ONTAP® 9

NetApp® Encryption Power Guide

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NetApp®

Contents

Deciding whether to use the NetApp Encryption Power Guide

NetApp offers both software- and hardware-based encryption technologies for ensuring that data at rest cannot be read if the storage medium is repurposed, returned, misplaced, or stolen.

- Software-based NetApp Volume Encryption (NVE) supports data encryption one volume at a time.
- Hardware-based NetApp Storage Encryption (NSE) supports full-disk encryption (FDE).

You should use this guide if you want to work with encryption in the following way:

- You want to use best practices, not explore every available option.
- You do not want to read a lot of conceptual background.
- You want to use the ONTAP command-line interface (CLI), not OnCommand System Manager or an automated scripting tool.
  The encryption technologies are not supported by System Manager.

If this guide is not suitable for your situation, you should see the following documentation instead:

- *ONTAP 9 commands*
- *NetApp Documentation: OnCommand Workflow Automation (current releases)*

Configuring NetApp Volume Encryption

NetApp Volume Encryption (NVE) is a software-based technology for encrypting data at rest one volume at a time. An encryption key accessible only to the storage system ensures that volume data cannot be read if the underlying device is repurposed, returned, misplaced, or stolen.

Understanding NVE

Both data, including Snapshot copies, and metadata are encrypted. Access to the data is given by a unique XTS-AES-256 key, one per volume. An external key management server or Onboard Key Manager serves keys to nodes:

- The external key management server is a third-party system in your storage environment that serves keys to nodes using the Key Management Interoperability Protocol (KMIP).
- The Onboard Key Manager is a built-in tool that serves keys to nodes from the same storage system as your data.

You can enable encryption on a new or existing volume. NVE supports the full range of storage efficiency features, including deduplication and compression.

You can use NVE on any type of aggregate (HDD, SSD, hybrid, array LUN), with any RAID type, and in any supported ONTAP implementation, including ONTAP Select. You can also use NVE with NetApp Storage Encryption (NSE) to “double encrypt” data on NSE drives.

When to use KMIP servers

Although it is less expensive and typically more convenient to use the onboard key manager, you should set up KMIP servers if any of the following are true:

- Your encryption key management solution must comply with Federal Information Processing Standards (FIPS) 140-2 or the OASIS KMIP standard.
- You need a multi-cluster solution.

  KMIP servers support multiple clusters with centralized management of encryption keys.
- Your business requires the added security of storing authentication keys on a system or in a location different from the data.

  KMIP servers store authentication keys separately from your data.

Support details

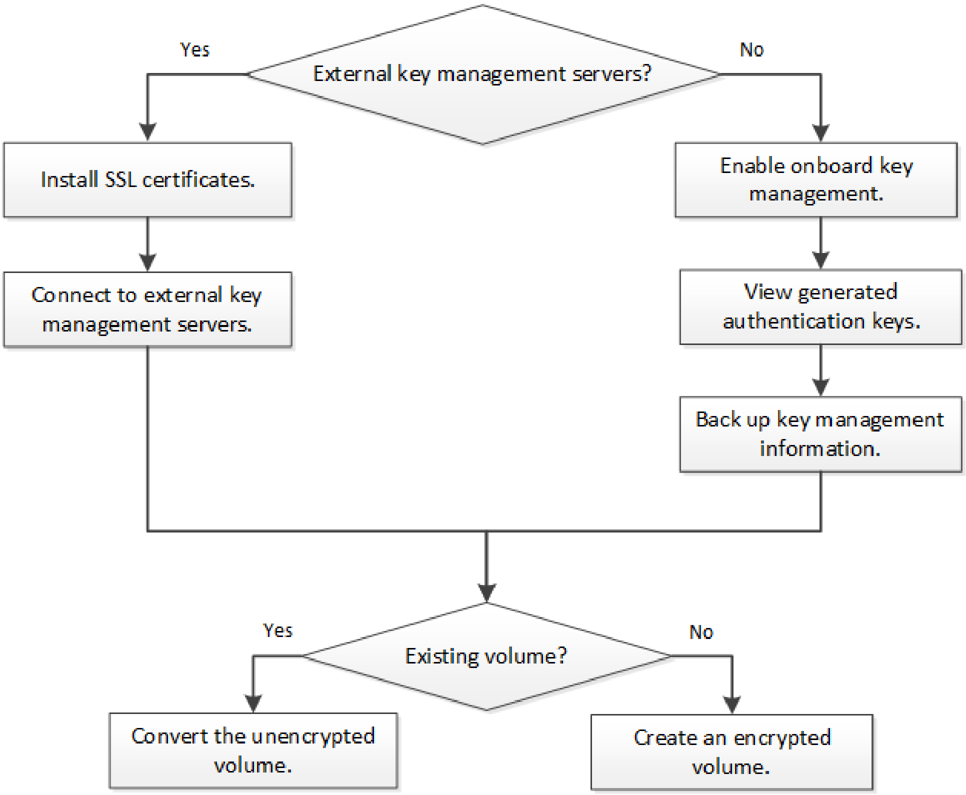
The following table shows NVE support details.

Resource or feature	Support details
Platforms	AES-NI offload capability required: see the Hardware Universe (HWU) to verify that NetApp Volume Encryption is supported for your platform.
ONTAP	All ONTAP implementations. Support for ONTAP Cloud is available in ONTAP 9.5 and later.
Devices	HDD, SSD, hybrid, array LUN.
RAID	RAID0, RAID4, RAID-DP, RAID-TEC.
Volumes	Data volumes only. You cannot encrypt data on a root volume, an SVM root volume, or a MetroCluster metadata volume.
Storage efficiency	Deduplication, compression, compaction, FlexClone. Clones use the same key as the parent, even after splitting the clone from the parent. You are warned to rekey the split clone.

Resource or feature	Support details
Replication	• For volume replication, the destination volume must have been enabled for encryption. • For SVM replication, the destination volume is automatically encrypted, unless the destination does not contain a node that supports volume encryption, in which case replication succeeds, but the destination volume is not encrypted. • For MetroCluster configurations, keys and passphrases are replicated to the partner site by the configuration replication service (CRS).
Compliance	Starting with ONTAP 9.2, SnapLock is supported.
FlexGroups	Starting with ONTAP 9.2, FlexGroups are supported.
7-Mode transition	Starting with 7-Mode Transition Tool 3.3, you can use the 7-Mode Transition Tool CLI to perform copy-based transition to NVE-enabled destination volumes on the clustered system.

NetApp Volume Encryption workflow

You must configure key management services before you can enable volume encryption. You can enable encryption on a new volume or on an existing volume.


External key management servers?
Yes
No
Install SSL certificates.
Connect to external key management servers.
Enable onboard key management.
View generated authentication keys.
Back up key management information.
Existing volume?
Yes
No
Convert the unencrypted volume.
Create an encrypted volume.

Configuring NVE

You must install the NVE license and configure key management services before you can encrypt data with NVE. Before installing the license, you should determine whether your ONTAP version supports NVE.

Determining whether your cluster version supports NVE

You should determine whether your cluster version supports NVE before you install the license. You can use the `version` command to determine the cluster version.

About this task

The cluster version is the lowest version of ONTAP running on any node in the cluster.

Step

1. Determine whether your cluster version supports NVE:

   `version -v`

   NVE is not supported if the command output displays the text “no-DARE” (for “no Data At Rest Encryption”), or if you are using a platform that is not listed in *Support details* on page 6.

   Example

   The following command determines whether NVE is supported on **`cluster1`**.

   ```
   cluster1::> version -v
   NetApp Release 9.1.0: Tue May 10 19:30:23 UTC 2016 <1no-DARE>
   ```

   The text “1no-DARE” in the command output indicates that NVE is not supported on your cluster version.

Installing the license

An NVE license entitles you to use the feature on all nodes in the cluster. You must install the license before you can encrypt data with NVE.

Before you begin

You must be a cluster administrator to perform this task.

About this task

You should have received the NVE license key from your sales representative.

Steps

1. Install the NVE license for a node:

   `system license add -license-code` ***`license_key`***

   Example

   The following command installs the license with the key **AAAAAAAAAAAAAAAAAAAAAAAAAAAA**.

   ```
   cluster1::> system license add -license-code AAAAAAAAAAAAAAAAAAAAAAAAAAAA
   ```

2. Verify that the license is installed by displaying all the licenses on the cluster:

   ```
   system license show
   ```

   For complete command syntax, see the man page for the command.

   #### Example

   The following command displays all the licenses on **cluster1**:

   ```
   cluster1::> system license show
   ```

   The NVE license package name is "VE".

Configuring external key management

You can use one or more external key management servers to secure the keys that the cluster uses to access encrypted data. An external key management server is a third-party system in your storage environment that serves keys to nodes using the Key Management Interoperability Protocol (KMIP).

Note: For ONTAP 9.1 and earlier versions, node management LIFs must be assigned to ports that are configured with the node management role before you can use the external key manager.

Installing SSL certificates on the cluster

The cluster and KMIP server use KMIP SSL certificates to verify each other's identity and establish an SSL connection. Before configuring the SSL connection with the KMIP server, you must install the KMIP client SSL certificates for the cluster, and the SSL public certificate for the root certificate authority (CA) of the KMIP server.

Before you begin

- The time must be synchronized on the server creating the certificates, the KMIP server, and the cluster.
- You must have obtained the public SSL KMIP client certificate (`client.pem`) for the cluster.
- You must have obtained the private SSL KMIP client certificate (`client_private.pem`) for the cluster.
  The SSL KMIP client certificate must not be password-protected.
- You must have obtained the SSL public certificate for the root certificate authority (CA) (`key_management_server_ipaddress_CA.pem`) of the KMIP server.

Note: You can install the client and server certificates on the KMIP server before or after installing the certificates on the cluster.

About this task

In an HA pair, both nodes must use the same public and private KMIP SSL certificates. If you connect multiple HA pairs to the same KMIP server, all nodes in the HA pairs must use the same public and private KMIP SSL certificates.

Steps

1. Install the SSL KMIP client certificates for the cluster:

   ```
   security certificate install -vserver admin_svm_name -type client -
   subtype kmip-cert
   ```

   You are prompted to enter the SSL KMIP public and private certificates.

Example

```
cluster1::> security certificate install -vserver svm1 -type client -
subtype kmip-cert
```

2. Install the SSL public certificate for the root certificate authority (CA) of the KMIP server:

   ```
   security certificate install -vserver admin_svm_name -type server-ca -
   subtype kmip-cert
   ```

   Example

   ```
   cluster1::> security certificate install -vserver svm1 -type server-ca -
   subtype kmip-cert
   ```

Enabling external key management in ONTAP 9.3 and later

You can use one or more KMIP servers to secure the keys the cluster uses to access encrypted data. You can connect up to four KMIP servers to a node. A minimum of two servers is recommended for redundancy and disaster recovery.

Before you begin

- The KMIP SSL client and server certificates must have been installed.
- You must be a cluster administrator to perform this task.

About this task

ONTAP configures KMIP server connectivity for all nodes in the cluster.

Note: NVE support for KMIP server authentication is available starting in ONTAP 9.3.

Steps

1. If you are upgrading to ONTAP 9.3 from a previous version, delete any external key management configurations for the cluster:

   ```
   security key-manager delete-kmip-config
   ```

   Example

   The following command deletes the external key management configurations for **`cluster1`**:

   ```
   cluster1::> security key-manager delete-kmip-config
   ```

2. Configure key manager connectivity for cluster nodes:

   ```
   security key-manager setup
   ```

   The key manager setup wizard opens.

