



**E-Series**

# Upgrading E-Series Controllers

November 2019 | 215-13050\_2019-11\_en-us  
[doccomments@netapp.com](mailto:doccomments@netapp.com)



# Contents

<b>Overview and requirements .....</b>	<b>4</b>
When to use this procedure .....	4
Upgrade considerations .....	4
Upgrade compatibility .....	5
<b>Upgrade E-Series controllers .....</b>	<b>7</b>
Prepare to upgrade controllers .....	7
Remove controllers .....	10
Step 1: Remove controller .....	11
Step 2: Remove battery .....	12
Install new controllers .....	12
Step 1: Install battery .....	13
Step 2: Install new controller canister .....	14
Unlock drives .....	14
Create internal security key .....	15
Controller swap with internal key management and one or more drives secured .....	16
Create external security key .....	18
Controller swap with external key management and all drives secured .....	20
Complete controller upgrade .....	22
Step 1: Power on controller .....	22
Step 2: Check status of controllers and trays .....	24
Step 3: Validate controller software version .....	24
Remount volumes after changing the vendor from LSI to NETAPP .....	26
Remounting volumes on an AIX host .....	26
Remounting volumes on a VMware host .....	26
Remounting volumes on a Windows host .....	27
<b>Reconfigure a SAS-2 system behind a new SAS-3 controller shelf without data preservation .....</b>	<b>28</b>
Step 1: Power down the controllers (non-data preservation) .....	28
Step 2: Install the controllers (non-data preservation) .....	29
Step 3: Power on the controllers (non-data preservation) .....	29
<b>Copyright .....</b>	<b>31</b>
<b>Trademark .....</b>	<b>32</b>
<b>How to send comments about documentation and receive update notifications .....</b>	<b>33</b>

## Overview and requirements

---

Learn what you need to know before upgrading and review the supported compatibility paths.

### When to use this procedure

You typically use this procedure when you want to upgrade all of the controllers to a different model or platform by replacing all of the controllers in a controller-drive tray.

You might also use this procedure in the following situations:

- When all controllers in a controller-drive tray encounter hardware failures and are no longer functional.
- To upgrade the dual inline memory modules (DIMMs) in your controller-drive tray by replacing both controllers with the same model of controllers, but with different DIMMs.

**Note:** The HIC upgrade scenarios are not covered within this procedure. Instead, refer to the HIC add, upgrade and replacement procedures for your E-Series system.

### Upgrade considerations

Learn about the considerations you need to keep in mind before you upgrade your controllers.

- **Duplex and simplex controller upgrades**  
For duplex controller-drive trays, you replace both controllers. For simplex controller-drive trays, you replace the one controller. In both cases, you must power off the controller-drive tray. As a result, you cannot access data on the storage array until you successfully complete the replacement.
- **Trays and shelves**  
Storage arrays with an E2800 or E5700 controller shelf typically use SANtricity System Manager. You might also use the Enterprise Management Window (EMW) from SANtricity Storage Manager to manage E2800 or E5700 controller shelves. All other controller-drive trays referenced in this procedure use SANtricity Storage Manager.
- **Controller batteries**  
A new controller is shipped without a battery installed. When possible, you should remove the battery from your old controller and then install that battery in the new controller. However, for some controller upgrades, the battery from the old controller is not compatible with the new controller. In those cases, you must order a battery along with your new controller, and have that battery available before you begin these tasks.
- **Vendor Identification**  
Some controller upgrades result in the Vendor ID in SCSI Inquiry Data changing from LSI to NETAPP. When the Vendor ID changes from LSI to NETAPP, additional steps are required on the Windows, VMware, and AIX operating systems to reclaim devices. Steps for these operating systems are included in this upgrade procedure.
- **Synchronous Mirroring and Asynchronous Mirroring**  
If your storage array participates in Synchronous Mirroring, only iSCSI or Fibre Channel connections are supported between the primary site and the remote site. If the host interface card (HIC) configuration in your new controllers does not include iSCSI or Fibre Channel connections, Synchronous Mirroring will not be supported.

For Asynchronous Mirroring, the local storage array and remote storage array can run different versions of firmware. The minimum firmware version supported is SANtricity firmware version 7.84.

- **Storage object limits**

If you change your controllers from 5x00 models to 2x00 models, your new storage array configuration will support lower numbers of some storage objects (for example, volumes) in the storage management software than your old configuration. You must make sure that your old configuration does not exceed the storage object limits. See [Netapp Hardware Universe](#) for more information.

### Upgrading to newer models

If you are replacing the controllers to upgrade to a new model, keep in mind that your current storage array might have premium features installed that the new model cannot support. For example, E2700 controllers do not support the legacy Snapshots premium feature.

If you replace E2600 controllers with E2700 controllers, and your storage array was using the legacy Snapshots feature, you must disable that feature and delete or convert all volumes (that is, snapshots, repositories) associated with that feature before you replace the controllers. You can convert legacy Snapshots to the updated Snapshots feature. Before you upgrade a controller-drive tray, you should disable any premium features used on your storage array that are not supported on the new controllers.

## Upgrade compatibility

Learn about the supported upgrade paths.

### From E2x00 to E2x00

- **Battery**- Reuse the old battery.
- **Vendor ID** - Additional steps required.
- **Feature Support** - Legacy snapshots are not supported on the E2700.
- **SAS-2 shelves**: E2800 controllers must not be placed into SAS-2 shelves.

### From E2x00 to E5x00

- **Battery**: Order a new battery.
- **Vendor ID**: Additional steps are required when upgrading from E2600 to E5500 or E5600, or when upgrading from E2700 to E5400.
- **Feature Support**: Legacy snapshots are not supported on the E5500 or E5600.  
Legacy RVM is not supported on the E5500 or E5600 with iSCSI HICs.  
Data Assurance is not supported on the E5500 or E5600 with iSCSI HICs.  
E5700 controllers must not be placed into SAS-2 shelves.
- **SAS-3 shelves**: E5400, E5500, and E5600 controllers must not be placed into SAS-3 shelves.

### From E5x00 to E2x00

- **Battery**: Order a new battery.
- **Vendor ID**: Additional steps are required when upgrading from E5500 or E5600 to E2600, or when upgrading from E5400 to E2700.

- **Feature Support:** Legacy snapshots are not supported on the E2700.
- **SAS-3 shelves:** E5400, E5500, and E5600 controllers must not be placed into SAS-3 shelves.

#### From E5x00 to o E5x00

- **Battery:** Reuse the old battery.
- **Vendor ID:** Additional steps required when upgrading from E5400 to E5500 or E5600.
- **Feature Support:** Legacy snapshots are not supported on the E5500 or E5600.  
Legacy RVM is not supported on the E5400 or E5500 with iSCSI HICs.  
Data Assurance is not supported on the E5400 or E5500 with iSCSI HICs.  
E5700 controllers must not be placed into SAS-2 shelves.
- **SAS-3 Shelves:** E5400, E5500, and E5600 controllers must not be placed into SAS-3 shelves.

#### From EF5x0 to EF5x0

- **Battery:** Reuse the old battery.
- **Vendor ID:** Additional steps required when upgrading from EF540 to EF550 or EF560.
- **Feature Support:** No Legacy Snapshots for EF550/EF560.  
No Data Assurance for EF550/EF560 with iSCSI.  
EF570 controllers must not be placed into SAS-3 shelves.
- **SAS-3 Shelves:** EF540, EF550, and EF560 controllers must not be placed into SAS-3 shelves.

#### SAS enclosures

The E5700 supports DE5600 and DE6600 SAS-2 enclosures via head upgrade. When utilizing a E5700 controller in SAS-2 enclosures, support for base host ports is disabled.

