## Contents

**Deciding whether to use the NetApp Encryption Power Guide** ............... 5

**Configuring NetApp Volume Encryption** .................................................. 6

  NetApp Volume Encryption workflow .......................................................... 9

  Configuring NVE ............................................................................................ 9

    Determining whether your cluster version supports NVE ........................... 9

    Installing the license ................................................................................... 10

    Configuring external key management .................................................... 10

    Enabling onboard key management in ONTAP 9.6 and later (NVE) ............ 14

    Enabling onboard key management in ONTAP 9.5 and earlier (NVE) ........ 16

  Encrypting volume data with NVE ................................................................. 18

    Enabling aggregate-level encryption with NVE license ............................ 18

    Enabling encryption on a new volume ....................................................... 19

    Enabling encryption on an existing volume with the volume encryption
      conversion start command ....................................................................... 21

    Enabling encryption on an existing volume with the volume move start
      command ................................................................................................. 22

**Configuring NetApp hardware-based encryption** ................................. 25

  Hardware-based encryption workflow .......................................................... 26

  Configuring external key management ....................................................... 27

    Collecting network information in ONTAP 9.2 and earlier ........................ 27

    Installing SSL certificates on the cluster ................................................. 28

    Enabling external key management in ONTAP 9.6 and later (HW-based) ... 29

    Enabling external key management in ONTAP 9.5 and earlier .................. 30

    Creating authentication keys in ONTAP 9.6 and later .............................. 31

    Creating authentication keys in ONTAP 9.5 and earlier ........................... 32

    Assigning a data authentication key to a FIPS drive or SED (external
      key management) ..................................................................................... 33

  Configuring onboard key management ....................................................... 34

    Enabling onboard key management in ONTAP 9.6 and later .................... 34

    Enabling onboard key management in ONTAP 9.5 and earlier .................. 36

    Assigning a data authentication key to a FIPS drive or SED (onboard
      key management) ..................................................................................... 37

    Assigning a FIPS 140-2 authentication key to a FIPS drive .................... 38

    Enabling cluster-wide FIPS-compliant mode for KMIP server connections ........ 39

**Managing NetApp encryption** ................................................................. 41

  Unencrypting volume data ............................................................................ 41

  Moving an encrypted volume ..................................................................... 42

  Delegating authority to run the volume move command .......................... 42

  Changing the encryption key for a volume with the volume encryption rekey
    start command .......................................................................................... 43
Changing the encryption key for a volume with the volume move start command ................................................................. 44
Deleting an encrypted volume ................................................................................................................................................. 45
Scrubbing data on an encrypted volume ................................................................................................................................... 46
Changing the onboard key management passphrase .............................................................................................................. 47
Backing up onboard key management information manually .................................................................................................. 48
Restoring onboard key management encryption keys ............................................................................................................. 49
Restoring external key management encryption keys ........................................................................................................... 50
Replacing SSL certificates ............................................................................................................................................................ 52
Replacing a FIPS drive or SED ...................................................................................................................................................... 53
Making data on a FIPS drive or SED inaccessible ........................................................................................................................ 54
Sanitizing a FIPS drive or SED .................................................................................................................................................... 54
Destroying a FIPS drive or SED .................................................................................................................................................. 55
Emergency shredding of data on an FIPS drive or SED ............................................................................................................... 57
Returning a FIPS drive or SED to service when authentication keys are lost ................................................................. 58
Returning a FIPS drive or SED to unprotected mode .................................................................................................................. 60
Deleting an external key manager connection .......................................................................................................................... 60
Modifying external key manager server properties ................................................................................................................ 61
Transitioning to external key management from onboard key management ....... 62
Transitioning to onboard key management from external key management .......... 63
What happens when key management servers are not reachable during the boot process ............................................................................................................. 63
Disabling encryption by default with ONTAP 9.7 and later ........................................................................................................ 65
Where to find additional information .......................................................... 66
Copyright ...................................................................................................................................................................................... 67
Trademark ................................................................................................................................................................................... 68
How to send comments about documentation and receive update notifications ............................................................................ 69
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 encryption supports data encryption one volume at a time.
- Hardware-based encryption supports full-disk encryption (FDE) of data as it is written.