3. Enter the appropriate response at each prompt.

4. Add a KMIP server:

   ```
   security key-manager add -address key_management_server_ipaddress
   ```

   Example

   ```
   clusterl::> security key-manager add -address 20.1.1.1
   ```

5. Add an additional KMIP server for redundancy:

   ```
   security key-manager add -address key_management_server_ipaddress
   ```

Example

```
clusterl::> security key-manager add -address 20.1.1.2
```

6. Verify that all configured KMIP servers are connected:

   `security key-manager show -status`

   For complete command syntax, see the man page.

   Example

```
cluster1::> security key-manager show -status

Node            Port      Registered Key Manager  Status
--------------  ----      ----------------------  ---------------
cluster1-01     5696      20.1.1.1                available
cluster1-01     5696      20.1.1.2                available
cluster1-02     5696      20.1.1.1                available
cluster1-02     5696      20.1.1.2                available
```

Enabling onboard key management (NVE)

You can use the Onboard Key Manager to secure the keys that the cluster uses to access encrypted data. You must enable Onboard Key Manager on each cluster that accesses an encrypted volume or a self-encrypting disk (SED).

Before you begin

- If you are using NSE with an external key management (KMIP) server, you must have deleted the external key manager database.

  Transitioning to onboard key management from external key management on page 53
- You must be a cluster administrator to perform this task.

About this task

You must run the `security key-manager setup` command each time you add a node to the cluster. In MetroCluster configurations, you must run `security key-manager setup` on the local cluster first, then on the remote cluster, using the same passphrase on each. Starting with ONTAP 9.5, you must run `security key-manager setup` and `security key-manager setup -sync-metrocluster-config yes` on the local cluster and it will synchronize with the remote cluster.

By default, you are not required to enter the key manager passphrase when a node is rebooted. Starting with ONTAP 9.4, you can use the `-enable-cc-mode true` option to require that users enter the passphrase after a reboot.

Note: After a failed passphrase attempt, you must reboot the node again.

Starting with ONTAP 9.5, ONTAP Key Manager supports Trusted Platform Module (TPM). TPM is a secure crypto processor and micro-controller designed to provide hardware-based security. Support for TPM is automatically enabled by ONTAP on detection of the TPM device driver. If you are upgrading to ONTAP 9.5, you must create new encryption keys for your data after enabling TPM support.

Steps

1. Start the key manager setup wizard:

   `security key-manager setup -enable-cc-mode true|false`

Example

The following example starts the key manager setup wizard on cluster1 without requiring that the passphrase be entered after every reboot:

```
cluster1::> security key-manager setup
Welcome to the key manager setup wizard, which will lead you through
the steps to add boot information.

...

Would you like to use onboard key-management? {yes, no} [yes]:
Enter the cluster-wide passphrase:    <32..256 ASCII characters long text>
Reenter the cluster-wide passphrase:    <32..256 ASCII characters long text>
```

2. Enter

   `yes`
   at the prompt to configure onboard key management.

3. At the passphrase prompt, enter a passphrase between 32 and 256 characters, or for “cc-mode”, a passphrase between 64 and 256 characters.

   Note: If the specified “cc-mode” passphrase is less than 64 characters, there is a five-second delay before the key manager setup wizard displays the passphrase prompt again.

4. At the passphrase confirmation prompt, reenter the passphrase.

5. Verify that keys are configured for all nodes:

   `security key-manager key show`

   For the complete command syntax, see the man page.

Example

```
cluster1::> security key-manager key show

Node: node1
Key Store: onboard
Key ID                                                           Used By
---------------------------------------------------------------- --------
0000000000000000020000000000010059851742AF2703FC91369B7DB47C4722 NSE-AK
000000000000000002000000000001008C07CC0AF1EF49E0105300EFC83004BF NSE-AK

Node: node2
Key Store: onboard
Key ID                                                           Used By
---------------------------------------------------------------- --------
0000000000000000020000000000010059851742AF2703FC91369B7DB47C4722 NSE-AK
000000000000000002000000000001008C07CC0AF1EF49E0105300EFC83004BF NSE-AK
```

After you finish

Copy the passphrase to a secure location outside the storage system for future use.

All key management information is automatically backed up to the replicated database (RDB) for the cluster. You should also back up the information manually for use in case of a disaster.

Related tasks

Backing up onboard key management information manually on page 40

Volume data encryption with NVE

You can enable encryption on a new volume or on an existing volume. You must have installed the NVE license and enabled key management before you can enable volume encryption. NVE is FIPS-140-2 level 1 compliant.

Enabling encryption on a new volume

You can use the `volume create` command to enable encryption on a new volume.

About this task

Starting with ONTAP 9.2, you can enable encryption on a SnapLock volume.

Steps

1. Create a new volume and enable encryption on the volume:

   `volume create -vserver` ***`SVM_name`*** **`-volume`** ***`volume_name`*** **`-aggregate`** ***`aggregate_name`*** **`-encrypt true`**

   For complete command syntax, see the man page for the command.

   Example

   The following command creates a volume named **`vol1`** on **`aggr1`** and enables encryption on the volume:

   ```
   cluster1::> volume create -vserver vs1 -volume vol1 -aggregate aggr1 -
   encrypt true
   ```

   The system creates an encryption key for the volume. Any data you put on the volume is encrypted.

2. Verify that the volume is enabled for encryption:

   `volume show -is-encrypted true`

   For complete command syntax, see the man page for the command.

   Example

   The following command displays the encrypted volumes on **`cluster1`**:

   ```
   cluster1::> volume show -is-encrypted true

   Vserver  Volume  Aggregate  State  Type  Size  Available  Used
   -------  ------  ---------  -----  ----  -----  --------- ----
   vs1      vol1    aggr2     online    RW  200GB    160.0GB  20%
   ```

Enabling encryption on an existing volume with the volume encryption conversion start command

Starting with ONTAP 9.3, you can use the `volume encryption conversion start` command to enable encryption on an existing volume.

About this task

Once you start a conversion operation, it must complete. If you encounter a performance issue during the operation, you can run the `volume encryption conversion pause` command to pause the operation, and the `volume encryption conversion restart` command to resume the operation.

> **Note:** You cannot use `volume encryption conversion start` to convert a SnapLock or FlexGroup volume.

Steps

1. Enable encryption on an existing volume:

   `volume encryption conversion start -vserver` ***`SVM_name`*** **`-volume`** ***`volume_name`***

   For complete command syntax, see the man page for the command.

   #### Example

   The following command enables encryption on the existing volume **`vol1`**:

   ```
   cluster1::> volume encryption conversion start -vserver vs1 -volume
   vol1
   ```

   The system creates an encryption key for the volume. The data on the volume is encrypted.

2. Verify the status of the conversion operation:

   `volume encryption conversion show`

   For complete command syntax, see the man page for the command.

   #### Example

   The following command displays the status of the conversion operation:

   ```
   cluster1::> volume encryption conversion show

   Vserver   Volume   Start Time           Status
   -------   ------   ------------------   ---------------------------
   vs1       vol1     9/18/2017 17:51:41   Phase 2 of 2 is in progress.
   ```

3. When the conversion operation is complete, verify that the volume is enabled for encryption:

   `volume show -is-encrypted true`

   For complete command syntax, see the man page for the command.

   #### Example

   The following command displays the encrypted volumes on **`cluster1`**:

   ```
   cluster1::> volume show -is-encrypted true

   Vserver  Volume  Aggregate  State  Type  Size  Available  Used
   -------  ------  ---------  -----  ----  -----  --------- ----
   vs1      vol1    aggr2     online    RW  200GB    160.0GB  20%
   ```

Result

If you are using a KMIP server to authenticate nodes to the system, ONTAP automatically “pushes” an authentication key to the server when you encrypt a volume.

Enabling encryption on an existing volume with the volume move start command

You can use the `volume move start` command to enable encryption on an existing volume. You must use `volume move start` in ONTAP 9.2 and earlier. You can use the same aggregate or a different aggregate.

Before you begin

You must be a cluster administrator to perform this task, or an SVM administrator to whom the cluster administrator has delegated authority.

Delegating authority to run the volume move command on page 34

About this task

You cannot use `volume move start` to enable encryption on a SnapLock or FlexGroup volume.

Steps

1. Move an existing volume and enable encryption on the volume:

   volume move start -vserver *SVM_name* -volume *volume_name* -destination-aggregate *aggregate_name* -encrypt-destination true|false

   For complete command syntax, see the man page for the command.

   #### Example

   The following command moves an existing volume named **vol1** to the destination aggregate **aggr2** and enables encryption on the volume:

   ```
   cluster1::> volume move start -vserver vs1 -volume vol1 -destination-
   aggregate aggr2 -encrypt-destination true
   ```

   The system creates an encryption key for the volume. The data on the volume is encrypted.

2. Verify that the volume is enabled for encryption:

   volume show -is-encrypted true

   For complete command syntax, see the man page for the command.

   #### Example

   The following command displays the encrypted volumes on **cluster1**:

   ```
   cluster1::> volume show -is-encrypted true

   Vserver  Volume  Aggregate  State   Type  Size  Available  Used
   -------  ------  ---------  -----   ----  -----  ---------  ----
   vs1      vol1    aggr2     online    RW  200GB    160.0GB   20%
   ```

Result

If you are using a KMIP server to authenticate nodes to the system, ONTAP automatically “pushes” an authentication key to the server when you encrypt a volume.

Configuring NetApp Storage Encryption

NetApp Storage Encryption (NSE) supports "self-encrypting" disks (SEDs) that encrypt data as it is written. The data cannot be read without an encryption key stored on the disk. The encryption key, in turn, is accessible only to an authenticated node.

Understanding NSE

On an I/O request, a node authenticates itself to an SED using an authentication key retrieved from an external key management server or Onboard Key Manager:

- The external key management server is a third-party system in your storage environment that serves keys to nodes using the Key Management Interoperability Protocol (KMIP).
- The Onboard Key Manager is a built-in tool that serves authentication keys to nodes from the same storage system as your data.

NSE supports self-encrypting HDDs and SSDs. You can use NetApp Volume Encryption with NSE to “double encrypt” data on NSE drives.

When to use KMIP servers

Although it is less expensive and typically more convenient to use the onboard key manager, you should set up KMIP servers if any of the following are true:

- Your encryption key management solution must comply with Federal Information Processing Standards (FIPS) 140-2 or the OASIS KMIP standard.
- You need a multi-cluster solution.

  KMIP servers support multiple clusters with centralized management of encryption keys.
- Your business requires the added security of storing authentication keys on a system or in a location different from the data.

  KMIP servers stores authentication keys separately from your data.

Support details

The following table shows important NSE support details. See the Interoperability Matrix for the latest information about supported KMIP servers, storage systems, and disk shelves.

