



Install Red Hat Enterprise Linux or CentOS StorageGRID

NetApp
September 04, 2024


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Install Red Hat Enterprise Linux or CentOS

Install Red Hat Enterprise Linux or CentOS: Overview

Installing a StorageGRID system in a Red Hat Enterprise Linux (RHEL) or CentOS Linux environment includes three primary steps.

1. **Preparation:** During planning and preparation, you perform the following tasks:
 - Learn about the hardware and storage requirements for StorageGRID.
 - Learn about the specifics of [StorageGRID networking](#) so you can configure your network appropriately.
 - Identify and prepare the physical or virtual servers you plan to use to host your StorageGRID grid nodes.
 - On the servers you have prepared:
 - Install Linux
 - Configure the host network
 - Configure host storage
 - Install container engine
 - Install the StorageGRID host services
 2. **Deployment:** Deploy grid nodes using the appropriate user interface. When you deploy grid nodes, they are created as part of the StorageGRID system and connected to one or more networks.
 - a. Use the Linux command line and node configuration files to deploy software-based grid nodes on the hosts you prepared in step 1.
 - b. Use the StorageGRID Appliance Installer to deploy StorageGRID appliance nodes.
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Hardware-specific installation and integration instructions are not included in the StorageGRID installation procedure. To learn how to install StorageGRID appliances, see the installation and maintenance instructions for your appliance.
3. **Configuration:** When all nodes have been deployed, use the Grid Manager to configure the grid and complete the installation.

These instructions recommend a standard approach for deploying and configuring a StorageGRID system. See also the information about the following alternative approaches:

- Use a standard orchestration framework such as Ansible, Puppet, or Chef to install RHEL or CentOS, configure networking and storage, install the container engine and the StorageGRID host service, and deploy virtual grid nodes.
- Automate the deployment and configuration of the StorageGRID system using a Python configuration script (provided in the installation archive).
- Automate the deployment and configuration of appliance grid nodes with a Python configuration script (available from the installation archive or from the StorageGRID Appliance Installer).
- If you are an advanced developer of StorageGRID deployments, use the installation REST APIs to automate the installation of StorageGRID grid nodes.

Plan and prepare for Red Hat or CentOS installation

Before you install (Red Hat or CentOS)

Before deploying grid nodes and configuring the StorageGRID grid, you must be familiar with the steps and requirements for completing the procedure.

The StorageGRID deployment and configuration procedures assume that you are familiar with the architecture and operation of the StorageGRID system.

You can deploy a single site or multiple sites at one time; however, all sites must meet the minimum requirement of having at least three Storage Nodes.

Before starting a StorageGRID installation, you must:

- Understand StorageGRID's compute requirements, including the minimum CPU and RAM requirements for each node.
- Understand how StorageGRID supports multiple networks for traffic separation, security, and administrative convenience, and have a plan for which networks you intend to attach to each StorageGRID node.

See the StorageGRID networking guidelines.

- Understand the storage and performance requirements of each type of grid node.
- Identify a set of servers (physical, virtual, or both) that, in aggregate, provide sufficient resources to support the number and type of StorageGRID nodes you plan to deploy.
- Understand the requirements for node migration, if you want to perform scheduled maintenance on physical hosts without any service interruption.
- Gather all networking information in advance. Unless you are using DHCP, gather the IP addresses to assign to each grid node, and the IP addresses of the domain name system (DNS) and network time protocol (NTP) servers that will be used.
- Install, connect, and configure all required hardware, including any StorageGRID appliances, to specifications.



Hardware-specific installation and integration instructions are not included in the StorageGRID installation procedure. To learn how to install StorageGRID appliances, see the installation and maintenance instructions for your appliance.

- Decide which of the available deployment and configuration tools you want to use.

Related information

[Networking guidelines](#)

[SG100 and SG1000 services appliances](#)

[SG6000 storage appliances](#)

[SG5700 storage appliances](#)

[SG5600 storage appliances](#)

Required materials

Before you install StorageGRID, you must gather and prepare required materials.

Item	Notes
NetApp StorageGRID license	You must have a valid, digitally signed NetApp license. Note: A non-production license, which can be used for testing and proof of concept grids, is included in the StorageGRID installation archive.
StorageGRID installation archive	You must download the StorageGRID installation archive and extract the files .
Service laptop	The StorageGRID system is installed through a service laptop. The service laptop must have: <ul style="list-style-type: none">• Network port• SSH client (for example, PuTTY)• Supported web browser
StorageGRID documentation	<ul style="list-style-type: none">• Release notes• Instructions for administering StorageGRID

Related information

[NetApp Interoperability Matrix Tool](#)

Download and extract the StorageGRID installation files

You must download the StorageGRID installation archive and extract the required files.

Steps

1. Go to the [NetApp Downloads page for StorageGRID](#).
2. Select the button for downloading the latest release, or select another version from the drop-down menu and select **Go**.
3. Sign in with the username and password for your NetApp account.
4. If a Caution/MustRead statement appears, read it and select the check box.



You must apply any required hotfixes after you install the StorageGRID release. For more information, see the [hotfix procedure in the recovery and maintenance instructions](#).

5. Read the End User License Agreement, select the check box, and then select **Accept & Continue**.
6. In the **Install StorageGRID** column, select the .tgz or .zip file for Red Hat Enterprise Linux or CentOS.



Select the .zip file if you are running Windows on the service laptop.

7. Save and extract the archive file.
8. Choose the files you need from the following list.

The files you need depend on your planned grid topology and how you will deploy your StorageGRID system.



The paths listed in the table are relative to the top-level directory installed by the extracted installation archive

Path and file name	Description
<code>./rpms/README</code>	A text file that describes all of the files contained in the StorageGRID download file.
<code>./rpms/NLF000000.txt</code>	A free license that does not provide any support entitlement for the product.
<code>./rpms/StorageGRID-Webscale-Images-version-SHA.rpm</code>	RPM package for installing the StorageGRID node images on your RHEL or CentOS hosts.
<code>./rpms/StorageGRID-Webscale-Service-version-SHA.rpm</code>	RPM package for installing the StorageGRID host service on your RHEL or CentOS hosts.
Deployment scripting tool	Description
<code>./rpms/configure-storagegrid.py</code>	A Python script used to automate the configuration of a StorageGRID system.
<code>./rpms/configure-sga.py</code>	A Python script used to automate the configuration of StorageGRID appliances.
<code>./rpms/configure-storagegrid.sample.json</code>	An example configuration file for use with the <code>configure-storagegrid.py</code> script.
<code>./rpms/storagegrid-ssoauth.py</code>	An example Python script that you can use to sign in to the Grid Management API when single sign-on is enabled.
<code>./rpms/configure-storagegrid.blank.json</code>	A blank configuration file for use with the <code>configure-storagegrid.py</code> script.
<code>./rpms/extras/ansible</code>	Example Ansible role and playbook for configuring RHEL or CentOS hosts for StorageGRID container deployment. You can customize the role or playbook as necessary.

Path and file name	Description
./rpms/extras/api-schemas	<p>API schemas for StorageGRID.</p> <p>Note: Before you perform an upgrade, you can use these schemas to confirm that any code you have written to use StorageGRID management APIs will be compatible with the new StorageGRID release if you do not have a non-production StorageGRID environment for upgrade compatibility testing.</p>

CPU and RAM requirements

Before installing StorageGRID software, verify and configure the hardware so that it is ready to support the StorageGRID system.

For information about supported servers, see the Interoperability Matrix.

Each StorageGRID node requires the following minimum resources:

- CPU cores: 8 per node
- RAM: At least 24 GB per node, and 2 to 16 GB less than the total system RAM, depending on the total RAM available and the amount of non-StorageGRID software running on the system

Ensure that the number of StorageGRID nodes you plan to run on each physical or virtual host does not exceed the number of CPU cores or the physical RAM available. If the hosts are not dedicated to running StorageGRID (not recommended), be sure to consider the resource requirements of the other applications.



Monitor your CPU and memory usage regularly to ensure that these resources continue to accommodate your workload. For example, doubling the RAM and CPU allocation for virtual Storage Nodes would provide similar resources to those provided for StorageGRID appliance nodes. Additionally, if the amount of metadata per node exceeds 500 GB, consider increasing the RAM per node to 48 GB or more. For information about managing object metadata storage, increasing the Metadata Reserved Space setting, and monitoring CPU and memory usage, see the instructions for administering, monitoring, and upgrading StorageGRID.

If hyperthreading is enabled on the underlying physical hosts, you can provide 8 virtual cores (4 physical cores) per node. If hyperthreading is not enabled on the underlying physical hosts, you must provide 8 physical cores per node.

If you are using virtual machines as hosts and have control over the size and number of VMs, you should use a single VM for each StorageGRID node and size the VM accordingly.

For production deployments, you should not run multiple Storage Nodes on the same physical storage hardware or virtual host. Each Storage Node in a single StorageGRID deployment should be in its own isolated failure domain. You can maximize the durability and availability of object data if you ensure that a single hardware failure can only impact a single Storage Node.

See also the information about storage requirements.

Related information

[NetApp Interoperability Matrix Tool](#)

[Storage and performance requirements](#)

[Administer StorageGRID](#)

[Monitor and troubleshoot](#)

[Upgrade software](#)

Storage and performance requirements

You must understand the storage requirements for StorageGRID nodes, so you can provide enough space to support the initial configuration and future storage expansion.

StorageGRID nodes require three logical categories of storage:

- **Container pool** — Performance-tier (10K SAS or SSD) storage for the node containers, which will be assigned to the container engine storage driver when you install and configure the container engine on the hosts that will support your StorageGRID nodes.
- **System data** — Performance-tier (10K SAS or SSD) storage for per-node persistent storage of system data and transaction logs, which the StorageGRID host services will consume and map into individual nodes.
- **Object data** — Performance-tier (10K SAS or SSD) storage and capacity-tier (NL-SAS/SATA) bulk storage for the persistent storage of object data and object metadata.

You must use RAID-backed block devices for all storage categories. Non-redundant disks, SSDs, or JBODs are not supported. You can use shared or local RAID storage for any of the storage categories; however, if you want to use StorageGRID's node migration capability, you must store both system data and object data on shared storage.

Performance requirements

The performance of the volumes used for the container pool, system data, and object metadata significantly impacts the overall performance of the system. You should use performance-tier (10K SAS or SSD) storage for these volumes to ensure adequate disk performance in terms of latency, input/output operations per second (IOPS), and throughput. You can use capacity-tier (NL-SAS/SATA) storage for the persistent storage of object data.

The volumes used for the container pool, system data, and object data must have write-back caching enabled. The cache must be on a protected or persistent media.

Requirements for hosts that use NetApp ONTAP storage

If the StorageGRID node uses storage assigned from a NetApp ONTAP system, confirm that the volume does not have a FabricPool tiering policy enabled. Disabling FabricPool tiering for volumes used with StorageGRID nodes simplifies troubleshooting and storage operations.



Never use FabricPool to tier any data related to StorageGRID back to StorageGRID itself. Tiering StorageGRID data back to StorageGRID increases troubleshooting and operational complexity.

Number of hosts required

Each StorageGRID site requires a minimum of three Storage Nodes.



In a production deployment, do not run more than one Storage Node on a single physical or virtual host. Using a dedicated host for each Storage Node provides an isolated failure domain.

Other types of nodes, such as Admin Nodes or Gateway Nodes, can be deployed on the same hosts, or they can be deployed on their own dedicated hosts as required.

Number of storage volumes for each host

The following table shows the number of storage volumes (LUNs) required for each host and the minimum size required for each LUN, based on which nodes will be deployed on that host.

The maximum tested LUN size is 39 TB.



These numbers are for each host, not for the entire grid.

LUN purpose	Storage category	Number of LUNs	Minimum size/LUN
Container engine storage pool	Container pool	1	Total number of nodes × 100 GB
/var/local volume	System data	1 for each node on this host	90 GB
Storage Node	Object data	3 for each Storage Node on this host Note: A software-based Storage Node can have 1 to 16 storage volumes; at least 3 storage volumes are recommended.	12 TB (4 TB/LUN) See Storage requirements for Storage Nodes for more information.
Admin Node audit logs	System data	1 for each Admin Node on this host	200 GB
Admin Node tables	System data	1 for each Admin Node on this host	200 GB



Depending on the audit level configured, the size of user inputs such as S3 object key name, and how much audit log data you need to preserve, you might need to increase the size of the audit log LUN on each Admin Node. As a general rule, a grid generates approximately 1 KB of audit data per S3 operation, which would mean that a 200 GB LUN would support 70 million operations per day or 800 operations per second for two to three days.

Minimum storage space for a host

The following table shows the minimum storage space required for each type of node. You can use this table to determine the minimum amount of storage you must provide to the host in each storage category, based on which nodes will be deployed on that host.



Disk snapshots cannot be used to restore grid nodes. Instead, refer to the recovery and maintenance procedures for each type of node.

Type of node	Container pool	System data	Object data
Storage Node	100 GB	90 GB	4,000 GB
Admin Node	100 GB	490 GB (3 LUNs)	<i>not applicable</i>
Gateway Node	100 GB	90 GB	<i>not applicable</i>
Archive Node	100 GB	90 GB	<i>not applicable</i>

Example: Calculating the storage requirements for a host

Suppose you plan to deploy three nodes on the same host: one Storage Node, one Admin Node, and one Gateway Node. You should provide a minimum of nine storage volumes to the host. You will need a minimum of 300 GB of performance-tier storage for the node containers, 670 GB of performance-tier storage for system data and transaction logs, and 12 TB of capacity-tier storage for object data.

