StorageGRID® Webscale 10.4

Appliance Installation and Maintenance Guide

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NetApp®

Contents

Safety notices

When you install the StorageGRID Webscale appliance, you must be aware of specific safety warnings that apply to the task. For additional warnings, see the printed Safety Notices document.

Warning: Risk of electrical shock - Before removing or installing a power supply, turn off the power switch and unplug the power cord.

Warning: Risk of bodily injury - Each tray has more than one power cord. To remove all electrical current from the devices, make sure that all of the power cords are disconnected from the power source.

Warning: Risk of bodily injury - Do not use equipment in the cabinet as a shelf or work space.

Warning: Risk of exposure to laser radiation - Do not disassemble or remove any part of an SFP transceiver because you might be exposed to laser radiation.

The following warning applies to the SG5612 only.

Warning: Risk of bodily injury - Two people or a mechanical lift are required to lift the component safely.

The following warnings apply to the SG5660 only.

Warning: Risk of bodily injury - Four people or a mechanical lift are required to lift the component safely.

Attention: Risk of equipment damage – If you want to move the SG5660 to a new location, you must remove all of the drives from the enclosure. Never move or ship the SG5660 with drives installed.

For additional warnings, refer to the printed Safety Notices document.

StorageGRID Webscale appliance overview

The StorageGRID Webscale appliance is an integrated storage and computing platform that operates as a Storage Node in a StorageGRID Webscale system. Housed in a DE1600 enclosure or DE6600 enclosure, the appliance includes the E5600SG controller, the E2700 controller, drives, fans, and power supplies.

The StorageGRID Webscale appliance includes the following components:

Component	Description
E5600SG controller	Compute server The E5600SG controller runs the Linux operating system and the StorageGRID Webscale software. This controller connects to the following: • The Admin, Grid, and Client networks for the StorageGRID Webscale system • The E2700 controller, using dual SAS paths (active/active) with the E5600SG controller operating as the initiator
E2700 controller	Storage controller The E2700 controller operates as a standard E-Series storage array in simplex mode, and runs the SANtricity operating system (controller firmware). This controller connects to the following: • The management network where SANtricity Storage Manager software is installed • The E5600SG controller, using dual SAS paths (active/active) with the E2700 controller operating as the target

The StorageGRID Webscale appliance also includes the following components, depending upon the appliance model:

Component	Model SG5612	Model SG5660
Drives	12 NL-SAS drives	60 NL-SAS drives
Enclosure	DE1600 enclosure, a two rack-unit (2U) chassis that houses the drives and the controllers	DE6600 enclosure, a four rack-unit (4U) chassis that houses the drives and the controllers
Power supplies and fans	Two power-fan canisters	Two power supplies and two fans

Note: The maximum raw storage available on each StorageGRID Webscale appliance Storage Node is fixed, based on the appliance model and configuration. You cannot expand the available storage by adding a shelf with additional drives.

All E-Series components operate as documented in the E-Series technical documents except as indicated in this guide. For details, see the E-Series documentation.

Note: The E5600SG controller is highly customized for StorageGRID Webscale, so some of the E-Series maintenance procedures might not apply (for example, the procedure for upgrading

controller firmware). For more information, see “Maintaining your StorageGRID Webscale appliance” in this guide.

Related tasks

Maintaining your StorageGRID Webscale appliance on page 46

Related information

NetApp Documentation: E2700 Series
NetApp Documentation: E5600 Series

StorageGRID Webscale appliance features

The StorageGRID Webscale appliance provides an integrated storage solution for creating a new StorageGRID Webscale system or for expanding the capacity of an existing system.

The StorageGRID Webscale appliance provides the following features:

- Combines the StorageGRID Webscale Storage Node computing and storage elements into a single, efficient, integrated solution
- Simplifies the installation and configuration of a Storage Node, automating most of the process required
- Provides a high-density storage solution with two enclosure options: one that is 2U and one that is 4U
- Uses 10-GbE IP interfaces directly to the Storage Node, without the need for intermediate storage interfaces such as FC or iSCSI
- Can be used in a hybrid grid environment that uses StorageGRID Webscale appliances and virtual (software-based) Storage Nodes
- Includes preconfigured storage and comes preloaded with the StorageGRID Webscale Appliance Installer (on the E5600SG controller) for field-ready software deployment and integration

Hardware diagrams

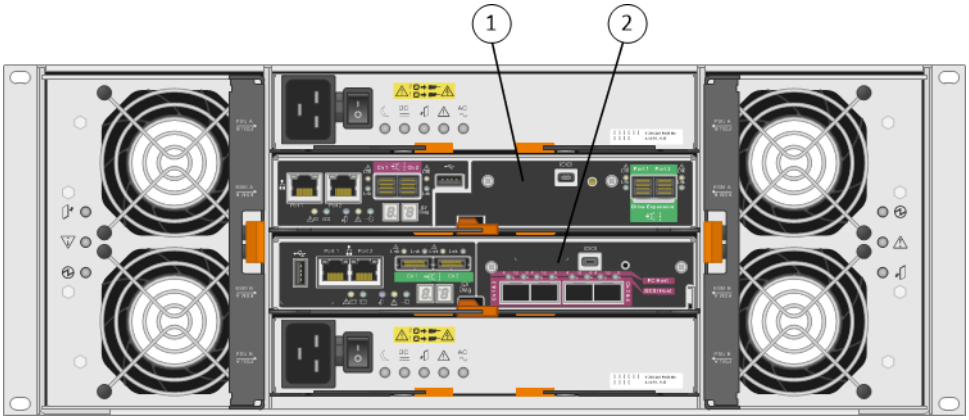
The SG5612 and SG5660 models of the StorageGRID Webscale appliance both include an E2700 controller and an E5600SG controller. You should review the diagrams to learn the differences between the models and the controllers.

Model SG5612 2U: Rear view of the E2700 controller and E5600SG controller

1	E2700 controller
2	E5600SG controller

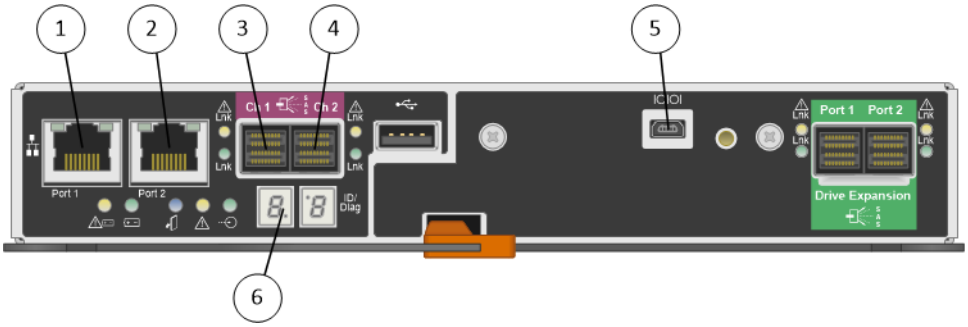
Model SG5660 4U: Rear view of the E2700 controller and E5600SG controller

The E2700 controller is above the E5600SG controller.



1	E2700 controller
2	E5600SG controller

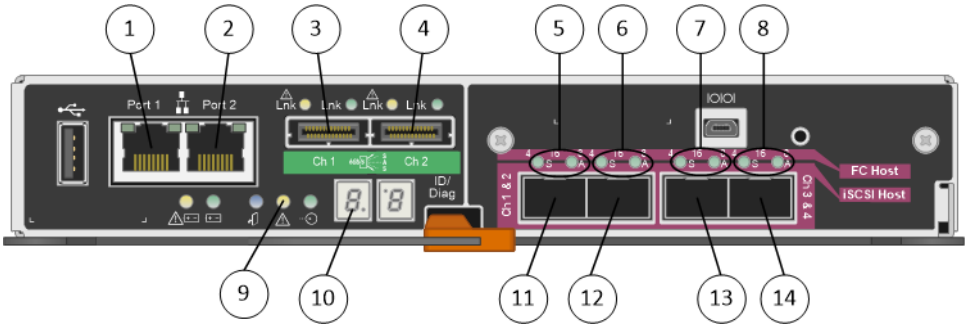
Rear view of the E2700 controller



1	Management port 1 (connects to the network where SANtricity Storage Manager is installed)
2	Management port 2 (used during installation to connect to a laptop)
3	SAS interconnect port 1
4	SAS interconnect port 2
5	Serial connection port
6	Seven-segment display

Note: The two SAS ports labeled Drive Expansion (green) on the rear of the E2700 controller are not used. The StorageGRID Webscale appliance does not support expansion drive shelves.

Rear view of the E5600SG controller



1	Management port 1 (connects to the Admin network for StorageGRID Webscale)
2	Management port 2 (used during installation to connect to a laptop)
3	SAS interconnect port 1
4	SAS interconnect port 2
5	Fault and Active LEDs for 10-GbE network port 1
6	Fault and Active LEDs for 10-GbE network port 2
7	Fault and Active LEDs for 10-GbE network port 3
8	Fault and Active LEDs for 10-GbE network port 4
9	Needs Attention LED
10	Seven-segment display
11	10-GbE network port 1
12	10-GbE network port 2
13	10-GbE network port 3
14	10-GbE network port 4

Note: The host interface card (HIC) on the StorageGRID Webscale appliance E5600SG controller supports only 10-Gb Ethernet connections. It cannot be used for iSCSI connections.

Planning your deployment

Planning your deployment involves checking the contents of the boxes, preparing the site, and ensuring that your systems meet the minimum resource requirements. Using a Deployment Data worksheet, you should also gather your site-specific deployment data.

Steps

1. Review the content of the boxes and ensure that you identify all components.
2. Verify that you have access to a service laptop with the installation requirements.
3. Prepare the site for the hardware installation.
4. Gather data for deploying the StorageGRID Webscale appliance.

Related tasks

Preparing the site on page 15
Gathering data for deploying StorageGRID Webscale appliance on page 17

Related references

StorageGRID Webscale appliance components on page 10
Service laptop requirements on page 12
StorageGRID Webscale appliance connections on page 15

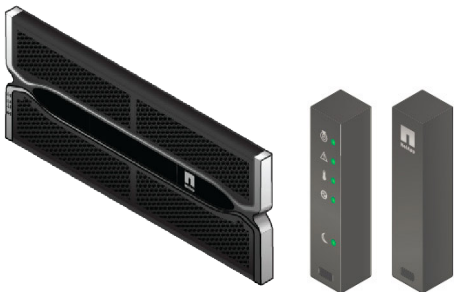
StorageGRID Webscale appliance components

Before installing the StorageGRID Webscale appliance, you should verify that the appliance boxes contain all required components and that you have additional tools required to install and manage them.

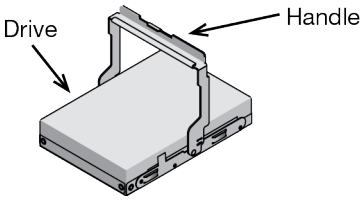
Hardware

The StorageGRID Webscale appliance includes the following hardware components:

 SG5660 enclosure, a 4U chassis with 60 drives	 SG5612 enclosure, a 2U chassis with 12 drives



4U bezel or 2U endcaps

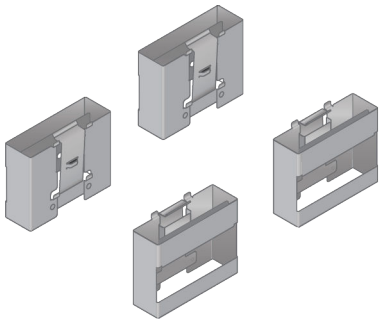


NL-SAS drives. Drives are preinstalled in the 2U SG5612, but not in the 4U SG5660 for shipment safety.

The E5600SG controller might need to be installed in the enclosure.

The E2700 controller is preinstalled inside the enclosure.