SAS-2 shelves	SAS-3 shelves
<p>SAS-2 shelves include the following models:</p> <ul style="list-style-type: none"> <li>• DE1600, DE5600, and DE6600 drive trays</li> <li>• E5400, E5500, and E5600 controller-drive trays</li> <li>• EF540, EF550 and EF560 flash arrays</li> <li>• E2600 and E2700 controller-drive trays</li> </ul>	<p>SAS-3 shelves include the following models:</p> <ul style="list-style-type: none"> <li>• E2800 controller shelves</li> <li>• E5700 controller shelves</li> <li>• DE212C, DE224C, DE460C drive shelves</li> </ul>

#### SAS-2 to SAS-3 investment protection

You can reconfigure your SAS-2 system to be used behind a new SAS-3 controller shelf (E57XX/EF570/E28XX).

**Attention:** This procedure requires an FPVR. To file an FPVR contact your sales team.

## Upgrade E-Series controllers

---

You can upgrade your storage array through the replacement of existing controllers. A controller consists of a board, firmware, and software. It controls the drives and implements the management software functions.

### Steps

1. [Prepare to upgrade controllers](#) on page 7  
You prepare to upgrade controllers by saving the drive security key, gathering support data, and taking the controller offline.
2. [Remove controllers](#) on page 10  
You remove controllers by disconnecting all cables and removing any SFP transceivers. Then, you can slide the controller canister out of the controller-drive tray.
3. [Install new controllers](#) on page 12  
After you have removed the old controllers, you can install new controllers in the controller-drive tray.
4. [Unlock drives](#) on page 14  
If you are upgrading E2800 and E5700 controllers, the drive security feature for these controllers result in the locking of drives whether partially, externally, or internally. If the drive security feature is enabled, these drives must be manually unlocked.
5. [Complete controller upgrade](#) on page 22  
You complete the controller upgrade by powering on the controller shelf and validating the controller software version. Then, you can collect support data and resume operations.
6. [Remount volumes after changing the vendor from LSI to NETAPP](#) on page 26  
You remount volumes if your controller upgrade results in changing the vendor ID from LSI to NETAPP.

## Prepare to upgrade controllers

You prepare to upgrade controllers by saving the drive security key, gathering support data, and taking the controller offline.

### Steps

1. Make sure that the existing storage array is updated to the latest released operating system (controller firmware) version available for your current controllers.  
  
**Note:** If you are upgrading to controllers that support SANtricity OS version 8.50, you must install the latest versions of SANtricity OS and the latest NVSRAM after you install and power on the new controllers. If you do not perform this upgrade, you might not be able to configure the storage array for Automatic Load Balancing (ALB).
2. If performing a complete controller replacement when using drive security, complete the following steps:

Security type and context	Steps
Internal key management, one or more drives locked	<ol style="list-style-type: none"> <li>a. Export the internal security key file to a known location on the management client (the system with a browser used for accessing System Manager). Use the <code>export storageArray securityKey</code> command. You must provide the pass phrase associated with the security key and specify the location where you want to save the command. For information about using this command, see the <i>Command Line Reference</i>.</li> <li>b. Know the pass phrase associated with the internal security key.</li> </ol>
External key management, all drives locked, you are able to transition to internal key management temporarily for the controller replacement (recommended).	<p>Perform the following steps, in order:</p> <ol style="list-style-type: none"> <li>a. Record the External KMS server address and port number using the <b>Settings &gt; System &gt; Security Key Management &gt; View/Edit Key Management Server Settings</b> dialog.</li> <li>b. Ensure that the client and server certificates are available on your local host so the storage array and key management server can authenticate each other after the controller replacement is finished. Use the <code>save storageArray keyManagementCertificate</code> command to save the certificates. Be sure to run the command twice, once with the <code>certificateType</code> parameter set to <code>client</code>, and the other with the parameter set to <code>server</code>. For information about using this command, see the <i>Command Line Reference</i>.</li> <li>c. Transition to internal key management by running the <code>disable storageArray externalKeyManagement</code> command.</li> <li>d. Export the internal security key file to a known location on the management client (the system with a browser used for accessing System Manager). Use the <code>export storageArray securityKey</code> command. You must provide the pass phrase associated with the security key and specify the location where you want to save the command. For information about using this command, see the <i>Command Line Reference</i>.</li> <li>e. Know the pass phrase associated with the internal security key.</li> </ol>
External key management, all drives locked, you are not able to transition to internal key management temporarily for the controller replacement.	<p>Perform the following steps, in order:</p> <ol style="list-style-type: none"> <li>a. Record the External KMS server address and port number using the <b>Settings &gt; System &gt; Security Key Management &gt; View/Edit Key Management Server Settings</b> dialog.</li> <li>b. Ensure that the client and server certificates are available on your local host so the storage array and key management server can authenticate each other after the controller replacement is finished. Use the <code>save storageArray keyManagementCertificate</code> command to save the certificates. Be sure to run the command twice, once with the <code>certificateType</code> parameter set to <code>client</code>, and the other with the parameter set to <code>server</code>. For information about using this command, see the <i>Command Line Reference</i>.</li> </ol>
External key management, partial drives locked	No additional steps are necessary.

### 3. Record the serial number for your storage array:



- a. Open SANtricity Storage Manager. In the **EMW** tree view, double-click your storage array to launch System Manager.
- b. From System Manager, select **Support > Support Center > Support Resources** tab.
- c. Scroll down to **Launch detailed storage array information**, and then select **Storage Array Profile**.

The Report appears on your screen.

- d. To locate the chassis serial number under the storage array profile, type **serial number** in the **Find** text box, and then click **Find**.

All matching terms are highlighted. To scroll through all the results one at a time, continue to click **Find**.

- e. Make a record of the Chassis Serial Number.

You need this serial number to perform the steps in [Complete controller upgrade](#) on page 22.

#### 4. Gather support data about your storage array by using either the GUI or the CLI:

- Use either System Manager or the Array Management Window to collect and save a support bundle of your storage array.
  - From System Manager, select **Support > Support Center > Diagnostics** tab. Then select **Collect Support Data** and click **Collect**.
  - From the Array Management Window toolbar, select **Monitor > Health > Collect Support Data Manually**. Then name and specify a location on your system where you want to store the support bundle.

The file is saved in the Downloads folder for your browser with the name `support-data.7z`.

If your shelf contains drawers, the diagnostics data for that shelf is archived in a separate zipped file named `tray-componet-state-capture.7z`.

- Use the CLI to run the `save storageArray supportData` command to gather comprehensive support data about the storage array.

**Note:** Gathering support data can temporarily impact performance on your storage array.

#### 5. Ensure that no I/O operations are occurring between the storage array and all connected hosts:

- Stop all processes that involve the LUNs mapped from the storage to the hosts.
- Ensure that no applications are writing data to any LUNs mapped from the storage to the hosts.
- Unmount all file systems associated with volumes on the array.

**Note:** The exact steps to stop host I/O operations depend on the host operating system and the configuration, which are beyond the scope of these instructions. If you are not sure how to stop host I/O operations in your environment, consider shutting down the host.

**Attention: Possible data loss** – If you continue this procedure while I/O operations are occurring, you might lose data.

6. If the storage array participates in a mirroring relationship, stop all host I/O operations on the secondary storage array.
7. If you are using asynchronous or synchronous mirroring, delete any mirrored pairs and deactivate any mirroring relationships through the System Manager or the Array Management window.