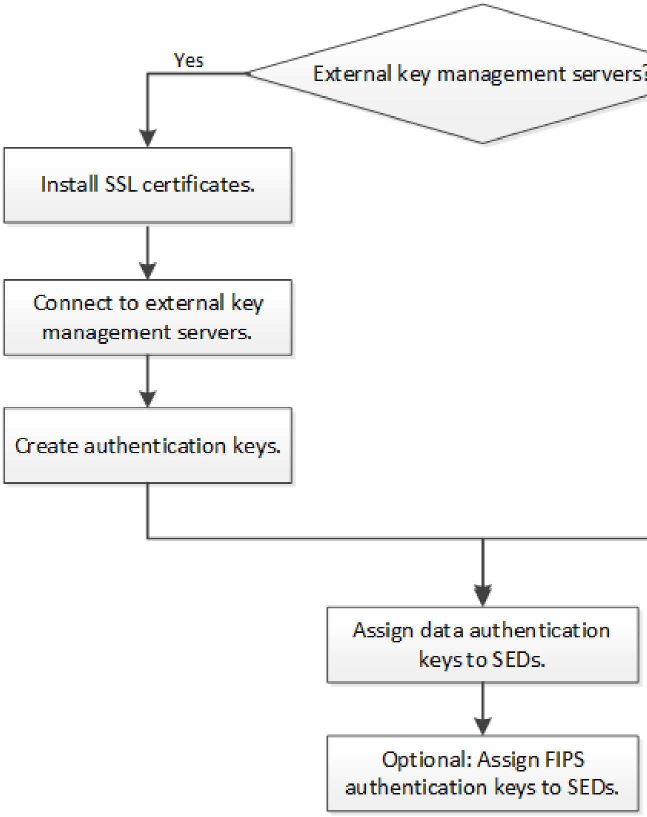
Resource or feature	Support details
MetroCluster	NSE does not support MetroCluster.
Non-homogenous disk sets	All disks for a node or HA pair must be self-encrypting. Conforming HA pairs can coexist with non-conforming HA pairs in the same cluster.
10 Gb network interfaces	Starting with ONTAP 9.3, NSE supports 10 Gb network interfaces for communications with external key management servers.
Ports for communication with the key management server	Starting with ONTAP 9.3, you can use any storage controller port for communication with the key management server. Otherwise, you should use port e0m for communication with key management servers. Depending on the storage controller model, certain network interfaces might not be available during the boot process for communication with key management servers.

Related information

NetApp Interoperability Matrix Tool

NetApp Storage Encryption workflow

You must configure key management services before the cluster can authenticate itself to the SED. You can use an external key management server or an onboard key manager.


External key management servers?
Yes
No
Install SSL certificates.
Connect to external key management servers.
Create authentication keys.
Enable onboard key management.
View generated authentication keys.
Back up key management information.
Assign data authentication keys to SEDs.
Optional: Assign FIPS authentication keys to SEDs.

Configuring external key management

You can use one or more external key management servers to secure the keys that the cluster uses to access encrypted data. An external key management server is a third-party system in your storage environment that serves keys to nodes using the Key Management Interoperability Protocol (KMIP).

Note: For ONTAP 9.1 and earlier versions, node management LIFs must be assigned to ports that are configured with the node management role before you can use the external key manager.

Collecting network information in ONTAP 9.2 and earlier

If you are using ONTAP 9.2 or earlier, you should fill out the network configuration worksheet before enabling external key management.

Note: Starting with ONTAP 9.3, the system discovers all needed network information automatically.

Item	Notes	Value
Key management network interface name		

Item	Notes	Value
Key management network interface IP address	IP address of node management LIF, in IPv4 or IPv6 format	
Key management network interface IPv6 network prefix length	If you are using IPv6, the IPv6 network prefix length	
Key management network interface subnet mask		
Key management network interface gateway IP address		
IPv6 address for the cluster network interface	Required only if you are using IPv6 for the key management network interface	
Port number for each KMIP server	Optional. The port number must be the same for all KMIP servers. If you do not provide a port number, it defaults to port 5696, which is the Internet Assigned Numbers Authority (IANA) assigned port for KMIP.	
Key tag name	Optional. The key tag name is used to identify all keys belonging to a node. The default key tag name is the node name.	

Related information

NetApp Technical Report 3954: NetApp Technical Report 3954: NetApp Storage Encryption Preinstallation Requirements and Procedures for IBM Tivoli Lifetime Key Manager

NetApp Technical Report 4074: NetApp Technical Report 4074: NetApp Storage Encryption Preinstallation Requirements and Procedures for SafeNet KeySecure

Installing SSL certificates on the cluster

The cluster and KMIP server use KMIP SSL certificates to verify each other's identity and establish an SSL connection. Before configuring the SSL connection with the KMIP server, you must install the KMIP client SSL certificates for the cluster, and the SSL public certificate for the root certificate authority (CA) of the KMIP server.

Before you begin

- The time must be synchronized on the server creating the certificates, the KMIP server, and the cluster.
- You must have obtained the public SSL KMIP client certificate (`client.pem`) for the cluster.
- You must have obtained the private SSL KMIP client certificate (`client_private.pem`) for the cluster.

  The SSL KMIP client certificate must not be password-protected.
- You must have obtained the SSL public certificate for the root certificate authority (CA) (`key_management_server_ipaddress_CA.pem`) of the KMIP server.

Note: You can install the client and server certificates on the KMIP server before or after installing the certificates on the cluster.

About this task

In an HA pair, both nodes must use the same public and private KMIP SSL certificates. If you connect multiple HA pairs to the same KMIP server, all nodes in the HA pairs must use the same public and private KMIP SSL certificates.

Steps

1. Install the SSL KMIP client certificates for the cluster:

   ```
   security certificate install -vserver admin_svm_name -type client -
   subtype kmip-cert
   ```

   You are prompted to enter the SSL KMIP public and private certificates.

   Example

   ```
   cluster1::> security certificate install -vserver svm1 -type client -
   subtype kmip-cert
   ```

2. Install the SSL public certificate for the root certificate authority (CA) of the KMIP server:

   ```
   security certificate install -vserver admin_svm_name -type server-ca -
   subtype kmip-cert
   ```

   Example

   ```
   cluster1::> security certificate install -vserver svm1 -type server-ca -
   subtype kmip-cert
   ```

Enabling external key management in ONTAP 9.3 and later

You can use one or more KMIP servers to secure the keys the cluster uses to access encrypted data. You can connect up to four KMIP servers to a node. A minimum of two servers is recommended for redundancy and disaster recovery.

Before you begin

- The KMIP SSL client and server certificates must have been installed.
- You must be a cluster administrator to perform this task.

About this task

ONTAP configures KMIP server connectivity for all nodes in the cluster.

Note: NVE support for KMIP server authentication is available starting in ONTAP 9.3.

Steps

1. If you are upgrading to ONTAP 9.3 from a previous version, delete any external key management configurations for the cluster:

   ```
   security key-manager delete-kmip-config
   ```

   Example

   The following command deletes the external key management configurations for **`cluster1`**:

   ```
   cluster1::> security key-manager delete-kmip-config
   ```

2. Configure key manager connectivity for cluster nodes:

   ```
   security key-manager setup
   ```

The key manager setup wizard opens.

3. Enter the appropriate response at each prompt.
4. Add a KMIP server:

   `security key-manager add -address *key_management_server_ipaddress*`

   Example

   ```
   clusterl::> security key-manager add -address 20.1.1.1
   ```

5. Add an additional KMIP server for redundancy:

   `security key-manager add -address *key_management_server_ipaddress*`

   Example

   ```
   clusterl::> security key-manager add -address 20.1.1.2
   ```

6. Verify that all configured KMIP servers are connected:

   `security key-manager show -status`

   For complete command syntax, see the man page.

   Example

   ```
   cluster1::> security key-manager show -status

   Node            Port      Registered Key Manager  Status
   --------------  ----      ----------------------  ---------------
   cluster1-01     5696      20.1.1.1                available
   cluster1-01     5696      20.1.1.2                available
   cluster1-02     5696      20.1.1.1                available
   cluster1-02     5696      20.1.1.2                available
   ```

Enabling external key management in ONTAP 9.2 and earlier

A node authenticates itself to the system using an authentication key retrieved from the KMIP server. You can connect up to four KMIP servers to a node. A minimum of two servers is recommended for redundancy and disaster recovery.

Before you begin

- If you are using NetApp Storage Encryption, all disks in the node or HA pair must be self-encrypting.

  See the Interoperability Matrix for disks that support NSE.
- The KMIP SSL client and server certificates must have been installed.
- You must be a cluster administrator to perform this task.

About this task

Each node in an HA pair must be able to access the other's disks in the event of a takeover. For that reason, you should configure key manager connectivity for each node in the pair.

Steps

1. Configure key manager connectivity for a node:

   `security key-manager setup -node *node*`

node defaults to the current node.

The key manager setup wizard opens.

2. Enter the information you specified in the configuration worksheet:

   - Select `no` when prompted to use onboard key management.
   - Enter `e0m` as the network interface.
   - Enter the IP address of the node management LIF, in IPv4 or IPv6 format.

   Example

   ```
   clusterl::> security key-manager setup

   Would you like to configure onboard key-management? {yes, no} [no]:
   Would you like to use KMIP server configuration? {yes, no} [yes]:

   Enter the TCP port number for KMIP server [5696]:
   Enter the network interface [e0c]:
   Would you like to configure an IPv4 address? {yes, no} [yes]:

   Enter the IP address: [20.1.1.1]:
   Enter the netmask: [255.255.1.1]:
   Enter the gateway: [20.1.1.5]:
   Would you like to configure an IPv6 address? {yes, no} [no]:
   ```

3. Repeat these steps for the partner node.

4. Add an additional KMIP server for redundancy:

   `security key-manager add -address` ***`key_management_server_ipaddress`***

   Example

   ```
   clusterl::> security key-manager add -address 20.1.1.2
   ```

5. Verify that all configured KMIP servers are connected:

   `security key-manager show -status`

   For complete command syntax, see the man page.

   Example

   ```
   cluster1::> security key-manager show -status

   Node                    Registered Key Manager  Status
   ----------------------  ----------------------  ---------------
   cluster1-01             20.1.1.1                available
   cluster1-01             20.1.1.2                available
   cluster1-02             20.1.1.1                available
   cluster1-02             20.1.1.2                available
   ```

Related information

NetApp Interoperability Matrix Tool

Creating authentication keys in ONTAP 9.3 and later

You can use the `security key-manager create-key` command to create the authentication keys for a node and store them on the configured KMIP servers.

Before you begin

You must be a cluster administrator to perform this task.

About this task

If you are using NetApp Storage Encryption and your security setup requires you to use different keys for data authentication and FIPS 140-2 authentication, you should create a separate key for each. If that is not the case, you can use the same authentication key for FIPS compliance that you use for data access.

ONTAP creates authentication keys for all nodes in the cluster.

- This command is not supported when onboard key management is enabled.
- You receive a warning if the configured key management servers are already storing more than 128 authentication keys.

  You can use the key management server software to delete any unused keys, then run the command again.

Steps

1. Create the authentication keys for cluster nodes:

   `security key-manager create-key`

   For complete command syntax, see the man page for the command.

   Note: The key ID displayed in the output is an identifier used to refer to the authentication key. It is not the actual authentication key or the data encryption key.

   #### Example

   ```
   cluster1::> security key-manager create-key
      (security key-manager create-key)
   Verifying requirements...

   Node: cluster1-01
   Creating authentication key...
   Authentication key creation successful.
   Key ID:
   F1CB30AFF1CB30B00101000000000000A68B167F92DD54196297159B5968923C

   Node: cluster1-01
   Key manager restore operation initialized.
   Successfully restored key information.

   Node: cluster1-02
   Key manager restore operation initialized.
   Successfully restored key information.
   ```

2. Verify that the authentication keys have been created:

   `security key-manager query`

   For complete command syntax, see the man page.

Example

```
cluster1::> security key-manager query

  (security key-manager query)

          Node: cluster1-01
   Key Manager: 20.1.1.1
 Server Status: available

Key Tag        Key Type  Restored
-------------  --------  --------
cluster1-01    NSE-AK    yes
       Key ID: F1CB30AFF1CB30B00101000000000000A68B167F92DD54196297159B5968923C


          Node: cluster1-02
   Key Manager: 20.1.1.1
 Server Status: available

Key Tag        Key Type  Restored
-------------  --------  --------
cluster1-02    NSE-AK    yes
       Key ID: F1CB30AFF1CB30B00101000000000000A68B167F92DD54196297159B5968923C
```

Creating authentication keys in ONTAP 9.2 and earlier

You can use the `security key-manager create-key` command to create the authentication keys for a node and store them on the configured KMIP servers.