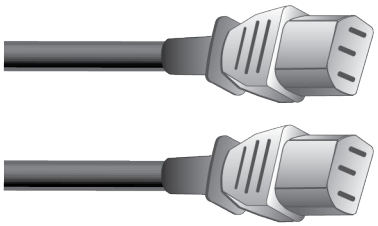
Mounting rails and screws



Enclosure handles (4U enclosures only)

Cables and connectors

The StorageGRID Webscale appliance includes the following cables and connectors:



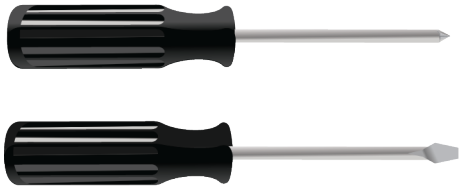
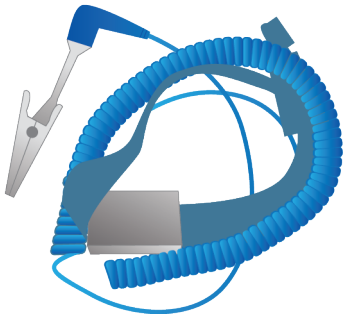
The appliance ships with two AC power cords for connecting to an external power source, such as a wall plug. Your cabinet might have special power cords that you use instead of the power cords that ship with the appliance.

Two 0.5-meter SAS interconnect cables with mini-SAS-HD and mini-SAS connectors.

The square connector plugs into the E2700 controller, and the rectangular connector plugs into the E5600SG controller.

Additional equipment you need

You need the following additional equipment for management and setup:

 Phillips No. 2 and medium flat-blade screwdrivers	 ESD wrist strap
 Ethernet cables	 Ethernet switch
 Management station service laptop	

Service laptop requirements

Before you install the StorageGRID Webscale appliance hardware, you should check to see if the service laptop has the minimum required resources.

The service laptop, which is needed for the hardware installation, must meet the following requirements:

- Microsoft Windows operating system
- Network port
- Supported web browser

  Note: If you plan to use Internet Explorer 11, you must disable webpage caching.

- NetApp SANtricity Storage Manager version 11.30 or later
- SSH client (for example, PuTTY)

Related tasks

Disabling webpage caching in Internet Explorer 11 on page 13

Related references

Web browser requirements on page 13

Related information

NetApp Documentation: SANtricity Storage Manager

Web browser requirements

You must use a supported web browser.

Web browser	Minimum supported version
Google Chrome	54
Microsoft Internet Explorer	11 (Native Mode)
Mozilla Firefox	50

You should set the browser window to a recommended width.

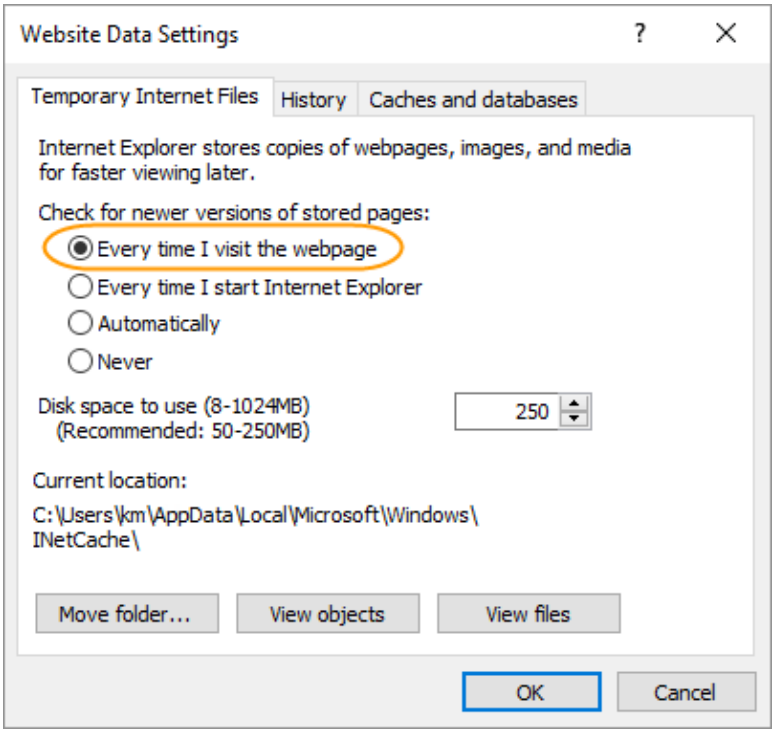
Browser width	Pixels
Minimum	1024
Optimum	1280

Disabling webpage caching in Internet Explorer 11

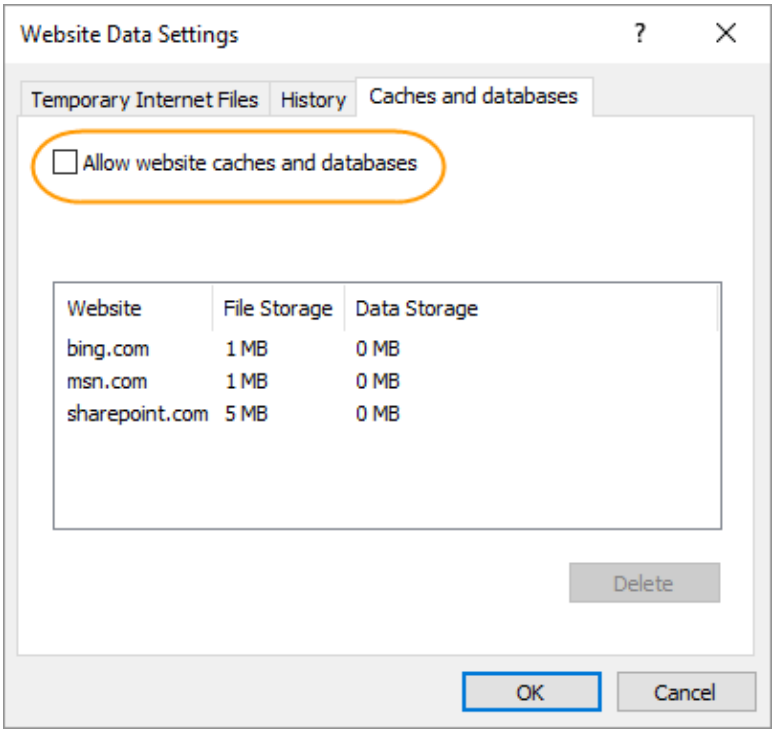
The StorageGRID Webscale Installer web page might appear to function incorrectly if you use webpage caching in Internet Explorer 11. You must disable caching if you want to use this browser to access the Installer web page.

Steps

1. From the top right corner of Internet Explorer 11, click the Gear icon .
2. From the menu, select **Internet options**.
3. On the **General** tab, locate the **Browsing history** section, and click **Settings**.
4. On the **Temporary Internet Files** tab, confirm that **Every time I visit the webpage** is selected.



5. On the **Caches and databases** tab, confirm that **Allow website caches and databases** is not selected.



6. Click **OK**.

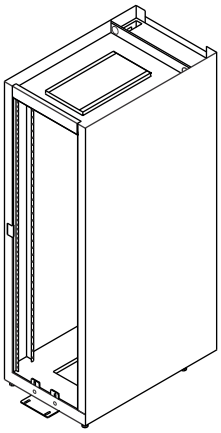
Preparing the site

Installing the controllers and drive trays into the cabinet requires some preparation.

About this task

You must do the following to prepare the site:

- Prepare the site for the cabinet and its requirements: for example, temperature, humidity, altitude range, airflow, heat dissipation, wiring, power, and grounding.
- Prepare the network for the controllers.
- Ensure that the cabinet in which the appliance will be mounted meets the installation site specifications for E-Series storage arrays.



For details, see the *E-Series Site Preparation Guide*.

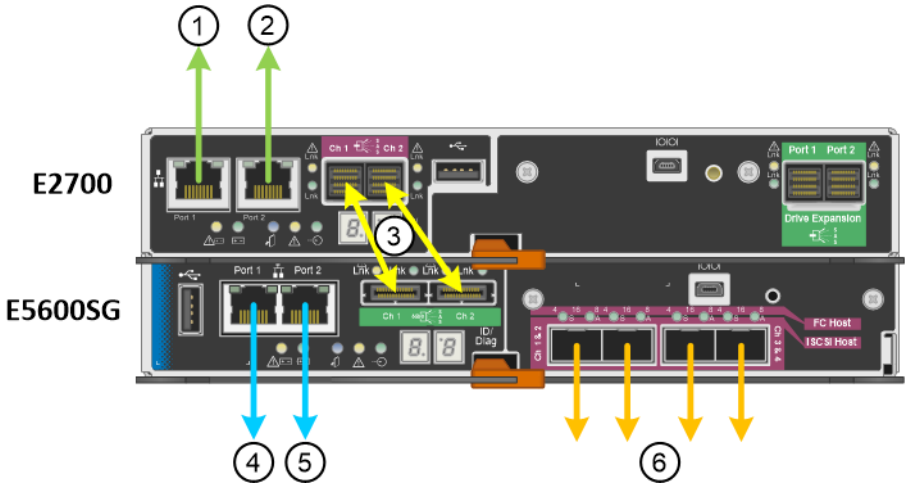
Related information

E-Series Site Preparation Guide

StorageGRID Webscale appliance connections

Before installing the StorageGRID Webscale appliance, make sure you understand how the controller ports are used.

The controllers in the StorageGRID Webscale appliance include the following ports. The diagram shows the SG5660 model; the controllers in the SG5612 model are side by side instead of stacked.



Item	Port	Type of port	Function
1	Management port 1 on the E2700 controller	1-Gb (RJ-45) Ethernet	Connects the E2700 controller to the network where SANtricity Storage Manager is installed.
2	Management port 2 on the E2700 controller	1-Gb (RJ-45) Ethernet	Connects the E2700 controller to a service laptop during installation.
3	Two SAS interconnect ports on each controller, labelled Ch 1 and Ch 2	E2700 controller: mini-SAS-HD E5600SG controller: mini-SAS	Connect the two controllers to each other.
4	Management port 1 on the E5600SG controller	1-Gb (RJ-45) Ethernet	Connects the E5600SG controller to the Admin network for StorageGRID Webscale.
5	Management port 2 on the E5600SG controller	1-Gb (RJ-45) Ethernet	Connects the E5600SG controller to a service laptop during installation.
6	Four network ports on the E5600SG controller	10-GbE (optical)	Connect the E5600SG controller to the Grid network and to the Client network (if used) for StorageGRID Webscale. The ports can be bonded together to provide redundant paths to the controller.

Connections for the 10-GbE ports on the E5600SG controller

The four network ports on the E5600SG controller are bonded together to provide redundant paths to the controller, as follows:

- **Fixed Port Configuration (default)** – Ports 2 and 4 control the Grid network, and ports 1 and 3 control the Client network, if enabled. The ports can be bonded in active-backup mode or in Link Aggregation Control Protocol mode (LACP IEEE 802.3ad).
    - In active-backup mode (default), only one port is active at a time. If the active port fails, its backup port automatically provides a failover connection. When you use fixed port configuration, port 4 provides a backup path for port 2 (Grid network), and port 3 provides a backup path for port 1 (Client network).

    - In LACP mode, each pair of ports forms a logical channel between the controller and the network, allowing for higher throughput. If one port fails, the other port provides a failover connection. LACP mode requires version 1.7 or later of the StorageGRID Webscale Appliance Installer.

- **Aggregate Port Configuration** – Starting with version 1.7 of the StorageGRID Webscale Appliance Installer, you can specify that all four ports be grouped in a single LACP bond, allowing all ports to be used for Grid network and Client network traffic. Aggregate Port Configuration significantly increases the throughout for each network and provides additional failover paths. When using Aggregate Port Configuration, you must specify a unique VLAN ID for each network. This VLAN ID will be added to each network packet to ensure that network traffic is routed to the correct network.

For more information on configuring these ports, see the instructions for cabling the appliance and the appropriate *StorageGRID Webscale Software Installation Guide*.

Related tasks

Gathering data for deploying StorageGRID Webscale appliance on page 17
Cabling the appliance on page 23

Related information

StorageGRID Webscale 10.4 Software Installation Guide for VMware Deployments
StorageGRID Webscale 10.4 Software Installation Guide for OpenStack Deployments
StorageGRID Webscale 10.4 Software Installation Guide for Red Hat Enterprise Linux Deployments

Gathering data for deploying StorageGRID Webscale appliance

Before deploying the StorageGRID Webscale appliance, you must gather information about Ethernet switch ports and IP addresses.