8. If there is a thin provisioned volume that is reported to the host as a thin volume and the old array is running firmware (8.25 firmware or above) that supports the UNMAP feature, disable Write Back Caching for all thin volumes:
  - a. From System Manager, select **Storage > Volumes**.
  - b. Select any volume, and then select **More > Change cache settings**.  
The Change Cache Setting dialog box appears. All volumes on the storage array appear in this dialog box.
  - c. Select the **Basic** tab and change the settings for read caching and write caching.
  - d. Click **Save**.
  - e. Wait five minutes to allow any data in cache memory to be flushed to disk.
9. If the Security Assertion Markup Language (SAML) is enabled on the controller, disable the SAML authentication.  
**Note:** After SAML is enabled, you cannot disable it through the SANtricity System Manager. To disable the SAML configuration, contact Technical Support for assistance.
10. Wait for all operations in progress to complete before continuing to the next step.
  - a. From System Manager's **Home** page, select **View Operations in Progress**.
  - b. Make sure all operations shown on the **Operations in Progress** window are complete before continuing.
11. Turn off power to the controller-drive tray.  
Wait for all of the LEDs on the controller-drive tray to go dark.
12. Turn off power to each drive tray that is connected to the controller-drive tray.  
Wait two minutes for all of the drives to spin down.

**After you finish**

Go to [Remove controllers](#) on page 10.

## Remove controllers

You remove controllers by disconnecting all cables and removing any SFP transceivers. Then, you can slide the controller canister out of the controller-drive tray.

**About this task**

If you are upgrading controllers in a duplex controller-drive tray, repeat all steps to remove the second controller canister.

**Steps**

1. [Step 1: Remove controller](#) on page 11  
Remove the controller canister so you can upgrade it with a new one. You must disconnect all cables and remove any SFP transceivers. Then, you can slide the controller canister out of the controller shelf.
2. [Step 2: Remove battery](#) on page 12  
Remove the battery only if you intend to use the battery from the old controller canister in the new controller canister.

## Step 1: Remove controller

You remove the controller canister so you can upgrade it with a new one. You must disconnect all cables and remove any SFP transceivers. Then, you can slide the controller canister out of the controller shelf.

### Before you begin

- You must have labels to identify each cable that is connected to the controller canister.

### Steps

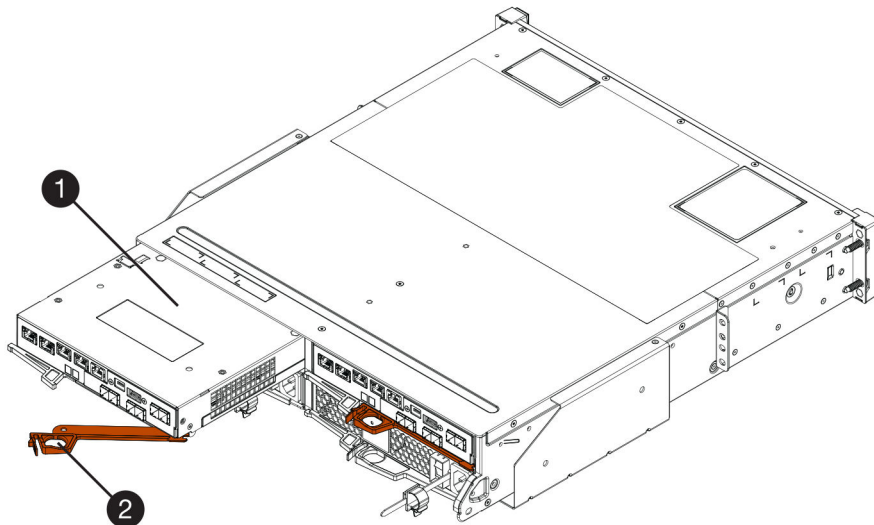
1. Put on an ESD wristband or take other antistatic precautions.
2. Label each cable that is attached to the old controller canister. Depending on the HIC configuration, you might be able to reconnect some cables after you replace the controller canister.
3. Disconnect all of the interface and Ethernet cables from the old controller canister.

If fiber-optic cables are present, you can use the two release levers to partially remove the controller canister. Opening these release levers makes it easier to press down the fiber-optic cable release tab.

**Attention:** To prevent degraded performance, do not twist, fold, pinch, or step on the cables.

4. If the old controller canister contains a Fibre Channel HIC or an InfiniBand HIC, remove the small form-factor pluggable (SFP+) transceivers (for Fibre Channel) or quad SFP (QSFP+) transceivers (for InfiniBand) from the HIC, and save them for possible reuse.
5. Remove controller A.
  - a. Unlock and rotate the release handles out to release the controller canister.
  - b. Using the release handles and your hands, pull the controller canister out of the controller-drive tray.

The following figure is an example of the general location for the release handles on controller models. Controller shelves and controller-drive trays have a similar configuration for the release handles.



- 1 Controller canister      2 Cam handle

6. Set the old controller canister on a flat, static-free surface near the controller-drive tray with the release levers up. Position the controller canister so that you can access the top cover.
7. (Conditional) If you are upgrading controllers in a duplex controller-drive tray, repeat all steps to remove the second controller canister.

#### After you finish

If you intend to use the battery from the old controller in the new controller, go to [Step 2: Remove battery](#) on page 12; otherwise go to [Install new controllers](#) on page 12.

## Step 2: Remove battery

You remove the battery only if you intend to use the battery from the old controller canister in the new controller canister.

#### Steps

1. Press down on both of the top cover latch buttons on the old controller canister, and slide the top cover to the rear of the canister.
2. Perform one of the following options, depending on your model of controller-drive tray, to release the old battery:
  - For the E2600 controller-drive tray or the E2700 controller-drive tray, unscrew the thumb screw that secures the battery to the controller canister.
  - For the E5400 controller-drive tray, the EF540 controller-drive tray, the E5500 controller-drive tray, the EF550 controller-drive tray, the E5600 controller-drive tray, or the EF560 controller-drive tray, release the tab that secures the battery to the controller canister.
3. Remove the battery by sliding it towards the rear of the old controller canister.

#### After you finish

Go to [Install new controllers](#) on page 12.

## Install new controllers

After you have removed the old controllers, you can install new controllers in the controller-drive tray.

#### About this task

If you are upgrading controllers in a duplex controller-drive tray, repeat all steps to install the second controller canister.

#### Steps

1. [Step 1: Install battery](#) on page 13  
Install the battery that you removed from the original controller canister or a new battery that you ordered.
2. [Step 2: Install new controller canister](#) on page 14  
Install the new controller canister into the controller shelf.

## Step 1: Install battery

You install the battery that you removed from the original controller canister or a new battery that you ordered.

### Before you begin

- You have the battery from the original controller canister or a new battery that you ordered.
- You have the new controller canister.

### About this task

Perform the following steps for each controller in the controller-drive tray.

### Steps

1. Unpack the new controller canister, and set it on a flat, static-free surface so that the removable cover faces up.
2. Press down on the cover button, and slide the cover off.
3. Orient the controller canister so that the slot for the battery faces toward you.
4. Depending on your controller model, do one of the following:
  - For E2600 or E2700 controller models:
    - a. Insert the battery circuit board by sliding it towards the front of the new controller canister.
    - b. Tighten the thumbscrew to secure the battery circuit board in the new controller canister card.
    - c. Reinstall the top cover on the new controller canister by sliding it forward until the top latch covers click.  
When the latch clicks into place, the bottom of the latch hooks into a metal slot on the chassis.
  - For other controller models:
    - a. Insert the battery into the new controller canister.  
Slide the battery into the canister, making sure it stays below the rivets on the wall of the new canister.
    - b. Keeping the locking handle at a 45 degree angle, align the connectors at the bottom of the battery with the connectors on the canister.
    - c. Push the battery down until you hear it click, and move the locking handle up to secure the controller battery to the controller canister.  
  
**Attention:** To make sure that the controller battery is seated correctly in an E5XX controller-drive tray, you might need to slide it out and insert it again. It is secure when you hear it click into place, and when the locking handle does not move out of its upright position when you wiggle it.
    - d. Reinstall the top cover on the new controller canister by sliding it forward until the top latch covers click.  
When the latch clicks into place, the bottom of the latch hooks into a metal slot on the chassis.
5. Turn the controller canister over to confirm that the battery is installed correctly.