Type of node	LUN purpose	Number of LUNs	LUN size
Storage Node	Container engine storage pool	1	300 GB (100 GB/node)
Storage Node	<code>/var/local</code> volume	1	90 GB
Storage Node	Object data	3	12 TB (4 TB/LUN)
Admin Node	<code>/var/local</code> volume	1	90 GB
Admin Node	Admin Node audit logs	1	200 GB
Admin Node	Admin Node tables	1	200 GB
Gateway Node	<code>/var/local</code> volume	1	90 GB
Total		9	Container pool: 300 GB System data: 670 GB Object data: 12,000 GB

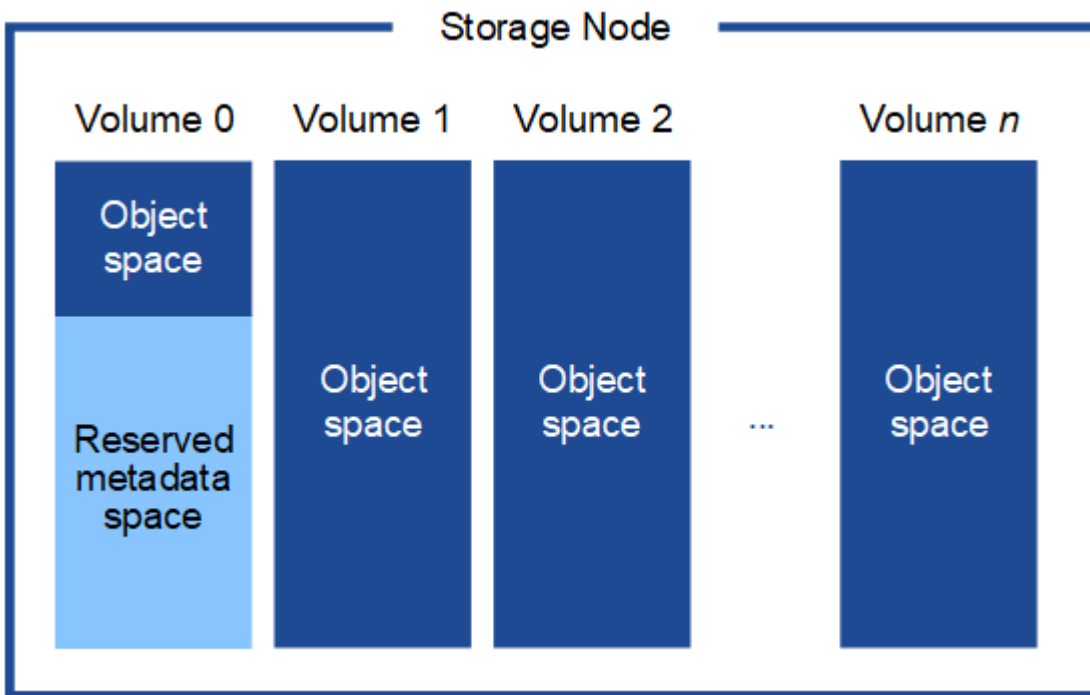
Storage requirements for Storage Nodes

A software-based Storage Node can have 1 to 16 storage volumes—3 or more storage volumes are recommended. Each storage volume should be 4 TB or larger.



An appliance Storage Node can have up to 48 storage volumes.

As shown in the figure, StorageGRID reserves space for object metadata on storage volume 0 of each Storage Node. Any remaining space on storage volume 0 and any other storage volumes in the Storage Node are used exclusively for 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. The three copies of object metadata are evenly distributed across all Storage Nodes at each site.

When you assign space to volume 0 of a new Storage Node, you must ensure there is adequate space for that node's portion of all object metadata.

- At a minimum, you must assign at least 4 TB to volume 0.



If you use only one storage volume for a Storage Node and you assign 4 TB or less to the volume, the Storage Node might enter the Storage Read-Only state on startup and store object metadata only.

- If you are installing a new StorageGRID 11.6 system and each Storage Node has 128 GB or more of RAM, you should assign 8 TB or more to volume 0. Using a larger value for volume 0 can increase the space allowed for metadata on each Storage Node.
- When configuring different Storage Nodes for a site, use the same setting for volume 0 if possible. If a site contains Storage Nodes of different sizes, the Storage Node with the smallest volume 0 will determine the metadata capacity of that site.

For details, go to [Manage object metadata storage](#).

Related information

[Node container migration requirements](#)

[Recover and maintain](#)

Node container migration requirements

The node migration feature allows you to manually move a node from one host to another. Typically, both hosts are in the same physical data center.

Node migration allows you to perform physical host maintenance without disrupting grid operations. You simply move all StorageGRID nodes, one at a time, to another host before taking the physical host offline. Migrating nodes requires only a short downtime for each node and should not affect operation or availability of grid services.

If you want to use the StorageGRID node migration feature, your deployment must meet additional requirements:

- Consistent network interface names across hosts in a single physical data center
- Shared storage for StorageGRID metadata and object repository volumes that is accessible by all hosts in a single physical data center. For example, you might use NetApp E-Series storage arrays.

If you are using virtual hosts and the underlying hypervisor layer supports VM migration, you might want to use this capability instead of StorageGRID's node migration feature. In this case, you can ignore these additional requirements.

Before performing migration or hypervisor maintenance, shut down the nodes gracefully. See the instructions for [shutting down a grid node](#).

VMware Live Migration not supported

OpenStack Live Migration and VMware live vMotion cause the virtual machine clock time to jump and are not supported for grid nodes of any type. Though rare, incorrect clock times can result in loss of data or configuration updates.

Cold migration is supported. In cold migration, you shut down the StorageGRID nodes before migrating them between hosts. See the instructions for [shutting down a grid node](#).

Consistent network interface names

In order to move a node from one host to another, the StorageGRID host service needs to have some confidence that the external network connectivity the node has at its current location can be duplicated at the new location. It gets this confidence through the use of consistent network interface names in the hosts.

Suppose, for example, that StorageGRID NodeA running on Host1 has been configured with the following interface mappings:

eth0 → bond0.1001

eth1 → bond0.1002

eth2 → bond0.1003

The lefthand side of the arrows corresponds to the traditional interfaces as viewed from within a StorageGRID container (that is, the Grid, Admin, and Client Network interfaces, respectively). The righthand side of the arrows corresponds to the actual host interfaces providing these networks, which are three VLAN interfaces subordinate to the same physical interface bond.

Now, suppose you want to migrate NodeA to Host2. If Host2 also has interfaces named bond0.1001, bond0.1002, and bond0.1003, the system will allow the move, assuming that the like-named interfaces will provide the same connectivity on Host2 as they do on Host1. If Host2 does not have interfaces with the same names, the move will not be allowed.

There are many ways to achieve consistent network interface naming across multiple hosts; see [Configuring the host network](#) for some examples.

Shared storage

In order to achieve rapid, low-overhead node migrations, the StorageGRID node migration feature does not physically move node data. Instead, node migration is performed as a pair of export and import operations, as follows:

1. During the “node export” operation, a small amount of persistent state data is extracted from the node container running on HostA and cached on that node’s system data volume. Then, the node container on HostA is deinstantiated.
2. During the “node import” operation, the node container on HostB that uses the same network interface and block storage mappings that were in effect on HostA is instantiated. Then, the cached persistent state data is inserted into the new instance.

Given this mode of operation, all of the node’s system data and object storage volumes must be accessible from both HostA and HostB for the migration to be allowed, and to work. In addition, they must have been mapped into the node using names that are guaranteed to refer to the same LUNs on HostA and HostB.

The following example shows one solution for block device mapping for a StorageGRID Storage Node, where DM multipathing is in use on the hosts, and the alias field has been used in `/etc/multipath.conf` to provide consistent, friendly block device names available on all hosts.

`/var/local` → `/dev/mapper/sgws-sn1-var-local`

`rangedb0` → `/dev/mapper/sgws-sn1-rangedb0`

`rangedb1` → `/dev/mapper/sgws-sn1-rangedb1`

`rangedb2` → `/dev/mapper/sgws-sn1-rangedb2`

`rangedb3` → `/dev/mapper/sgws-sn1-rangedb3`

Deployment tools

You might benefit from automating all or part of the StorageGRID installation.

Automating the deployment might be useful in any of the following cases:

- You already use a standard orchestration framework, such as Ansible, Puppet, or Chef, to deploy and configure physical or virtual hosts.
- You intend to deploy multiple StorageGRID instances.
- You are deploying a large, complex StorageGRID instance.

The StorageGRID host service is installed by a package and driven by configuration files that can be created interactively during a manual installation, or prepared ahead of time (or programmatically) to enable automated installation using standard orchestration frameworks. StorageGRID provides optional Python scripts for automating the configuration of StorageGRID appliances, and the whole StorageGRID system (the “grid”). You can use these scripts directly, or you can inspect them to learn how to use the [StorageGRID installation REST API](#) in grid deployment and configuration tools you develop yourself.

If you are interested in automating all or part of your StorageGRID deployment, review [Automate the installation](#) before beginning the installation process.

Prepare the hosts (Red Hat or CentOS)

Install Linux

You must install Linux on all grid hosts. Use the [NetApp Interoperability Matrix Tool](#) to get a list of supported versions.

Steps

1. Install Linux on all physical or virtual grid hosts according to the distributor’s instructions or your standard procedure.



If you are using the standard Linux installer, NetApp recommends selecting the “compute node” software configuration, if available, or “minimal install” base environment. Do not install any graphical desktop environments.

2. Ensure that all hosts have access to package repositories, including the Extras channel.

You might need these additional packages later in this installation procedure.

3. If swap is enabled:

a. Run the following command: `$ sudo swapoff --all`

b. Remove all swap entries from `/etc/fstab` to persist the settings.



Failing to disable swap entirely can severely lower performance.

Configure the host network (Red Hat Enterprise Linux or CentOS)

After completing the Linux installation on your hosts, you might need to perform some additional configuration to prepare a set of network interfaces on each host that are suitable for mapping into the StorageGRID nodes you will deploy later.

What you'll need

- You have reviewed the [StorageGRID networking guidelines](#).
- You have reviewed the information about [node container migration requirements](#).
- If you are using virtual hosts, you have read the [considerations and recommendations for MAC address cloning](#) before configuring the host network.



If you are using VMs as hosts, you should select VMXNET 3 as the virtual network adapter. The VMware E1000 network adapter has caused connectivity issues with StorageGRID containers deployed on certain distributions of Linux.

About this task

Grid nodes must be able to access the Grid Network and, optionally, the Admin and Client Networks. You provide this access by creating mappings that associate the host's physical interface to the virtual interfaces for each grid node. When creating host interfaces, use friendly names to facilitate deployment across all hosts, and to enable migration.

The same interface can be shared between the host and one or more nodes. For example, you might use the same interface for host access and node Admin Network access, to facilitate host and node maintenance. Although the same interface can be shared between the host and individual nodes, all must have different IP addresses. IP addresses cannot be shared between nodes or between the host and any node.

You can use the same host network interface to provide the Grid Network interface for all StorageGRID nodes on the host; you can use a different host network interface for each node; or you can do something in between. However, you would not typically provide the same host network interface as both the Grid and Admin Network interfaces for a single node, or as the Grid Network interface for one node and the Client Network interface for another.

You can complete this task in many ways. For example, if your hosts are virtual machines and you are deploying one or two StorageGRID nodes for each host, you can simply create the correct number of network interfaces in the hypervisor, and use a 1-to-1 mapping. If you are deploying multiple nodes on bare metal hosts for production use, you can leverage the Linux networking stack's support for VLAN and LACP for fault tolerance and bandwidth sharing. The following sections provide detailed approaches for both of these examples. You do not need to use either of these examples; you can use any approach that meets your needs.



Do not use bond or bridge devices directly as the container network interface. Doing so could prevent node start-up caused by a kernel issue with the use of MACVLAN with bond and bridge devices in the container namespace. Instead, use a non-bond device, such as a VLAN or virtual Ethernet (veth) pair. Specify this device as the network interface in the node configuration file.

Related information

[Creating node configuration files](#)

Considerations and recommendations for MAC address cloning

MAC address cloning causes the container to use the MAC address of the host, and the host to use the MAC address of either an address you specify or a randomly generated one. You should use MAC address cloning to avoid the use of promiscuous mode network configurations.

Enabling MAC cloning

In certain environments, security can be enhanced through MAC address cloning because it enables you to use a dedicated virtual NIC for the Admin Network, Grid Network, and Client Network. Having the container use the MAC address of the dedicated NIC on the host allows you to avoid using promiscuous mode network configurations.



MAC address cloning is intended to be used with virtual server installations and might not function properly with all physical appliance configurations.



If a node fails to start due to a MAC cloning targeted interface being busy, you might need to set the link to "down" before starting node. Additionally, it is possible that the virtual environment might prevent MAC cloning on a network interface while the link is up. If a node fails to set the MAC address and start due to an interface being busy, setting the link to "down" before starting the node might fix the issue.

MAC address cloning is disabled by default and must be set by node configuration keys. You should enable it when you install StorageGRID.

There is one key for each network:

- `ADMIN_NETWORK_TARGET_TYPE_INTERFACE_CLONE_MAC`
- `GRID_NETWORK_TARGET_TYPE_INTERFACE_CLONE_MAC`
- `CLIENT_NETWORK_TARGET_TYPE_INTERFACE_CLONE_MAC`

Setting the key to "true" causes the container to use the MAC address of the host's NIC. Additionally, the host will then use the MAC address of the specified container network. By default, the container address is a randomly generated address, but if you have set one using the `_NETWORK_MAC` node configuration key, that address is used instead. The host and container will always have different MAC addresses.



Enabling MAC cloning on a virtual host without also enabling promiscuous mode on the hypervisor might cause Linux host networking using the host's interface to stop working.

MAC cloning use cases

There are two use cases to consider with MAC cloning:

- **MAC cloning not enabled:** When the `_CLONE_MAC` key in the node configuration file is not set, or set to "false," the host will use the host NIC MAC and the container will have a StorageGRID-generated MAC unless a MAC is specified in the `_NETWORK_MAC` key. If an address is set in the `_NETWORK_MAC` key, the container will have the address specified in the `_NETWORK_MAC` key. This configuration of keys requires the use of promiscuous mode.
- **MAC cloning enabled:** When the `_CLONE_MAC` key in the node configuration file is set to "true," the container uses the host NIC MAC, and the host uses a StorageGRID-generated MAC unless a MAC is specified in the `_NETWORK_MAC` key. If an address is set in the `_NETWORK_MAC` key, the host uses the specified address instead of a generated one. In this configuration of keys, you should not use promiscuous mode.