About this task

Refer to *StorageGRID Webscale appliance connections* on page 15, and use the following worksheet to collect the information from your administrator.

Information needed	Your value
Specify the Ethernet switch port you will connect to management port 1 on the E2700 controller (used to access the management network for SANtricity Storage Manager)	Switch port for management port 1 on E2700 controller:
Specify the Ethernet switch port you will connect to management port 1 on the E5600SG controller (used to access the Admin network for StorageGRID Webscale)	Switch port for management port 1 on E5600SG controller:

Information needed	Your value
MAC addresses or IP addresses for management ports • If the management network (or networks) includes a DHCP server, enter the MAC address from the labels next to management port 1 on the back of each controller. The network administrator can use the MAC address to determine what IP address was assigned by the DHCP server. (For some E5600SG controllers, the DHCP-assigned IP address is displayed on the seven-segment display after you apply power.) • If you do not use DHCP, enter the static IP address that you plan to use for these ports on your network.	Address for management port 1 on E2700 controller: Address for management port 1 on E5600SG controller:
Specify the switch ports you will connect to the four 10-GbE optical ports on the E5600SG controller. **Note:** If you plan to use Fixed Port Configuration, ports 2 and 4 connect to the Grid network for StorageGRID Webscale, and ports 1 and 3 connect to the Client network for StorageGRID Webscale. If you plan to use Aggregate Port Configuration, see information about StorageGRID Webscale appliance connections and cabling the appliance.	Switch port for Port 2: Switch port for Port 4: Switch port for Port 1: Switch port for Port 3:
Specify the IP address of the Grid network interface for StorageGRID Webscale. **Note:** This information might not be available at the time you are performing the hardware phase of the installation.	Grid network IP address:
Specify the IP address of the Client network interface for StorageGRID Webscale. **Note:** This information might not be available at the time you are performing the hardware phase of the installation.	Client network IP address:

Related tasks

Cabling the appliance on page 23

Related references

StorageGRID Webscale appliance connections on page 15

Installation overview

Typically, installation is performed in two phases: the hardware installation in the data center and, later, the software installation.

Hardware installation

The hardware installation occurs before the software installation, even months before, and someone other than the software installer can perform it. Installation of the physical components requires the following:

- Physical access to the StorageGRID Webscale appliance hardware
- Knowledge of the IP address for the network where SANtricity Storage Manager is installed
- Knowledge of the IP address for the Admin network for StorageGRID Webscale

Software installation

The software installation occurs after the hardware installation. Installation of the software requires knowledge about the following:

- StorageGRID Webscale software
- Grid network IP addresses
- Client network IP addresses, if used

For details, see StorageGRID Webscale software installation instructions.

Related information

StorageGRID Webscale 10.4 Software Installation Guide for VMware Deployments
StorageGRID Webscale 10.4 Software Installation Guide for OpenStack Deployments
StorageGRID Webscale 10.4 Software Installation Guide for Red Hat Enterprise Linux Deployments

Installing the appliance hardware

Hardware installation includes several major tasks, including installing hardware components, cabling those components, and configuring ports.

Steps

Registering the hardware

Registering the hardware provides support benefits.

Steps

1. Go to the NetApp Support Site at *mysupport.netapp.com*.
2. Log in to your existing NetApp Support Site account or create an account.
   - If you already have a registered account, you can log in to it and add the StorageGRID Webscale appliance to your existing account.
   - If you are a new customer, click **Register Now**, located at the top of the Support Site.
3. Select **Products > Register Products**.

   A product registration page opens.
4. Enter the product serial number, and click **Submit**.

   You can find the serial number on the packing slip, in your confirmation email, or on the appliance itself.

5. On the product details page, enter the requested details, and click **Submit** to complete your product registration.

Installing the hardware

Installing the hardware involves installing the mounting rails, enclosure, and, for the SG5660, the drives.

Before you begin

Installation of the StorageGRID Webscale appliance hardware is similar to the installation of the E2700 and E5600 E-Series storage systems.

You have the following documents:

- *NetApp E-Series Storage Systems E2700 Controller-Drive Tray and Related Drive Trays Installation Guide*
- *NetApp E-Series Storage Systems E5600 Controller-Drive Tray and Related Drive Trays Installation Guide*

About this task

Warning: Risk of electrical shock - Before removing or installing a power supply, turn off the power switch and unplug the power cord.

Warning: Risk of bodily injury - Each tray has more than one power cord. To remove all electrical current from the devices, make sure that all of the power cords are disconnected from the power source.

Warning: Risk of bodily injury - Do not use equipment in the cabinet as a shelf or work space.

Warning: Risk of exposure to laser radiation - Do not disassemble or remove any part of an SFP transceiver because you might be exposed to laser radiation.

The following warning applies to the SG5612 only.

Warning: Risk of bodily injury - Two people or a mechanical lift are required to lift the component safely.

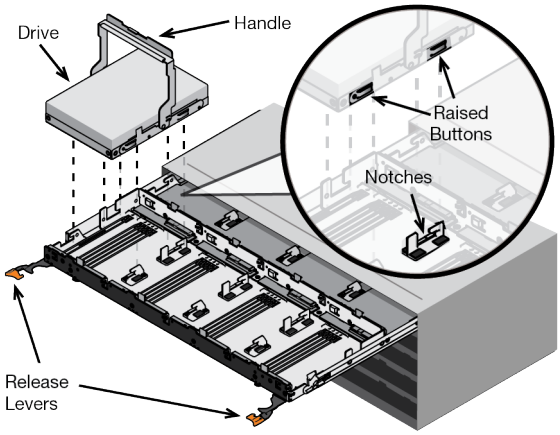
The following warning applies to the SG5660 only.

Warning: Risk of bodily injury - Four people or a mechanical lift are required to lift the component safely.

Attention: Risk of equipment damage – If you want to move the SG5660 to a new location, you must remove all of the drives from the enclosure. Never move or ship the SG5660 with drives installed.

For additional warnings, refer to the printed Safety Notices document.

Task	Description
Install the mounting rails	Install the mounting rails into the cabinet.

Task	Description
Install enclosure in rack	Install the DE1600 enclosure or DE6600 enclosure in the rack. If you are lifting the DE6600 enclosure by hand, attach the four enclosure handles for easier lifting. You can remove these handles later.
Install drives in drive drawer	For the SG5660 model, install the drives in the DE6600 enclosure drive drawer. 

Related information

E2700 Controller-Drive Tray and Related Drive Trays Installation Guide
E5600 Controller-Drive Tray and Related Drive Trays Installation Guide

Installing the E5600SG controller in the enclosure

If the E5600SG controller is not installed when you receive the enclosure, you might need to install it into Slot B.

About this task

You can skip this procedure if the E5600SG controller is already installed in the enclosure.

Steps

1. Remove the insert that was placed in Slot B for shipment.

   In the SG5660 enclosure, Slot B is the bottom slot. In the SG5612 enclosure, Slot B is the slot on the right.

2. Install the E5600SG controller into Slot B.

After you finish

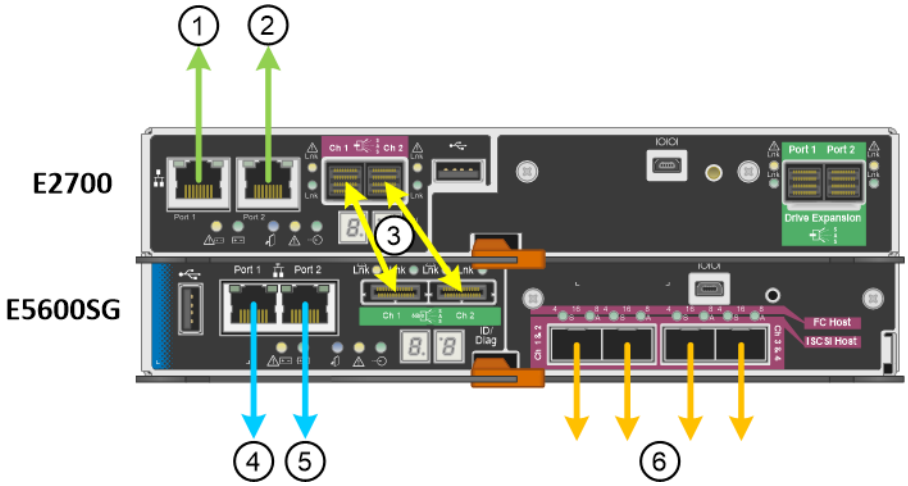
Continue with cabling the appliance.

Cabling the appliance

You must connect the two controllers to each other with SAS interconnect cables, connect the management ports to the appropriate management network, and connect the 10 GbE ports on the E5600SG controller to the Grid network and optional Client network for StorageGRID Webscale.

About this task

When connecting the cables, refer to the following diagram, which shows the E2700 controller on the top and the E5600SG controller on the bottom. The diagram shows the SG5660 model; the controllers in the SG5612 model are side by side instead of stacked.



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3	Two SAS interconnect ports on each controller, labelled Ch 1 and Ch 2	E2700 controller: mini-SAS-HD E5600SG controller: mini-SAS	Connect the two controllers to each other.
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5	Management port 2 on the E5600SG controller	1-Gb (RJ-45) Ethernet	Connects the E5600SG controller to a service laptop during installation.
6	Four network ports on the E5600SG controller	10-GbE (optical)	Connect the E5600SG controller to the Grid network and to the Client network (if used) for StorageGRID Webscale. The ports can be bonded together to provide redundant paths to the controller.

When connecting the 10-GbE network ports on the E5600SG controller, note that version 1.7 and later of the StorageGRID Webscale Appliance Installer supports two configurations for these ports, as follows:

- In the **Fixed Port Configuration**, ports 2 and 4 are bonded together for the Grid network, and ports 1 and 3 are bonded together for the Client network, if used. The ports can be bonded using active-backup mode or Link Aggregation Control Protocol mode (LACP IEEE 802.3ad).
- In the optional **Aggregated Port Configuration**, all four ports are grouped together in a single LACP bond, and all ports are used for both Grid network and Client network traffic. If you plan to use Aggregated Port Configuration:
  - You must be using version 1.7 or later of the StorageGRID Webscale Appliance Installer.

    Note: You cannot determine which version of the StorageGRID Webscale Appliance Installer is included with the appliance until you configure the E5600SG controller management port. If you discover that you need to upgrade the StorageGRID WebscaleAppliance Installer to version 1.7, you must contact technical support.

  - The ports must be connected to switches that can support VLAN, LACP, or multi-chassis link aggregation groups (MLAG), or equivalent, if multiple switches are participating in the LACP bond.
  - You must understand how to configure the switches to use VLAN, LACP, or MLAG, or equivalent, if multiple switches are participating in the LACP bond.

For more information, see the appropriate *StorageGRID Webscale Installation Guide*.

Steps

1. Connect the E2700 controller to the E5600SG controller, using the two SAS interconnect cables.

Connect this port...	To this port...
SAS interconnect port 1 (labeled Ch 1) on the E2700 controller	SAS interconnect port 1 (labeled Ch 1) on the E5600SG controller
SAS interconnect port 2 (labeled Ch 2) on the E2700 controller	SAS interconnect port 2 (labeled Ch 2) on the E5600SG controller

   Use the square connector (mini-SAS HD) for the E2700 controller, and use the rectangular connector (mini-SAS) for the E5600SG controller.

   Attention: Make sure the pull tabs on the SAS connectors are at the bottom, and carefully insert each connector until it clicks into place. Do not push on the connector if there is any resistance. Verify the position of the pull tab before continuing.

2. Connect the E2700 controller to the management network where SANtricity Storage Manager software is installed, using an Ethernet cable.

Connect this port...	To this port...
Port 1 on the E2700 controller (the RJ-45 port on the left)	Switch port on the management network used for SANtricity Storage Manager
Port 2 on the E2700 controller	Service laptop, if not using DHCP

3. Connect the E5600SG controller to the Admin network for StorageGRID Webscale, using an Ethernet cable.

Connect this port...	To this port...
Port 1 on the E5600SG controller (the RJ-45 port on the left)	Switch port on the Admin network for StorageGRID Webscale
Port 2 on the E5600SG controller	Service laptop, if not using DHCP

4. Using 10-GbE optical cables and SFP transceivers as required, connect the 10-GbE optical ports on the E5600SG controller to the appropriate switch ports.