**After you finish**

Go to [Step 2: Install new controller canister](#) on page 14.

**Step 2: Install new controller canister**

You install the new controller canister into the controller shelf.

**Steps**

1. Slide the new controller canister all the way into the controller-drive tray. Rotate the release levers towards the center of the controller canister to lock it into place.
2. If your new controller canister has a Fibre Channel HIC or an InfiniBand HIC, install the SFP+ transceivers (Fibre Channel) or QSFP+ transceiver (InfiniBand) into the controller canister.

Depending on the HICs involved in your upgrade, you might be able to reuse SFP+ transceiver or QSFP+ transceivers that you removed from your old controller canister.

3. Reconnect all of the cables between the controller-drive tray and the drive trays.

If the drive cabling configuration is the same as it was with your old controllers, use the labels that you attached to the cables to reconnect the cables correctly.

**Note:** If you are upgrading to E2700 controllers from an earlier model, the drive cabling configuration might be different from the configuration used for the old controllers.

**After you finish**

Go to [Complete controller upgrade](#) on page 22.

**Unlock drives**

If you are upgrading E2800 and E5700 controllers, the drive security feature for these controllers result in the locking of drives whether partially, externally, or internally. If the drive security feature is enabled, these drives must be manually unlocked.

**Choices**

- [Create internal security key](#) on page 15  
To use the Drive Security feature, you can create an internal security key that is shared by the controllers and secure-capable drives in the storage array. Internal keys are maintained on the controller's persistent memory.
- [Controller swap with internal key management and one or more drives secured](#) on page 16  
If you swap both controllers in a dual-controller system, or one controller in a simplex system, are using an internal security key, and one or more drives in the storage array are locked, you must import the appropriate security key to the new storage array. Importing the key allows you to unlock access to the drives.
- [Create external security key](#) on page 18  
To use the Drive Security feature with a key management server, you must create an external key that is shared by the key management server and the secure-capable drives in the storage array.
- [Controller swap with external key management and all drives secured](#) on page 20  
If you swap both controllers in a dual-controller system, or one controller in a simplex system, are using an external security key, and all drives in the storage array are locked, you must reestablish communication with the external key management server to unlock access to the drives.

## Create internal security key

To use the Drive Security feature, you can create an internal security key that is shared by the controllers and secure-capable drives in the storage array. Internal keys are maintained on the controller's persistent memory.

### Before you begin

- Secure-capable drives must be installed in the storage array. These drives can be Full Disk Encryption (FDE) drives or Federal Information Processing Standard (FIPS) drives.

### About this task

You define an identifier and a pass phrase to associate with the internal security key.

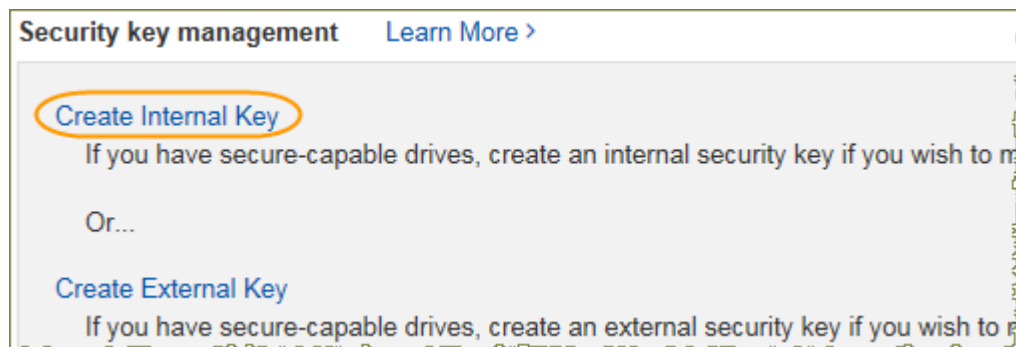
**Note:** The pass phrase for Drive Security is independent from the storage array's Administrator password.

The Drive Security feature must be enabled. Otherwise, a Cannot Create Security Key dialog box opens during this task. If necessary, contact your storage vendor for instructions on enabling the Drive Security feature.

**Note:** If both FDE and FIPS drives are installed in the storage array, they all share the same security key.

### Steps

- Select **Settings > System**.
- Under **Security key management**, select **Create Internal Key**.



If you have not yet generated a security key, the Create Security Key dialog box opens.

- Enter information in the following fields:
  - Define a security key identifier** – You can either accept the default value (storage array name and time stamp, which is generated by the controller firmware) or enter your own value. You can enter up to 189 alphanumeric characters without spaces, punctuation, or symbols.
 

**Note:** Additional characters are generated automatically, appended to both ends of the string you enter. The generated characters ensure that the identifier is unique.
  - Define a pass phrase/Re-enter pass phrase** – Enter and confirm a pass phrase. The value can have between 8 and 32 characters, and must include each of the following:
    - An uppercase letter (one or more). Keep in mind that the pass phrase is case sensitive.
    - A number (one or more).

- A non-alphanumeric character, such as !, \*, @ (one or more).

**Important:** Be sure to record your entries for later use. If you need to move a secure-enabled drive from the storage array, you must know the identifier and pass phrase to unlock drive data.

4. Click **Create**.

The security key is stored on the controller in a non-accessible location. Along with the actual key, there is an encrypted key file that is downloaded from your browser.

**Note:** The path for the downloaded file might depend on the default download location of your browser.

5. Record your key identifier, pass phrase, and the location of the downloaded key file, and then click **Close**.

### Result

You can now create secure-enabled volume groups or pools, or you can enable security on existing volume groups and pools.

**Note:** Whenever power to the drives is turned off and then on again, all the secure-enabled drives change to a Security Locked state. In this state, the data is inaccessible until the controller applies the correct security key during drive initialization. If someone physically removes a locked drive and installs it in another system, the Security Locked state prevents unauthorized access to its data.

### After you finish

You should validate the security key to make sure the key file is not corrupted.

## Controller swap with internal key management and one or more drives secured

If you swap both controllers in a dual-controller system, or one controller in a simplex system, are using an internal security key, and one or more drives in the storage array are locked, you must import the appropriate security key to the new storage array. Importing the key allows you to unlock access to the drives.

### Before you begin

**Note:** If you receive a seven-segment display lock-down code of L5 after performing a controller replacement of mixed secured drives with internal key management, contact technical support.

- For the drives that are locked in the storage array, you must know the security key identifier and the pass phrase.

**Note:** The pass phrase is not the same as the storage array's Administrator password.

- The security key file is available on the management client (the system with a browser used for accessing System Manager).
- You must first create a new internal security key on the new replacement controllers before importing the original security key that was in place on the array prior to the controller replacement.

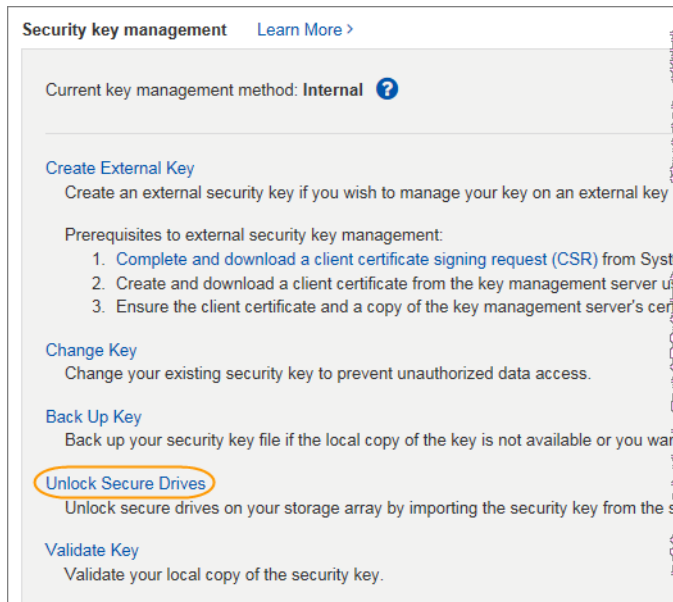
### About this task

After the array discovers the drives, a `Needs Attention` condition appears along with a status of `Security Key Needed` for these re-located drives. You can unlock drive data by importing their security key into the storage array. During this process, you select the security key identifier from a drop-down list, and then enter the pass phrase for the key.