Before you begin

You must be a cluster administrator to perform this task.

About this task

If you are using NetApp Storage Encryption and your security setup requires you to use different keys for data authentication and FIPS 140-2 authentication, you should create a separate key for each. If that is not the case, you can use the same authentication key for FIPS compliance that you use for data access.

When you create an authentication key for a node, the system automatically “restores” the key from the KMIP server and “pushes” it to its partner node. Each node can then use the same key to access its own disks and to access its partner's disks in case of a takeover.

- This command is not supported when onboard key management is enabled.
- You receive a warning if the configured key management servers are already storing more than 128 authentication keys.
  You can use the key management server software to delete any unused keys, then run the command again.

Steps

1. Create the authentication key that the current node and its partner will use to access storage:

   `security key-manager create-key`

   For complete command syntax, see the man page for the command.

   Note: The key ID displayed in the output is an identifier used to refer to the authentication key. It is not the actual authentication key or the data encryption key.

Example

```
cluster1::> security key-manager create-key
   (security key-manager create-key)
Verifying requirements...

Node: cluster1-01
```

```
Creating authentication key...
Authentication key creation successful.
Key ID:
F1CB30AFF1CB30B00101000000000000A68B167F92DD54196297159B5968923C

Node: cluster1-01
Key manager restore operation initialized.
Successfully restored key information.

Node: cluster1-02
Key manager restore operation initialized.
Successfully restored key information.
```

2. Verify that the authentication keys have been created:

   `security key-manager query`

   For complete command syntax, see the man page.

   Example

```
cluster1::> security key-manager query

  (security key-manager query)

        Node: cluster1-01
 Key Manager: 20.1.1.1
       Count: 1

Key Tag        Key ID                                                            Restored
-------------  ----------------------------------------------------------------  --------
cluster1-01    F1CB30AFF1CB30B00101000000000000A68B167F92DD54196297159B5968923C  yes


        Node: cluster1-02
 Key Manager: 20.1.1.1
       Count: 1

Key Tag        Key ID                                                            Restored
-------------  ----------------------------------------------------------------  --------
cluster1-02    F1CB30AFF1CB30B00101000000000000A68B167F92DD54196297159B5968923C  yes
```

Assigning a data authentication key to SEDs (external key management)

You can use the `storage encryption disk modify` command to assign a data authentication key to an SED. Cluster nodes use this key to access data on the SED.

Before you begin

You must be a cluster administrator to perform this task.

About this task

An SED is protected from unauthorized access only if the authentication key ID for the node is set to a value other than the SED's default manufacturer secure ID (MSID), which the system evaluates to 0x0. When you assign an authentication key to an SED, the system changes the authentication key ID for the node to a non-MSID value.

Steps

1. Assign a data authentication key to SEDs:

   `storage encryption disk modify -disk` ***`disk_ID`*** **`-data-key-id`** ***`key_ID`***

   For complete command syntax, see the man page for the command.

   Note: You can use the `security key-manager query` command to view key IDs.

Example

```
cluster1::> storage encryption disk modify -disk 0.10.* -data-key-id
F1CB30AFF1CB30B00101000000000000A68B167F92DD54196297159B5968923C

Info: Starting modify on 14 disks.
      View the status of the operation by using the
      storage encryption disk show-status command.
```

2. Verify that the authentication keys have been assigned:

   `storage encryption disk show`

   For complete command syntax, see the man page.

Example

```
cluster1::> storage encryption disk show
Disk    Mode Data Key ID
-----   ---- ----------------------------------------------------------------
0.0.0   data F1CB30AFF1CB30B00101000000000000A68B167F92DD54196297159B5968923C
0.0.1   data F1CB30AFF1CB30B00101000000000000A68B167F92DD54196297159B5968923C
[...]
```

Assigning a FIPS 140-2 authentication key to SEDs (external key management)

You can use the `storage encryption disk modify` command with the `-fips-key-id` option to assign a FIPS 140-2 authentication key to an SED. Cluster nodes use this key for SED operations other than data access, such as allowing firmware downloads.

Before you begin

The drive firmware must support FIPS 140-2 compliance. The Interoperability Matrix contains information about supported drive firmware versions.

About this task

Your security setup may require you to use different keys for data authentication and FIPS 140-2 authentication. If that is not the case, you can use the same authentication key for FIPS compliance that you use for data access.

Steps

1. Assign a FIPS 140-2 authentication key to SEDs:

   `storage encryption disk modify -disk` ***`disk_id`*** **`-fips-key-id`** ***`fips_authentication_key_id`***

   You can use the `security key-manager query` command to view key IDs.

Example

```
cluster1::> storage encryption disk modify -disk 2.10.* -fips-key-id
6A1E21D80000000001000000000000005A1FB4EE8F62FD6D8AE6754C9019F35A

Info: Starting modify on 14 disks.
      View the status of the operation by using the
      storage encryption disk show-status command.
```

2. Verify that the authentication key has been assigned:

   `storage encryption disk show -fips`

For complete command syntax, see the man page.

Example

```
cluster1::> storage encryption disk show -fips
Disk    Mode FIPS-Compliance Key ID
------  ---- ----------------------------------------------------------------
2.10.0  full 6A1E21D80000000001000000000000005A1FB4EE8F62FD6D8AE6754C9019F35A
2.10.1  full 6A1E21D80000000001000000000000005A1FB4EE8F62FD6D8AE6754C9019F35A
[...]
```

Related information

NetApp Interoperability Matrix Tool

Enabling cluster-wide FIPS-compliant mode for KMIP server connections

You can use the `security config modify` command with the `-is-fips-enabled` option to enable cluster-wide FIPS-compliant mode for data in flight. Doing so forces the cluster to use OpenSSL in FIPS mode with TLS connections to KMIP servers.

Before you begin

All KMIP servers must support TLSv1.2. The system requires TLSv1.2 to complete the connection to the KMIP server when cluster-wide FIPS-compliant mode is enabled.

About this task

When you enable cluster-wide FIPS-compliant mode, the cluster will automatically select only TLS protocols. Cluster-wide FIPS-compliant mode is disabled by default.

You must reboot cluster nodes manually after modifying the cluster-wide security configuration.

Steps

1. Set the privilege level to advanced:

   `set -privilege advanced`

2. Verify that TLSv1.2 is supported:

   `security config show -supported-protocols`

   For complete command syntax, see the man page.

   #### Example

```
cluster1::> security config show
          Cluster                                              Cluster Security
Interface FIPS Mode  Supported Protocols     Supported Ciphers Config Ready
--------- ---------- ----------------------- ----------------- ----------------
SSL       false      TLSv1.2, TLSv1.1, TLSv1 ALL:!LOW:         yes
                                             !aNULL:!EXP:
                                             !eNULL
```

3. Enable cluster-wide FIPS-compliant mode:

   `security config modify -is-fips-enabled true -interface SSL`

   For complete command syntax, see the man page.

4. Reboot cluster nodes manually.

5. Verify that cluster-wide FIPS-compliant mode is enabled:

   `security config show`

Example

```
cluster1::> security config show
          Cluster                                              Cluster Security
Interface FIPS Mode  Supported Protocols     Supported Ciphers Config Ready
--------- ---------- ----------------------- ----------------- ----------------
SSL       true       TLSv1.2, TLSv1.1        ALL:!LOW:         yes
                                             !aNULL:!EXP:
                                             !eNULL:!RC4
```

Authentication using the Onboard Key Manager

You can use the Onboard Key Manager to authenticate cluster nodes to an SED. The Onboard Key Manager is a built-in tool that serves authentication keys to nodes from the same storage system as your data. The Onboard Key Manager is FIPS-140-2 level 1 compliant.

Enabling onboard key management

You can use the Onboard Key Manager to secure the keys that the cluster uses to access encrypted data. You must enable Onboard Key Manager on each cluster that accesses an encrypted volume or a self-encrypting disk (SED).

Before you begin

- If you are using NSE with an external key management (KMIP) server, you must have deleted the external key manager database.
  Transitioning to onboard key management from external key management on page 53
- You must be a cluster administrator to perform this task.

About this task

You must run the `security key-manager setup` command each time you add a node to the cluster. In MetroCluster configurations, you must run `security key-manager setup` on the local cluster first, then on the remote cluster, using the same passphrase on each. Starting with ONTAP 9.5, you must run `security key-manager setup` and `security key-manager setup -sync-metrocluster-config yes` on the local cluster and it will synchronize with the remote cluster.

By default, you are not required to enter the key manager passphrase when a node is rebooted. Starting with ONTAP 9.4, you can use the `-enable-cc-mode true` option to require that users enter the passphrase after a reboot.

Note: After a failed passphrase attempt, you must reboot the node again.

Starting with ONTAP 9.5, ONTAP Key Manager supports Trusted Platform Module (TPM). TPM is a secure crypto processor and micro-controller designed to provide hardware-based security. Support for TPM is automatically enabled by ONTAP on detection of the TPM device driver. If you are upgrading to ONTAP 9.5, you must create new encryption keys for your data after enabling TPM support.

Steps

1. Start the key manager setup wizard:

   `security key-manager setup -enable-cc-mode true|false`

   #### Example

   The following example starts the key manager setup wizard on cluster1 without requiring that the passphrase be entered after every reboot:

```
cluster1::> security key-manager setup
Welcome to the key manager setup wizard, which will lead you through
the steps to add boot information.

...

Would you like to use onboard key-management? {yes, no} [yes]:
Enter the cluster-wide passphrase:    <32..256 ASCII characters long text>
Reenter the cluster-wide passphrase:    <32..256 ASCII characters long text>
```

2. Enter

   `yes`
   at the prompt to configure onboard key management.

3. At the passphrase prompt, enter a passphrase between 32 and 256 characters, or for “cc-mode”, a passphrase between 64 and 256 characters.

   Note: If the specified “cc-mode” passphrase is less than 64 characters, there is a five-second delay before the key manager setup wizard displays the passphrase prompt again.

4. At the passphrase confirmation prompt, reenter the passphrase.

5. Verify that keys are configured for all nodes:

   `security key-manager key show`

   For the complete command syntax, see the man page.

   Example

```
cluster1::> security key-manager key show

Node: node1
Key Store: onboard
Key ID                                                           Used By
---------------------------------------------------------------- --------
0000000000000000020000000000010059851742AF2703FC91369B7DB47C4722 NSE-AK
000000000000000002000000000001008C07CC0AF1EF49E0105300EFC83004BF NSE-AK

Node: node2
Key Store: onboard
Key ID                                                           Used By
---------------------------------------------------------------- --------
0000000000000000020000000000010059851742AF2703FC91369B7DB47C4722 NSE-AK
000000000000000002000000000001008C07CC0AF1EF49E0105300EFC83004BF NSE-AK
```

After you finish

Copy the passphrase to a secure location outside the storage system for future use.

All key management information is automatically backed up to the replicated database (RDB) for the cluster. You should also back up the information manually for use in case of a disaster.

Related tasks

Backing up onboard key management information manually on page 40

Viewing the keys generated by the Onboard Key Manager

You can use the `security key-manager key show` command to view the authentication keys generated by the Onboard Key Manager. These are the keys you assign to SEDs for data and optional FIPS 140-2 authentication.

Before you begin

You must be a cluster administrator to perform this task.

About this task

The Onboard Key Manager generates two keys, one for data authentication and one for FIPS 140-2 authentication, in case your security setup requires you to use a different key for each. If that is not the case, you can use the same authentication key for FIPS compliance that you use for data access.