If you do not want to use MAC address cloning and would rather allow all interfaces to receive and transmit data for MAC addresses other than the ones assigned by the hypervisor, ensure that the security properties at the virtual switch and port group levels are set to **Accept** for Promiscuous Mode, MAC Address Changes, and Forged Transmits. The values set on the virtual switch can be overridden by the values at the port group level, so ensure that settings are the same in both places.

To enable MAC cloning, see the [instructions for creating node configuration files](#).

MAC cloning example

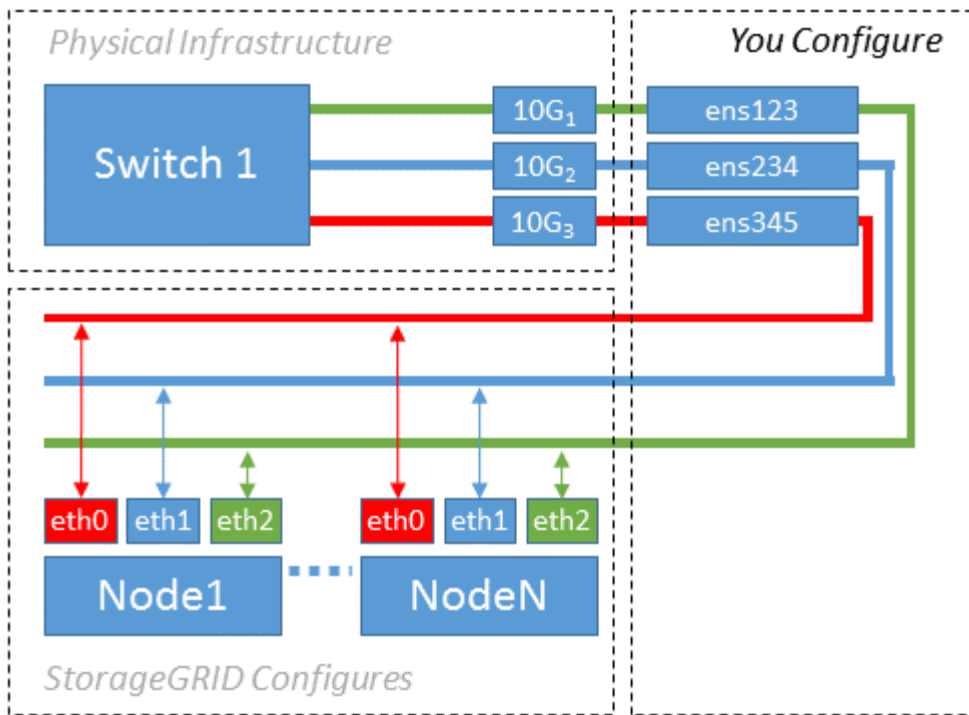
Example of MAC cloning enabled with a host having MAC address of 11:22:33:44:55:66 for the interface `ens256` and the following keys in the node configuration file:

- `ADMIN_NETWORK_TARGET = ens256`
- `ADMIN_NETWORK_MAC = b2:9c:02:c2:27:10`
- `ADMIN_NETWORK_TARGET_TYPE_INTERFACE_CLONE_MAC = true`

Result: the host MAC for `ens256` is `b2:9c:02:c2:27:10` and the Admin Network MAC is `11:22:33:44:55:66`

Example 1: 1-to-1 mapping to physical or virtual NICs

Example 1 describes a simple physical interface mapping that requires little or no host-side configuration.



The Linux operating system creates the `ensXYZ` interfaces automatically during installation or boot, or when the interfaces are hot-added. No configuration is required other than ensuring that the interfaces are set to come up automatically after boot. You do have to determine which `ensXYZ` corresponds to which StorageGRID network (Grid, Admin, or Client) so you can provide the correct mappings later in the configuration process.

Note that the figure show multiple StorageGRID nodes; however, you would normally use this configuration for single-node VMs.

If Switch 1 is a physical switch, you should configure the ports connected to interfaces 10G1 through 10G3 for access mode, and place them on the appropriate VLANs.

Example 2: LACP bond carrying VLANs

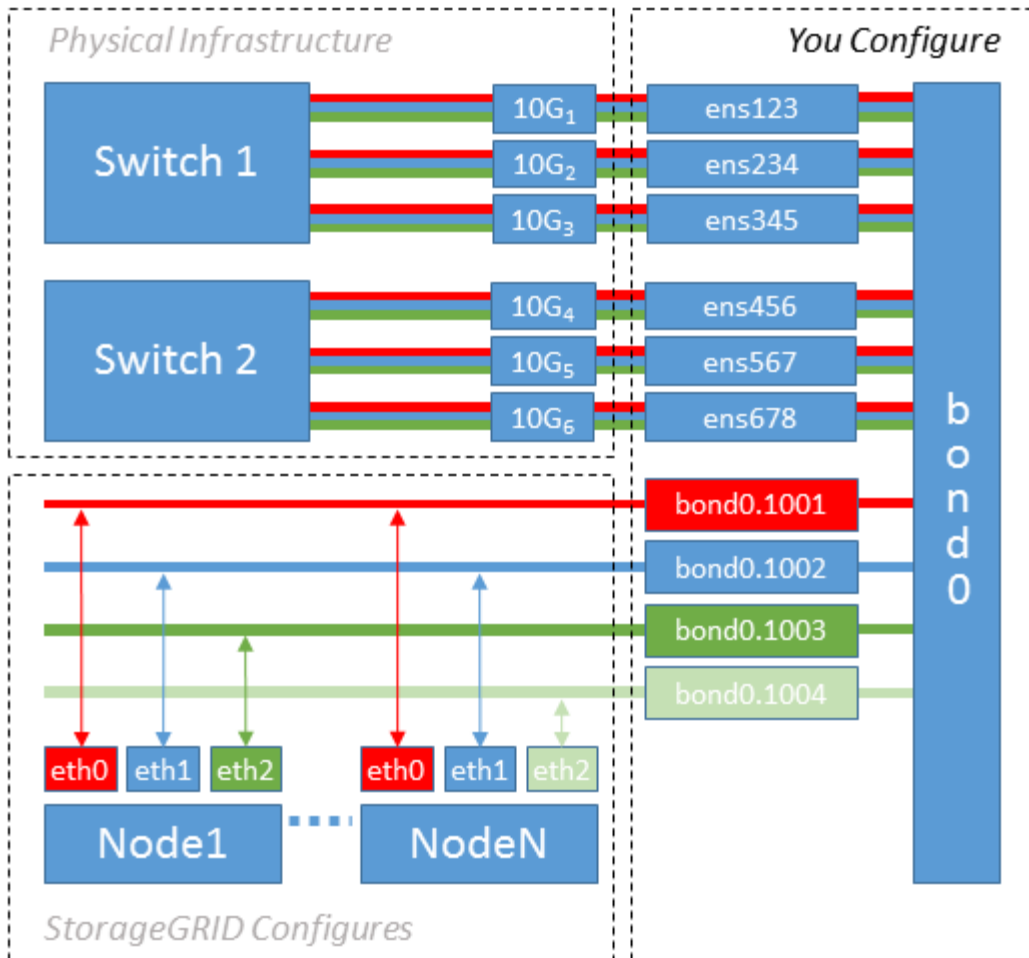
About this task

Example 2 assumes you are familiar with bonding network interfaces and with creating VLAN interfaces on the Linux distribution you are using.

Example 2 describes a generic, flexible, VLAN-based scheme that facilitates the sharing of all available network bandwidth across all nodes on a single host. This example is particularly applicable to bare metal hosts.

To understand this example, suppose you have three separate subnets for the Grid, Admin, and Client Networks at each data center. The subnets are on separate VLANs (1001, 1002, and 1003) and are presented to the host on a LACP-bonded trunk port (`bond0`). You would configure three VLAN interfaces on the bond: `bond0.1001`, `bond0.1002`, and `bond0.1003`.

If you require separate VLANs and subnets for node networks on the same host, you can add VLAN interfaces on the bond and map them into the host (shown as `bond0.1004` in the illustration).



Steps

1. Aggregate all physical network interfaces that will be used for StorageGRID network connectivity into a single LACP bond.

Use the same name for the bond on every host. For example, `bond0`.

2. Create VLAN interfaces that use this bond as their associated “physical device,” using the standard VLAN interface naming convention `physdev-name.VLAN ID`.

Note that steps 1 and 2 require appropriate configuration on the edge switches terminating the other ends of the network links. The edge switch ports must also be aggregated into a LACP port channel, configured as a trunk, and allowed to pass all required VLANs.

Sample interface configuration files for this per-host networking configuration scheme are provided.

Related information

[Example /etc/sysconfig/network-scripts](#)

Configure host storage

You must allocate block storage volumes to each host.

What you'll need

You have reviewed the following topics, which provide information you need to accomplish this task:

Storage and performance requirements

Node container migration requirements

About this task

When allocating block storage volumes (LUNs) to hosts, use the tables in “Storage requirements” to determine the following:

- Number of volumes required for each host (based on the number and types of nodes that will be deployed on that host)
- Storage category for each volume (that is, System Data or Object Data)
- Size of each volume

You will use this information as well as the persistent name assigned by Linux to each physical volume when you deploy StorageGRID nodes on the host.



You do not need to partition, format, or mount any of these volumes; you just need to ensure they are visible to the hosts.

Avoid using “raw” special device files (`/dev/sdb`, for example) as you compose your list of volume names. These files can change across reboots of the host, which will impact proper operation of the system. If you are using iSCSI LUNs and device mapper multipathing, consider using multipath aliases in the `/dev/mapper` directory, especially if your SAN topology includes redundant network paths to the shared storage. Alternatively, you can use the system-created softlinks under `/dev/disk/by-path/` for your persistent device names.

For example:

```
ls -l
$ ls -l /dev/disk/by-path/
total 0
lrwxrwxrwx 1 root root 9 Sep 19 18:53 pci-0000:00:07.1-ata-2 -> ../../sr0
lrwxrwxrwx 1 root root 9 Sep 19 18:53 pci-0000:03:00.0-scsi-0:0:0:0 ->
../../sda
lrwxrwxrwx 1 root root 10 Sep 19 18:53 pci-0000:03:00.0-scsi-0:0:0:0-part1
-> ../../sda1
lrwxrwxrwx 1 root root 10 Sep 19 18:53 pci-0000:03:00.0-scsi-0:0:0:0-part2
-> ../../sda2
lrwxrwxrwx 1 root root 9 Sep 19 18:53 pci-0000:03:00.0-scsi-0:0:1:0 ->
../../sdb
lrwxrwxrwx 1 root root 9 Sep 19 18:53 pci-0000:03:00.0-scsi-0:0:2:0 ->
../../sdc
lrwxrwxrwx 1 root root 9 Sep 19 18:53 pci-0000:03:00.0-scsi-0:0:3:0 ->
../../sdd
```

Results will differ for each installation.

Assign friendly names to each of these block storage volumes to simplify the initial StorageGRID installation and future maintenance procedures. If you are using the device mapper multipath driver for redundant access

to shared storage volumes, you can use the `alias` field in your `/etc/multipath.conf` file.

For example:

```
multipaths {
  multipath {
    wwid 3600a09800059d6df00005df2573c2c30
    alias docker-storage-volume-hostA
  }
  multipath {
    wwid 3600a09800059d6df00005df3573c2c30
    alias sgws-adm1-var-local
  }
  multipath {
    wwid 3600a09800059d6df00005df4573c2c30
    alias sgws-adm1-audit-logs
  }
  multipath {
    wwid 3600a09800059d6df00005df5573c2c30
    alias sgws-adm1-tables
  }
  multipath {
    wwid 3600a09800059d6df00005df6573c2c30
    alias sgws-gw1-var-local
  }
  multipath {
    wwid 3600a09800059d6df00005df7573c2c30
    alias sgws-sn1-var-local
  }
  multipath {
    wwid 3600a09800059d6df00005df7573c2c30
    alias sgws-sn1-rangedb-0
  }
  ...
}
```

This will cause the aliases to appear as block devices in the `/dev/mapper` directory on the host, allowing you to specify a friendly, easily-validated name whenever a configuration or maintenance operation requires specifying a block storage volume.



If you are setting up shared storage to support StorageGRID node migration and using device mapper multipathing, you can create and install a common `/etc/multipath.conf` on all co-located hosts. Just make sure to use a different container engine storage volume on each host. Using aliases and including the target hostname in the alias for each container engine storage volume LUN will make this easy to remember and is recommended.

Related information

[Configure container engine storage volume](#)

Configure container engine storage volume

Before installing the container engine (Docker or Podman), you might need to format the storage volume and mount it.

About this task

You can skip these steps if you plan to use local storage for the Docker or Podman storage volume and have sufficient space available on the host partition containing `/var/lib/docker` for Docker and `/var/lib/containers` for Podman.



Podman is supported only on Red Hat Enterprise Linux (RHEL).

Steps

1. Create a file system on the container engine storage volume:

```
sudo mkfs.ext4 container-engine-storage-volume-device
```

2. Mount the container engine storage volume:

- For Docker:

```
sudo mkdir -p /var/lib/docker
sudo mount container-storage-volume-device /var/lib/docker
```

- For Podman:

```
sudo mkdir -p /var/lib/containers
sudo mount container-storage-volume-device /var/lib/containers
```

3. Add an entry for container-storage-volume-device to `/etc/fstab`.

This step ensures that the storage volume will remount automatically after host reboots.

Install Docker

The StorageGRID system runs on Red Hat Enterprise Linux or CentOS as a collection of containers. If you have chosen to use the Docker container engine, follow these steps to install Docker. Otherwise, [install Podman](#).

Steps

1. Install Docker by following the instructions for your Linux distribution.



If Docker is not included with your Linux distribution, you can download it from the Docker website.