## Steps

1. Import the security key that you saved in [Prepare to upgrade controllers](#) on page 7 by selecting the **Storage Array** menu and then selecting **Security > Drive Security > Import Key**.
  - If there were only secured drives (no unsecured drives) in the storage array, the controllers automatically reboot to complete the import operation. Wait for all controllers to boot up. When a controller finishes booting, its icon appears in the Enterprise Management Window (EMW).
2. Select **Settings > System**.
3. Under **Security key management**, select **Unlock Secure Drives**.



The Unlock Secure Drives dialog box opens.

4. From the drop-down list in the first field (click the arrow on the far right), select the security key identifier that is associated with the drives you want to unlock.
 

When you select an identifier, the associated drive information appears below the field and the **Browse** button becomes available. The drives are identified by shelf number, drawer number, and bay number.
5. Click **Browse**, and then select the security key file that corresponds to the identifier.
 

The key file you selected appears below the field.
6. Enter the pass phrase associated with this key file.
 

The characters you enter are masked.
7. Click **Unlock**.
 

If the unlock operation is successful, the dialog box displays the following message:

The associated secure drives have been unlocked.

When all drives are locked and then unlocked, each controller in the storage array reboots. However, if there are already some unlocked drives in the target storage array, then the controllers will not reboot.
8. If the storage array began with a mix of secured and unsecured drives, set the formerly secured drives to a native state:

- a. Run the `set drives=( trayID1,[drawerID1],[slotID1 ... trayIDn,  
[drawerIDn],[slotIDn] nativeState SMcli` command.

The drive you specify are the drives that were secured when you began the controller replacement.

- b. Reset all controllers using SANtricity System Manager.
- c. Wait for all controllers to boot up. When a controller has finished booting, it appears in the EMW.

## Create external security key

To use the Drive Security feature with a key management server, you must create an external key that is shared by the key management server and the secure-capable drives in the storage array.

### Before you begin

- Secure-capable drives must be installed in the array. These drives can be Full Disk Encryption (FDE) drives or Federal Information Processing Standard (FIPS) drives.
 

**Note:** If both FDE and FIPS drives are installed in the storage array, they all share the same security key.
- The Drive Security feature must be enabled. Otherwise, a Cannot Create Security Key dialog box opens during this task. If necessary, contact your storage vendor for instructions on enabling the Drive Security feature.
- The client and server certificates are available on your local host so the storage array and key management server can authenticate each other. The client certificate validates the controllers, while the server certificate validates the key management server.

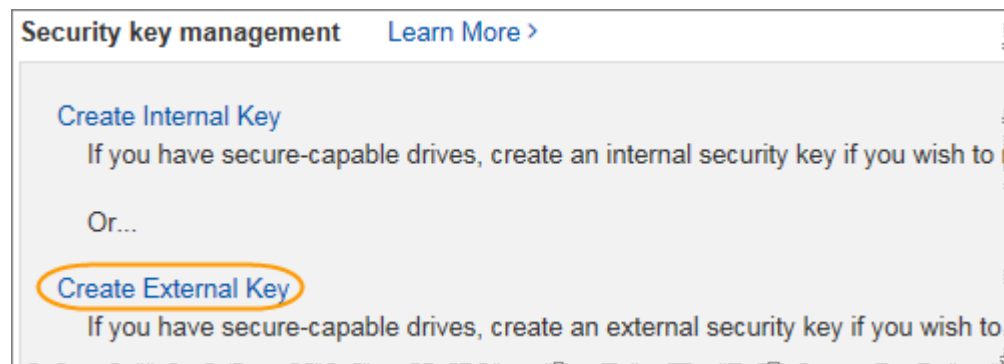
### About this task

In this task, you define the IP address of the key management server and the port number it uses, and then load certificates for external key management.

### Steps

1. Select **Settings > System**.
2. Under **Security key management**, select **Create External Key**.

**Note:** If internal key management is currently configured, a dialog box opens and asks you to confirm that you want to switch to external key management.



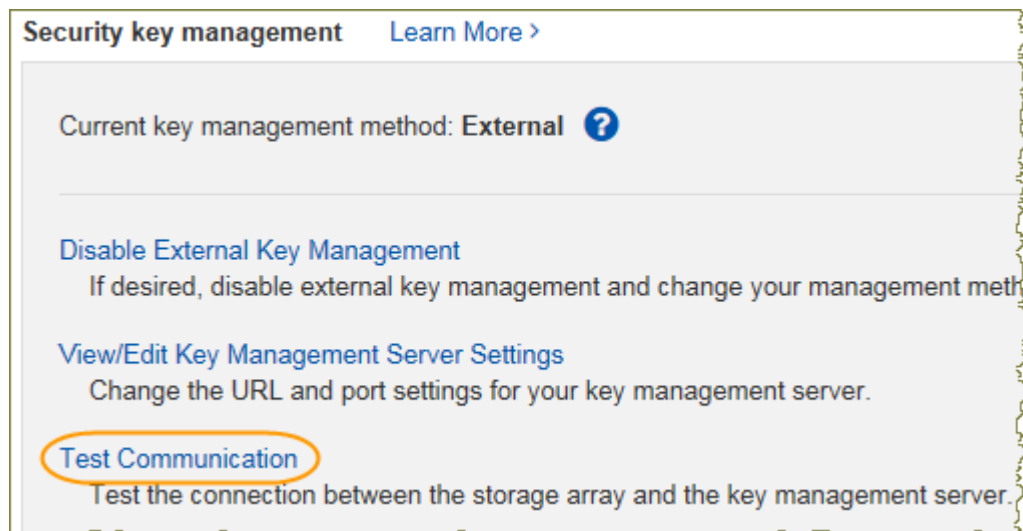
The Create External Security Key dialog box opens.

3. Under **Connect to Key Server**, enter information in the following fields:

- **Key management server address** – Enter the fully qualified domain name or the IP address (IPv4 or IPv6) of the server used for key management.
  - **Key management port number** – Enter the port number used for the Key Management Interoperability Protocol (KMIP) communications. The most common port number used for key management server communications is 5696.
  - **Select client certificate** – Click the first **Browse** button to select the certificate file for the storage array's controllers.
  - **Select key management server's server certificate** – Click the second **Browse** button to select the certificate file for the key management server.
4. Click **Next**.
  5. Under **Create/Backup Key**, enter information in the following field:
    - **Define a pass phrase/Re-enter pass phrase** – Enter and confirm a pass phrase. The value can have between 8 and 32 characters, and must include each of the following:
      - An uppercase letter (one or more). Keep in mind that the pass phrase is case sensitive.
      - A number (one or more).
      - A non-alphanumeric character, such as !, \*, @ (one or more).

**Important: Be sure to record your entries for later use.** If you need to move a secure-enabled drive from the storage array, you must know the pass phrase to unlock drive data.
  6. Click **Finish**.  
 The system connects to the key management server with the credentials you entered. A copy of the security key is then stored on your local system.  

**Note:** The path for the downloaded file might depend on the default download location of your browser.
  7. Record your pass phrase and the location of the downloaded key file, and then click **Close**.  
 The page displays the following message with additional links for external key management:  
 Current key management method: External
  8. Test the connection between the storage array and the key management server by selecting **Test Communication**.