The Onboard Key Manager automatically assigns the keys generated for the current node to its partner node. Each node can then use the same key to access its own disks and to access its partner's disks in case of a takeover.

Step

1. View the authentication keys generated by the Onboard Key Manager:

   `security key-manager key show`

   For complete command syntax, see the man page.

   > **Note:** The key ID displayed in the output is an identifier used to refer to the authentication key. It is not the actual authentication key or the data encryption key.

   #### Example

```
cluster1::> security key-manager key show

Node: cluster1-01
Key Store: onboard
Key ID
-----------------------------------------------------------------------------
F1CB30AFF1CB30B00101000000000000A68B167F92DD54196297159B5968923C
6A1E21D80000000001000000000000005A1FB4EE8F62FD6D8AE6754C9019F35A

Node: cluster1-02
Key Store: onboard
Key ID
-----------------------------------------------------------------------------
F1CB30AFF1CB30B00101000000000000A68B167F92DD54196297159B5968923C
6A1E21D80000000001000000000000005A1FB4EE8F62FD6D8AE6754C9019F35A
4 entries were displayed.
```

Assigning a data authentication key to SEDs (onboard key management)

You can use the `storage encryption disk modify` command to assign a data authentication key to an SED. Cluster nodes use this key to access data on the SED.

Before you begin

You must be a cluster administrator to perform this task.

About this task

An SED is protected from unauthorized access only if the authentication key ID for the node is set to a value other than the SED's default manufacturer secure ID (MSID), which the system evaluates to 0x0. When you assign an authentication key to an SED, the system changes the authentication key ID for the node to a non-MSID value.

Steps

1. Assign a data authentication key to SEDs:

   `storage encryption disk modify -disk` ***`disk_ID`*** **`-data-key-id`** ***`key_ID`***

   For complete command syntax, see the man page for the command.

   > **Note:** You can use the `security key-manager query` command to view key IDs.

Example

```
cluster1::> storage encryption disk modify -disk 0.10.* -data-key-id
F1CB30AFF1CB30B00101000000000000A68B167F92DD54196297159B5968923C

Info: Starting modify on 14 disks.
      View the status of the operation by using the
      storage encryption disk show-status command.
```

2. Verify that the authentication keys have been assigned:

   `storage encryption disk show`

   For complete command syntax, see the man page.

Example

```
cluster1::> storage encryption disk show
Disk    Mode Data Key ID
-----   ---- ----------------------------------------------------------------
0.0.0   data F1CB30AFF1CB30B00101000000000000A68B167F92DD54196297159B5968923C
0.0.1   data F1CB30AFF1CB30B00101000000000000A68B167F92DD54196297159B5968923C
[...]
```

Assigning a FIPS 140-2 authentication key to SEDs (onboard key management)

You can use the `storage encryption disk modify` command with the `-fips-key-id` option to assign a FIPS 140-2 authentication key to an SED. Cluster nodes use this key for SED operations other than data access, such as allowing firmware downloads.

Before you begin

The drive firmware must support FIPS 140-2 compliance. The Interoperability Matrix contains information about supported drive firmware versions.

About this task

Your security setup may require you to use different keys for data authentication and FIPS 140-2 authentication. If that is not the case, you can use the same authentication key for FIPS compliance that you use for data access.

Steps

1. Assign a FIPS 140-2 authentication key to SEDs:

   `storage encryption disk modify -disk` ***`disk_id`*** **`-fips-key-id`** ***`fips_authentication_key_id`***

   You can use the `security key-manager query` command to view key IDs.

Example

```
cluster1::> storage encryption disk modify -disk 2.10.* -fips-key-id
6A1E21D80000000001000000000000005A1FB4EE8F62FD6D8AE6754C9019F35A

Info: Starting modify on 14 disks.
      View the status of the operation by using the
      storage encryption disk show-status command.
```

2. Verify that the authentication key has been assigned:

   `storage encryption disk show -fips`

For complete command syntax, see the man page.

Example

```
cluster1::> storage encryption disk show -fips
Disk    Mode FIPS-Compliance Key ID
------  ---- ----------------------------------------------------------------
2.10.0  full 6A1E21D80000000001000000000000005A1FB4EE8F62FD6D8AE6754C9019F35A
2.10.1  full 6A1E21D80000000001000000000000005A1FB4EE8F62FD6D8AE6754C9019F35A
[...]
```

Related information

NetApp Interoperability Matrix Tool

Managing NetApp encryption

ONTAP offers a rich set of services for managing encryption. You can restore authentication keys, replace SSL certificates, return SEDs to service when authentication keys are no longer available, and much more.

Unencrypting volume data

You can use the `volume move start` command to unencrypt volume data.

Before you begin

You must be a cluster administrator to perform this task, or an SVM administrator to whom the cluster administrator has delegated authority.

Delegating authority to run the volume move command on page 34

Steps

1. Move an existing volume and unencrypt the data on the volume:

   `volume move start -vserver` ***`SVM_name`*** **`-volume`** ***`volume_name`*** **`-destination-aggregate`** ***`aggregate_name`*** **`-encrypt-destination false`**

   For complete command syntax, see the man page for the command.

   #### Example

   The following command moves an existing volume named **`vol1`** to the destination aggregate **`aggr3`** and unencrypts the data on the volume:

   ```
   cluster1::> volume move start -vserver vs1 -volume vol1 -destination-
   aggregate aggr3 -encrypt-destination false
   ```

   The system deletes the encryption key for the volume. The data on the volume is unencrypted.

2. Verify that the volume is disabled for encryption:

   `volume show -encryption`

   For complete command syntax, see the man page for the command.

   #### Example

   The following command displays whether volumes on **`cluster1`** are encrypted:

   ```
   cluster1::> volume show -encryption

   Vserver  Volume   Aggregate   State    Encryption State
   -------  ------   ---------   -----    ----------------
   vs1      vol1     aggr1       online   none
   ```

Moving an encrypted volume

You can use the `volume move start` command to move an encrypted volume. The moved volume can reside on the same aggregate or a different aggregate.

Before you begin

You must be a cluster administrator to perform this task, or an SVM administrator to whom the cluster administrator has delegated authority.

Delegating authority to run the volume move command on page 34

About this task

The `-encrypt-destination` option for `volume move start` defaults to true for encrypted volumes. Requiring you to specify explicitly that you do not want the destination volume to be encrypted ensures that you do not inadvertently unencrypt the data on the volume.

Steps

1. Move an existing volume and leave the data on the volume encrypted:

   `volume move start -vserver` ***`SVM_name`*** **`-volume`** ***`volume_name`*** **`-destination-aggregate`** ***`aggregate_name`***

   For complete command syntax, see the man page for the command.

   #### Example

   The following command moves an existing volume named **`vol1`** to the destination aggregate **`aggr3`** and leaves the data on the volume encrypted:

   ```
   cluster1::> volume move start -vserver vs1 -volume vol1 -destination-
   aggregate aggr3
   ```

2. Verify that the volume is enabled for encryption:

   `volume show -is-encrypted true`

   For complete command syntax, see the man page for the command.

   #### Example

   The following command displays the encrypted volumes on **`cluster1`**:

   ```
   cluster1::> volume show -is-encrypted true

   Vserver  Volume  Aggregate  State   Type  Size  Available  Used
   -------  ------  ---------  -----   ----  -----  ---------  ----
   vs1      vol1    aggr3     online    RW  200GB    160.0GB   20%
   ```

Delegating authority to run the volume move command

You can use the `volume move` command to encrypt an existing volume, move an encrypted volume, or unencrypt a volume. Cluster administrators can run `volume move` command themselves, or they can delegate the authority to run the command to SVM administrators.

About this task

By default, SVM administrators are assigned the **`vsadmin`** role, which does not include the authority to move volumes. You must assign the **`vsadmin-volume`** role to SVM administrators to enable them to run the `volume move` command.

Step

1. Delegate authority to run the `volume move` command:

   `security login modify -vserver` ***`SVM_name`*** **`-user-or-group-name`** ***`user_or_group_name`*** **`-application`** ***`application`*** **`-authmethod`** ***`authentication_method`*** **`-role vsadmin-volume`**

   For complete command syntax, see the man page for the command.

   #### Example

   The following command grants the SVM administrator authority to run the `volume move` command.

   ```
   cluster1::>security login modify -vserver engData -user-or-group-name
   SVM-admin -application ssh -authmethod domain -role vsadmin-volume
   ```

Changing the encryption key for a volume with the volume encryption rekey start command

It is a security best practice to change the encryption key for a volume periodically. Starting with ONTAP 9.3, you can use the `volume encryption rekey start` command to change the encryption key.

About this task

Once you start a rekey operation, it must complete. There is no returning to the old key. If you encounter a performance issue during the operation, you can run the `volume encryption rekey pause` command to pause the operation, and the `volume encryption rekey restart` command to resume the operation.

Until the rekey operation finishes, the volume will have two keys. New writes and their corresponding reads will use the new key. Otherwise, reads will use the old key.

> **Note:** You cannot use `volume encryption rekey start` to rekey a SnapLock or FlexGroup volume.

Steps

1. Change an encryption key:

   `volume encryption rekey start -vserver` ***`SVM_name`*** **`-volume`** ***`volume_name`***

Example

The following command changes the encryption key for **vol1** on SVM **vs1**:

```
cluster1::> volume encryption rekey start -vserver vs1 -volume vol1
```

2. Verify the status of the rekey operation:

   volume encryption rekey show

   For complete command syntax, see the man page for the command.

Example

The following command displays the status of the rekey operation:

```
cluster1::> volume encryption rekey show

Vserver   Volume   Start Time           Status
-------   ------   ------------------   ---------------------------
vs1       vol1     9/18/2017 17:51:41   Phase 2 of 2 is in progress.
```

3. When the rekey operation is complete, verify that the volume is enabled for encryption:

   volume show -is-encrypted true

   For complete command syntax, see the man page for the command.

Example

The following command displays the encrypted volumes on **cluster1**:

```
cluster1::> volume show -is-encrypted true

Vserver  Volume  Aggregate  State  Type  Size  Available  Used
-------  ------  ---------  -----  ----  -----  --------- ----
vs1      vol1    aggr2     online    RW  200GB    160.0GB  20%
```

Changing the encryption key for a volume with the volume move start command

It is a security best practice to change the encryption key for a volume periodically. You can use the `volume move start` command to change the encryption key. You must use `volume move start` in ONTAP 9.2 and earlier. The moved volume can reside on the same aggregate or a different aggregate.

Before you begin

You must be a cluster administrator to perform this task, or an SVM administrator to whom the cluster administrator has delegated authority.

Delegating authority to run the volume move command on page 34

About this task

You cannot use `volume move start` to rekey a SnapLock or FlexGroup volume.

Steps

1. Move an existing volume and change the encryption key:

   volume move start -vserver *SVM_name* -volume *volume_name* -destination-aggregate *aggregate_name* -generate-destination-key true

For complete command syntax, see the man page for the command.

Example

The following command moves an existing volume named **`vol1`** to the destination aggregate **`aggr2`** and changes the encryption key:

```
cluster1::> volume move start -vserver vs1 -volume vol1 -destination-
aggregate aggr2 -generate-destination-key true
```

A new encryption key is created for the volume. The data on the volume remains encrypted.

2. Verify that the volume is enabled for encryption:

   `volume show -is-encrypted true`

   For complete command syntax, see the man page for the command.

   Example

   The following command displays the encrypted volumes on **`cluster1`**:

```
cluster1::> volume show -is-encrypted true

Vserver  Volume  Aggregate  State  Type  Size  Available  Used
-------  ------  ---------  -----  ----  -----  ---------  ----
vs1      vol1    aggr2     online    RW  200GB    160.0GB  20%
```

Deleting an encrypted volume

You can use the `volume delete` command to delete an encrypted volume.