   - If you plan to use the Fixed Port Configuration, or if the E5600SG controller includes version 1.6 or earlier of the StorageGRID Webscale Appliance Installer, connect the ports as shown in the table.

Connect this port....	To this port...
E5600SG controller Port 1	Switch port on Client network for StorageGRID Webscale (optional)
E5600SG controller Port 2	Switch port on Grid network for StorageGRID Webscale
E5600SG controller Port 3	Switch port on Client network for StorageGRID Webscale (optional)
E5600SG controller Port 4	Switch port on Grid network for StorageGRID Webscale

     If you have version 1.7 or later of the StorageGRID Webscale Appliance Installer, you can specify how the ports should be bonded (either active-backup mode or LACP (802.3ad) mode) when you configure the appliance. You can also optionally specify VLAN IDs for each network.

   - If you plan to use the Aggregate Port Configuration, connect all four ports to one or more switches. When you configure the appliance with the StorageGRID Webscale Appliance Installer, you must specify VLAN IDs for the Grid network and the Client network. See your switch documentation for more instructions.

     Warning: Risk of exposure to laser radiation – Do not disassemble or remove any part of an SFP transceiver because you might be exposed to laser radiation.

Related tasks

Configuring the E5600SG controller management port on page 34

Related information

StorageGRID Webscale 10.4 Software Installation Guide for VMware Deployments
StorageGRID Webscale 10.4 Software Installation Guide for OpenStack Deployments
StorageGRID Webscale 10.4 Software Installation Guide for Red Hat Enterprise Linux Deployments

Connecting the AC power cords

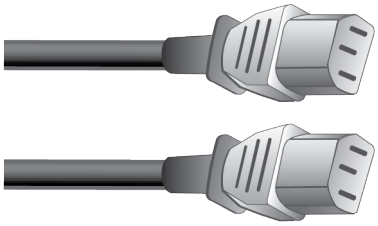
You must connect the AC power cords to the external power source and to the AC power connector on each controller. After you have connected the power cords, you can turn the power on.

About this task

Consider the following power source issues:

- You should use separate power sources for each power supply.
  Connecting to independent power sources maintains power redundancy.
- You can use the power cords shipped with the controller with typical outlets used in the destination country, such as wall receptacles of an uninterrupted power supply (UPS).
  However, these power cords are not intended for use in most EIA-compliant cabinets.

The following illustration shows the power cords:



Warning: Risk of bodily injury. To remove all electrical current from the devices, make sure that all of the power cords are disconnected from the power source.

Steps

1. Turn off the power switches in the enclosure or chassis.
2. Turn off the power switches on the controllers.
3. Connect the primary power cords from the cabinet to the external power sources.
4. Connect the power cords to the AC power connector on each controller.

Turning power on

Powering on the enclosure provides power to both controllers.

Steps

1. Turn on the two power supply switches at the rear of the enclosure.

   While the power is being applied, the LEDs on the controllers go on and off intermittently.

   The power-on process can take up to ten minutes to complete. The controllers reboot several times during the initial startup sequence, which causes the fans to ramp up and down and the LEDs to flash.
2. Check the Power LED and the Host Link Active LEDs on each controller to verify that the power was turned on.
3. Wait for all drives to show a persistent green LED, indicating that they have come online.
4. Check for green LEDs on the front and rear of the enclosure.

   If you see any amber LEDs, make a note of their locations.
5. Look at the seven-segment display for the E5600SG controller.

- If version 1.6 or later of the StorageGRID Webscale Appliance Installer is included with the controller, this display shows **HO**, followed by a repeating sequence of two digits.

  ```
  HO -- IP address for Admin network -- IP address for Grid network
  HO
  ```

  In the sequence, the first set of numbers is the DHCP-assigned IP address for the controller's management port 1. This address is used to connect the controller to the Admin network for StorageGRID Webscale. The second set of numbers is the DHCP-assigned IP address used to connect the appliance to the Grid network for StorageGRID Webscale.

  Note: If an IP address could not be assigned using DHCP, 0.0.0.0 is displayed.

- If version 1.3 of the StorageGRID Webscale Appliance Installer is included with the controller, this display shows **IM**.

  Note: DHCP IP addresses are not supported by version 1.3 of the StorageGRID Webscale Appliance Installer.

Viewing boot-up status and reviewing error codes on the controllers

The seven-segment display on each controller shows status and error codes when the appliance powers up, while the hardware is initializing, and when the hardware fails and must back out of the initialization. If you are monitoring the progress or troubleshooting, you should watch the sequence of the codes as they appear.

About this task

The status and error codes for the E5600SG controller are not the same as those for the E2700 controller.

Steps

1. During boot-up, view the codes shown on the seven-segment displays to monitor progress.
2. To review error codes for the E5600SG controller, see the seven-segment display status and error code information.
3. To review error codes for the E2700 controller, see the E2700 controller documentation on the Support Site.

Related references

E5600SG controller seven-segment display codes on page 27

Related information

NetApp Documentation: E2700 Series

E5600SG controller seven-segment display codes

The seven-segment display on the E5600SG controller shows status and error codes while the appliance powers up and while the hardware is initializing. You can use these codes to determine status and troubleshoot errors.

When reviewing status and error codes on the E5600SG controller, you should look at the following types of codes:

General boot-up codes

Represent the standard boot-up events.

Normal boot-up codes

Represent the normal boot-up events that occur in the appliance.

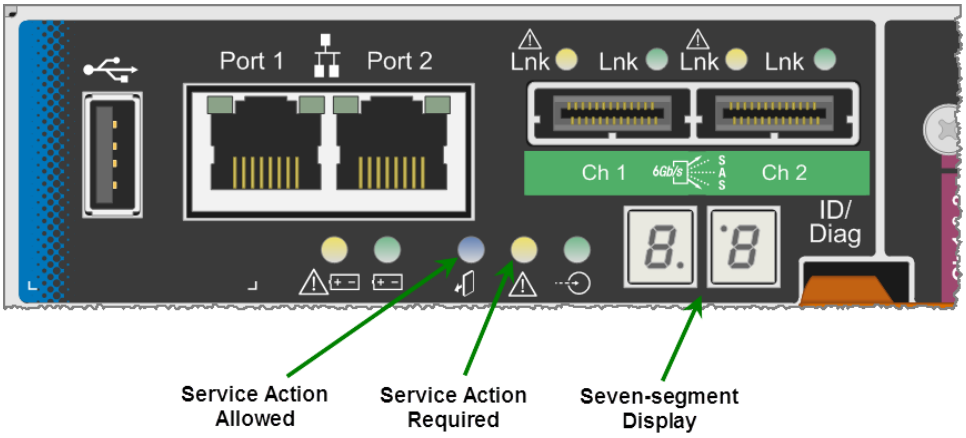
Error codes

Indicate issues during the boot-up events.

The codes that appear differ depending on the installation version. You can determine the installation version by referring to *Determining the StorageGRID Webscale Appliance Installer version* on page 44.

StorageGRID Webscale controls only the following LEDs on the E5600SG controller and only after the StorageGRID Webscale Appliance Installer has started:

- Service Action Allowed LED
- Service Action Required LED
- Seven-segment display



The decimal points on the seven-segment display are not used by the StorageGRID Webscale appliance:

- The upper decimal point adjacent to the least significant digit is the platform diagnostic LED. This is turned on during reset and initial hardware configuration. Otherwise, it is turned off.
- The lower decimal point adjacent to the most significant digit is turned off.

To diagnose other issues, you might want to look at these resources:

- To see all other hardware and environmental diagnostic information, see the E-Series operating system hardware diagnostics.
  This includes looking for hardware issues such as power, temperature, and disk drives. The appliance relies on the E-Series operating system to monitor all platform environmental statuses.
- To determine firmware and driver issues, look at the link lights on the SAS and network ports. For details, see the E-Series E5600 documentation.

General boot-up codes

During boot-up or after a hard reset of the hardware, the Service Action Allowed and the Service Action Required LEDs come on while the hardware is initializing. The seven-segment display shows a sequence of codes that are the same for E-Series hardware and not specific to the E5600SG controller.

During boot-up, the Field Programmable Gate Array (FPGA) controls the functions and initialization on the hardware.

Code	Indication
19	FPGA initialization.
68	FPGA initialization.
...	FPGA initialization. This is a quick succession of codes.
AA	Platform BIOS booting.
FF	Bios boot-up complete. This is an intermediate state before E5600SG controller initializes and manages LEDs to indicate status.

After the AA and FF codes appear, either the normal boot-up codes appear or error codes appear. Additionally, the Service Action Allowed and the Service Action Required LEDs are turned off.

Normal boot-up codes

These codes represent the normal boot-up events that occur in the appliance, in chronological order.

Code, if version is 1.4 or earlier	Code, if version is 1.5 or later	Indication
MB	HI	The master boot script has started.
PP	PP	The platform FPGA firmware is checking for updates.
HP	HP	The host interface card (HIC) is checking for updates.
RB	RB	After firmware updates, the system is rebooting, if necessary.
FP	FP	The firmware update checks have been completed. Starting the process (utmagent) to communicate with and manage the E2700 controller. This process facilitates appliance provisioning.
SE	HE	The system is synchronizing with the E-Series operating system.
SI	HC	The StorageGRID Webscale installation is being checked.
IM	HO	Installation management and active interfacing are occurring.
SG	HA	The Linux operating system and StorageGRID Webscale are running.

Error codes

These codes represent error conditions that might be shown on the E5600SG controller as the appliance boots up. Additional two-digit hexadecimal codes are displayed if specific low-level hardware errors occur. If any of these codes persists for more than a second or two, or if you are unable to resolve the error by following one of the prescribed troubleshooting procedures, contact technical support.

Code, if version is 1.4 or earlier	Code, if version is 1.5 or later	Indication
22	22	No master boot record found on any boot device.
23	23	No SATA drive installed.
2A, 2B	2A, 2B	Stuck bus, unable to read DIMM SPD data.
40	40	Invalid DIMMs.
41	41	Invalid DIMMs.
42	42	Memory test failed.
51	51	SPD reading failure.
92 to 96	92 to 96	PCI bus initialization.
A0 to A3	A0 to A3	SATA drive initialization.
AB	AB	Alternate boot code.
AE	AE	Booting OS.
EA	EA	DDR3 training failed.
E8	E8	No memory installed.
EI	EU	The installation script was not found.
EM	EP	"ManageSGA" code indicates that pregrid communication with the E2700 controller failed.

Related references

Troubleshooting the hardware installation on page 41

Related information

E5600 Controller-Drive Tray and Related Drive Trays Installation Guide

NetApp Support

Configuring the management ports

As part of the hardware installation process, you must configure the management ports on both controllers.

About this task

Configuring management ports includes these major tasks:

- Adding the storage array to SANtricity Storage Manager, using the IP address of the E2700 controller
- Manually configuring the E2700 controller using SANtricity Storage Manager
- Verifying initial connectivity
- Configuring the E5600SG controller using the StorageGRID Webscale Appliance Installer web page, which is included with the controller

Adding a storage array to SANtricity Storage Manager

You must add the StorageGRID Webscale appliance to SANtricity Storage Manager using the IP address of the E2700 controller. You can then use SANtricity Storage Manager to manage the hardware components and the controller firmware.

Before you begin

- If management port 1 on the E2700 controller controller is connected to a network with a DHCP server, you have obtained the dynamically assigned IP address for the controller. (Your network administrator can use the controller's MAC address to look up the IP address. The MAC address is printed on a label on the back of the controller near the management port.)

  Note: If you do not have a DHCP server or you are unable to obtain this address, you can set the IP address manually, as described.

- You have a service laptop with SANtricity Storage Manager already installed.

About this task

For detailed instructions, see the SANtricity Storage Manager documentation.