Test results display in the dialog box.

### Result

When external key management is enabled, you can create secure-enabled volume groups or pools, or you can enable security on existing volume groups and pools.

**Note:** Whenever power to the drives is turned off and then on again, all the secure-enabled drives change to a Security Locked state. In this state, the data is inaccessible until the controller applies the correct security key during drive initialization. If someone physically removes a locked drive and installs it in another system, the Security Locked state prevents unauthorized access to its data.

### After you finish

- You should validate the security key to make sure the key file is not corrupted.

## Controller swap with external key management and all drives secured

If you swap both controllers in a dual-controller system, or one controller in a simplex system, are using an external security key, and all drives in the storage array are locked, you must reestablish communication with the external key management server to unlock access to the drives.

### Before you begin

- Both the External KMS and the controller are on the same subnet.
- You recorded the External KMS server address and port number in [Prepare to upgrade controllers](#) on page 7.
- You retrieved the client and server certificates and stored them on your local host in [Prepare to upgrade controllers](#) on page 7. These certificates are needed so the storage array and key management server can authenticate each other. The client certificate validates the controllers, while the server certificate validates the key management server.
- You know the pass phrase associated with the external security key.

### Steps

1. Select **Settings > System**.
2. Under **Connect to Key Server**, enter information in the following fields:
  - **Key management server address** – Enter the fully qualified domain name or the IP address (IPv4 or IPv6) of the server used for key management.
  - **Key management port number** – Enter the port number used for the Key Management Interoperability Protocol (KMIP) communications. The most common port number used for key management server communications is 5696.
  - **Select client certificate** – Click the first **Browse** button to select the certificate file for the storage array's controllers.
  - **Select key management server's server certificate** – Click the second **Browse** button to select the certificate file for the key management server.
3. Click **Next**.
4. Click **Finish**.

The system connects to the key management server with the credentials you entered. A copy of the security key is then stored on your local system.

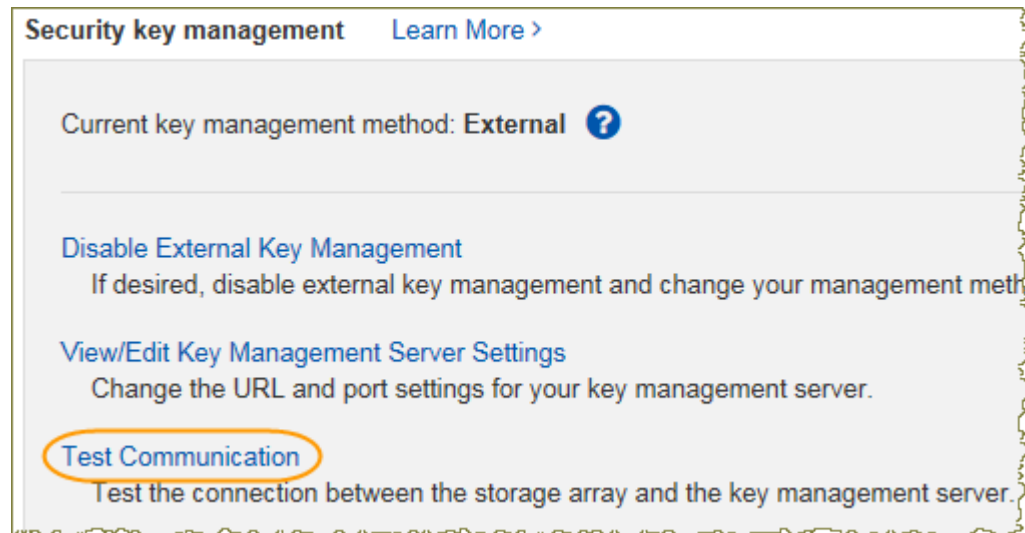
**Note:** The path for the downloaded file might depend on the default download location of your browser.

5. Record the location of the downloaded key file, and then click **Close**.

The page displays the following message with additional links for external key management:

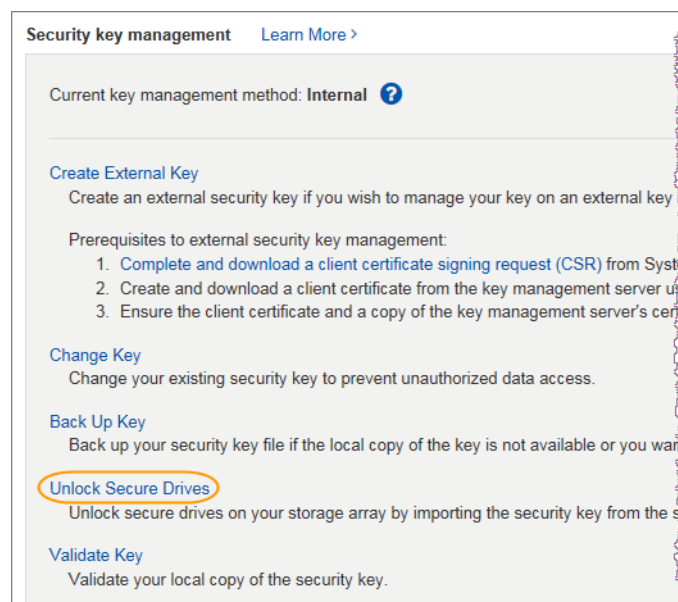
Current key management method: External

6. Test the connection between the storage array and the key management server by selecting **Test Communication**.



Test results display in the dialog box.

7. Select **Settings > System**.
8. Under **Security key management**, select **Unlock Secure Drives**.



The Unlock Secure Drives dialog box opens.

9. From the drop-down list in the first field (click the arrow on the far right), select the security key identifier that is associated with the drives you want to unlock.

When you select an identifier, the associated drive information appears below the field and the **Browse** button becomes available. The drives are identified by shelf number, drawer number, and bay number.

10. Click **Browse**, and then select the security key file that corresponds to the identifier.

The key file you selected appears below the field.

11. Enter the pass phrase associated with this key file.

The characters you enter are masked.

12. Click **Unlock**.

If the unlock operation is successful, the dialog box displays: "The associated secure drives have been unlocked."

### Result

When all drives are locked and then unlocked, each controller in the storage array will reboot. However, if there are already some unlocked drives in the target storage array, then the controllers will not reboot.

## Complete controller upgrade

You complete the controller upgrade by powering on the controller shelf and validating the controller software version. Then, you can collect support data and resume operations.

### About this task

If you are upgrading controllers in a duplex controller-drive tray, repeat all steps to complete the upgrade for the second controller.

### Steps

1. [Step 1: Power on controller](#) on page 22  
You must power on the controller shelf to confirm that it is working correctly.
2. [Step 2: Check status of controllers and trays](#) on page 24  
You can the LEDs and the storage management software to check the status of your controllers and trays.
3. [Step 3: Validate controller software version](#) on page 24  
You must sure that your new controllers are running with the correct operating system (controller firmware) level and NVSRAM.

## Step 1: Power on controller

You must power on the controller shelf to confirm that it is working correctly.

### Steps

1. Turn on the power switch on the rear of each drive tray that is connected to the controller-drive tray.
2. Wait two minutes for the drives to spin up.
3. Turn on the power switch on the rear of the controller-drive tray.
4. Wait three minutes for the power-up process to complete.

5. If you are performing a complete controller replacement for either E2800 or E5700 controllers, proceed to one of the following procedures based on your drive security scenario.