Before you begin

- You must be a cluster administrator to perform this task, or an SVM administrator to whom the cluster administrator has delegated authority.
  Delegating authority to run the volume move command on page 34
- The volume must be offline.

Step

1. Delete an encrypted volume:

   `volume delete -vserver` ***`SVM_name`*** **`-volume`** ***`volume_name`***

   For complete command syntax, see the man page for the command.

   Example

   The following command deletes an encrypted volume named **`vol1`**:

```
cluster1::> volume delete -vserver vs1 -volume vol1
```

   Enter `yes` when you are prompted to confirm deletion.

   The system deletes the encryption key for the volume after 24 hours.

   Use `volume delete` with the `-force true` option to delete a volume and destroy the corresponding encryption key immediately. For more information, see the man page.

After you finish

You can use the `volume recovery-queue` command to recover a deleted volume during the retention period after issuing the `volume delete` command:

```
volume recovery-queue SVM_name -volume volume_name
```

How to use the Volume Recovery feature

Scrubbing data on an encrypted volume

Starting with ONTAP 9.4, you can use the *secure-purge* feature to non-disruptively “scrub” data on NVE-enabled volumes. Scrubbing data on an encrypted volume ensures that it cannot be recovered from the physical media.

Before you begin

- You must be a cluster administrator to perform this task.
- Advanced privileges are required for this task.

About this task

You can use secure-purge in cases of “spillage,” where data traces may have been left behind when blocks were overwritten, or for securely deleting a vacating tenant's data. Secure-purge works only for previously deleted files on NVE-enabled volumes. You cannot scrub an unencrypted volume. You must use KMIP servers to serve keys, not the Onboard Key Manager.

Secure-purge deletes all Snapshot copies in the volume. If the volume is the source of a SnapMirror relationship, you must break the SnapMirror relationship before you can purge the volume. If there are busy Snapshot copies in the volume, you must release the Snapshot copies before you can purge the volume. You may need to split a FlexClone volume from its parent, for example.

Successfully invoking the secure-purge feature triggers a volume move that re-encrypts the remaining, unpurged data with a new key. The moved volume remains on the current aggregate. The old key is automatically destroyed, ensuring that purged data cannot be recovered from the storage media.

Secure-purge may take from several minutes to many hours to complete, depending on the amount of data in the deleted files. You can use the `volume encryption secure-purge show` command to view the status of the operation. You can use the `volume encryption secure-purge abort` command to terminate the operation.

The following features do not support secure-purge:

- FlexClone
- MetroCluster
- SnapVault
- FabricPool
- FlexGroup

Steps

1. On the NAS client or SAN host, delete the files you want to securely purge.

2. On the storage system, change to advanced privilege level:

   ```
   set -privilege advanced
   ```

3. Securely purge the deleted files:

   ```
   volume encryption secure-purge start -vserver SVM_name -volume
   volume_name
   ```

Example

The following command securely purges the deleted files on **`vol1`** on SVM **`vs1`**:

```
cluster1::> volume encryption secure-purge start -vserver vs1 -volume
vol1
```

Successfully invoking the secure-purge feature triggers a volume move that re-encrypts the remaining, unpurged data with a new key. The moved volume remains on the current aggregate. The old key is automatically destroyed, ensuring that purged data cannot be recovered from the storage media.

4. Verify the status of the secure-purge operation:

   `volume encryption secure-purge show`

   Example

   The following command displays the status of the secure-purge operation:

   ```
   cluster1::> volume encryption secure-purge show
   ```

Restoring onboard key management encryption keys

Occasionally, you may need to restore an onboard key management encryption key. You can use the `security key-manager key show` command to verify that a key needs to be restored, and the `security key-manager setup` command to restore the key.

Before you begin

- If you are using NSE with an external key management (KMIP) server, you must have deleted the external key manager database.
  Transitioning to onboard key management from external key management on page 53
- You must be a cluster administrator to perform this task.

Steps

1. Verify that a key needs to be restored:

   `security key-manager key show`

   For complete command syntax, see the man page.

   Example

   The following example shows that the encryption key on node 3 needs to be restored:

   ```
   cluster1::> security key-manager key show

   Node: node1
   Key Store: onboard
   Key ID                                                           Used By
   ---------------------------------------------------------------- --------
   0000000000000000020000000000010059851742AF2703FC91369B7DB47C4722 NSE-AK
   000000000000000002000000000001008C07CC0AF1EF49E0105300EFC83004BF NSE-AK
   00000000000000000200000000000A001C72BB549425E31F89754F99C5314947 SVM-KEK
   00000000000000000200000000000A003F31AF41EA0D55F534D8A58AD63011E6 SVM-KEK
   00000000000000000200000000000A006118875D8F90D3B95355418D73FC14C0 SVM-KEK
   00000000000000000200000000000A00AA32BFB16960116E1D91140EDA72D97A SVM-KEK
   00000000000000000200000000000A00ED1742ABF87BD99BB44429E5E5007ADE SVM-KEK

   Node: node2
   Key Store: onboard
   Key ID                                                           Used By
   ```

```
---------------------------------------------------------------- --------
0000000000000000020000000000010059851742AF2703FC91369B7DB47C4722 NSE-AK
000000000000000002000000000001008C07CC0AF1EF49E0105300EFC83004BF NSE-AK
0000000000000000020000000000A001C72BB549425E31F89754F99C5314947 SVM-KEK
0000000000000000020000000000A003F31AF41EA0D55F534D8A58AD63011E6 SVM-KEK
0000000000000000020000000000A006118875D8F90D3B95355418D73FC14C0 SVM-KEK
0000000000000000020000000000A00AA32BFB16960116E1D91140EDA72D97A SVM-KEK

Node: node3
Key Store: onboard
Key ID                                                           Used By
---------------------------------------------------------------- --------
0000000000000000020000000000A00ED1742ABF87BD99BB44429E5E5007ADE SVM-KEK
14 entries were displayed.


Error: One or more nodes have onboard key management keys that need to be
       restored. To identify the nodes, run "security key-manager key show
       -restored no". Then, restore the keys on those nodes using the command
       "security key-manager setup -node <nodename>".
```

2. Start the key manager setup wizard:

   `security key-manager setup -enable-cc-mode true|false`

   #### Example

   The following command starts the key manager setup wizard on **`cluster1`**:

```
cluster1::> security key-manager setup
Welcome to the key manager setup wizard, which will lead you through
the steps to add boot information.

Enter the following commands at any time
"help" or "?" if you want to have a question clarified,
"back" if you want to change your answers to previous questions, and
"exit" if you want to quit the key manager setup wizard. Any changes
you made before typing "exit" will be applied.

Restart the key manager setup wizard with "security key-manager
setup". To accept a default or omit a question, do not enter a value.

Would you like to use onboard key-management? {yes, no} [yes]:
Enter the cluster-wide passphrase:    <32..256 UTF8 characters long text>
Reenter the cluster-wide passphrase:    <32..256 UTF8 characters long text>
```

Changing the onboard key management passphrase

It is a security best practice to change the onboard key management passphrase periodically. You can use the `security key-manager update-passphrase` command to change the onboard key management passphrase.

Before you begin

- You must be a cluster administrator to perform this task.
- Advanced privileges are required for this task.

Steps

1. Change to advanced privilege level:

   `set -privilege advanced`

2. Change the onboard key management passphrase:

   `security key-manager update-passphrase`

Example

The following command lets you change the key management passphrase for **`cluster1`**:

```
cluster1::> security key-manager update-passphrase
Warning: This command will reconfigure the cluster passphrase for
onboard key-management.
Do you want to continue? {y|n}:
Enter current passphrase:    <32..256 ASCII characters long text>
Enter new passphrase:    <32..256 ASCII characters long text>
Reenter the new passphrase:    <32..256 ASCII characters long text>
```

3. Enter **`y`** at the prompt to change the onboard key management passphrase.
4. Enter the current passphrase at the current passphrase prompt.
5. Enter the new passphrase at the new passphrase prompt.
6. Reenter the new passphrase at the passphrase confirmation prompt.

After you finish

You should copy the onboard key management passphrase to a secure location outside the storage system for future use.

You should back up key management information manually whenever you change the onboard key management passphrase.

Backing up onboard key management information manually on page 40

Backing up onboard key management information manually

You should back up onboard key management information manually whenever you configure the Onboard Key Manager passphrase. You can use the `security key-manager backup show` command to display the key management backup information for the cluster. You can then copy the backup information to a secure location outside the storage system.

Before you begin

You must be a cluster administrator to perform this task.

About this task

All key management information is automatically backed up to the replicated database (RDB) for the cluster. You should also back up key management information manually for use in case of a disaster.

Step

1. Display the key management backup information for the cluster:

   `security key-manager backup show`

Example

The following command displays the key management backup information for **`cluster1`** in a hex dump:

```
security key-manager backup show
----BEGIN BACKUP-----
cb5101eab69b7d832287d16b2a02debe
d6f9b7798979c2d70a3c2ac231873a00
d9994b44c61160de3ae02250fb8e7803
90989a7ebf7a3ed8c89f8073dde3c558
```

```
6effff9497f7666cc990c3398f86df3e
7ecf4ca826736ecd1a761b102184861b
....

----END BACKUP-----
```

After you finish

You should copy the backup information to a secure location outside the storage system for use in case of a disaster.

Restoring external key management authentication keys in ONTAP 9.3 and later

You can use the `security key-manager restore` command to manually restore external key management authentication keys and “push” them to a different node. You might want to do this if you are adding a new node to the cluster, or restarting a node that was down temporarily when you created the keys for the cluster.

Before you begin

You must be a cluster administrator to perform this task.

About this task

You can use the `security key-manager query` command to determine if a key has been restored.

This command is not supported when onboard key management is enabled.

Step

1. Restore the current node's authentication keys and key IDs to a different node:

   `security key-manager restore -node` ***`node`***

   `node` defaults to all nodes. For complete command syntax, see the man page for the command.

   #### Example

   ```
   cluster1::> security key-manager restore -node cluster1-02
      (security key-manager restore)

           Node: cluster1-02
    Key Manager: 20.1.1.1
          Count: 2

   Key IDs
   ----------------------------------------------------------------
   F1CB30AFF1CB30B00101000000000000A68B167F92DD54196297159B5968923C
   F1CB30AFF1CB30B00101000000000000CF0EFD81EA9F6324EA97B369351C56AC
   ```

Restoring external key management authentication keys in ONTAP 9.2 and earlier

You can use the `security key-manager restore` command to manually restore external key management authentication keys and “push” them to a different node. You might want to do this if you are adding a new node to the cluster, or restarting a node that was down temporarily when you created the keys for its partner.

Before you begin

You must be a cluster administrator to perform this task.

About this task

When you create an authentication key for a node, the system automatically “restores” the key from the KMIP server and “pushes” it to its partner node. The partner can then use the key to access the node's disks in the event of a takeover. The `security key-manager restore` command lets you restore authentication keys manually, to any node in the cluster. You can use the `security key-manager query` command to determine if a key has been restored.

This command is not supported when onboard key management is enabled.

Step

1. Restore the current node's authentication keys and key IDs to a different node:

   `security key-manager restore -node` ***`node`***

   `node` defaults to all nodes. For complete command syntax, see the man page for the command.