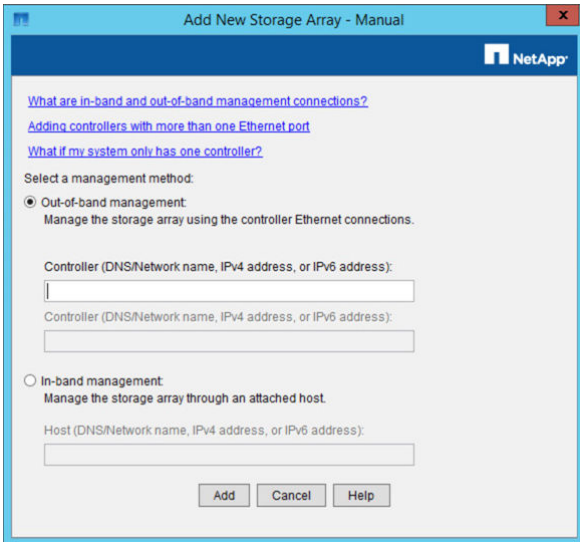
Steps

1. Access the E2700 controller with the service laptop.

Option	Description
Have DHCP-assigned IP address	Make sure the service laptop and the E2700 controller are on the same subnet.
Do not have DHCP-assigned address	**a.** Configure the service laptop IP address with `192.168.129.1/24` **b.** Connect the service laptop to E2700 controller management Port 2 using an Ethernet patch cord.

2. On the service laptop, open the SANtricity Storage Manager client.
3. In SANtricity Storage Manager, in the **Select Addition Method** page, select **Manual**, and click **OK**.
4. Select **Edit > Add Storage Array**.

   The Add New Storage Array - Manual page appears.



5. In the **Out-of-band management** box , enter one of the following values:
   - **Using DHCP:** The IP address assigned by the DHCP server to management port 1 on the E2700 controller
   - **Not using DHCP:** `192.168.129.101`

     Note: Because you are currently configuring only the E2700 controller, enter only one controller IP address.
6. Click **Add**.
7. Continue with configuring the management ports.

Related information

NetApp Documentation: SANtricity Storage Manager

Configuring the E2700 controller management port

You can use SANtricity Storage Manager on the service laptop to set the IP address for the E2700 controller management port. If you accessed the E2700 controller using an IP address obtained using DHCP, you must follow these steps to set a static IP address.

Before you begin

You must have a service laptop with SANtricity Storage Manager already installed.

About this task

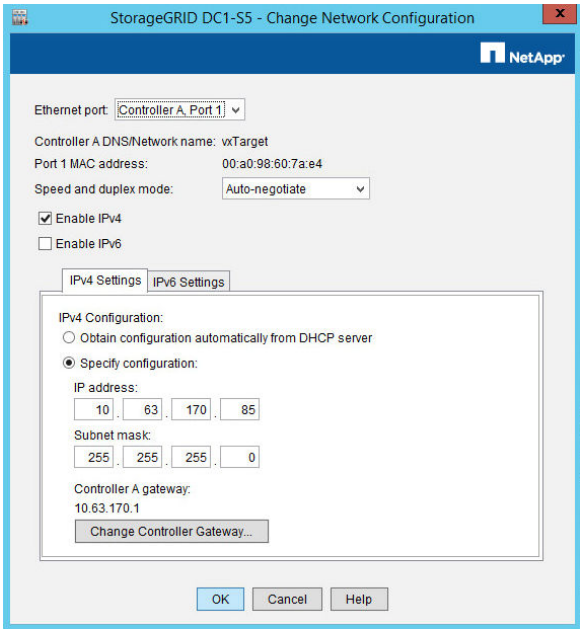
For detailed instructions, see the SANtricity Storage Manager documentation.

Attention: To ensure that you do not lose your management connection to the hardware and the controller firmware in the StorageGRID Webscale appliance, NetApp strongly recommends that you set a static IP address for E2700 controller by following the steps in this section.

Steps

1. From SANtricity Storage Manager, click the **Devices** tab.
2. In the **Devices** tab, double-click the newly added array.

3. Click the **Hardware** tab.
4. In the **Hardware** pane of the Array Management Window, highlight **Controller A, Port 1**.
5. On the Array Management Window, from the **Hardware** menu, select **Controller** > **Configure** > **Configure Management Ports**:



6. Change the IP address of Controller A, Port 1 to the management IP address, gateway, and subnet mask by doing the following:
   a. From the **Speed and duplex mode** drop-down list, select **Auto-negotiate**.

      After you select **Auto-negotiate**, make sure that your Ethernet switch is also set to Auto-negotiate. Connectivity issues might occur if automatic negotiation is selected in SANtricity Storage Manager but not set for the Ethernet switch.

   b. Depending on the format of your network configuration, select either **Enable IPv4** or **Enable IPv6**, or select both boxes.
   c. Select **Specify configuration**, and change the IP address of Controller A, Port 1 to a routable management IP address, gateway, and subnet mask.
   d. Click **OK**.
7. After the change, ping the IP address using an external laptop, not the service laptop.

   It might take a few minutes to get a response to the ping.
8. If the ping returns the IP data, disconnect the Ethernet cable from your service laptop, and reconnect the cable from the controller to the management network.
9. In SANtricity Storage Manager, remove the newly added storage array and add it again using the new IP addresses of Port 1.
10. Optionally, rename the controller by completing the following steps:
    a. From the Enterprise Management Window, right-click the controller name and select **Rename**.

b. Enter a new name for the controller, and click **OK**.

Related information

NetApp Documentation: SANtricity Storage Manager

Configuring the E5600SG controller management port

Management port 1 on the E5600SG controller connects the controller to the Admin network for StorageGRID Webscale. You can configure this port using a web browser on the service laptop. Additionally, you should enter the subnet mask for the network and at least a default gateway.

Before you begin

- You must have a service laptop with a web browser already installed.

  Note: Mozilla Firefox is the recommended browser for this task.

About this task

If management port 1 and the 10-GbE optical ports 2 and 4 on the E5600SG controller are connected to networks with DHCP servers, and the controller includes version 1.5 or later of the StorageGRID Webscale Appliance Installer, the controller attempts to obtain dynamically assigned IP addresses when you power on the enclosure. After the controller has completed the power-on process, its seven-segment display shows **HO**, followed by a repeating sequence of two digits.

```
HO -- IP address for Admin network -- IP address for Grid network HO
```

In the sequence:

- The first set of numbers is the DHCP-assigned IP address for management port 1 on the E5600SG controller (if available). This address is used to connect to the Admin network for StorageGRID Webscale.
- The second set of numbers is the DHCP-assigned IP address used to connect the appliance to the Grid network for StorageGRID Webscale.

Note: If an IP address could not be assigned using DHCP, 0.0.0.0 is displayed.

Your network administrator can also use the controller's MAC address to look up the dynamically assigned IP address for the controller's management port. The MAC address is printed on a label on the back of the E5600SG controller (adjacent to the port).

Note: If the E5600SG controller includes an earlier version of the StorageGRID Webscale Appliance Installer, the display shows **IM**. Earlier versions of the StorageGRID Webscale Appliance Installer do not support the use of DHCP IP addresses.

While the DHCP-assigned addresses allow you to access the E5600SG controller initially, you must follow the steps in this section to configure static IP addresses for all E5600SG controller interfaces. You must also follow these steps if you have version 1.3 of the StorageGRID Webscale Appliance Installer.

Attention: To ensure that you do not lose access to the StorageGRID Webscale appliance, NetApp strongly recommends that you set a static IP address for all E5600SG controller interfaces. A static IP is required for VMware-based grids.

Steps

1. Access the E5600SG controller with the service laptop.

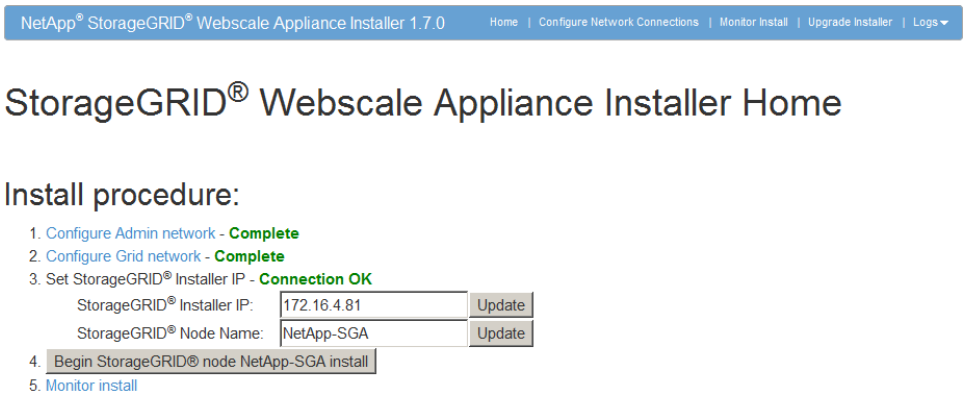
Option	Description
Have DHCP-assigned IP address	Make sure the service laptop and the E5600SG controller are on the same subnet.
Do not have DHCP-assigned address	**a.** Configure the service laptop IP address with `169.254.0.2` **b.** Connect the service laptop to management port 2 on the E5600SG controller, using an Ethernet patch cord.

2. Open a web browser on the service laptop, and access the StorageGRID Webscale Appliance Installer web page:

   - **Using DHCP:** `http://Management_Port_IP:8080`
   - **Not using DHCP:** `http://169.254.0.1:8080`

   The StorageGRID Webscale Appliance Installer web page appears.

   - If the StorageGRID Webscale Appliance Installer acquired an IP address using DHCP (version 1.6 or later), the web page looks like this:



   - If the StorageGRID Webscale Appliance Installer could not acquire an IP address using DHCP, the web page looks like this:

   Note: These examples show version 1.7 of the StorageGRID Webscale Appliance Installer web page. The version number immediately follows the product name in the menu bar. Earlier versions of this page might not include the version number in the heading.

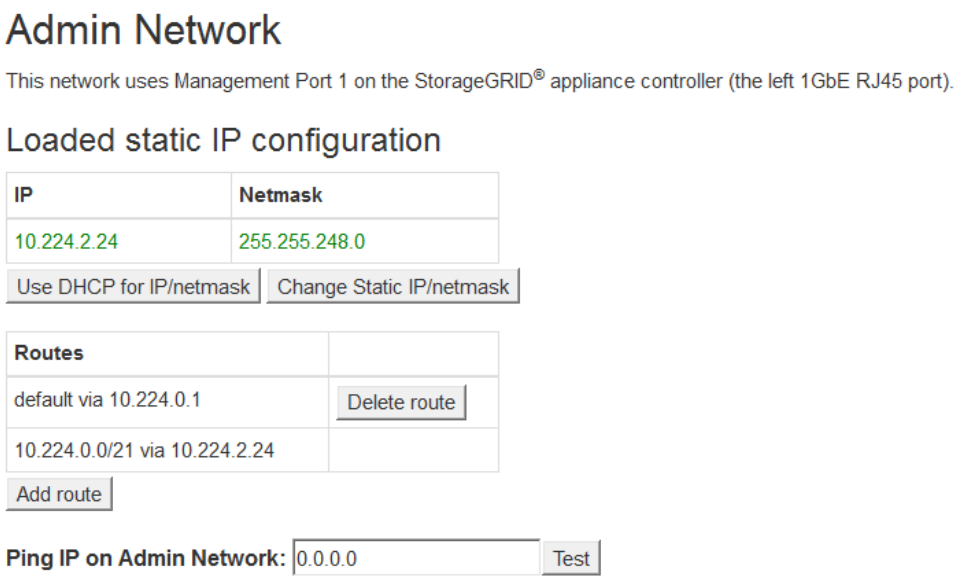
   Attention: If you want to use Aggregated Port Configuration for the StorageGRID Webscale Grid and Client networks, you must use version 1.7 or greater of the StorageGRID Webscale

Appliance Installer. Contact technical support to upgrade the Appliance Installer to version 1.7 if required.

3. From the menu bar of the StorageGRID Webscale Appliance Installer web page, click **Configure Network Connections**.

The Configure Network Connections page appears, with sections for configuring the 10GbE ports, the Admin Network, the Grid Network, and the Client Network.

4. To set the IP address for management port 1 on the E5600SG controller, go to the Admin Network section of the page, and click **Change Static IP/netmask**.



The button name changes to **Save Changes** and a pop-up appears.

5. In the pop-up, click **OK**.
6. Enter the IP address for management port 1 on the controller, and click **Save**.

   The route information is displayed, based on the specified IP address.

7. If needed, edit the route, and click **Save route**.
8. Click **Home** to return to the main **Appliance Installer** web page.