Complete controller replacement type	Procedure and prerequisites
All unsecured drives, neither External or Internal Key Management	Proceed to <a href="#">After you finish</a> on page 23.
Mix of secured and unsecured drives, Internal Key Management	<p>You first must create an internal security key and then import the security key manually to unlock the secured drives. After the drives are unlocked, you can access the drives.</p> <ol style="list-style-type: none"> <li><a href="#">Create internal security key</a> on page 15</li> <li><a href="#">Controller swap with internal key management and one or more drives secured</a> on page 16</li> </ol>
All secured drives, Internal Key Management	<a href="#">Controller swap with internal key management and one or more drives secured</a> on page 16
Mix of secured and unsecured drives, External Key Management	<p>Proceed to <a href="#">After you finish</a> on page 23.</p> <p><b>Attention:</b> After performing the controller replacement, the controllers will automatically resynchronize with the External Key Management Server and the drives will unlock and be accessible.</p> <p><b>Note:</b> If you receive a seven-segment display lock-down code of L5 after performing a controller replacement of mixed secured drives with internal key management, contact technical support.</p>
All secured drives, External Key Management, you have temporarily switched back to Internal Key Management for the controller replacement procedure	<p>You must first unlock the secured drives using the Internal Key Management procedure. After the drives are unlocked, then you transition back to External Key Management by creating a new external security key for the storage array.</p> <ol style="list-style-type: none"> <li><a href="#">Controller swap with internal key management and one or more drives secured</a> on page 16</li> <li><a href="#">Create external security key</a> on page 18</li> </ol>
All secured drives, External Key Management, you have not temporarily switched to Internal Key Management for the controller replacement procedure	<a href="#">Controller swap with external key management and all drives secured</a> on page 20

#### After you finish

Go to [Step 2: Check controller status](#) on page 24.

## Step 2: Check status of controllers and trays

You can use the LEDs and the storage management software to check the status of your controllers and trays.

### Steps

1. Look at the LEDs on controller A to make sure that it is booting correctly.  
 The Host Link Service Action Required LEDs turn green during the reboot. The seven-segment display shows the sequence OS+ Sd+ blank- to indicate that the controller is performing Start-of-day (SOD) processing.  
 After the controller successfully completes rebooting, the seven-segment display shows the tray ID matching the seven-segment display on the second controller. You can then discover the new controller canister by using the storage management software.
2. If any of the controller-drive tray's Service Action Required LEDs are *on*, or if the Controller Service Action Required LED is *on*:
  - a. Check that the controller canister has been installed correctly and that all of the cables are correctly seated. Reinstall the controller canister, if necessary.
  - b. Check the controller-drive tray's Service Action Required LEDs and the Controller Service Action Required LED again. If the problem is not corrected, contact technical support.
3. For a duplex configuration, repeat step 1 through step 2 for controller B.
4. Using the LEDs and the storage management software, check the status of all of the trays in the storage array. If any component has a Needs Attention status, use the Recovery Guru to troubleshoot. If the problem is not resolved, contact technical support.

### After you finish

Go to [Step 3: Validate controller software version](#) on page 24.

## Step 3: Validate controller software version

You must ensure that your new controllers are running with the correct operating system (controller firmware) level and NVSRAM.

### Steps

1. Do one of the following:
  - If you are upgrading to controllers that do not support SANtricity 11.30 and controller firmware 8.30, make sure that the version running on the new controllers matches the version that was last running on the original controllers. Normally, this will be the most recent release supported by the old controllers. If necessary, install the appropriate version on the new controllers.
  - If you are upgrading to controllers that run SANtricity 11.30 and controller firmware 8.30, download and install the latest NVSRAM after you power on the new controllers.
2. If your controller upgrade involves a protocol change (for example, Fibre Channel to iSCSI), and you already have hosts defined for your storage array, associate the new host ports with your hosts:
  - a. From System Manager, select **Storage > Host**.
  - b. Select the host to which the ports will be associated, and then click **View/Edit Settings**.



A dialog box appears that shows the current host settings.

- c. Click the **Host Ports** tab.

The dialog box shows the current host port identifiers.

- d. To update the host port identifier information associated with each host, replace the host port IDs from the old host adapters with the new host port IDs for the new host adapter.
- e. Repeat step d for each host.
- f. Click **Save**.

For information about compatible hardware, refer to the [NetApp Interoperability Matrix](#) and the [NetApp Hardware Universe](#).

3. Enable Write Back Caching for all thin volumes if it had been disabled in preparing for the headswap.
4. Enable SAML for the controller replacements if disabled in preparing for the headswap.
  - a. From System Manager, select the **SAML** tab, and then select the **Enable SAML** link.  
The **Confirm Enable SAML** dialog opens.
  - b. Type `enable`, and then click **Enable**.
  - c. Enter user credentials for an SSO login test.
5. Gather support data about your storage array by using either the GUI or the CLI:
  - Use either System Manager or the Array Management Window to collect and save a support bundle of your storage array.
    - From the System Manager, first select **Support > Support Center > Diagnostics** tab. Then select **Collect Support Data** and click **Collect**.
    - From the Array Management Window toolbar, select **Monitor > Health > Collect Support Data Manually**. Then name and specify a location on your system where you want to store the support bundle.

The file is saved in the Downloads folder for your browser with the name `support-data.7z`.

If your shelf contains drawers, the diagnostics data for that shelf is archived in a separate zipped file named `tray-componet-state-capture.7z`

- Use the CLI to run the `save storageArray supportData` command to gather comprehensive support data about the storage array.

**Note:** Gathering support data can temporarily impact performance on your storage array.

6. Alert NetApp Technical Support to the changes that you made to the configuration of your storage array.
  - a. Get the serial number of the controller-drive tray that you recorded in [Prepare to upgrade controllers](#) on page 7.
  - b. Log in to the NetApp support site at [mysupport.netapp.com/eservice/assistant](https://mysupport.netapp.com/eservice/assistant).
  - c. Select **Product Registration** from the drop-down list under **Category 1**.
  - d. Enter the following text in the **Comments** text box, substituting the serial number of your controller-drive tray for `serial number`:

Please create alert against Serial Number: *serial number*. The alert name should be "E-Series Upgrade". The alert text should read as follows:

"Attention: The controllers in this system have been upgraded from the original configuration. Verify the controller configuration before ordering replacement controllers and notify dispatch that the system has been upgraded."

- e. Click the **Submit** button at the bottom of the form.

#### After you finish

If your controller upgrade results in changing the vendor ID from LSI to NETAPP, go to [Remount volumes after changing the vendor from LSI to NETAPP](#) on page 26; otherwise your controller upgrade is complete and you can resume normal operations.

## Remount volumes after changing the vendor from LSI to NETAPP

You remount volumes if your controller upgrade results in changing the vendor ID from LSI to NETAPP.

#### Choices

- [Remounting volumes on an AIX host](#) on page 26  
After you replace the controllers, you might observe that host shows the new volumes on the storage array, but also shows the original volumes as failed.
- [Remounting volumes on a VMware host](#) on page 26  
You address problems that might appear on VMware hosts after the controller upgrade.
- [Remounting volumes on a Windows host](#) on page 27  
You remount volumes on a Windows host to enable attached hosts to perform I/O operations with the volumes located on the upgraded storage array.

### Remounting volumes on an AIX host

After you replace the controllers, you might observe that host shows the new volumes on the storage array, but also shows the original volumes as failed.

#### Step

1. If failed volumes appear, run the `cfgmgr` command.

### Remounting volumes on a VMware host

You address problems that might appear on VMware hosts after the controller upgrade.

#### About this task

After you replace the controllers, you might observe the following conditions:

- VMware shows new paths for the volumes on the storage array, but also shows the original paths as dead paths.
- The hosts still list the volumes on the storage array as having LSI vendor IDs. This might occur when the volumes were claimed by the LSI rule at the start and so continue to use the same LSI rule when the volumes come back on line.

- The Display Name does not reflect the change from LSI to NetApp. This might occur because the display name became free test after initial discovery. In this case, you can change the Display Name manually.