   #### Example

```
cluster1::> security key-manager restore -node cluster1-02
   (security key-manager restore)

        Node: cluster1-02
 Key Manager: 20.1.1.1
       Count: 2

Key IDs
----------------------------------------------------------------
F1CB30AFF1CB30B00101000000000000A68B167F92DD54196297159B5968923C
F1CB30AFF1CB30B00101000000000000CF0EFD81EA9F6324EA97B369351C56AC
```

Replacing an SED

You can replace an SED the same way you replace an ordinary disk. You must rekey the SED to enable NSE.

Before you begin

- You must know the key ID for the authentication key used by the SED.
- You must be a cluster administrator to perform this task.

Steps

1. Ensure that the disk has been marked as failed:

   `storage disk show -broken`

   For complete command syntax, see the man page.

Example

```
cluster1::> storage disk show -broken
Original Owner: cluster1-01
  Checksum Compatibility: block
                                                                 Usable Physical
    Disk   Outage Reason HA Shelf Bay Chan   Pool  Type    RPM     Size     Size
    ------ ---- ------------ ---- --- ---- ------ ----- -----  -------  -------
    0.0.0  admin  failed  0b    1   0    A  Pool0  FCAL  10000  132.8GB  133.9GB
    0.0.7  admin  removed 0b    2   6    A  Pool1  FCAL  10000  132.8GB  134.2GB
[...]
```

2. Remove the failed disk and replace it with a new SED, following the instructions in the hardware guide for your disk shelf model.

3. Assign ownership of the newly replaced SED:

   `storage disk assign -disk` ***`disk_name`*** **`-owner`** ***`node`***

   For complete command syntax, see the man page.

   #### Example

   ```
   cluster1::> storage disk assign -disk 2.1.1 -owner cluster1-01
   ```

4. Confirm that the new disk has been assigned:

   `storage encryption disk show`

   For complete command syntax, see the man page.

   #### Example

   ```
   cluster1::> storage encryption disk show
   Disk     Mode Data Key ID
   -----    ---- ----------------------------------------------------------------
   0.0.0    data F1CB30AFF1CB30B001010000000000000A68B167F92DD54196297159B5968923C
   0.0.1    data F1CB30AFF1CB30B001010000000000000A68B167F92DD54196297159B5968923C
   1.10.0   data F1CB30AFF1CB30B001010000000000000CF0EFD81EA9F6324EA97B369351C56AC
   1.10.1   data F1CB30AFF1CB30B001010000000000000CF0EFD81EA9F6324EA97B369351C56AC
   2.1.1    open 0x0
   [...]
   ```

5. Assign the authentication keys to the SED.

   Assigning a data authentication key to SEDs (external key management) on page 24

Replacing SSL certificates

All SSL certificates have an expiration date. You must update your certificates before they expire to prevent loss of access to authentication keys.

Before you begin

- You must have obtained the replacement public and private certificates for the cluster.
- You must have obtained the replacement public certificate for the KMIP server.

Note: You can install the replacement client and server certificates on the KMIP server before or after installing the certificates on the cluster.

Steps

1. Disable the connection to the KMIP server:

   ```
   security key-manager delete -address key_management_server_ipaddress
   ```

   #### Example

   ```
   cluster1::> security key-manager delete -address 20.1.0.0
   ```

2. Delete the client certificates for the cluster:

   ```
   security certificate delete -vserver admin_svm_name -common-name
   fqdn_or_custom_common_name -ca certificate_authority -type client -
   subtype kmip-cert
   ```

   #### Example

   ```
   cluster1::> security certificate delete -vserver vs0 -common-name
   www.example.com -ca "Verisign Inc" -type client -subtype kmip-cert
   ```

3. Delete the KMIP server certificate:

   ```
   security certificate delete -vserver admin_svm_name -common-name
   fqdn_or_custom_common_name -ca certificate_authority -type server-ca -
   subtype kmip-cert
   ```

   #### Example

   ```
   cluster1::> security certificate delete -vserver vs0 -common-name
   www.example.com -ca "Verisign Inc" -type server-ca -subtype kmip-cert
   ```

4. Install the replacement client and server certificates.

   Installing SSL certificates on the cluster on page 9

5. Connect to the KMIP server.

   Connecting to external key management servers on page 20

Making data on an SED inaccessible

If you want to make data on an SED permanently inaccessible, but keep the SED’s unused space available for new data, you can sanitize the disk. If you want to make data permanently inaccessible and you do not need to reuse the SED, you can destroy it.

- Disk sanitization
  When you sanitize an SED, the system changes the disk encryption key to a new random value, resets the power-on lock state to false, and sets the key ID to the default manufacturer secure ID (MSID). Doing so renders the data on the disk inaccessible and impossible to retrieve. You can reuse sanitized disks as non-zeroed spare disks.

- Disk destroy
  When you destroy an SED, the system sets the disk encryption key to an unknown random value and locks the disk irreversibly. Doing so renders the disk permanently unusable and the data on it permanently inaccessible.

You can sanitize or destroy individual SEDs, or all the SEDs for a node.

If you think an SED might need to be sanitized

Disk sanitization can be time-consuming. If you think an SED might need to be sanitized, following some simple guidelines will reduce the time it takes to complete the process:

- Make sure disk aggregates are no larger than necessary.
  If aggregates are larger than needed, sanitization requires more time, disk space, and bandwidth.

- When you back up aggregates containing sensitive data, avoid backing them up to aggregates that also contain large amounts of nonsensitive data.
  Doing so reduces the amount of time you will need to move the nonsensitive data before sanitizing the SED containing the sensitive data.

Choices

- Sanitizing an SED on page 45
- Destroying an SED on page 46
- Emergency shredding of data on an SED on page 47

Sanitizing an SED

If you want to make data on an SED permanently inaccessible, but keep the SED's unused space available for new data, you can use the `storage encryption disk sanitize` command to sanitize the SED.

Before you begin

You must be a cluster administrator to perform this task.

About this task

When you sanitize an SED, the system changes the disk encryption key to a new random value, resets the power-on lock state to false, and sets the authentication key ID to the default manufacturer secure ID (MSID). Doing so renders the data on the disk inaccessible and impossible to retrieve. You can reuse sanitized disks as non-zeroed spare disks.

Steps

1. Migrate any data that needs to be preserved to an aggregate for a different disk.

2. Delete the aggregate on the SED to be sanitized:

   `storage aggregate delete -aggregate` ***`aggregate_name`***

   For complete command syntax, see the man page.

   Example

   ```
   cluster1::> storage aggregate delete -aggregate aggr1
   ```

3. Identify the disk ID for the SED to be sanitized:

   `storage encryption disk show`

   For complete command syntax, see the man page.

   Example

   ```
   cluster1::> storage encryption disk show
   Disk    Mode Data Key ID
   -----   ---- ----------------------------------------------------------------
   0.0.0   data F1CB30AFF1CB30B00101000000000000A68B167F92DD54196297159B5968923C
   0.0.1   data F1CB30AFF1CB30B00101000000000000A68B167F92DD54196297159B5968923C
   1.10.2  data F1CB30AFF1CB30B00101000000000000CF0EFD81EA9F6324EA97B369351C56AC
   [...]
   ```

4. Sanitize the disk:

   `storage encryption disk sanitize -disk` ***`disk_id`***

   You can use this command to sanitize hot spare or broken disks only. To sanitize all disks regardless of type, use the `-force-all-state` option. For complete command syntax, see the man page.

   > **Note:** You are prompted to enter a confirmation phrase before continuing. Enter the phrase exactly as shown on the screen.

   Example

   ```
   cluster1::> storage encryption disk sanitize -disk 1.10.2

   Warning: This operation will cryptographically sanitize 1 spare or
   broken self-encrypting disk on 1 node.
            To continue, enter sanitize disk: sanitize disk

   Info: Starting sanitize on 1 disk.
         View the status of the operation using the
         storage encryption disk show-status command.
   ```

Destroying an SED

If you want to make SED data permanently inaccessible and you do not need to reuse the SED, you can use the `storage encryption disk destroy` command to destroy the disk.

Before you begin

You must be a cluster administrator to perform this task.

About this task

When you destroy an SED, the system sets the disk encryption key to an unknown random value and locks the disk irreversibly. Doing so renders the disk permanently unusable and the data on it permanently inaccessible.

Steps

1. Migrate any data that needs to be preserved to an aggregate for a different disk.

2. Delete the aggregate on the SED to be destroyed:

   `storage aggregate delete -aggregate` ***`aggregate_name`***

   For complete command syntax, see the man page.

   Example

   ```
   cluster1::> storage aggregate delete -aggregate aggr1
   ```

3. Identify the disk ID for the SED to be destroyed:

   `storage encryption disk show`

   For complete command syntax, see the man page.

Example

```
cluster1::> storage encryption disk show
Disk    Mode Data Key ID
-----   ---- ----------------------------------------------------------------
0.0.0   data F1CB30AFF1CB30B00101000000000000A68B167F92DD54196297159B5968923C
0.0.1   data F1CB30AFF1CB30B00101000000000000A68B167F92DD54196297159B5968923C
1.10.2  data F1CB30AFF1CB30B00101000000000000CF0EFD81EA9F6324EA97B369351C56AC
[...]
```

4. Destroy the disk:

   `storage encryption disk destroy -disk` ***`disk_id`***

   For complete command syntax, see the man page.

   Note: You are prompted to enter a confirmation phrase before continuing. Enter the phrase exactly as shown on the screen.

Example

```
cluster1::> storage encryption disk destroy -disk 1.10.2

Warning: This operation will cryptographically destroy 1 spare or
broken
         self-encrypting disks on 1 node.
         You cannot reuse destroyed disks unless you revert
         them to their original state using the PSID value.
         To continue, enter
          destroy disk
         :destroy disk

Info: Starting destroy on 1 disk.
      View the status of the operation by using the
      "storage encryption disk show-status" command.
```

Emergency shredding of data on an SED

In case of a security emergency, you can instantly prevent access to SEDs, even if power is not available to the storage system or the KMIP server.

Before you begin

- You must be using a KMIP server, and the KMIP server must be configured with an easily destroyed authentication item (for example, a smart card or USB drive).
- You must be a cluster administrator to perform this task.

Step

1. Perform emergency shredding of data on an SED:

If...	Then...
Power is available to the storage system and you have time to take the storage system offline gracefully	**a.** If the storage system is configured as an HA pair, disable takeover. **b.** Take all aggregates offline and delete them. **c.** Set the privilege level to advanced: **`set -privilege advanced`** **d.** If the SEDs are in FIPS-compliance mode, set the FIPS authentication key ID for the node back to the default MSID: **`storage encryption disk modify -disk * -fips-key-id 0x0`** **e.** Halt the storage system. **f.** Boot into maintenance mode. **g.** Sanitize or destroy the disks: • If you want to make the data on the disks inaccessible and still be able to reuse the disks, sanitize the disks: **`disk encrypt sanitize -all`** • If you want to make the data on the disks inaccessible and you do not need to save the disks, destroy the disks: **`disk encrypt destroy`** ***`disk_id1 disk_id2 …`*** **Note:** The `disk encrypt sanitize` and `disk encrypt destroy` commands are reserved for maintenance mode only. These commands must be run on each HA node, and are not available for broken disks. **h.** Repeat these steps for the partner node. This leaves the storage system in a permanently disabled state with all data erased. To use the system again, you must reconfigure it.
Power is available to the storage system and you must shred the data immediately	**a.** If the storage system is configured as an HA pair, disable takeover. **b.** Set the privilege level to advanced: **`set -privilege advanced`** **c.** Sanitize or destroy the disks: • If you want to make the data on the disks inaccessible and still be able to reuse the disks, sanitize the disks: **`storage encryption disk sanitize -disk * -force-all-states true`** • If you want to make the data on the disks inaccessible and you do not need to save the disks, destroy the disks: **`storage encryption disk destroy -disk * -force-all-states true`** The storage system panics, leaving the system in a permanently disabled state with all data erased. To use the system again, you must reconfigure it.