2. Ensure Docker has been enabled and started by running the following two commands:

```
sudo systemctl enable docker
```

```
sudo systemctl start docker
```

3. Confirm you have installed the expected version of Docker by entering the following:

```
sudo docker version
```

The Client and Server versions must be 1.11.0 or later.

Install Podman

The StorageGRID system runs on Red Hat Enterprise Linux as a collection of containers. If you have chosen to use the Podman container engine, follow these steps to install Podman. Otherwise, [install Docker](#).



Podman is supported only on Red Hat Enterprise Linux (RHEL).

Steps

1. Install Podman and Podman-Docker by following the instructions for your Linux distribution.



You must also install the Podman-Docker package when you install Podman.

2. Confirm you have installed the expected version of Podman and Podman-Docker by entering the following:

```
sudo docker version
```



The Podman-Docker package allows you to use Docker commands.

The Client and Server versions must be 3.2.3 or later.

```
Version: 3.2.3
API Version: 3.2.3
Go Version: go1.15.7
Built: Tue Jul 27 03:29:39 2021
OS/Arch: linux/amd64
```

Install StorageGRID host services

You use the StorageGRID RPM package to install the StorageGRID host services.

About this task

These instructions describe how to install the host services from the RPM packages. As an alternative, you can

use the Yum repository metadata included in the installation archive to install the RPM packages remotely. See the Yum repository instructions for your Linux operating system.

Steps

1. Copy the StorageGRID RPM packages to each of your hosts, or make them available on shared storage.

For example, place them in the `/tmp` directory, so you can use the example command in the next step.

2. Log in to each host as root or using an account with sudo permission, and run the following commands in the order specified:

```
sudo yum --nogpgcheck localinstall /tmp/StorageGRID-Webscale-Images-  
version-SHA.rpm
```

```
sudo yum --nogpgcheck localinstall /tmp/StorageGRID-Webscale-Service-  
version-SHA.rpm
```



You must install the Images package first, and the Service package second.



If you placed the packages in a directory other than `/tmp`, modify the command to reflect the path you used.

Deploy virtual grid nodes (Red Hat or CentOS)

Create node configuration files for Red Hat Enterprise Linux or CentOS deployments

Node configuration files are small text files that provide the information the StorageGRID host service needs to start a node and connect it to the appropriate network and block storage resources. Node configuration files are used for virtual nodes and are not used for appliance nodes.

Where do I put the node configuration files?

You must place the configuration file for each StorageGRID node in the `/etc/storagegrid/nodes` directory on the host where the node will run. For example, if you plan to run one Admin Node, one Gateway Node, and one Storage Node on HostA, you must place three node configuration files in `/etc/storagegrid/nodes` on HostA. You can create the configuration files directly on each host using a text editor, such as vim or nano, or you can create them elsewhere and move them to each host.

What do I name the node configuration files?

The names of the configuration files are significant. The format is `node-name.conf`, where `node-name` is a name you assign to the node. This name appears in the StorageGRID Installer and is used for node maintenance operations, such as node migration.

Node names must follow these rules:

- Must be unique
- Must start with a letter
- Can contain the characters A through Z and a through z
- Can contain the numbers 0 through 9
- Can contain one or more hyphens (-)
- Must be no more than 32 characters, not including the `.conf` extension

Any files in `/etc/storagegrid/nodes` that do not follow these naming conventions will not be parsed by the host service.

If you have a multi-site topology planned for your grid, a typical node naming scheme might be:

```
site-nodetype-nodenum.conf
```

For example, you might use `dc1-adm1.conf` for the first Admin Node in Data Center 1, and `dc2-sn3.conf` for the third Storage Node in Data Center 2. However, you can use any scheme you like, as long as all node names follow the naming rules.

What is in a node configuration file?

The configuration files contain key/value pairs, with one key and one value per line. For each key/value pair, you must follow these rules:

- The key and the value must be separated by an equal sign (=) and optional whitespace.
- The keys can contain no spaces.
- The values can contain embedded spaces.
- Any leading or trailing whitespace is ignored.

Some keys are required for every node, while others are optional or only required for certain node types.

The table defines the acceptable values for all supported keys. In the middle column:

R: required
BP: best practice
O: optional

Key	R, BP, or O?	Value
ADMIN_IP	BP	<p>Grid Network IPv4 address of the primary Admin Node for the grid to which this node belongs. Use the same value you specified for GRID_NETWORK_IP for the grid node with NODE_TYPE = VM_Admin_Node and ADMIN_ROLE = Primary. If you omit this parameter, the node attempts to discover a primary Admin Node using mDNS.</p> <p>How grid nodes discover the primary Admin Node</p> <p>Note: This value is ignored, and might be prohibited, on the primary Admin Node.</p>
ADMIN_NETWORK_CONFIG	O	DHCP, STATIC, or DISABLED
ADMIN_NETWORK_ESL	O	<p>Comma-separated list of subnets in CIDR notation to which this node should communicate via the Admin Network gateway.</p> <p>Example: 172.16.0.0/21,172.17.0.0/21</p>
ADMIN_NETWORK_GATEWAY	O (R)	<p>IPv4 address of the local Admin Network gateway for this node. Must be on the subnet defined by ADMIN_NETWORK_IP and ADMIN_NETWORK_MASK. This value is ignored for DHCP-configured networks.</p> <p>Note: This parameter is required if ADMIN_NETWORK_ESL is specified.</p> <p>Examples:</p> <p>1.1.1.1</p> <p>10.224.4.81</p>
ADMIN_NETWORK_IP	O	<p>IPv4 address of this node on the Admin Network. This key is only required when ADMIN_NETWORK_CONFIG = STATIC; do not specify it for other values.</p> <p>Examples:</p> <p>1.1.1.1</p> <p>10.224.4.81</p>

Key	R, BP, or O?	Value
ADMIN_NETWORK_MAC	O	<p>The MAC address for the Admin Network interface in the container.</p> <p>This field is optional. If omitted, a MAC address will be generated automatically.</p> <p>Must be 6 pairs of hexadecimal digits separated by colons.</p> <p>Example: b2:9c:02:c2:27:10</p>
ADMIN_NETWORK_MASK	O	<p>IPv4 netmask for this node, on the Admin Network. This key is only required when ADMIN_NETWORK_CONFIG = STATIC; do not specify it for other values.</p> <p>Examples:</p> <p>255.255.255.0</p> <p>255.255.248.0</p>
ADMIN_NETWORK_MTU	O	<p>The maximum transmission unit (MTU) for this node on the Admin Network. Do not specify if ADMIN_NETWORK_CONFIG = DHCP. If specified, the value must be between 1280 and 9216. If omitted, 1500 is used.</p> <p>If you want to use jumbo frames, set the MTU to a value suitable for jumbo frames, such as 9000. Otherwise, keep the default value.</p> <p>IMPORTANT: The MTU value of the network must match the value configured on the switch port the node is connected to. Otherwise, network performance issues or packet loss might occur.</p> <p>Examples:</p> <p>1500</p> <p>8192</p>

Key	R, BP, or O?	Value
ADMIN_NETWORK_TARGET	BP	<p>Name of the host device that you will use for Admin Network access by the StorageGRID node. Only network interface names are supported. Typically, you use a different interface name than what was specified for GRID_NETWORK_TARGET or CLIENT_NETWORK_TARGET.</p> <p>Note: Do not use bond or bridge devices as the network target. Either configure a VLAN (or other virtual interface) on top of the bond device, or use a bridge and virtual Ethernet (veth) pair.</p> <p>Best practice: Specify a value even if this node will not initially have an Admin Network IP address. Then you can add an Admin Network IP address later, without having to reconfigure the node on the host.</p> <p>Examples:</p> <pre>bond0.1002</pre> <pre>ens256</pre>
ADMIN_NETWORK_TARGET_TYPE	O	<p>Interface</p> <p>(This is the only supported value.)</p>
ADMIN_NETWORK_TARGET_TYPE_INTERFACE_CLONE_MAC	BP	<p>True or False</p> <p>Set the key to "true" to cause the StorageGRID container use the MAC address of the host host target interface on the Admin Network.</p> <p>Best practice: In networks where promiscuous mode would be required, use the ADMIN_NETWORK_TARGET_TYPE_INTERFACE_CLONE_MAC key instead.</p> <p>For more details on MAC cloning:</p> <p>Considerations and recommendations for MAC address cloning (Red Hat Enterprise Linux or CentOS)</p> <p>Considerations and recommendations for MAC address cloning (Ubuntu or Debian)</p>
ADMIN_ROLE	R	<p>Primary or Non-Primary</p> <p>This key is only required when NODE_TYPE = VM_Admin_Node; do not specify it for other node types.</p>

Key	R, BP, or O?	Value
BLOCK_DEVICE_AUDIT_LOGS	R	<p>Path and name of the block device special file this node will use for persistent storage of audit logs. This key is only required for nodes with NODE_TYPE = VM_Admin_Node; do not specify it for other node types.</p> <p>Examples:</p> <pre data-bbox="719 394 1393 646">/dev/disk/by-path/pci-0000:03:00.0-scsi-0:0:0:0 /dev/disk/by-id/wwn-0x600a09800059d6df000060d757b475fd /dev/mapper/sgws-adm1-audit-logs</pre>

Key	R, BP, or O?	Value
BLOCK_DEVICE_RANGEDB_000	R	<p>Path and name of the block device special file this node will use for persistent object storage. This key is only required for nodes with NODE_TYPE = VM_Storage_Node; do not specify it for other node types.</p> <p>Only BLOCK_DEVICE_RANGEDB_000 is required; the rest are optional. The block device specified for BLOCK_DEVICE_RANGEDB_000 must be at least 4 TB; the others can be smaller.</p> <p>Do not leave gaps. If you specify BLOCK_DEVICE_RANGEDB_005, you must also specify BLOCK_DEVICE_RANGEDB_004.</p> <p>Note: For compatibility with existing deployments, two-digit keys are supported for upgraded nodes.</p> <p>Examples:</p> <pre>/dev/disk/by-path/pci-0000:03:00.0-scsi-0:0:0:0</pre> <pre>/dev/disk/by-id/wwn-0x600a09800059d6df000060d757b475fd</pre> <pre>/dev/mapper/sgws-sn1-rangedb-000</pre>
BLOCK_DEVICE_RANGEDB_001		
BLOCK_DEVICE_RANGEDB_002		
BLOCK_DEVICE_RANGEDB_003		
BLOCK_DEVICE_RANGEDB_004		
BLOCK_DEVICE_RANGEDB_005		
BLOCK_DEVICE_RANGEDB_006		
BLOCK_DEVICE_RANGEDB_007		
BLOCK_DEVICE_RANGEDB_008		
BLOCK_DEVICE_RANGEDB_009		
BLOCK_DEVICE_RANGEDB_010		
BLOCK_DEVICE_RANGEDB_011		
BLOCK_DEVICE_RANGEDB_012		
BLOCK_DEVICE_RANGEDB_013		
BLOCK_DEVICE_RANGEDB_014		
BLOCK_DEVICE_RANGEDB_015		

Key	R, BP, or O?	Value
BLOCK_DEVICE_TABLES	R	<p>Path and name of the block device special file this node will use for persistent storage of database tables. This key is only required for nodes with NODE_TYPE = VM_Admin_Node; do not specify it for other node types.</p> <p>Examples:</p> <pre>/dev/disk/by-path/pci-0000:03:00.0-scsi-0:0:0:0</pre> <pre>/dev/disk/by-id/wwn-0x600a09800059d6df000060d757b475fd</pre> <pre>/dev/mapper/sgws-adm1-tables</pre>
BLOCK_DEVICE_VAR_LOCAL	R	<p>Path and name of the block device special file this node will use for its /var/local persistent storage.</p> <p>Examples:</p> <pre>/dev/disk/by-path/pci-0000:03:00.0-scsi-0:0:0:0</pre> <pre>/dev/disk/by-id/wwn-0x600a09800059d6df000060d757b475fd</pre> <pre>/dev/mapper/sgws-sn1-var-local</pre>
CLIENT_NETWORK_CONFIG	O	DHCP, STATIC, or DISABLED
CLIENT_NETWORK_GATEWAY	O	<p>IPv4 address of the local Client Network gateway for this node, which must be on the subnet defined by CLIENT_NETWORK_IP and CLIENT_NETWORK_MASK. This value is ignored for DHCP-configured networks.</p> <p>Examples:</p> <pre>1.1.1.1</pre> <pre>10.224.4.81</pre>

Key	R, BP, or O?	Value
CLIENT_NETWORK_IP	O	<p>IPv4 address of this node on the Client Network. This key is only required when CLIENT_NETWORK_CONFIG = STATIC; do not specify it for other values.</p> <p>Examples:</p> <p>1.1.1.1</p> <p>10.224.4.81</p>
CLIENT_NETWORK_MAC	O	<p>The MAC address for the Client Network interface in the container.</p> <p>This field is optional. If omitted, a MAC address will be generated automatically.</p> <p>Must be 6 pairs of hexadecimal digits separated by colons.</p> <p>Example: b2:9c:02:c2:27:20</p>
CLIENT_NETWORK_MASK	O	<p>IPv4 netmask for this node on the Client Network. This key is only required when CLIENT_NETWORK_CONFIG = STATIC; do not specify it for other values.</p> <p>Examples:</p> <p>255.255.255.0</p> <p>255.255.248.0</p>
CLIENT_NETWORK_MTU	O	<p>The maximum transmission unit (MTU) for this node on the Client Network. Do not specify if CLIENT_NETWORK_CONFIG = DHCP. If specified, the value must be between 1280 and 9216. If omitted, 1500 is used.</p> <p>If you want to use jumbo frames, set the MTU to a value suitable for jumbo frames, such as 9000. Otherwise, keep the default value.</p> <p>IMPORTANT: The MTU value of the network must match the value configured on the switch port the node is connected to. Otherwise, network performance issues or packet loss might occur.</p> <p>Examples:</p> <p>1500</p> <p>8192</p>