### Steps

1. Perform a rescan on the each host.
2. Halt all host I/O operations to this subsystem.
3. Reclaim the volumes under NetApp rule.
  - a. Run the `esxcli storage core device list` command. Check the output from the command to identify volumes whose names have the form `aa.xxxx`.
  - b. Run the command `do esxcli storage core claiming reclaim -d naa.xxxxxx` to change the LSI vendor ID to NetApp.

## Remounting volumes on a Windows host

You remount volumes on a Windows host to enable attached hosts to perform I/O operations with the volumes located on the upgraded storage array.

### Steps

1. In the **Device Manager**, select **Show Hidden Devices**.
2. For each NETAPP SCSI Disk Device listed in the **Device Manager**, right-click on the entry, and select **Uninstall**.  
  
If Windows displays a dialog box with a message indicating that you should reboot the host, finish uninstalling all of the volumes before you scan for hardware and reboot.
3. Right-click in the **Device Manager**, and select **Scan for Hardware Changes**.
4. Reboot the host.

## Reconfigure a SAS-2 system behind a new SAS-3 controller shelf without data preservation

---

You can convert the controller shelf in an approved SAS-2 array (E2700, E550/EF5500, E5600/EF560) to a drive shelf and then place that shelf and any associated approved SAS-2 drive shelves (DE1600, DE5600, DE6600) behind a new approved SAS-3 array (E2800, E5700/EF570) and approved SAS-3 drive shelves (DE212C, DE224C, DE460C) without data preservation.

### About this task

Due to the complexity of this procedure, the following is required:

- This procedure requires an FPVR. To file an FPVR contact NetApp Professional Services.
  - Note:** Failure to acquire an FPVR before attempting this procedure can result in drive failure and controller lock down.
- If you are able to back up your data, you can perform this procedure without assistance from NetApp Professional Services.
- If you cannot back up your data, contact NetApp Professional Services for assistance with this procedure.
- Make sure both of your arrays are prepared for the procedure:
  - **Existing array:** Existing array with SANtricity OS 8.25 or later that is powered up.
  - **New array:** New array unpacked and powered down.
- Record the serial number from the SAS-2 controller shelf that you will be converting to a drive shelf.

### Steps

1. [Step 1: Power down the controllers \(non-data preservation\)](#) on page 28  
All operations must be shut down before you can power down the controllers.
2. [Step 2: Install the controllers \(non-data preservation\)](#) on page 29  
Upon successful shut down, you can replace the controllers in the array.
3. [Step 3: Power on the controllers \(non-data preservation\)](#) on page 29  
After installation is complete, power on the controllers and submit your configuration changes to NetApp Technical Support.

## Step 1: Power down the controllers (non-data preservation)

All operations must be shut down before you can power down the controllers.

### Steps

1. If the existing SAS-2 array is still accessible, delete all volume groups, power down both controllers, and remove all cables.
2. Record the serial number from the SAS-2 controller shelf that you will be converting to a drive shelf.
3. If drive security is in use for the existing array, ensure that the security key is available.

#### After you finish

Go to [Step 2: Power down the controllers \(non-data preservation\)](#) on page 29.

## Step 2: Install the controllers (non-data preservation)

Upon successful shut down, you can replace the controllers in the array.

#### Steps

1. Replace both controllers in the existing array with IOMs or ESMs.
2. If possible, use the host cables and network cables from the existing array and connect them to the controllers in the new array.  
**Note:** Depending on the host connections of your new array, different cables may be required.
3. Cable the drive shelves behind the controllers in the new array.

The existing controller-drive tray and any attached drive trays become drive shelves and can be cabled to the controllers in the new array.

**Note:** Connecting SAS-2 to SAS-3 requires SAS HD to miniSAS cables. For more detailed cabling information for your particular controller and expansion shelf configuration, refer to the [E-Series Hardware Cabling Guide](#).

#### After you finish

Go to [Step 3: Power on the controllers \(non-data preservation\)](#) on page 29.

## Step 3: Power on the controllers (non-data preservation)

After installation is complete, power on the controllers and submit your configuration changes to NetApp Technical Support.

#### Steps

1. Power up the new array including any attached drive shelves.
2. Configure the management port and the IP addresses by installing the [SANtricity Quick Connect](#) utility.
3. If drive security was in use on the existing array, import the security key.
4. If you were unable to delete the volume groups from your existing array before performing this procedure, you must set all foreign drives to appear as native. For detailed information on how to set drives to native, refer to the SANtricity Online Help.
5. Send your configuration changes to NetApp Technical Support.
  - a. Get the serial number of the old controller-drive tray that you recorded in Step 2.
  - b. Log in to the NetApp Support Site: [mysupport.netapp.com/eservice/assistant](https://mysupport.netapp.com/eservice/assistant).
  - c. From the drop-down list under **Category 1** on the **Give Us Feedback** page, select **Installed products**.
  - d. From the drop-down list under **Category 2** on the **Give Us Feedback** page, select **Decommission request**.

- e. Enter the following text in the **Comments** text box, substituting the serial number of your controller-drive tray for *serial number*:

Please decommission this serial number as the entitlement has been moved to another serial number in the system. Please reference this in the SN notes.

- f. Select **Submit**.

### **Result**

The completed SAS-2 to SAS-3 configuration changes are submitted to NetApp Technical Support.

## Copyright

---

Copyright © 2019 NetApp, Inc. All rights reserved. Printed in the U.S.

No part of this document covered by copyright may be reproduced in any form or by any means—graphic, electronic, or mechanical, including photocopying, recording, taping, or storage in an electronic retrieval system—without prior written permission of the copyright owner.

Software derived from copyrighted NetApp material is subject to the following license and disclaimer:

THIS SOFTWARE IS PROVIDED BY NETAPP "AS IS" AND WITHOUT ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, WHICH ARE HEREBY DISCLAIMED. IN NO EVENT SHALL NETAPP BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

NetApp reserves the right to change any products described herein at any time, and without notice. NetApp assumes no responsibility or liability arising from the use of products described herein, except as expressly agreed to in writing by NetApp. The use or purchase of this product does not convey a license under any patent rights, trademark rights, or any other intellectual property rights of NetApp.

The product described in this manual may be protected by one or more U.S. patents, foreign patents, or pending applications.

Data contained herein pertains to a commercial item (as defined in FAR 2.101) and is proprietary to NetApp, Inc. The U.S. Government has a non-exclusive, non-transferrable, non-sublicensable, worldwide, limited irrevocable license to use the Data only in connection with and in support of the U.S. Government contract under which the Data was delivered. Except as provided herein, the Data may not be used, disclosed, reproduced, modified, performed, or displayed without the prior written approval of NetApp, Inc. United States Government license rights for the Department of Defense are limited to those rights identified in DFARS clause 252.227-7015(b).

## Trademark

---

NETAPP, the NETAPP logo, and the marks listed on the NetApp Trademarks page are trademarks of NetApp, Inc. Other company and product names may be trademarks of their respective owners.

<http://www.netapp.com/us/legal/netapptmlist.aspx>



## How to send comments about documentation and receive update notifications

---

You can help us to improve the quality of our documentation by sending us your feedback. You can receive automatic notification when production-level (GA/FCS) documentation is initially released or important changes are made to existing production-level documents.

If you have suggestions for improving this document, send us your comments by email.

[doccomments@netapp.com](mailto:doccomments@netapp.com)

To help us direct your comments to the correct division, include in the subject line the product name, version, and operating system.

If you want to be notified automatically when production-level documentation is released or important changes are made to existing production-level documents, follow Twitter account @NetAppDoc.

You can also contact us in the following ways:

- NetApp, Inc., 1395 Crossman Ave., Sunnyvale, CA 94089 U.S.
- Telephone: +1 (408) 822-6000
- Fax: +1 (408) 822-4501
- Support telephone: +1 (888) 463-8277