Verifying connectivity

You should verify the connectivity from the management ports on both the E2700 controller and the E5600SG controller to ensure that they are working, ensure that both controllers have valid IP addresses, and verify SAS interconnect connectivity.

Before you begin

You must have access to the service laptop with SANtricity Storage Manager installed.

Steps

1. Verify connectivity from management port 1 on each controller to another device on the management network by entering the IP address:

   `ping <IP_address>`

2. In SANtricity Storage Manager, click the **Devices** tab of the Enterprise Management Window to display information about the storage arrays.
3. Double-click the storage array.
4. In the Array Management Window, click the **Hardware** tab to see the configuration.
5. Perform one of these steps, depending on the status shown:

   Optimal

   No problems need to be resolved.

   Needs Attention

   Select **Storage Array** > **Recovery Guru** and follow the steps in the Recovery Guru to resolve the issue.

   Unresponsive

   Refer to the online Help topics in the Enterprise Management Window for the procedure.

6. To verify the SAS interconnect connectivity, do the following:

   - Connect to management port 2 on the E5600SG controller with an Ethernet cable.
   - Open SANtricity Storage Manager on the service laptop and access the E2700 controller using the link-local IP address 169.254.0.1.

   If SANtricity Storage Manager connects to the E2700 controller, the SAS interconnect connection is successful.

Configuring the AutoSupport tool for the StorageGRID Webscale appliance

The AutoSupport tool collects data in a customer support bundle from all AutoSupport-enabled storage arrays and automatically sends the data to technical support. Configuring AutoSupport assists technical support with remote troubleshooting and problem analysis of the storage management software.

Before you begin

- The AutoSupport feature must be enabled and activated on the storage array.
  The AutoSupport feature is activated and deactivated globally on a storage management station and can be enabled or disabled for an individual storage array.
- The Storage Manager Event Monitor must be running on at least one machine with access to the storage array and, preferably, on no more than one machine.

About this task

All of the data is compressed into a single compressed archive file format (7z) at the location you specify.

AutoSupport provides the following types of messages:

Message types	Description
Event messages	• Sent when a support event on the managed storage array occurs • Include system configuration and diagnostic information
Daily messages	• Sent once every day during a user configurable time interval in the local time of the storage array • Include the current system event logs and performance data
Weekly messages	• Sent once every week during a user configurable time interval in the local time of the storage array • Include configuration and system state information

Steps

1. From the Enterprise Management Window in SANtricity Storage Manager, select the **Devices** tab, and then select **Discovered Storage Arrays**.
2. Select **Tools > AutoSupport > Configuration**.
3. Use SANtricity Storage Manager online Help, if needed, to complete the task.

Related information

NetApp Documentation: SANtricity Storage Manager

Configuring StorageGRID Webscale appliance passwords

Setting up AutoSupport requires that you configure passwords for the appliance. Setting passwords maintains system security.

Steps

1. From the Enterprise Management Window in SANtricity Storage Manager, double-click the controller.
2. From the Array Management Window, select the **Storage Array** menu, and select **Security > Set Password**.
3. Configure the password.
4. Use SANtricity Storage Manager online Help, if needed, to complete the task.

Configuring email and SNMP alarm targets

Configuring AutoSupport requires that you identify email for notifications and SNMP alarm targets. This enables administrators to receive timely information about alarms and operations.

Steps

1. From the Enterprise Management Window in SANtricity Storage Manager, select the **Devices** tab, and then select a node.
2. Select **Edit > Configure Alerts**.
3. Use SANtricity Storage Manager online Help, if needed, to complete the task.

Verifying receipt of AutoSupport

You should verify that NetApp technical support is receiving your AutoSupport messages. On the My AutoSupport site, you can find the AutoSupport status of your systems. Verifying receipt of these messages ensures that NetApp technical support has your information if you need assistance.

About this task

AutoSupport can show one of the following statuses:

ON

An ON status indicates that technical support is currently receiving AutoSupport messages from the system.

OFF

An OFF status suggests that you might have disabled AutoSupport because NetApp technical support has not received a Weekly Log from the system in the last 15 calendar days or there might have been a change in your environment or configuration (as an example).

DECLINE

A DECLINE status means that you have notified NetApp technical support that you will not enable AutoSupport.

After NetApp receives a Weekly Log from the system, the AutoSupport status changes to ON.

Steps

1. Go to the NetApp Support Site at *mysupport.netapp.com*, and log in to the My AutoSupport site.
2. If the AutoSupport status is OFF, and you believe that is incorrect, complete the following:
   a. Check your system configuration to ensure that you have turned AutoSupport on.
   b. Check your network environment and configuration to ensure that the system can send messages to technical support.

Changing the RAID volume configuration settings

If you have an SG5660 with 60 drives, you can select the RAID volume configuration that is appropriate for your deployment environment. You can only change the RAID volume configuration before you start the installation of the StorageGRID Webscale appliance Storage Node.

Before you begin

- You must have a service laptop with a web browser already installed.
- You must already have the IP address of the management network.

About this task

Before starting the installation of the StorageGRID Webscale appliance Storage Node, you can choose from two volume configuration options:

- **Dynamic Disk Pools (DDP)** – This is the default, and recommended setting. DDP is an enhanced hardware data protection scheme that delivers system performance, reduced rebuild times, and ease of management.

- **RAID6** – This is a hardware protection scheme that uses to parity stripes on each disk, and allows for two disk failures within the RAID set before any data is lost. RAID6 provides improved storage efficiency over DDP (typically 5-10%), but does not recover from failures as efficiently.

  Note: The SG5612 does not support RAID6. If you have this model, you must use the DDP option.

Steps

1. Using the service laptop, open a web browser and access the RAID6 Option web page on the StorageGRID Webscale appliance:

   `http://`*`Management_Port_IP`*`:8080/advanced`

   `Management_Port_IP` is the IP address of management port 1 on the E5600SG controller controller (provisioned during the physical installation).

2. If you want to change from the default DDP value to RAID6:

   a. Click **Change volume configuration to RAID6**.

   b. Click **OK** in the confirmation dialog box.

3. If you have selected RAID6 and want to restore DDP:

   a. Click **Change volume configuration to DDP**.

   b. Click **OK** in the confirmation dialog box.

Troubleshooting the hardware installation

If you encounter issues during the installation, you might find it helpful to review troubleshooting information related to hardware setup and connectivity issues.

Related references

Hardware setup appears to hang on page 41
Connectivity issues on page 43

Hardware setup appears to hang

Issue

The StorageGRID Webscale appliance hardware installation cannot begin or appears halted.

Cause

This issue occurs when the hardware installation cannot locate a required installation file, the factory image is incomplete or corrupt, or the hardware installation is still in progress.

Corrective action

1. Check the Needs Attention LED on either controller and look for a flashing error code.
   During power up, the Service Action Allowed and Service Action Required LEDs are turned on while the hardware is initializing. The upper decimal point of the lower digit, called the *diagnostic LED*, also illuminates. The seven-segment display runs through a sequence of codes that are common for both controllers. This is normal and is not an indication of an error. When the hardware boots successfully, the Service Action LEDs are turned off, and the displays are driven by the firmware.
2. On the E5600SG controller controller, review the seven-segment codes that are not errors.

   Note: The installation and provisioning take time. Some installation phases do not report updates to the installer for several minutes.

   When an error occurs, the Controller Fault LED illuminates and the seven-segment displays flash a sequence beginning with an E code, such as EM.
3. If a seven-segment error code appears, depending on the controller, use the following references:

Controller	Reference
E2700 controller	NetApp E-Series documentation
E5600SG controller	Seven-segment error codes, such as EI or EM

4. If this does not resolve the connection issue, contact technical support from the NetApp Support Site at *mysupport.netapp.com*.

Related references

E5600SG controller seven-segment display codes on page 27

Related information

E2700 Controller-Drive Tray and Related Drive Trays Installation Guide
NetApp Documentation: E2700 Series

EI or EU Error: Installation script not found

The codes that appear depend on which version of the Appliance Installer you have. The EI code displays if you have version 1.4 or earlier. The EU code displays if you have version 1.5 or later.

Description

This message occurs when the StorageGRID Webscale appliance software installation cannot begin, either because it cannot locate a needed installation file or because a factory image is incomplete or corrupt.

Corrective action

1. Restart the installation.
2. If this does not resolve the connection issue, contact technical support from the NetApp Support Site at *mysupport.netapp.com*.

EM or EP Error: Manage SGA returned

The codes that appear depend on which version of the Appliance Installer you have. The EM code displays if you have version 1.4 or earlier. The EP code displays if you have version 1.5 or later.

Description

This message occurs when the pre-grid communication with the E2700 controller fails for any of several reasons, including that the appliance is not cabled correctly, an installation file is missing or corrupt, or a power failure occurred.

Corrective action

1. Check the cabling on the hardware.
2. Check for power issues.
3. Ping the appliance:

   `ping <E5600_controller_IP>`

4. Check the logs on the E2700 controller.
5. Reboot the appliance.
6. Complete the steps for any `unable to connect` message.
7. If this does not resolve the connection issue, contact technical support fromthe NetApp Support Site at *mysupport.netapp.com*.

Related references

Unable to connect to StorageGRID Webscale appliance over the network on page 43

Connectivity issues

If you encounter connectivity issues during the StorageGRID Webscale appliance installation, you might find it helpful to review troubleshooting information.

Unable to connect to StorageGRID Webscale appliance over the network

Issue

You cannot connect to the appliance.

Cause

This could occur if there is a network issue or the hardware installation did not complete successfully.

Corrective action

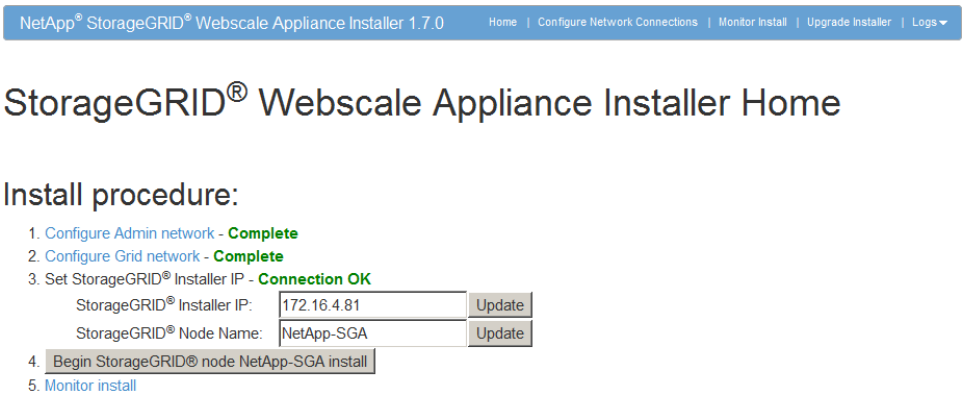
1. Ping the appliance:

   `ping <E5600_controller_IP>`

2. Access the StorageGRID Webscale Appliance Installer by opening a browser and entering the following: **`http://<Management_Port_IP>:8080`**

   For *`Management_Port_IP`*, enter the IP address for management port 1 on the E5600SG controller (provisioned during the physical installation).

   The StorageGRID Webscale Appliance Installer Home web page appears:

   After you install the appliance, the status for each of the procedures on the web page indicates that the procedure is complete.

3. Click **Configure Admin network**, and check the IP.
4. If you receive a response from the ping, check that port 8080 is open in the firewalls.
5. Reboot the appliance.
6. Refresh the installation web page.
7. If this does not resolve the connection issue, contact technical support from the NetApp Support Site at *mysupport.netapp.com*.

Determining the StorageGRID Webscale Appliance Installer version

The title bar of the StorageGRID Webscale Appliance Installer shows the version number. You might find it helpful to determine the version so that you can use the seven-segment LED codes appropriate for the version you have.