Key	R, BP, or O?	Value
CLIENT_NETWORK_TARGET	BP	<p>Name of the host device that you will use for Client Network access by the StorageGRID node. Only network interface names are supported. Typically, you use a different interface name than what was specified for GRID_NETWORK_TARGET or ADMIN_NETWORK_TARGET.</p> <p>Note: Do not use bond or bridge devices as the network target. Either configure a VLAN (or other virtual interface) on top of the bond device, or use a bridge and virtual Ethernet (veth) pair.</p> <p>Best practice: Specify a value even if this node will not initially have a Client Network IP address. Then you can add a Client Network IP address later, without having to reconfigure the node on the host.</p> <p>Examples:</p> <pre>bond0.1003</pre> <pre>ens423</pre>
CLIENT_NETWORK_TARGET_TYPE	O	<p>Interface</p> <p>(This is only supported value.)</p>
CLIENT_NETWORK_TARGET_TYPE_INTERFACE_CLONE_MAC	BP	<p>True or False</p> <p>Set the key to "true" to cause the StorageGRID container to use the MAC address of the host target interface on the Client Network.</p> <p>Best practice: In networks where promiscuous mode would be required, use the CLIENT_NETWORK_TARGET_TYPE_INTERFACE_CLONE_MAC key instead.</p> <p>For more details on MAC cloning:</p> <p>Considerations and recommendations for MAC address cloning (Red Hat Enterprise Linux or CentOS)</p> <p>Considerations and recommendations for MAC address cloning (Ubuntu or Debian)</p>
GRID_NETWORK_CONFIG	BP	<p>STATIC or DHCP</p> <p>(Defaults to STATIC if not specified.)</p>

Key	R, BP, or O?	Value
GRID_NETWORK_GATEWAY	R	<p>IPv4 address of the local Grid Network gateway for this node, which must be on the subnet defined by GRID_NETWORK_IP and GRID_NETWORK_MASK. This value is ignored for DHCP-configured networks.</p> <p>If the Grid Network is a single subnet with no gateway, use either the standard gateway address for the subnet (X.Y.Z.1) or this node's GRID_NETWORK_IP value; either value will simplify potential future Grid Network expansions.</p>
GRID_NETWORK_IP	R	<p>IPv4 address of this node on the Grid Network. This key is only required when GRID_NETWORK_CONFIG = STATIC; do not specify it for other values.</p> <p>Examples:</p> <p>1.1.1.1</p> <p>10.224.4.81</p>
GRID_NETWORK_MAC	O	<p>The MAC address for the Grid Network interface in the container.</p> <p>This field is optional. If omitted, a MAC address will be generated automatically.</p> <p>Must be 6 pairs of hexadecimal digits separated by colons.</p> <p>Example: b2:9c:02:c2:27:30</p>
GRID_NETWORK_MASK	O	<p>IPv4 netmask for this node on the Grid Network. This key is only required when GRID_NETWORK_CONFIG = STATIC; do not specify it for other values.</p> <p>Examples:</p> <p>255.255.255.0</p> <p>255.255.248.0</p>

Key	R, BP, or O?	Value
GRID_NETWORK_MTU	O	<p>The maximum transmission unit (MTU) for this node on the Grid Network. Do not specify if GRID_NETWORK_CONFIG = DHCP. If specified, the value must be between 1280 and 9216. If omitted, 1500 is used.</p> <p>If you want to use jumbo frames, set the MTU to a value suitable for jumbo frames, such as 9000. Otherwise, keep the default value.</p> <p>IMPORTANT: The MTU value of the network must match the value configured on the switch port the node is connected to. Otherwise, network performance issues or packet loss might occur.</p> <p>IMPORTANT: For the best network performance, all nodes should be configured with similar MTU values on their Grid Network interfaces. The Grid Network MTU mismatch alert is triggered if there is a significant difference in MTU settings for the Grid Network on individual nodes. The MTU values do not have to be the same for all network types.</p> <p>Examples:</p> <p>1500 8192</p>
GRID_NETWORK_TARGET	R	<p>Name of the host device that you will use for Grid Network access by the StorageGRID node. Only network interface names are supported. Typically, you use a different interface name than what was specified for ADMIN_NETWORK_TARGET or CLIENT_NETWORK_TARGET.</p> <p>Note: Do not use bond or bridge devices as the network target. Either configure a VLAN (or other virtual interface) on top of the bond device, or use a bridge and virtual Ethernet (veth) pair.</p> <p>Examples:</p> <p>bond0.1001</p> <p>ens192</p>
GRID_NETWORK_TARGET_TYPE	O	<p>Interface</p> <p>(This is the only supported value.)</p>

Key	R, BP, or O?	Value
GRID_NETWORK_TARGET_TYPE_INTERFACE_CLONE_MAC	BP	<p>True or False</p> <p>Set the value of the key to "true" to cause the StorageGRID container to use the MAC address of the host target interface on the Grid Network.</p> <p>Best practice: In networks where promiscuous mode would be required, use the GRID_NETWORK_TARGET_TYPE_INTERFACE_CLONE_MAC key instead.</p> <p>For more details on MAC cloning:</p> <p>Considerations and recommendations for MAC address cloning (Red Hat Enterprise Linux or CentOS)</p> <p>Considerations and recommendations for MAC address cloning (Ubuntu or Debian)</p>
INTERFACES_TARGET_nnnn	O	<p>Name and optional description for an extra interface you want to add to this node. You can add multiple extra interfaces to each node.</p> <p>For <i>nnnn</i>, specify a unique number for each INTERFACES_TARGET entry you are adding.</p> <p>For the value, specify the name of the physical interface on the bare-metal host. Then, optionally, add a comma and provide a description of the interface, which is displayed on the VLAN interfaces page and the HA groups page.</p> <p>For example: INTERFACES_TARGET_01=ens256, Trunk</p> <p>If you add a trunk interface, you must configure a VLAN interface in StorageGRID. If you add an access interface, you can add the interface directly to an HA group; you do not need to configure a VLAN interface.</p>

Key	R, BP, or O?	Value
MAXIMUM_RAM	O	<p>The maximum amount of RAM that this node is allowed to consume. If this key is omitted, the node has no memory restrictions. When setting this field for a production-level node, specify a value that is at least 24 GB and 16 to 32 GB less than the total system RAM.</p> <p>Note: The RAM value affects a node's actual metadata reserved space. See the instructions for administering StorageGRID for a description of what Metadata Reserved Space is.</p> <p>The format for this field is <number><unit>, where <unit> can be b, k, m, or g.</p> <p>Examples:</p> <p>24g</p> <p>38654705664b</p> <p>Note: If you want to use this option, you must enable kernel support for memory cgroups.</p>
NODE_TYPE	R	<p>Type of node:</p> <p>VM_Admin_Node VM_Storage_Node VM_Archive_Node VM_API_Gateway</p>

Key	R, BP, or O?	Value
PORT_REMAP	O	<p>Remaps any port used by a node for internal grid node communications or external communications. Remapping ports is necessary if enterprise networking policies restrict one or more ports used by StorageGRID, as described in “Internal grid node communications” or “External communications.”</p> <p>IMPORTANT: Do not remap the ports you are planning to use to configure load balancer endpoints.</p> <p>Note: If only PORT_REMAP is set, the mapping that you specify is used for both inbound and outbound communications. If PORT_REMAP_INBOUND is also specified, PORT_REMAP applies only to outbound communications.</p> <p>The format used is: <network type>/<protocol>/<default port used by grid node>/<new port>, where <network type> is grid, admin, or client, and protocol is tcp or udp.</p> <p>For example:</p> <pre>PORT_REMAP = client/tcp/18082/443</pre>
PORT_REMAP_INBOUND	O	<p>Remaps inbound communications to the specified port. If you specify PORT_REMAP_INBOUND but do not specify a value for PORT_REMAP, outbound communications for the port are unchanged.</p> <p>IMPORTANT: Do not remap the ports you are planning to use to configure load balancer endpoints.</p> <p>The format used is: <network type>/<protocol:>/<remapped port >/<default port used by grid node>, where <network type> is grid, admin, or client, and protocol is tcp or udp.</p> <p>For example:</p> <pre>PORT_REMAP_INBOUND = grid/tcp/3022/22</pre>

Related information

[Networking guidelines](#)

How grid nodes discover the primary Admin Node

Grid nodes communicate with the primary Admin Node for configuration and management. Each grid node must know the IP address of the primary Admin Node on the Grid Network.

To ensure that a grid node can access the primary Admin Node, you can do either of the following when deploying the node:

- You can use the ADMIN_IP parameter to enter the primary Admin Node's IP address manually.
- You can omit the ADMIN_IP parameter to have the grid node discover the value automatically. Automatic discovery is especially useful when the Grid Network uses DHCP to assign the IP address to the primary Admin Node.

Automatic discovery of the primary Admin Node is accomplished using a multicast Domain Name System (mDNS). When the primary Admin Node first starts up, it publishes its IP address using mDNS. Other nodes on the same subnet can then query for the IP address and acquire it automatically. However, because multicast IP traffic is not normally routable across subnets, nodes on other subnets cannot acquire the primary Admin Node's IP address directly.

If you use automatic discovery:



- You must include the ADMIN_IP setting for at least one grid node on any subnets that the primary Admin Node is not directly attached to. This grid node will then publish the primary Admin Node's IP address for other nodes on the subnet to discover with mDNS.
- Ensure that your network infrastructure supports passing multi-cast IP traffic within a subnet.

Example node configuration files

You can use the example node configuration files to help set up the node configuration files for your StorageGRID system. The examples show node configuration files for all types of grid nodes.

For most nodes, you can add Admin and Client Network addressing information (IP, mask, gateway, and so on) when you configure the grid using the Grid Manager or the Installation API. The exception is the primary Admin Node. If you want to browse to the Admin Network IP of the primary Admin Node to complete grid configuration (because the Grid Network is not routed, for example), you must configure the Admin Network connection for the primary Admin Node in its node configuration file. This is shown in the example.



In the examples, the Client Network target has been configured as a best practice, even though the Client Network is disabled by default.

Example for primary Admin Node

Example file name: `/etc/storagegrid/nodes/dc1-adm1.conf`

Example file contents:

```

NODE_TYPE = VM_Admin_Node
ADMIN_ROLE = Primary
BLOCK_DEVICE_VAR_LOCAL = /dev/mapper/dcl-adm1-var-local
BLOCK_DEVICE_AUDIT_LOGS = /dev/mapper/dcl-adm1-audit-logs
BLOCK_DEVICE_TABLES = /dev/mapper/dcl-adm1-tables
GRID_NETWORK_TARGET = bond0.1001
ADMIN_NETWORK_TARGET = bond0.1002
CLIENT_NETWORK_TARGET = bond0.1003

GRID_NETWORK_IP = 10.1.0.2
GRID_NETWORK_MASK = 255.255.255.0
GRID_NETWORK_GATEWAY = 10.1.0.1

ADMIN_NETWORK_CONFIG = STATIC
ADMIN_NETWORK_IP = 192.168.100.2
ADMIN_NETWORK_MASK = 255.255.248.0
ADMIN_NETWORK_GATEWAY = 192.168.100.1
ADMIN_NETWORK_ESL = 192.168.100.0/21,172.16.0.0/21,172.17.0.0/21

```

Example for Storage Node

Example file name: /etc/storagegrid/nodes/dcl-sn1.conf

Example file contents:

```

NODE_TYPE = VM_Storage_Node
ADMIN_IP = 10.1.0.2
BLOCK_DEVICE_VAR_LOCAL = /dev/mapper/dcl-sn1-var-local
BLOCK_DEVICE_RANGEDB_00 = /dev/mapper/dcl-sn1-rangedb-0
BLOCK_DEVICE_RANGEDB_01 = /dev/mapper/dcl-sn1-rangedb-1
BLOCK_DEVICE_RANGEDB_02 = /dev/mapper/dcl-sn1-rangedb-2
BLOCK_DEVICE_RANGEDB_03 = /dev/mapper/dcl-sn1-rangedb-3
GRID_NETWORK_TARGET = bond0.1001
ADMIN_NETWORK_TARGET = bond0.1002
CLIENT_NETWORK_TARGET = bond0.1003

GRID_NETWORK_IP = 10.1.0.3
GRID_NETWORK_MASK = 255.255.255.0
GRID_NETWORK_GATEWAY = 10.1.0.1

```

Example for Archive Node

Example file name: /etc/storagegrid/nodes/dcl-ar1.conf

Example file contents:


```
NODE_TYPE = VM_Archive_Node
ADMIN_IP = 10.1.0.2
BLOCK_DEVICE_VAR_LOCAL = /dev/mapper/dcl-arcl-var-local
GRID_NETWORK_TARGET = bond0.1001
ADMIN_NETWORK_TARGET = bond0.1002
CLIENT_NETWORK_TARGET = bond0.1003

GRID_NETWORK_IP = 10.1.0.4
GRID_NETWORK_MASK = 255.255.255.0
GRID_NETWORK_GATEWAY = 10.1.0.1
```

Example for Gateway Node

Example file name: /etc/storagegrid/nodes/dcl-gw1.conf

Example file contents:

```
NODE_TYPE = VM_API_Gateway
ADMIN_IP = 10.1.0.2
BLOCK_DEVICE_VAR_LOCAL = /dev/mapper/dcl-gw1-var-local
GRID_NETWORK_TARGET = bond0.1001
ADMIN_NETWORK_TARGET = bond0.1002
CLIENT_NETWORK_TARGET = bond0.1003
GRID_NETWORK_IP = 10.1.0.5
GRID_NETWORK_MASK = 255.255.255.0
GRID_NETWORK_GATEWAY = 10.1.0.1
```

Example for a non-primary Admin Node

Example file name: /etc/storagegrid/nodes/dcl-adm2.conf

Example file contents:

```
NODE_TYPE = VM_Admin_Node
ADMIN_ROLE = Non-Primary
ADMIN_IP = 10.1.0.2
BLOCK_DEVICE_VAR_LOCAL = /dev/mapper/dc1-adm2-var-local
BLOCK_DEVICE_AUDIT_LOGS = /dev/mapper/dc1-adm2-audit-logs
BLOCK_DEVICE_TABLES = /dev/mapper/dc1-adm2-tables
GRID_NETWORK_TARGET = bond0.1001
ADMIN_NETWORK_TARGET = bond0.1002
CLIENT_NETWORK_TARGET = bond0.1003

GRID_NETWORK_IP = 10.1.0.6
GRID_NETWORK_MASK = 255.255.255.0
GRID_NETWORK_GATEWAY = 10.1.0.1
```

Validate the StorageGRID configuration

After creating configuration files in `/etc/storagegrid/nodes` for each of your StorageGRID nodes, you must validate the contents of those files.

