certain maintenance procedures at the same time you are running the EC rebalance procedure.

Procedure	Allowed during EC rebalance procedure?
Additional EC rebalance procedures	No. You can only run one EC rebalance procedure at a time.
Decommission procedure	No.
EC data repair job	<ul style="list-style-type: none"><li>• You are prevented from starting a decommission procedure or an EC data repair while the EC rebalance procedure is running.</li><li>• You are prevented from starting the EC rebalance procedure while a Storage Node decommission procedure or an EC data repair is running.</li></ul>
Expansion procedure	No. If you need to add new Storage Nodes in an expansion, run the EC rebalance procedure after adding all new nodes.

Procedure	Allowed during EC rebalance procedure?
Upgrade procedure	<p>No.</p> <p>If you need to upgrade StorageGRID software, perform the upgrade procedure before or after running the EC rebalance procedure. As required, you can terminate the EC rebalance procedure to perform a software upgrade.</p>
Appliance node clone procedure	<p>No.</p> <p>If you need to clone an appliance Storage Node, run the EC rebalance procedure after adding the new node.</p>
Hotfix procedure	<p>Yes.</p> <p>You can apply a StorageGRID hotfix while the EC rebalance procedure is running.</p>
Other maintenance procedures	<p>No.</p> <p>You must terminate the EC rebalance procedure before running other maintenance procedures.</p>

## How EC rebalance procedure interacts with ILM

While the EC rebalance procedure is running, avoid making ILM changes that might change the location of existing erasure-coded objects. For example, don't start using an ILM rule that has a different erasure-coding profile. If you need to make such ILM changes, you should terminate the EC rebalance procedure.

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