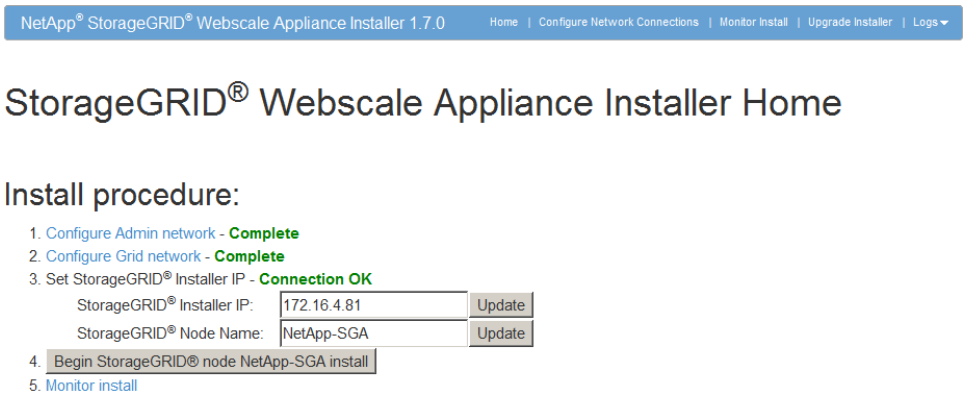
Before you begin

- You must have a service laptop with a web browser already installed.
- You must already have the IP address of the management network.

Steps

1. Using the service laptop, open a web browser and access the StorageGRID Webscale Appliance Installer web page:

   `http://169.254.0.1:8080`



2. Note the installer version in the title bar.

   Note: The example shows version 1.7 of the StorageGRID Webscale Appliance Installer web page. Earlier versions are similar, but might not include the version number in the heading.

Unable to connect to StorageGRID Webscale appliance via point-to-point Ethernet link

Issue

The appliance card fails to boot successfully.

Cause

This issue could occur if the appliance card does not connect due to a networking issue with the service laptop.

Corrective action

1. Make sure that the seven-segment displays indicate that the appliance is booted and ready.
2. Verify that the installer's laptop is configured and capable of connecting to a link-local connection.
3. Reboot the appliance.
4. Refresh the installation web page.
5. Restart the installation.

Related references

E5600SG controller seven-segment display codes on page 27

Maintaining your StorageGRID Webscale appliance

You might need to upgrade the E-Series SANtricity OS controller software on the E2700 controller or replace the E2700 controller, the E5600SG controller, or specific components.

Upgrading controller software on the E2700 controller

You might need to upgrade the SANtricity OS controller software on an E2700 controller if the controller is operational but not functioning optimally, or if you want to use the new features in a new software release.

Before you begin

You must have access to the online help for the SANtricity Storage Manager Enterprise Management Window or the *SANtricity Storage Manager System Upgrade Guide*.

Note: You can use the Enterprise Management Window to perform both major upgrades and minor upgrades. You can use the Array Management Window to perform minor upgrades only.

About this task

SANtricity OS controller software upgrades should not be applied to the E2700 controller unless the controller software release is specifically stated to be compatible with the StorageGRID Webscale appliance.

The E2700 controller used in the StorageGRID Webscale appliance supports E-Series SANtricity OS Controller Software version 8.30.x only. You should not install a different version.

Note: Contact technical support with any upgrade-related questions.

Steps

1. Download the controller software installation files.
   a. Go to *NetApp Downloads: Software* and sign in.
   b. Locate **E-Series/EF-Series SANtricity OS Controller Software**.
   c. For the platform, select **E2700**.
   d. Select the version of E-Series SANtricity OS controller software you want to install, and click **View & Download**.
   e. Follow the online instructions to download the appropriate ZIP or TAR file for the E2700 controller in your StorageGRID Webscale appliance.
2. If the StorageGRID Webscale appliance is running in a StorageGRID Webscale system, shut down the E5600SG controller.
   a. From the service laptop, log in to the grid node:
      i. Enter the following command: `ssh admin@grid_node_IP`
      ii. Enter the password listed in the `Passwords.txt` file.
      iii. Enter the following command to switch to root: `su -`

iv. Enter the password listed in the `Passwords.txt` file.

Once logged in as root, the prompt changes from `$` to `#`.

b. Stop all StorageGRID Webscale services:

```
/etc/init.d/servermanager stop
```

c. Shut down the E5600SG controller:

```
shutdown -h now
```

Shutting down the E5600SG controller interrupts the connectivity to the E2700 controller, so you can apply the controller software upgrade.

3. Refer to the *SANtricity Storage Manager System Upgrade Guide* or the SANtricity Storage Manager online Help, and upgrade the E2700 controller's firmware, NVSRAM, or both.

Attention: If you need to upgrade the NVSRAM in the E2700 controller, you must confirm that the SANtricity OS file you downloaded was designated as compatible with StorageGRID Webscale appliances.

4. Once the upgrade operation has completed, power cycle the StorageGRID Webscale appliance.

a. Turn off both power switches, and wait until all LED and seven-segment display activity has stopped.

b. Turn on both power switches.

c. Wait 10 minutes. Confirm that none of the amber LEDs on the front or back of the shelf are lit.

5. Monitor the seven-segment codes.

- E2700 controller:
  The final LED state is `99`.
- E5600SG controller:
  The final LED state is `HA` for version 1.5 or later, or `SG` for version 1.3.

Related information

NetApp E-Series and EF-Series Systems Documentation Center
SANtricity Storage Manager 11.30 Upgrade Guide

Replacing the E2700 controller

You might need to replace the E2700 controller. The process for replacing the controller depends on whether the controller is operational.

Before you begin

You must have access to the following resources:

- E-Series hardware replacement information on the Support Site
- E2700 controller documentation on the Support Site

Related information

NetApp E-Series and EF-Series Hardware Replacement Procedures
NetApp Documentation: E2700 Series

Replacing an operational E2700 controller

You might need to replace an operational E2700 controller if it is not functioning optimally. For example, you might need to replace an operational controller that repeatedly hangs and needs to be rebooted or one that does not always reboot successfully.

About this task

If both controllers are functioning sufficiently to allow for a controlled shutdown, you can shut down the E5600SG controller to interrupt the connectivity to the E2700 controller.

Steps

1. Put on antistatic protection.
2. Label each cable attached to the E2700 controller, so you can reconnect the cables correctly.
3. If the StorageGRID Webscale appliance is running in a StorageGRID Webscale system, shut down the E5600SG controller.
   a. From the service laptop, log in to the grid node:
      i. Enter the following command: `ssh admin@grid_node_IP`
      ii. Enter the password listed in the `Passwords.txt` file.
      iii. Enter the following command to switch to root: `su -`
      iv. Enter the password listed in the `Passwords.txt` file.

      Once logged in as root, the prompt changes from `$` to `#`.
   b. Stop all StorageGRID Webscale services:

      `/etc/init.d/servermanager stop`
   c. Shut down the E5600SG controller:

      `shutdown -h now`

      Shutting down the E5600SG controller interrupts the connectivity to the E2700 controller, so you can replace it.
4. Turn off power to the enclosure, which turns power off to both controllers.
5. Wait until all LED and seven-segment display activity on the rear of the controller has stopped.
6. Remove the cables.
7. Remove the controller, as described in the E2700 controller documentation.
8. Insert the new controller, as described in the E2700 controller documentation.
9. Replace all cables.
10. Turn the power on to the controller.
11. Monitor the seven-segment codes.
    - E2700 controller:
      The final LED state is `99`.
    - E5600SG controller:
      The final LED state is `HA` for version 1.5 or later, or `SG` for version 1.3.

Related information

NetApp E-Series and EF-Series Hardware Replacement Procedures
NetApp Documentation: E2700 Series

Replacing a failed E2700 controller

If the E2700 controller has failed, you must replace it. In this case, you cannot perform a controlled shutdown.

Steps

1. Put on antistatic protection.
2. Label each cable attached to the E2700 controller, so you can reconnect the cables correctly.
3. Turn off power to the enclosure, which turns power off to both controllers.
4. Wait until all LED and seven-segment display activity on the rear of the controller has stopped.
5. Remove the cables.
6. Remove the controller, as described in the E2700 controller documentation.
7. Insert the new controller, as described in the E2700 controller documentation.
8. Replace all cables.
9. Turn the power back on to the enclosure.

Replacing the E5600SG controller

You might need to replace the E5600SG controller.

Before you begin

You must have access to the following resources:

- E-Series hardware replacement information on the NetApp Support Site at *mysupport.netapp.com*
- E5600 documentation on the Support Site

About this task

If both controllers are functioning sufficiently to allow for a controlled shutdown, you can shut down the E5600SG controller first to interrupt the connectivity to the E2700 controller.

Steps

1. Use antistatic protection.
2. Label each cable that is attached to the E5600SG controller, so you can reconnect the cables correctly.

   Attention: To prevent degraded performance, do not twist, fold, pinch, or step on the cables. Do not bend the cables tighter than a 5-cm (2-in) radius.

3. If the StorageGRID Webscale appliance is running in a StorageGRID Webscale system, shut down the E5600SG controller.

   a. From the service laptop, log in to the grid node:

i. Enter the following command: `ssh admin@grid_node_IP`

ii. Enter the password listed in the `Passwords.txt` file.

iii. Enter the following command to switch to root: `su -`

iv. Enter the password listed in the `Passwords.txt` file.

Once logged in as root, the prompt changes from `$` to `#`.

b. Stop all StorageGRID Webscale services:

```
/etc/init.d/servermanager stop
```

c. Shut down the E5600SG controller:

```
shutdown -h now
```

4. Turn off the power to the enclosure, and wait until all LED and seven-segment display activity on the rear of the controller has stopped.
5. Remove the cables.
6. Remove the controller, as described in the E5600SG controller documentation.
7. Insert the new controller, as described in the E5600SG controller documentation.
8. Replace all cables.
9. Turn the power back on to the enclosure.
10. Monitor the seven-segment codes.
    - E2700 controller:
      The final LED state is `99`.
    - E5600SG controller:
      The final LED state is `HA` for version 1.5 or later, or `SG` for version 1.3.
11. Verify post-replacement operation by checking that the Storage Node appears accurately in the Grid Management Interface and that no alarms appear.

Related information

NetApp E-Series and EF-Series Hardware Replacement Procedures
NetApp Documentation: E5600 Series

Replacing components in the StorageGRID Webscale appliance

You might need to replace a drive, fan canister, or power canister in the StorageGRID Webscale appliance.

Before you begin

You must have access to the E-Series hardware replacement information on the Support Site.

About this task

To replace the drive, fan canister, or power canister, use the standard procedures for an E2700 series system.

Note: The SG5612 model includes a combined power-fan canister.

Related information

NetApp E-Series and EF-Series Hardware Replacement Procedures
NetApp Documentation: E2700 Series

Where to go next

After you install the StorageGRID Webscale appliance, you might want to perform additional StorageGRID Webscale configuration steps.

You might want to complete the following tasks:

- Install and configure the StorageGRID Webscale software.
  See the software installation instructions.
  See the *Administrator Guide* for configuration information.
- Integrate and verify client API connections (CDMI, S3, or Swift).
  See the appropriate API guide.

You use SANtricity Storage Manager to complete the following tasks:

- Connect to each StorageGRID Webscale appliance.
- Verify receipt of AutoSupport data.

For details, see the StorageGRID Webscale and SANtricity documentation.

Related information

StorageGRID Webscale 10.4 Administrator Guide
StorageGRID Webscale 10.3 Cloud Data Management Interface Implementation Guide
StorageGRID Webscale 10.4 S3 (Simple Storage Service) Implementation Guide
StorageGRID Webscale 10.4 Swift Implementation Guide
StorageGRID Webscale 10.4 Software Installation Guide for OpenStack Deployments
StorageGRID Webscale 10.4 Software Installation Guide for VMware Deployments
StorageGRID Webscale 10.4 Software Installation Guide for Red Hat Enterprise Linux Deployments
NetApp Documentation: SANtricity Storage Manager

Regulatory compliance statements

This product meets the FCC radio frequency interference regulatory compliance, laser products compliance, and regional compliance statements.

FCC radio frequency interference statement

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the Federal Communications Commission (FCC) Rules. These limits are designed to provide reasonable protection against harmful interference in a commercial installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his/her own expense.