To validate the contents of the configuration files, run the following command on each host:

```
sudo storagegrid node validate all
```

If the files are correct, the output shows **PASSED** for each configuration file, as shown in the example.

```
Checking for misnamed node configuration files... PASSED
Checking configuration file for node dc1-adm1... PASSED
Checking configuration file for node dc1-gw1... PASSED
Checking configuration file for node dc1-sn1... PASSED
Checking configuration file for node dc1-sn2... PASSED
Checking configuration file for node dc1-sn3... PASSED
Checking for duplication of unique values between nodes... PASSED
```



For an automated installation, you can suppress this output by using the `-q` or `--quiet` options in the `storagegrid` command (for example, `storagegrid --quiet...`). If you suppress the output, the command will have a non-zero exit value if any configuration warnings or errors were detected.

If the configuration files are incorrect, the issues are shown as **WARNING** and **ERROR**, as shown in the example. If any configuration errors are found, you must correct them before you continue with the installation.

```

Checking for misnamed node configuration files...
WARNING: ignoring /etc/storagegrid/nodes/dcl-adml
WARNING: ignoring /etc/storagegrid/nodes/dcl-sn2.conf.keep
WARNING: ignoring /etc/storagegrid/nodes/my-file.txt
Checking configuration file for node dcl-adml...
ERROR: NODE_TYPE = VM_Foo_Node
      VM_Foo_Node is not a valid node type.  See *.conf.sample
ERROR: ADMIN_ROLE = Foo
      Foo is not a valid admin role.  See *.conf.sample
ERROR: BLOCK_DEVICE_VAR_LOCAL = /dev/mapper/sgws-gw1-var-local
      /dev/mapper/sgws-gw1-var-local is not a valid block device
Checking configuration file for node dcl-gw1...
ERROR: GRID_NETWORK_TARGET = bond0.1001
      bond0.1001 is not a valid interface.  See `ip link show`
ERROR: GRID_NETWORK_IP = 10.1.3
      10.1.3 is not a valid IPv4 address
ERROR: GRID_NETWORK_MASK = 255.248.255.0
      255.248.255.0 is not a valid IPv4 subnet mask
Checking configuration file for node dcl-sn1...
ERROR: GRID_NETWORK_GATEWAY = 10.2.0.1
      10.2.0.1 is not on the local subnet
ERROR: ADMIN_NETWORK_ESL = 192.168.100.0/21,172.16.0foo
      Could not parse subnet list
Checking configuration file for node dcl-sn2... PASSED
Checking configuration file for node dcl-sn3... PASSED
Checking for duplication of unique values between nodes...
ERROR: GRID_NETWORK_IP = 10.1.0.4
      dcl-sn2 and dcl-sn3 have the same GRID_NETWORK_IP
ERROR: BLOCK_DEVICE_VAR_LOCAL = /dev/mapper/sgws-sn2-var-local
      dcl-sn2 and dcl-sn3 have the same BLOCK_DEVICE_VAR_LOCAL
ERROR: BLOCK_DEVICE_RANGEDB_00 = /dev/mapper/sgws-sn2-rangedb-0
      dcl-sn2 and dcl-sn3 have the same BLOCK_DEVICE_RANGEDB_00

```

Start the StorageGRID host service

To start your StorageGRID nodes, and ensure they restart after a host reboot, you must enable and start the StorageGRID host service.

Steps

1. Run the following commands on each host:

```

sudo systemctl enable storagegrid
sudo systemctl start storagegrid

```

2. Run the following command to ensure the deployment is proceeding:

```
sudo storagegrid node status node-name
```

For any node that returns a status of “Not-Running” or “Stopped”, run the following command:

```
sudo storagegrid node start node-name
```

3. If you have previously enabled and started the StorageGRID host service (or if you are unsure if the service has been enabled and started), also run the following command:

```
sudo systemctl reload-or-restart storagegrid
```

Configure the grid and complete installation (Red Hat or CentOS)

Navigate to the Grid Manager

You use the Grid Manager to define all of the information required to configure your StorageGRID system.

What you'll need

The primary Admin Node must be deployed and have completed the initial startup sequence.

Steps

1. Open your web browser and navigate to one of the following addresses:

```
https://primary_admin_node_ip  
  
client_network_ip
```

Alternatively, you can access the Grid Manager on port 8443:

```
https://primary_admin_node_ip:8443
```

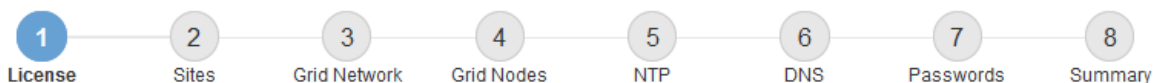


You can use the IP address for the primary Admin Node IP on the Grid Network or on the Admin Network, as appropriate for your network configuration.

1. Click **Install a StorageGRID system**.

The page used to configure a StorageGRID system appears.

Install



License

Enter a grid name and upload the license file provided by NetApp for your StorageGRID system.

Grid Name

License File

Specify the StorageGRID license information

You must specify the name for your StorageGRID system and upload the license file provided by NetApp.

Steps

1. On the License page, enter a meaningful name for your StorageGRID system in **Grid Name**.

After installation, the name is displayed at the top of the Nodes menu.

2. Click **Browse**, locate the NetApp License File (`NLFunique_id.txt`), and click **Open**.

The license file is validated, and the serial number and licensed storage capacity are displayed.



The StorageGRID installation archive includes a free license that does not provide any support entitlement for the product. You can update to a license that offers support after installation.

Install



License

Enter a grid name and upload the license file provided by NetApp for your StorageGRID system.

Grid Name	<input type="text" value="Grid1"/>
New License File	<input type="button" value="Browse"/>
License Serial Number	<input type="text" value="950719"/>
Storage Capacity (TB)	<input type="text" value="240"/>

3. Click **Next**.

Add sites

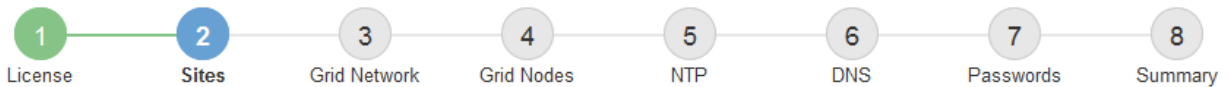
You must create at least one site when you are installing StorageGRID. You can create additional sites to increase the reliability and storage capacity of your StorageGRID system.

Steps

1. On the Sites page, enter the **Site Name**.
2. To add additional sites, click the plus sign next to the last site entry and enter the name in the new **Site Name** text box.

Add as many additional sites as required for your grid topology. You can add up to 16 sites.

Install



Sites

In a single-site deployment, infrastructure and operations are centralized in one site.

In a multi-site deployment, infrastructure can be distributed asymmetrically across sites, and proportional to the needs of each site. Typically, sites are located in geographically different locations. Having multiple sites also allows the use of distributed replication and erasure coding for increased availability and resiliency.

Site Name 1	<input type="text" value="Raleigh"/>	✕
Site Name 2	<input type="text" value="Atlanta"/>	+ ✕

3. Click **Next**.

Specify Grid Network subnets

You must specify the subnets that are used on the Grid Network.

About this task

The subnet entries include the subnets for the Grid Network for each site in your StorageGRID system, along with any subnets that need to be reachable via the Grid Network.

If you have multiple grid subnets, the Grid Network gateway is required. All grid subnets specified must be reachable through this gateway.

Steps

1. Specify the CIDR network address for at least one Grid Network in the **Subnet 1** text box.
2. Click the plus sign next to the last entry to add an additional network entry.

If you have already deployed at least one node, click **Discover Grid Networks Subnets** to automatically populate the Grid Network Subnet List with the subnets reported by grid nodes that have registered with the Grid Manager.

Install



Grid Network

You must specify the subnets that are used on the Grid Network. These entries typically include the subnets for the Grid Network for each site in your StorageGRID system. Select Discover Grid Networks to automatically add subnets based on the network configuration of all registered nodes.

Note: You must manually add any subnets for NTP, DNS, LDAP, or other external servers accessed through the Grid Network gateway.

Subnet 1



3. Click **Next**.

Approve pending grid nodes

You must approve each grid node before it can join the StorageGRID system.

What you'll need

You have deployed all virtual and StorageGRID appliance grid nodes.



It is more efficient to perform one single installation of all the nodes, rather than installing some nodes now and some nodes later.

Steps

1. Review the Pending Nodes list, and confirm that it shows all of the grid nodes you deployed.



If a grid node is missing, confirm that it was deployed successfully.

2. Select the radio button next to a pending node you want to approve.



Grid Nodes

Approve and configure grid nodes, so that they are added correctly to your StorageGRID system.

Pending Nodes

Grid nodes are listed as pending until they are assigned to a site, configured, and approved.

<input type="button" value="+ Approve"/> <input type="button" value="✕ Remove"/>		<input type="text" value="Search"/> <input type="button" value="Q"/>				
	Grid Network MAC Address ↑↓	Name ↑↓	Type ↑↓	Platform ↑↓	Grid Network IPv4 Address ↓	
<input checked="" type="radio"/>	50:6b:4b:42:d7:00	NetApp-SGA	Storage Node	StorageGRID Appliance	172.16.5.20/21	

Approved Nodes

Grid nodes that have been approved and have been configured for installation. An approved grid node's configuration can be edited if errors are identified.

<input type="button" value="✎ Edit"/> <input type="button" value="↺ Reset"/> <input type="button" value="✕ Remove"/>		<input type="text" value="Search"/> <input type="button" value="Q"/>				
	Grid Network MAC Address ↑↓	Name ↑↓	Site ↑↓	Type ↑↓	Platform ↑↓	Grid Network IPv4 Address ↓
<input type="radio"/>	00:50:56:87:42:ff	dc1-adm1	Raleigh	Admin Node	VMware VM	172.16.4.210/21
<input type="radio"/>	00:50:56:87:c0:16	dc1-s1	Raleigh	Storage Node	VMware VM	172.16.4.211/21
<input type="radio"/>	00:50:56:87:79:ee	dc1-s2	Raleigh	Storage Node	VMware VM	172.16.4.212/21
<input type="radio"/>	00:50:56:87:db:9c	dc1-s3	Raleigh	Storage Node	VMware VM	172.16.4.213/21
<input type="radio"/>	00:50:56:87:62:38	dc1-g1	Raleigh	API Gateway Node	VMware VM	172.16.4.214/21

3. Click **Approve**.
4. In General Settings, modify settings for the following properties, as necessary:

Storage Node Configuration

General Settings

Site	<input type="text" value="Raleigh"/>
Name	<input type="text" value="NetApp-SGA"/>
NTP Role	<input type="text" value="Automatic"/>
ADC Service	<input type="text" value="Automatic"/>

Grid Network

Configuration	STATIC
IPv4 Address (CIDR)	<input type="text" value="172.16.5.20/21"/>
Gateway	<input type="text" value="172.16.5.20"/>

Admin Network

Configuration	STATIC
IPv4 Address (CIDR)	<input type="text" value="10.224.5.20/21"/>
Gateway	<input type="text" value="10.224.0.1"/>
Subnets (CIDR)	<input type="text" value="10.0.0.0/8"/> x
	<input type="text" value="172.19.0.0/16"/> x
	<input type="text" value="172.21.0.0/16"/> + x

Client Network

Configuration	STATIC
IPv4 Address (CIDR)	<input type="text" value="47.47.5.20/21"/>
Gateway	<input type="text" value="47.47.0.1"/>

- **Site:** The name of the site with which this grid node will be associated.
- **Name:** The name that will be assigned to the node, and the name that will be displayed in the Grid Manager. The name defaults to the name you specified when you configured the node. During this step of the installation process, you can change the name as required.



After you complete the installation, you cannot change the name of the node.



For a VMware node, you can change the name here, but this action will not change the name of the virtual machine in vSphere.

- **NTP Role:** The Network Time Protocol (NTP) role of the grid node. The options are **Automatic**, **Primary**, and **Client**. Selecting **Automatic** assigns the Primary role to Admin Nodes, Storage Nodes with ADC services, Gateway Nodes, and any grid nodes that have non-static IP addresses. All other grid nodes are assigned the Client role.



Make sure that at least two nodes at each site can access at least four external NTP sources. If only one node at a site can reach the NTP sources, timing issues will occur if that node goes down. In addition, designating two nodes per site as primary NTP sources ensures accurate timing if a site is isolated from the rest of the grid.

- **ADC service** (Storage Nodes only): Select **Automatic** to let the system determine whether the node requires the Administrative Domain Controller (ADC) service. The ADC service keeps track of the location and availability of grid services. At least three Storage Nodes at each site must include the ADC service. You cannot add the ADC service to a node after it is deployed.

5. In Grid Network, modify settings for the following properties as necessary:

- **IPv4 Address (CIDR):** The CIDR network address for the Grid Network interface (eth0 inside the container). For example: 192.168.1.234/21
- **Gateway:** The Grid Network gateway. For example: 192.168.0.1

The gateway is required if there are multiple grid subnets.



If you selected DHCP for the Grid Network configuration and you change the value here, the new value will be configured as a static address on the node. You must make sure the resulting IP address is not within a DHCP address pool.