If...	Then...
Power is available to the KMIP server but not to the storage system	**a.** Log in to the KMIP server. **b.** Destroy all keys associated with the SEDs containing the data you want to prevent access to. This prevents access to disk encryption keys by the storage system.
Power is not available to the KMIP server or the storage system	Destroy the authentication item for the KMIP server (for example, the smart card). This prevents access to disk encryption keys by the storage system.

For complete command syntax, see the man pages.

Returning SEDs to service when authentication keys are lost

The system treats an SED as broken if you lose the authentication keys for it permanently and cannot retrieve them from the KMIP server. Although you cannot access or recover the data on the disk, you can take steps to make the SED’s unused space available again for data.

Before you begin

You must be a cluster administrator to perform this task.

About this task

You should use this process only if you are certain that the authentication keys for the SED are permanently lost and that you cannot recover them.

Step

1. Return SEDs to service:

If the SEDS are...	Use these steps...
Not in FIPS-compliance mode, or in FIPS-compliance mode and the FIPS key is available	**a.** Sanitize the broken disk: **storage encryption disk sanitize -disk *disk_id*** **b.** Set the privilege level to advanced: **set -privilege advanced** **c.** Unfail the sanitized disk: **storage disk unfail -spare true -disk *disk_id*** **d.** Check whether the disk has an owner: **storage disk show -disk *disk_id*** **e.** If the disk does not have an owner, assign one, then unfail the disk again: **storage disk assign -owner *node* -disk *disk_id*** **storage disk unfail -spare true -disk *disk_id*** **f.** Verify that the SED is now a spare and ready to be reused in an aggregate: **storage disk show -disk *disk_id***
In FIPS-compliance mode, the FIPS key is not available, and the SEDs have a PSID printed on the label	**a.** Obtain the SED's PSID from its disk label. **b.** Set the privilege level to advanced: **set -privilege advanced** **c.** Reset the SED to its factory-configured settings: **storage encryption disk revert-to-original-state -disk *disk_id* -psid *disk_physical_secure_id*** **d.** Unfail the sanitized disk: **storage disk unfail -spare true -disk *disk_id*** **e.** Check whether the disk has an owner: **storage disk show -disk *disk_id*** **f.** If the disk does not have an owner, assign one, then unfail the disk again: **storage disk assign -owner *node* -disk *disk_id*** **storage disk unfail -spare true -disk *disk_id*** **g.** Verify that the SED is now a spare and ready to be reused in an aggregate: **storage disk show -disk *disk_id***

For complete command syntax, see the man pages.

Returning SEDs to unprotected mode

An SED is protected from unauthorized access only if the authentication key ID for the node is set to a value other than the SED's default manufacturer secure ID (MSID), which the system evaluates to

0x0. You can return an SED to unprotected mode by using the `storage encryption disk modify` command to set the key ID to 0x0.

Before you begin

You must be a cluster administrator to perform this task.

Steps

1. Set the privilege level to advanced:

   `set -privilege advanced`

2. If the SED is running in FIPS-compliance mode, set the FIPS authentication key ID for the node back to the default MSID:

   `storage encryption disk modify -disk` ***`disk_id`*** **`-fips-key-id 0x0`**

   You can use the `security key-manager query` command to view key IDs.

   #### Example

   ```
   cluster1::> storage encryption disk modify -disk 2.10.11 -fips-key-id
   0x0

   Info: Starting modify on 14 disks.
         View the status of the operation by using the
         storage encryption disk show-status command.
   ```

3. Set the data authentication key ID for the node back to the default MSID:

   `storage encryption disk modify -disk` ***`disk_id`*** **`-data-key-id 0x0`**

   You can use the `security key-manager query` command to view key IDs.

   #### Example

   ```
   cluster1::> storage encryption disk modify -disk 2.10.11 -data-key-id
   0x0

   Info: Starting modify on 14 disks.
         View the status of the operation by using the
         storage encryption disk show-status command.
   ```

Deleting an external key manager connection in ONTAP 9.3 and later

You can disconnect a KMIP server from a node when you no longer need the server. You might disconnect a KMIP server when you are transitioning to volume encryption, for example.

Before you begin

You must be a cluster administrator to perform this task.

About this task

When you disconnect a KMIP server from one node in an HA pair, the system automatically disconnects the server from all cluster nodes.

> **Note:** If you plan to continue using external key management after disconnecting a KMIP server, make sure another KMIP server is available to serve authentication keys.

Step

1. Disconnect a KMIP server from the current node:

   ```
   security key-manager delete -address key_management_server_ipaddress
   ```

   #### Example

   ```
   cluster1::> security key-manager delete -address 10.233.1.198
   (security key-manager delete)
   ```

Deleting an external key manager connection in ONTAP 9.2 and earlier

You can disconnect a KMIP server from a node when you no longer need the server. You might disconnect a KMIP server when you are transitioning to volume encryption, for example.

Before you begin

You must be a cluster administrator to perform this task.

About this task

When you disconnect a KMIP server from one node in an HA pair, the system automatically disconnects the server from the partner node.

Note: If you plan to continue using external key management after disconnecting a KMIP server, make sure another KMIP server is available to serve authentication keys.

Step

1. Disconnect a KMIP server from the current node:

   ```
   security key-manager delete -address key_management_server_ipaddress
   ```

   #### Example

   ```
   cluster1::> security key-manager delete -address 10.233.1.198
   (security key-manager delete)

   Node: cluster1-01
   Key manager 10.233.1.198 registration will be removed from service.
   Key manager registration successfully removed.

   Node: cluster1-02
   Key manager 10.233.1.198 registration will be removed from service.
   Key manager registration successfully removed.
   ```

Transitioning to external key management from onboard key management

If you want to switch to external key management from onboard key management, you must delete the onboard key management configuration before you can enable external key management.

Before you begin

- If you have been using NSE, you must have reset the authentication keys of all NSE disks to MSID (0x0).
  Returning SEDs to unprotected mode on page 50
- If you have been using NVE, you must have unencrypted all volumes.
  Unencrypting volume data on page 32
- You must be a cluster administrator to perform this task.

Step

1. Delete the onboard key management configuration for a cluster:

   `security key-manager delete-key-database`

   #### Example

   The following command deletes the onboard key management configuration for **`cluster1`**:

   ```
   cluster1::> security key-manager delete-key-database
   ```

Transitioning to onboard key management from external key management

If you want to switch to onboard key management from external key management, you must delete the external key management configuration before you can enable onboard key management.

Before you begin

- If you have been using NSE, you must have reset the authentication keys of all NSE disks to MSID (0x0).
  Returning SEDs to unprotected mode on page 50
- You must have deleted all external key manager connections.
  Deleting an external key manager connection in ONTAP 9.2 and earlier on page 52
- You must be a cluster administrator to perform this task.

Step

1. Delete the external key management configuration for a cluster:

   `security key-manager delete-kmip-config`

   #### Example

   The following command deletes the external key management configuration for **`cluster1`**:

   ```
   cluster1::> security key-manager delete-kmip-config
   ```

What happens when key management servers are not reachable during the boot process

ONTAP takes certain precautions to avoid undesired behavior in the event that a storage system configured for NSE cannot reach any of the specified key management servers during the boot process.

If the storage system is configured for NSE, the SEDs are rekeyed and locked, and the SEDs are powered on, the storage system must retrieve the required authentication keys from the key management servers to authenticate itself to the SEDs before it can access the data.

The storage system attempts to contact the specified key management servers for up to three hours. If the storage system cannot reach any of them after that time, the boot process stops and the storage system halts.

If the storage system successfully contacts any specified key management server, it then attempts to establish an SSL connection for up to 15 minutes. If the storage system cannot establish an SSL connection with any specified key management server, the boot process stops and the storage system halts.

While the storage system attempts to contact and connect to key management servers, it displays detailed information about the failed contact attempts at the CLI. You can interrupt the contact attempts at any time by pressing Ctrl-C.

As a security measure, SEDs allow only a limited number of unauthorized access attempts, after which they disable access to the existing data. If the storage system cannot contact any specified key management servers to obtain the proper authentication keys, it can only attempt to authenticate with the default key which leads to a failed attempt and a panic. If the storage system is configured to automatically reboot in case of a panic, it enters a boot loop which results in continuous failed authentication attempts on the SEDs.

Halting the storage system in these scenarios is by design to prevent the storage system from entering a boot loop and possible unintended data loss as a result of the SEDs locked permanently due to exceeding the safety limit of a certain number of consecutive failed authentication attempts. The limit and the type of lockout protection depends on the manufacturing specifications and type of SED:

SED type	Number of consecutive failed authentication attempts resulting in lockout	Lockout protection type when safety limit is reached
HDD	1024	Permanent. Data cannot be recovered, even when the proper authentication key becomes available again.
X440_PHM2800MCTO 800GB NSE SSDs with firmware revisions NA00 or NA01	5	Temporary. Lockout is only in effect until disk is power-cycled.
X577_PHM2800MCTO 800GB NSE SSDs with firmware revisions NA00 or NA01	5	Temporary. Lockout is only in effect until disk is power-cycled.
X440_PHM2800MCTO 800GB NSE SSDs with higher firmware revisions	1024	Permanent. Data cannot be recovered, even when the proper authentication key becomes available again.

SED type	Number of consecutive failed authentication attempts resulting in lockout	Lockout protection type when safety limit is reached
X577_PHM2800MCTO 800GB NSE SSDs with higher firmware revisions	1024	Permanent. Data cannot be recovered, even when the proper authentication key becomes available again.
All other SSD models	1024	Permanent. Data cannot be recovered, even when the proper authentication key becomes available again.

For all SED types, a successful authentication resets the try count to zero.

If you encounter this scenario where the storage system is halted due to failure to reach any specified key management servers, you must first identify and correct the cause for the communication failure before you attempt to continue booting the storage system.

NVE APIs

You can use Zephyr APIs to integrate with NVE functionality in scripts or workflow automation. The APIs use XML messaging over HTTP, HTTPS, and Windows DCE/RPC.

security-key-manager-backup-get

Display the Onboard Key Manager backup information.

security-key-manager-delete-keys

Delete the Onboard Key Manager configuration.

security-key-manager-delete-kmip-config

Delete an external key manager configuration.

security-key-manager-key-get-iter

Display the IDs for the NSE authentication key, the NSE FIPS authentication key, and the SVM key encryption key. Each node should show the same sets of keys.

security-key-manager-setup

Enable key management.

security-key-manager-update-passphrase

Change the passphrase for the Onboard Key Manager.

volume-create

Create a volume and enable encryption on the volume.

volume-move-start

Move a volume and enable encryption on the volume. Also used to move an encrypted volume and unencrypt a volume.

Where to find additional information

You can learn more about the tasks described in this guide in NetApp's extensive documentation library.

- *Disk and aggregate management*
  Describes how to manage physical storage in NetApp systems, including disks, aggregates, and RAID groups.
- *Logical storage management*
  Describes how to manage logical storage in NetApp systems, including FlexVol volumes, FlexClone volumes, FlexCache volumes, files, and LUNs.
- *FlexGroup volumes management*
  Describes how to manage FlexGroup volumes.
- *Archive and compliance using SnapLock technology*
  Describes how to manage SnapLock volumes.
- *ONTAP 9 commands*
  Describes encryption commands in reference format.
- *NetApp Documentation: OnCommand Workflow Automation (current releases)*
  Describes how to use the OnCommand Workflow Automation scripting tool to perform encryption-related tasks.

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