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This equipment uses Small Form-factor Pluggable (SFP) optical transceivers, which are unmodified Class 1 laser products pursuant to 21 CFR, Subchapter J, Section 1040.10. All optical transceivers used with this product are required to be 21 CFR certified Class 1 laser products. For outside the USA, this equipment has been tested and found compliant with Class 1 laser product requirements contained in European Normalization standard EN 60825 1:2007. Class 1 levels of laser radiation are not considered to be hazardous and are considered safe based upon current medical knowledge. This class includes all lasers or laser systems which cannot emit levels of optical radiation above the exposure limits for the eye under any exposure conditions inherent in the design of the laser products.

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Glossary

ACL

Access control list. Specifies which users or groups of users are allowed to access an object and what operations are permitted, for example, read, write, and execute.

active-backup mode

A method for bonding two physical ports together for redundancy.

ADC service

Administrative Domain Controller. The ADC service maintains topology information, provides authentication services, and responds to queries from the LDR, CMN, and CLB services. The ADC service is present on each of the first three Storage Nodes installed at a site.

ADE

Asynchronous Distributed Environment. Proprietary development environment used as a framework for services within the StorageGRID Webscale system.

Admin Node

The Admin Node provides services for the web interface, system configuration, and audit logs. See also, *primary Admin Node*.

Amazon S3

Proprietary web service from Amazon for the storage and retrieval of data.

AMS service

Audit Management System. The AMS service monitors and logs all audited system events and transactions to a text log file. The AMS service is present on the Admin Node.

API Gateway Node

An API Gateway Node provides load balancing functionality to the StorageGRID Webscale system and is used to distribute the workload when multiple client applications are performing ingest and retrieval operations. API Gateway Nodes include a Connection Load Balancer (CLB) service.

ARC service

Archive. The ARC service provides the management interface with which you configure connections to external archival storage such as the cloud through an S3 interface or tape through TSM middleware. The ARC service is present on the Archive Node.

Archive Node

The Archive Node manages the archiving of object data to an external archival storage system.

atom

Atoms are the lowest level component of the container data structure, and generally encode a single piece of information.

audit message

Information about an event occurring in the StorageGRID Webscale system that is captured and logged to a file.

Base64

A standardized data encoding algorithm that enables 8-bit data to be converted into a format that uses a smaller character set, enabling it to safely pass through legacy systems

that can process only basic (low order) ASCII text excluding control characters. See RFC 2045 for more details.

bundle

A structured collection of configuration information used internally by various components of the StorageGRID Webscale system. Bundles are structured in container format.

Cassandra

An open-source database that is scalable and distributed, provides high availability, and handles large amounts of data across multiple servers.

CBID

Content Block Identifier. A unique internal identifier of a piece of content within the StorageGRID Webscale system.

CDMI

Cloud Data Management Interface. An industry-standard defined by SNIA that includes a RESTful interface for object storage. For more information, see *www.snia.org/cdmi*.

CIDR

Classless Inter-Domain Routing. A notation used to compactly describe a subnet mask used to define a range of IP addresses. In CIDR notation, the subnet mask is expressed as an IP address in dotted decimal notation, followed by a slash and the number of bits in the subnet. For example, 192.0.2.0/24.

CLB service

Connection Load Balancer. The CLB service provides a gateway into the StorageGRID Webscale system for client applications connecting through HTTP. The CLB service is part of the API Gateway Node.

Cloud Data Management Interface

See *CDMI*.

CMN service

Configuration Management Node. The CMN service manages system-wide configurations and grid tasks. The CMN service is present on the primary Admin Node.

CMS service

Content Management System. The CMS service carries out the operations of the active ILM policy's ILM rules, determining how object data is protected over time. The CMS service is present on the Storage Node.

command

In HTTP, an instruction in the request header such as GET, HEAD, DELETE, OPTIONS, POST, or PUT. Also known as an HTTP method.

container

Created when an object is split into segments. A container object lists the header information for all segments of the split object and is used by the LDR service to assemble the segmented object when it is retrieved by a client application.

content block ID

See *CBID*.

content handle

See *UUID*.

CSTR

Null-terminated, variable-length string.

DC

Data Center site.

DDS service

Distributed Data Store. The DDS service interfaces with the distributed key-value store and manages object metadata. It distributes metadata copies to multiple instances of the distributed key-value store so that metadata is always protected against loss.

distributed key value store

Data storage and retrieval that unlike a traditional relational database manages data across grid nodes.

DNS

Domain Name System.

enablement layer

Used during installation to customize the Linux operating system installed on each grid node. Only the packages needed to support the services hosted on the grid node are retained, which minimizes the overall footprint occupied by the operating system and maximizes the security of each grid node.

Fibre Channel

A networking technology primarily used for storage.

Grid ID signed text block

A Base64 encoded block of cryptographically signed data that contains the grid ID. See also, *provisioning*.

grid node

The basic software building block for the StorageGRID Webscale system, for example, Admin Node or Storage Node. Each grid node type consists of a set of services that perform a specialized set of tasks.

grid task

System-wide scripts used to trigger various actions that implement specific changes to the StorageGRID Webscale system. For example, most maintenance and expansion procedures involve running grid tasks. Grid tasks are typically long-term operations that span many entities within the StorageGRID Webscale system. See also, *Task Signed Text Block*.

ILM

Information Lifecycle Management. A process of managing content storage location and duration based on content value, cost of storage, performance access, regulatory compliance, and other factors. See also, *Admin Node* and *storage pool*.

LACP

Link Aggregation Control Protocol. A method for bundling two or more physical ports together to form a single logical channel.

LAN

Local Area Network. A network of interconnected computers that is restricted to a small area, such as a building or campus. A LAN can be considered a node to the Internet or other wide area network.

latency

Time duration for processing a transaction or transmitting a unit of data from end to end. When evaluating system performance, both throughput and latency need to be considered. See also, *throughput*.

LDR service

Local Distribution Router. The LDR service manages the storage and transfer of content within the StorageGRID Webscale system. The LDR service is present on the Storage Node.

LUN

See *object store*.

mDNS

Multicast Domain Name System. A system for resolving IP addresses in a small network where no DNS server has been installed.

metadata

Information related to or describing an object stored in the StorageGRID Webscale system; for example, ingest time.

MLAG

Multi-Chassis Link Aggregation Group. A type of link aggregation group that uses two (and sometimes more) switches to provide redundancy in case one of the switches fails.

MTU

Maximum transmission unit. The largest size packet or frame that can be sent in any transmission.

namespace

A set whose elements are unique names. There is no guarantee that a name in one namespace is not repeated in a different namespace.

nearline

A term describing data storage that is neither “online” (implying that it is instantly available, like spinning disk) nor “offline” (which can include offsite storage media). An example of a nearline data storage location is a tape that is loaded in a tape library, but is not mounted.

NFS

Network File System. A protocol (developed by SUN Microsystems) that enables access to network files as if they were on local disks.

NMS service

Network Management System. The NMS service provides a web-based interface for managing and monitoring the StorageGRID Webscale system. The NMS service is present on the Admin Node. See also, *Admin Node*.

node ID

An identification number assigned to a service within the StorageGRID Webscale system. Each service (such as an NMS service or ADC service) must have a unique node ID. The number is set during system configuration and tied to authentication certificates.

NTP

Network Time Protocol. A protocol used to synchronize distributed clocks over a variable latency network, such as the Internet.

object

An artificial construct used to describe a system that divides content into data and metadata.

object segmentation

A StorageGRID Webscale process that splits a large object into a collection of small objects (segments) and creates a segment container to track the collection. The segment container contains the UUID for the collection of small objects as well as the header

information for each small object in the collection. All of the small objects in the collection are the same size. See also, *segment container*.

object storage

An approach to storing data where the data is accessed by unique identifiers and not by a user-defined hierarchy of directories and files. Each object has both data (for example, a picture) and metadata (for example, the date the picture was taken). Object storage operations act on entire objects as opposed to reading and writing bytes as is commonly done with files, and provided via APIs or HTTP instead of NAS (CIFS/NFS) or block protocols (iSCSI/ FC/FCOE).

object store

A configured file system on a disk volume. The configuration includes a specific directory structure and resources initialized at system installation.

OID

Object Identifier. The unique identifier of an object.

primary Admin Node

Admin Node that hosts the CMN service. Each StorageGRID Webscale system has only one primary Admin Node. See also, *Admin Node*.

provisioning

The process of generating a new or updated Recovery Package and GPT repository. See also, *SAID*.

quorum

A simple majority: 50% + 1. Some system functionality requires a quorum of the total number of a particular service type.

Recovery Package

A .zip file containing deployment-specific files and software needed to install, expand, upgrade, and maintain a StorageGRID Webscale system. The package also contains system-specific configuration and integration information, including server hostnames and IP addresses, and highly confidential passwords needed during system maintenance, upgrade, and expansion. See also, *SAID*.

SAID

Software Activation and Integration Data. The component in the Recovery Package that includes the `Passwords.txt` file.

SATA

Serial Advanced Technology Attachment. A connection technology used to connect server and storage devices.

SCSI

Small Computer System Interface. A connection technology used to connect servers and peripheral devices, such as storage systems.

segment container

An object created by the StorageGRID Webscale system during the segmentation process. Object segmentation splits a large object into a collection of small objects (segments) and creates a segment container to track the collection. A segment container contains the UUID for the collection of segmented objects as well as the header information for each segment in the collection. When assembled, the collection of segments creates the original object. See also, *object segmentation*.

server

Used when specifically referring to hardware. Might also refer to a virtual machine.

service

A unit of the StorageGRID Webscale system, such as the ADC service, NMS service, or SSM service. Each service performs unique tasks critical to the normal operations of a StorageGRID Webscale system.

SQL

Structured Query Language. An industry-standard interface language for managing relational databases. An SQL database is one that supports the SQL interface.

ssh

Secure Shell. A UNIX shell program and supporting protocols used to log in to a remote computer and run commands over an authenticated and encrypted channel.

SSL

Secure Socket Layer. The original cryptographic protocol used to enable secure communications over the Internet. See also, *TLS*.

SSM service

Server Status Monitor. A component of the StorageGRID Webscale software that monitors hardware conditions and reports to the NMS service. Every grid node runs an instance of the SSM service.

Storage Node

The Storage Node provides storage capacity and services to store, move, verify, and retrieve objects stored on disks.

storage pool

The element of an ILM rule that determines the location where an object is stored.

storage volume

See *object store*

StorageGRID

A registered trademark of NetApp, Inc., used for an object storage grid architecture and software system.

Task Signed Text Block

A Base64 encoded block of cryptographically signed data that provides the set of instructions that define a grid task.

TCP/IP

Transmission Control Protocol/Internet Protocol. A process of encapsulating and transmitting packet data over a network. It includes positive acknowledgment of transmissions.

throughput

The amount of data that can be transmitted or the number of transactions that can be processed by a system or subsystem in a given period of time. See also, *latency*.

Tivoli Storage Manager

IBM storage middleware product that manages storage and retrieval of data from removable storage resources.

TLS

Transport Layer Security. A cryptographic protocol used to enable secure communications over the Internet. See RFC 2246 for more details.

transfer syntax

The parameters, such as the byte order and compression method, needed to exchange data between systems.

URI

Universal Resource Identifier. A generic set of all names or addresses used to refer to resources that can be served from a computer system. These addresses are represented as short text strings.

UTC

A language-independent international abbreviation, UTC is neither English nor French. It means both “Coordinated Universal Time” and “Temps Universel Coordonné.” UTC refers to the standard time common to every place in the world.

UUID

Universally Unique Identifier. Unique identifier for each piece of content in the StorageGRID Webscale system. UUIDs provide client applications with a content handle that permits them to access content in a way that does not interfere with the StorageGRID Webscale system’s management of that same content. A 128-bit number that is guaranteed to be unique. See RFC 4122 for more details.

virtual machine (VM)

A software platform that enables the installation of an operating system and software, substituting for a physical server and permitting the sharing of physical server resources among several virtual servers.

VLAN

Virtual local area network (or virtual LAN). A group of devices that are located on different LAN segments but are configured to communicate as if they were attached to the same network switch.

WAN

Wide area network. A network of interconnected computers that covers a large geographic area, such as a country.

XFS

A scalable, high-performance journaled file system originally developed by Silicon Graphics.

XML

Extensible Markup Language. A text format for the extensible representation of structured information; classified by type and managed like a database. XML has the advantages of being verifiable, human readable, and easily interchangeable between different systems.

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