6. If you want to configure the Admin Network for the grid node, add or update the settings in the Admin Network section as necessary.

Enter the destination subnets of the routes out of this interface in the **Subnets (CIDR)** text box. If there are multiple Admin subnets, the Admin gateway is required.



If you selected DHCP for the Admin Network configuration and you change the value here, the new value will be configured as a static address on the node. You must make sure the resulting IP address is not within a DHCP address pool.

Appliances: For a StorageGRID appliance, if the Admin Network was not configured during the initial installation using the StorageGRID Appliance Installer, it cannot be configured in this Grid Manager dialog box. Instead, you must follow these steps:

- Reboot the appliance: In the Appliance Installer, select **Advanced > Reboot**.

Rebooting can take several minutes.

- Select **Configure Networking > Link Configuration** and enable the appropriate networks.
- Select **Configure Networking > IP Configuration** and configure the enabled networks.
- Return to the Home page and click **Start Installation**.
- In the Grid Manager: If the node is listed in the Approved Nodes table, reset the node.
- Remove the node from the Pending Nodes table.
- Wait for the node to reappear in the Pending Nodes list.

- h. Confirm that you can configure the appropriate networks. They should already be populated with the information you provided on the IP Configuration page.

For additional information, see the installation and maintenance instructions for your appliance model.

7. If you want to configure the Client Network for the grid node, add or update the settings in the Client Network section as necessary. If the Client Network is configured, the gateway is required, and it becomes the default gateway for the node after installation.



If you selected DHCP for the Client Network configuration and you change the value here, the new value will be configured as a static address on the node. You must make sure the resulting IP address is not within a DHCP address pool.

Appliances: For a StorageGRID appliance, if the Client Network was not configured during the initial installation using the StorageGRID Appliance Installer, it cannot be configured in this Grid Manager dialog box. Instead, you must follow these steps:

- a. Reboot the appliance: In the Appliance Installer, select **Advanced > Reboot**.

Rebooting can take several minutes.

- b. Select **Configure Networking > Link Configuration** and enable the appropriate networks.
- c. Select **Configure Networking > IP Configuration** and configure the enabled networks.
- d. Return to the Home page and click **Start Installation**.
- e. In the Grid Manager: If the node is listed in the Approved Nodes table, reset the node.
- f. Remove the node from the Pending Nodes table.
- g. Wait for the node to reappear in the Pending Nodes list.
- h. Confirm that you can configure the appropriate networks. They should already be populated with the information you provided on the IP Configuration page.

For additional information, see the installation and maintenance instructions for your appliance.

8. Click **Save**.

The grid node entry moves to the Approved Nodes list.



Grid Nodes

Approve and configure grid nodes, so that they are added correctly to your StorageGRID system.

Pending Nodes

Grid nodes are listed as pending until they are assigned to a site, configured, and approved.

+ Approve
✕ Remove

Search Q

Grid Network MAC Address	Name	Type	Platform	Grid Network IPv4 Address
<i>No results found.</i>				

◀
▶

Approved Nodes

Grid nodes that have been approved and have been configured for installation. An approved grid node's configuration can be edited if errors are identified.

✎ Edit
🔄 Reset
✕ Remove

Search Q

	Grid Network MAC Address	Name	Site	Type	Platform	Grid Network IPv4 Address
<input type="radio"/>	00:50:56:87:42:ff	dc1-adm1	Raleigh	Admin Node	VMware VM	172.16.4.210/21
<input type="radio"/>	00:50:56:87:c0:16	dc1-s1	Raleigh	Storage Node	VMware VM	172.16.4.211/21
<input type="radio"/>	00:50:56:87:79:ee	dc1-s2	Raleigh	Storage Node	VMware VM	172.16.4.212/21
<input type="radio"/>	00:50:56:87:db:9c	dc1-s3	Raleigh	Storage Node	VMware VM	172.16.4.213/21
<input type="radio"/>	00:50:56:87:62:38	dc1-g1	Raleigh	API Gateway Node	VMware VM	172.16.4.214/21
<input type="radio"/>	50:6b:4b:42:d7:00	NetApp-SGA	Raleigh	Storage Node	StorageGRID Appliance	172.16.5.20/21

◀
▶

9. Repeat these steps for each pending grid node you want to approve.

You must approve all nodes that you want in the grid. However, you can return to this page at any time before you click **Install** on the Summary page. You can modify the properties of an approved grid node by selecting its radio button and clicking **Edit**.

10. When you are done approving grid nodes, click **Next**.

Specify Network Time Protocol server information

You must specify the Network Time Protocol (NTP) configuration information for the StorageGRID system, so that operations performed on separate servers can be kept synchronized.

About this task

You must specify IPv4 addresses for the NTP servers.

You must specify external NTP servers. The specified NTP servers must use the NTP protocol.

You must specify four NTP server references of Stratum 3 or better to prevent issues with time drift.



When specifying the external NTP source for a production-level StorageGRID installation, do not use the Windows Time (W32Time) service on a version of Windows earlier than Windows Server 2016. The time service on earlier versions of Windows is not sufficiently accurate and is not supported by Microsoft for use in high-accuracy environments, such as StorageGRID.

[Support boundary to configure the Windows Time service for high-accuracy environments](#)

The external NTP servers are used by the nodes to which you previously assigned Primary NTP roles.



Make sure that at least two nodes at each site can access at least four external NTP sources. If only one node at a site can reach the NTP sources, timing issues will occur if that node goes down. In addition, designating two nodes per site as primary NTP sources ensures accurate timing if a site is isolated from the rest of the grid.

Steps

1. Specify the IPv4 addresses for at least four NTP servers in the **Server 1** to **Server 4** text boxes.
2. If necessary, select the plus sign next to the last entry to add additional server entries.

The screenshot shows the NetApp StorageGRID installation wizard interface. At the top, there is a blue header with "NetApp® StorageGRID®" and a "Help" dropdown. Below the header is a navigation bar with "Install" and a progress indicator. The progress indicator consists of eight numbered steps: 1 (License), 2 (Sites), 3 (Grid Network), 4 (Grid Nodes), 5 (NTP), 6 (DNS), 7 (Passwords), and 8 (Summary). Step 5, "NTP", is currently selected and highlighted in blue. Below the progress bar, the "Network Time Protocol" section is visible. It contains the instruction: "Enter the IP addresses for at least four Network Time Protocol (NTP) servers, so that operations performed on separate servers are kept in sync." There are four input fields labeled "Server 1" through "Server 4". The values entered are: Server 1: 10.60.248.183, Server 2: 10.227.204.142, Server 3: 10.235.48.111, and Server 4: 0.0.0.0. A plus sign (+) is located to the right of the Server 4 input field.

3. Select **Next**.

Specify Domain Name System server information

You must specify Domain Name System (DNS) information for your StorageGRID system, so that you can access external servers using hostnames instead of IP addresses.

About this task

Specifying DNS server information allows you to use Fully Qualified Domain Name (FQDN) hostnames rather than IP addresses for email notifications and AutoSupport. Specifying at least two DNS servers is

recommended.



Provide two to six IPv4 addresses for DNS servers. You should select DNS servers that each site can access locally in the event of network islanding. This is to ensure an islanded site continues to have access to the DNS service. After configuring the grid-wide DNS server list, you can further customize the DNS server list for each node. For details, see the information about modifying the DNS configuration in the recovery and maintenance instructions.

If the DNS server information is omitted or incorrectly configured, a DNST alarm is triggered on each grid node's SSM service. The alarm clears when DNS is configured correctly and the new server information has reached all grid nodes.

Steps

1. Specify the IPv4 address for at least one DNS server in the **Server 1** text box.
2. If necessary, select the plus sign next to the last entry to add additional server entries.

The screenshot shows the NetApp StorageGRID installation wizard. The progress bar at the top indicates the current step is 6, DNS. Below the progress bar, the steps are: 1 License, 2 Sites, 3 Grid Network, 4 Grid Nodes, 5 NTP, 6 DNS, 7 Passwords, and 8 Summary. The DNS step is highlighted in blue. Below the progress bar, the text reads: "Domain Name Service. Enter the IP address for at least one Domain Name System (DNS) server, so that server hostnames can be used instead of IP addresses. Specifying at least two DNS servers is recommended. Configuring DNS enables server connectivity, email notifications, and NetApp AutoSupport." There are two input fields for DNS servers. The first field, labeled "Server 1", contains the IP address "10.224.223.130" and has a red 'x' icon to its right. The second field, labeled "Server 2", contains the IP address "10.224.223.136" and has a red '+ x' icon to its right.

The best practice is to specify at least two DNS servers. You can specify up to six DNS servers.

3. Select **Next**.

Specify the StorageGRID system passwords

As part of installing your StorageGRID system, you need to enter the passwords to use to secure your system and perform maintenance tasks.

About this task

Use the Install passwords page to specify the provisioning passphrase and the grid management root user password.

- The provisioning passphrase is used as an encryption key and is not stored by the StorageGRID system.
- You must have the provisioning passphrase for installation, expansion, and maintenance procedures, including downloading the Recovery Package. Therefore, it is important that you store the provisioning passphrase in a secure location.
- You can change the provisioning passphrase from the Grid Manager if you have the current one.

- The grid management root user password may be changed using the Grid Manager.
- Randomly generated command line console and SSH passwords are stored in the Passwords.txt file in the Recovery Package.

Steps

1. In **Provisioning Passphrase**, enter the provisioning passphrase that will be required to make changes to the grid topology of your StorageGRID system.

Store the provisioning passphrase in a secure place.

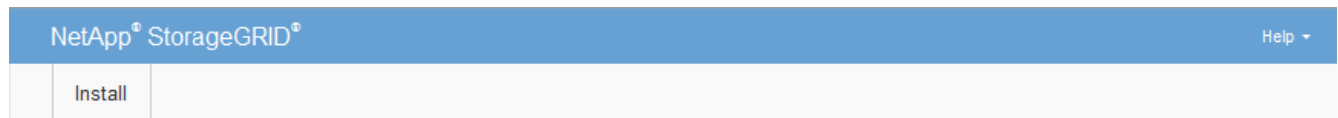


If after the installation completes and you want to change the provisioning passphrase later, you can use the Grid Manager. Select **CONFIGURATION > Access control > Grid passwords**.

2. In **Confirm Provisioning Passphrase**, reenter the provisioning passphrase to confirm it.
3. In **Grid Management Root User Password**, enter the password to use to access the Grid Manager as the “root” user.

Store the password in a secure place.

4. In **Confirm Root User Password**, reenter the Grid Manager password to confirm it.



Passwords

Enter secure passwords that meet your organization's security policies. A text file containing the command line passwords must be downloaded during the final installation step.

Provisioning Passphrase	<input type="password" value="....."/>
Confirm Provisioning Passphrase	<input type="password" value="....."/>
Grid Management Root User Password	<input type="password" value="....."/>
Confirm Root User Password	<input type="password" value="....."/>

Create random command line passwords.

5. If you are installing a grid for proof of concept or demo purposes, optionally deselect the **Create random command line passwords** check box.

For production deployments, random passwords should always be used for security reasons. Deselect **Create random command line passwords** only for demo grids if you want to use default passwords to access grid nodes from the command line using the “root” or “admin” account.



You are prompted to download the Recovery Package file (`sgws-recovery-package-id-revision.zip`) after you click **Install** on the Summary page. You must [download this file](#) to complete the installation. The passwords required to access the system are stored in the `Passwords.txt` file, contained in the Recovery Package file.

6. Click **Next**.

Review your configuration and complete installation

You must carefully review the configuration information you have entered to ensure that the installation completes successfully.

Steps

1. View the **Summary** page.

NetApp® StorageGRID® Help ▾

Install

1 License 2 Sites 3 Grid Network 4 Grid Nodes 5 NTP 6 DNS 7 Passwords 8 **Summary**

Summary

Verify that all of the grid configuration information is correct, and then click Install. You can view the status of each grid node as it installs. Click the Modify links to go back and change the associated information.

General Settings

Grid Name	Grid1	Modify License
Passwords	Auto-generated random command line passwords	Modify Passwords

Networking

NTP	10.60.248.183 10.227.204.142 10.235.48.111	Modify NTP
DNS	10.224.223.130 10.224.223.136	Modify DNS
Grid Network	172.16.0.0/21	Modify Grid Network

Topology

Topology	Atlanta	Modify Sites	Modify Grid Nodes
	Raleigh		
	dc1-adm1 dc1-g1 dc1-s1 dc1-s2 dc1-s3 NetApp-SGA		

2. Verify that all of the grid configuration information is correct. Use the Modify links on the Summary page to go back and correct any errors.

3. Click **Install**.



If a node is configured to use the Client Network, the default gateway for that node switches from the Grid Network to the Client Network when you click **Install**. If you lose connectivity, you must ensure that you are accessing the primary Admin Node through an accessible subnet. See [Networking guidelines](#) for details.

4. Click **Download Recovery Package**.

When the installation progresses to the point where the grid topology is defined, you are prompted to download the Recovery Package file (.zip), and confirm that you can successfully access the contents of this file. You must download the Recovery Package file so that you can recover the StorageGRID system if one or more grid nodes fail. The installation continues in the background, but you cannot complete the installation and access the StorageGRID system until you download and verify this file.

5. Verify that you can extract the contents of the .zip file, and then save it in two safe, secure, and separate locations.



The Recovery Package file must be secured because it contains encryption keys and passwords that can be used to obtain data from the StorageGRID system.

6. Select the **I have successfully downloaded and verified the Recovery Package file** check box, and click **Next**.

Download Recovery Package

Before proceeding, you must download the Recovery Package file. This file is necessary to recover the StorageGRID system if a failure occurs.

When the download completes, open the .zip file and confirm it includes a "gpt-backup" directory and a second .zip file. Then, extract this inner .zip file and confirm you can open the passwords.txt file.

After you have verified the contents, copy the Recovery Package file to two safe, secure, and separate locations. The Recovery Package file must be secured because it contains encryption keys and passwords that can be used to obtain data from the StorageGRID system.

The Recovery Package is required for recovery procedures and must be stored in a secure location.

[Download Recovery Package](#)

I have successfully downloaded and verified the Recovery Package file.

If the installation is still in progress, the status page appears. This page indicates the progress of the installation for each grid node.

Installation Status

If necessary, you may [Download the Recovery Package file](#) again.

Name	Site	Grid Network IPv4 Address	Progress	Stage
dc1-adm1	Site1	172.16.4.215/21	<div style="width: 100%;"><div style="width: 100%;"></div></div>	Starting services
dc1-g1	Site1	172.16.4.216/21	<div style="width: 100%;"><div style="width: 100%;"></div></div>	Complete
dc1-s1	Site1	172.16.4.217/21	<div style="width: 50%;"><div style="width: 50%;"></div></div>	Waiting for Dynamic IP Service peers
dc1-s2	Site1	172.16.4.218/21	<div style="width: 20%;"><div style="width: 20%;"></div></div>	Downloading hotfix from primary Admin if needed
dc1-s3	Site1	172.16.4.219/21	<div style="width: 10%;"><div style="width: 10%;"></div></div>	Downloading hotfix from primary Admin if needed

When the Complete stage is reached for all grid nodes, the sign-in page for the Grid Manager appears.

7. Sign in to the Grid Manager using the "root" user and the password you specified during the installation.

Post-installation guidelines

After completing grid node deployment and configuration, follow these guidelines for DHCP addressing and network configuration changes.

- If DHCP was used to assign IP addresses, configure a DHCP reservation for each IP address on the networks being used.

You can only set up DHCP during the deployment phase. You cannot set up DHCP during configuration.



Nodes reboot when their IP addresses change, which can cause outages if a DHCP address change affects multiple nodes at the same time.

- You must use the Change IP procedures if you want to change IP addresses, subnet masks, and default gateways for a grid node. See [Configure IP addresses](#).
- If you make networking configuration changes, including routing and gateway changes, client connectivity to the primary Admin Node and other grid nodes might be lost. Depending on the networking changes applied, you might need to re-establish these connections.

Automate the installation (Red Hat Enterprise Linux or CentOS)

You can automate the installation of the StorageGRID host service and the configuration of grid nodes.

Automating the deployment might be useful in any of the following cases:

- You already use a standard orchestration framework, such as Ansible, Puppet, or Chef, to deploy and configure physical or virtual hosts.
- You intend to deploy multiple StorageGRID instances.
- You are deploying a large, complex StorageGRID instance.

The StorageGRID host service is installed by a package and driven by configuration files. You can create the configuration files using one of these methods:

- [Create the configuration files](#) interactively during a manual installation.
- Prepare the configuration files ahead of time (or programmatically) to enable automated installation using standard orchestration frameworks, as describe in this article.

StorageGRID provides optional Python scripts for automating the configuration of StorageGRID appliances and the entire StorageGRID system (the “grid”). You can use these scripts directly, or you can inspect them to learn how to use the StorageGRID Installation REST API in grid deployment and configuration tools you develop yourself.

Automate the installation and configuration of the StorageGRID host service

You can automate the installation of the StorageGRID host service using standard orchestration frameworks such as Ansible, Puppet, Chef, Fabric, or SaltStack.

The StorageGRID host service is packaged in an RPM and is driven by configuration files that you can prepare

ahead of time (or programmatically) to enable automated installation. If you already use a standard orchestration framework to install and configure RHEL or CentOS, adding StorageGRID to your playbooks or recipes should be straightforward.

See the example Ansible role and playbook in the `/extras` folder supplied with the installation archive. The Ansible playbook shows how the `storagegrid` role prepares the host and installs StorageGRID onto the target servers. You can customize the role or playbook as necessary.



The example playbook does not include the steps required to create network devices before starting the StorageGRID host service. Add these steps before finalizing and using the playbook.

You can automate all of the steps for preparing the hosts and deploying virtual grid nodes.

Automate the configuration of StorageGRID

After deploying the grid nodes, you can automate the configuration of the StorageGRID system.

What you'll need

- You know the location of the following files from the installation archive.

Filename	Description
<code>configure-storagegrid.py</code>	Python script used to automate the configuration
<code>configure-storagegrid.sample.json</code>	Sample configuration file for use with the script
<code>configure-storagegrid.blank.json</code>	Blank configuration file for use with the script

- You have created a `configure-storagegrid.json` configuration file. To create this file, you can modify the sample configuration file (`configure-storagegrid.sample.json`) or the blank configuration file (`configure-storagegrid.blank.json`).

About this task

You can use the `configure-storagegrid.py` Python script and the `configure-storagegrid.json` configuration file to automate the configuration of your StorageGRID system.



You can also configure the system using the Grid Manager or the Installation API.

Steps

1. Log in to the Linux machine you are using to run the Python script.
2. Change to the directory where you extracted the installation archive.

For example:

```
cd StorageGRID-Webscale-version/platform
```

where `platform` is `debs`, `rpms`, or `vsphere`.

3. Run the Python script and use the configuration file you created.

For example:

```
./configure-storagegrid.py ./configure-storagegrid.json --start-install
```

Result

A Recovery Package .zip file is generated during the configuration process, and it is downloaded to the directory where you are running the installation and configuration process. You must back up the Recovery Package file so that you can recover the StorageGRID system if one or more grid nodes fails. For example, copy it to a secure, backed up network location and to a secure cloud storage location.



The Recovery Package file must be secured because it contains encryption keys and passwords that can be used to obtain data from the StorageGRID system.

If you specified that random passwords should be generated, you need to extract the `Passwords.txt` file and look for the passwords required to access your StorageGRID system.

```
#####  
##### The StorageGRID "recovery package" has been downloaded as: #####  
#####      ./sgws-recovery-package-994078-rev1.zip      #####  
##### Safeguard this file as it will be needed in case of a #####  
#####      StorageGRID node recovery. #####  
#####
```

Your StorageGRID system is installed and configured when a confirmation message is displayed.

```
StorageGRID has been configured and installed.
```

Related information

[Overview of the installation REST API](#)

Overview of the installation REST API

StorageGRID provides the StorageGRID Installation API for performing installation tasks.

The API uses the Swagger open source API platform to provide the API documentation. Swagger allows both developers and non-developers to interact with the API in a user interface that illustrates how the API responds to parameters and options. This documentation assumes that you are familiar with standard web technologies and the JSON (JavaScript Object Notation) data format.



Any API operations you perform using the API Docs webpage are live operations. Be careful not to create, update, or delete configuration data or other data by mistake.

Each REST API command includes the API's URL, an HTTP action, any required or optional URL parameters,

and an expected API response.

StorageGRID Installation API

The StorageGRID Installation API is only available when you are initially configuring your StorageGRID system, and in the event that you need to perform a primary Admin Node recovery. The Installation API can be accessed over HTTPS from the Grid Manager.

To access the API documentation, go to the installation web page on the primary Admin Node and select **Help > API Documentation** from the menu bar.

The StorageGRID Installation API includes the following sections:

- **config** — Operations related to the product release and versions of the API. You can list the product release version and the major versions of the API supported by that release.
- **grid** — Grid-level configuration operations. You can get and update grid settings, including grid details, Grid Network subnets, grid passwords, and NTP and DNS server IP addresses.
- **nodes** — Node-level configuration operations. You can retrieve a list of grid nodes, delete a grid node, configure a grid node, view a grid node, and reset a grid node's configuration.
- **provision** — Provisioning operations. You can start the provisioning operation and view the status of the provisioning operation.
- **recovery** — Primary Admin Node recovery operations. You can reset information, upload the Recover Package, start the recovery, and view the status of the recovery operation.
- **recovery-package** — Operations to download the Recovery Package.
- **schemas** — API schemas for advanced deployments
- **sites** — Site-level configuration operations. You can create, view, delete, and modify a site.

Where to go next

After completing an installation, you must perform a series of integration and configuration steps. Some steps are required; others are optional.

Required tasks

- Create a tenant account for each client protocol (Swift or S3) that will be used to store objects on your StorageGRID system.
- Control system access by configuring groups and user accounts. Optionally, you can configure a federated identity source (such as Active Directory or OpenLDAP), so you can import administration groups and users. Or, you can create local groups and users.
- Integrate and test the S3 or Swift API client applications you will use to upload objects to your StorageGRID system.
- When you are ready, configure the information lifecycle management (ILM) rules and ILM policy you want to use to protect object data.



When you install StorageGRID, the default ILM policy, Baseline 2 Copies Policy, is active. This policy includes the stock ILM rule (Make 2 Copies), and it applies if no other policy has been activated.

- If your installation includes appliance Storage Nodes, use SANtricity software to complete the following tasks:
 - Connect to each StorageGRID appliance.
 - Verify receipt of AutoSupport data.
- If your StorageGRID system includes any Archive Nodes, configure the Archive Node's connection to the target external archival storage system.



If any Archive Nodes will use Tivoli Storage Manager as the external archival storage system, you must also configure Tivoli Storage Manager.

- Review and follow the StorageGRID system hardening guidelines to eliminate security risks.
- Configure email notifications for system alerts.

Optional tasks

- If you want to receive notifications from the (legacy) alarm system, configure mailing lists and email notifications for alarms.
- Update grid node IP addresses if they have changed since you planned your deployment and generated the Recovery Package. See information about changing IP addresses in the recovery and maintenance instructions.
- Configure storage encryption, if required.
- Configure storage compression to reduce the size of stored objects, if required.
- Configure audit client access. You can configure access to the system for auditing purposes through an NFS or a CIFS file share. See the instructions for administering StorageGRID.



Audit export through CIFS/Samba has been deprecated and will be removed in a future StorageGRID release.

Related information

[Administer StorageGRID](#)

[Use S3](#)

[Use Swift](#)

[Manage objects with ILM](#)

[Monitor and troubleshoot](#)

[Recover and maintain](#)

[SG100 and SG1000 services appliances](#)

[SG5600 storage appliances](#)

[SG5700 storage appliances](#)

[SG6000 storage appliances](#)

[Release notes](#)

[System hardening](#)

[Review audit logs](#)

[Upgrade software](#)

Troubleshoot installation issues

If any problems occur while installing your StorageGRID system, you can access the installation log files. Technical support might also need to use the installation log files to resolve issues.

The following installation log files are available from the container that is running each node:

- `/var/local/log/install.log` (found on all grid nodes)
- `/var/local/log/gdu-server.log` (found on the primary Admin Node)

The following installation log files are available from the host:

- `/var/log/storagegrid/daemon.log`
- `/var/log/storagegrid/nodes/node-name.log`

To learn how to access the log files, see the instructions for monitoring and troubleshooting StorageGRID. For help troubleshooting appliance installation issues, see the installation and maintenance instructions for your appliances. If you need additional help, contact technical support.

Related information

[Monitor and troubleshoot](#)

[SG100 and SG1000 services appliances](#)

[SG6000 storage appliances](#)

[SG5700 storage appliances](#)

[SG5600 storage appliances](#)

[NetApp Support](#)

Example `/etc/sysconfig/network-scripts`

You can use the example files to aggregate four Linux physical interfaces into a single LACP bond and then establish three VLAN interfaces subtending the bond for use as StorageGRID Grid, Admin, and Client Network interfaces.

Physical interfaces

Note that the switches at the other ends of the links must also treat the four ports as a single LACP trunk or port channel, and must pass at least the three referenced VLANs with tags.

/etc/sysconfig/network-scripts/ifcfg-ens160

```
TYPE=Ethernet
NAME=ens160
UUID=011b17dd-642a-4bb9-acae-d71f7e6c8720
DEVICE=ens160
ONBOOT=yes
MASTER=bond0
SLAVE=yes
```

/etc/sysconfig/network-scripts/ifcfg-ens192

```
TYPE=Ethernet
NAME=ens192
UUID=e28eb15f-76de-4e5f-9a01-c9200b58d19c
DEVICE=ens192
ONBOOT=yes
MASTER=bond0
SLAVE=yes
```

/etc/sysconfig/network-scripts/ifcfg-ens224

```
TYPE=Ethernet
NAME=ens224
UUID=b0e3d3ef-7472-4cde-902c-ef4f3248044b
DEVICE=ens224
ONBOOT=yes
MASTER=bond0
SLAVE=yes
```

/etc/sysconfig/network-scripts/ifcfg-ens256

```
TYPE=Ethernet
NAME=ens256
UUID=7cf7aabc-3e4b-43d0-809a-1e2378faa4cd
DEVICE=ens256
ONBOOT=yes
MASTER=bond0
SLAVE=yes
```

Bond interface

/etc/sysconfig/network-scripts/ifcfg-bond0

```
DEVICE=bond0
TYPE=Bond
BONDING_MASTER=yes
NAME=bond0
ONBOOT=yes
BONDING_OPTS=mode=802.3ad
```

VLAN interfaces

/etc/sysconfig/network-scripts/ifcfg-bond0.1001

```
VLAN=yes
TYPE=Vlan
DEVICE=bond0.1001
PHYSDEV=bond0
VLAN_ID=1001
REORDER_HDR=0
BOOTPROTO=none
UUID=296435de-8282-413b-8d33-c4dd40fca24a
ONBOOT=yes
```

/etc/sysconfig/network-scripts/ifcfg-bond0.1002

```
VLAN=yes
TYPE=Vlan
DEVICE=bond0.1002
PHYSDEV=bond0
VLAN_ID=1002
REORDER_HDR=0
BOOTPROTO=none
UUID=dbaaec72-0690-491c-973a-57b7dd00c581
ONBOOT=yes
```

/etc/sysconfig/network-scripts/ifcfg-bond0.1003

```
VLAN=yes  
TYPE=Vlan  
DEVICE=bond0.1003  
PHYSDEV=bond0  
VLAN_ID=1003  
REORDER_HDR=0  
BOOTPROTO=none  
UUID=d1af4b30-32f5-40b4-8bb9-71a2fbf809a1  
ONBOOT=yes
```

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