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 ONTAP System Manager or an automated scripting tool.

As of ONTAP 9.7, System Manager supports onboard key manager encryption. For more information, see the System Manager documentation:

- https://docs.netapp.com/us-en/ontap/task_security_encrypt_stored_data_sw.html
- https://docs.netapp.com/us-en/ontap/task_security_encrypt_stored_data_hw.html

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). It is a best practice to configure external key management servers on a different storage system from your data.
- The Onboard Key Manager is a built-in tool that serves keys to nodes from the same storage system as your data.

Starting with ONTAP 9.7, aggregate and volume encryption is enabled by default if you have a volume encryption (VE) license and use an onboard or external key manager. Whenever an external or onboard key manager is configured there is a change in how data at rest encryption is configured for brand new aggregates and brand new volumes. Brand new aggregates will have NetApp Aggregate Encryption (NAE) enabled by default. Brand new volumes that are not part of an NAE aggregate will have NetApp Volume Encryption (NVE) enabled by default. If a data storage virtual machine (SVM) is configured with its own key-manager using multi-tenant key management in an aggregate with NAE, then the volume created for that SVM is automatically configured with NVE.

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

**Note:** If you are using SnapLock, you can enable encryption only on new, empty SnapLock volumes. You cannot enable encryption on an existing SnapLock volume.

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 hardware-based encryption to “double encrypt” data on self-encrypting drives.

**Note:** AFF A220, AFF A800, FAS2720, FAS2750, and later systems store core dumps on their boot device. When NVE is enabled on these systems, the core dump is also encrypted.

Aggregate-level encryption

Ordinarily, every encrypted volume is assigned a unique key. When the volume is deleted, the key is deleted with it.

Starting with ONTAP 9.6, you can use NetApp Aggregate Encryption (NAE) to assign keys to the containing aggregate for the volumes to be encrypted. When an encrypted volume is deleted, the keys for the aggregate are preserved. The keys are deleted only after the last encrypted volume in the aggregate is deleted.

You must use aggregate-level encryption if you plan to perform inline or background aggregate-level deduplication. Aggregate-level deduplication is otherwise not supported by NVE.

Starting with ONTAP 9.7, aggregate and volume encryption is enabled by default if you have a volume encryption (VE) license and use an onboard or external key manager.

NVE and NAE volumes can coexist on the same aggregate. Volumes encrypted under aggregate-level encryption are NAE volumes by default. You can override the default when you encrypt the volume.
You can use the `volume move` command to convert an NVE volume to an NAE volume, and vice versa. You can replicate an NAE volume to an NVE volume.

**When to use external key management 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, 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.

**Scope of external key management**

The scope of external key management determines whether key management servers secure all the SVMs in the cluster or selected SVMs only:

- You can use a `cluster scope` to configure external key management for all the SVMs in the cluster. The cluster administrator has access to every key stored on the servers.
- Starting with ONTAP 9.6, you can use an `SVM scope` to configure external key management for a named SVM in the cluster. That’s best for multitenant environments in which each tenant uses a different SVM (or set of SVMs) to serve data. Only the SVM administrator for a given tenant has access to the keys for that tenant.

You can use both scopes in the same cluster. If key management servers have been configured for an SVM, ONTAP uses only those servers to secure keys. Otherwise, ONTAP secures keys with the key management servers configured for the cluster.

**Support details**

The following table shows NVE support details:

<table>
<thead>
<tr>
<th>Resource or feature</th>
<th>Support details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Platforms</strong></td>
<td>AES-NI offload capability required. See the Hardware Universe (HWU) to verify that NVE and NAE are supported for your platform.</td>
</tr>
</tbody>
</table>
| **Encryption**      | Starting ONTAP 9.7, newly created aggregates and volumes are encrypted by default when you add a volume encryption (VE) and have an onboard or external key manager configured. If you need to create an unencrypted aggregate, use the following command:  
  `storage aggregate create -encrypt-with-aggr-key false`  
  If you need to create a plain text volume, use the following command:  
  `volume create -encrypt false`  
  Encryption is not enabled by default when:  
  - VE is not configured  
  - Key manager is not configured  
  - Platform or software does not support encryption  
  - Hardware encryption is enabled |
<p>| <strong>ONTAP</strong>           | All ONTAP implementations. Support for ONTAP Cloud is available in ONTAP 9.5 and later. |</p>
<table>
<thead>
<tr>
<th>Resource or feature</th>
<th>Support details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Devices</td>
<td>HDD, SSD, hybrid, array LUN.</td>
</tr>
<tr>
<td>RAID</td>
<td>RAID0, RAID4, RAID-DP, RAID-TEC.</td>
</tr>
<tr>
<td>Volumes</td>
<td>Data volumes only. You cannot encrypt data on a root volume, an SVM root volume, or a MetroCluster metadata volume.</td>
</tr>
</tbody>
</table>
| Aggregate-level encryption          | Starting with ONTAP 9.6, NVE supports aggregate-level encryption (NAE):  
• You must use aggregate-level encryption if you plan to perform inline or background aggregate-level deduplication.  
• You cannot rekey an aggregate-level encryption volume.  
• Secure-purge is not supported on aggregate-level encryption volumes.  
• In addition to data volumes, NAE supports encryption of SVM root volumes and the MetroCluster metadata volume. NAE does not support encryption of the root volume. |
| SVM scope                           | Starting with ONTAP 9.6, NVE supports SVM scope for external key management only, not for Onboard Key Manager. MetroCluster is not supported.                                                                    |
| 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.                                         |
| Replication                         |  
• For volume replication, the destination volume must have been enabled for encryption. Encryption can be configured for the source and unconfigured for the destination, and vice versa.  
• 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, each cluster pulls external key management keys from its configured key servers. OKM keys are replicated to the partner site by the configuration replication service. |
| Compliance                          | Starting with ONTAP 9.2, SnapLock is supported in both Compliance and Enterprise modes, for new volumes only. You cannot enable encryption on an existing SnapLock volume.                                                |
| FlexGroups                          | Starting with ONTAP 9.2, FlexGroups are supported. Destination aggregates must be of the same type as source aggregates, either volume-level or aggregate-level. Starting with ONTAP 9.5, in-place rekey of FlexGroup volumes is 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.

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 7.
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 <no-DARE>
```

The text “no-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 AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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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 for the cluster.
- You must have obtained the private key associated with the SSL KMIP client certificate 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) 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 cluster1 -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 cluster1 -type server-ca -subtype kmip-cert

Enabling external key management in ONTAP 9.6 and later (NVE)

You can use one or more KMIP servers to secure the keys the cluster uses to access encrypted data. Starting with ONTAP 9.6, you can use one or more KMIP servers to secure the keys a given SVM uses to access encrypted data.

Before you begin

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

You can connect up to four KMIP servers to a cluster or SVM. A minimum of two servers is recommended for redundancy and disaster recovery.

The scope of external key management determines whether key management servers secure all the SVMs in the cluster or selected SVMs only:

• You can use a cluster scope to configure external key management for all the SVMs in the cluster. The cluster administrator has access to every key stored on the servers.
• Starting with ONTAP 9.6, you can use an SVM scope to configure external key management for a named SVM in the cluster. That's best for multitenant environments in which each tenant uses a different SVM (or set of SVMs) to serve data. Only the SVM administrator for a given tenant has access to the keys for that tenant.

You can use both scopes in the same cluster. If key management servers have been configured for an SVM, ONTAP uses only those servers to secure keys. Otherwise, ONTAP secures keys with the key management servers configured for the cluster.

You can configure onboard key management at the cluster scope and external key management at the SVM scope. You can use the `security key-manager key migrate` command to migrate keys from onboard key management at the cluster scope to external key managers at the SVM scope.

Steps

1. Configure key manager connectivity for the cluster:

   `security key-manager external enable -vserver admin_SVM -key-servers host_name|IP_address:port,... -client-cert client_certificate -server-ca-cert server_CA_certificates`

   **Note:** The `security key-manager external enable` command replaces the `security key-manager setup` command. If you run the command at the cluster login prompt, `admin_SVM` defaults to the admin SVM of the current cluster.

   You must be the cluster administrator to configure cluster scope. You can run the `security key-manager external modify` command to change the external key management configuration.

   **Example**

   The following command enables external key management for `cluster1` with three external key servers. The first key server is specified using its hostname and port, the second is specified using an IP address and the default port, and the third is specified using an IPv6 address and port:

   ```bash
   cluster1::> security key-manager external enable -vserver cluster1 -key-servers ks1.local:15696,10.0.0.10,[fd20:8b1e:b255:814e:32bd:f35c:832c:5a09]:1234 -client-cert AdminVserverClientCert -server-ca-certs AdminVserverServerCaCert
   ```

2. Configure key manager connectivity for an SVM:

   `security key-manager external enable -vserver SVM -key-servers host_name|IP_address:port,... -client-cert client_certificate -server-ca-cert server_CA_certificates`

   **Note:** If you run the command at the SVM login prompt, `SVM` defaults to the current SVM.

   You must be a cluster or SVM administrator to configure SVM scope. You can run the `security key-manager external modify` command to change the external key management configuration.
Example

The following command enables external key management for \texttt{svml} with a single key server listening on the default port 5696:

```
svml1l::> security key-manager external enable -vserver svml -key-servers keyserv1e.svml.com -client-cert SVM1ClientCert -server-ca-certs SVM1ServerCaCert
```

3. Repeat the last step for any additional SVMs.

\textbf{Note:} You can also use the security key-manager external add servers command to configure additional SVMs. The security key-manager external add servers command replaces the security key-manager add command. For complete command syntax, see the man page.

4. Verify that all configured KMIP servers are connected:

```
security key-manager external show-status -node node_name
```

\textbf{Note:} The security key-manager external show-status command replaces the security key-manager show -status command. For complete command syntax, see the man page.

Example

```
cluster1l::> security key-manager external show-status

Node | Vserver | Key Server | Status
---- | ------ | ---------- | -----
node1 | svml1 | keyserv1e.svml.com:5696 | available
cluster1 | 10.0.0.10:5696 | available
 | fd20:881e:b255:814e:32bd:f35c:832c:5a09:1234 | available
 | ksl.local:15696 | available
node2 | svml1 | keyserv1e.svml.com:5696 | available
cluster1 | 10.0.0.10:5696 | available
 | fd20:881e:b255:814e:32bd:f35c:832c:5a09:1234 | available
 | ksl.local:15696 | available
```

8 entries were displayed.

Enabling external key management in ONTAP 9.5 and earlier

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.

Steps

1. Configure key manager connectivity for cluster nodes:

```
security key-manager setup
```
The key manager setup wizard opens.

2. Enter the appropriate response at each prompt.

3. Add a KMIP server:

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

   Example

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

4. Add an additional KMIP server for redundancy:

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

   Example

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

5. Verify that all configured KMIP servers are connected:

   ```bash
   security key-manager show -status
   ```

   For complete command syntax, see the man page.

   Example

   ```bash
   clusterl::> security key-manager show -status
   Node            Port      Registered Key Manager  Status
   ---------------  ----      ----------------------  ---------------
   clusterl-01     5696      20.1.1.1                available
   clusterl-01     5696      20.1.1.2                available
   clusterl-02     5696      20.1.1.1                available
   clusterl-02     5696      20.1.1.2                available
   ```

Enabling onboard key management in ONTAP 9.6 and later (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.

Before you begin

You must be a cluster administrator to perform this task.

About this task

You must run the `security key-manager onboard enable` command each time you add a node to the cluster. In MetroCluster configurations, you must run `security key-manager onboard enable` on the local cluster first, then on the remote cluster, using the same passphrase on each.

By default, you are not required to enter the key manager passphrase when a node is rebooted. You can use the `cc-mode-enabled=yes` option to require that users enter the passphrase after a reboot.

For NVE, if you set `cc-mode-enabled=yes`, volumes you create with the `volume create` and `volume move start` commands are automatically encrypted. For `volume create`, you need not specify `-encrypt true`. For `volume move start`, you need not specify `-encrypt-destination true`.

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

1. Start the key manager setup wizard:

   security key-manager onboard enable -cc-mode-enabled yes|no

   **Note:** Set cc-mode-enabled=yes to require that users enter the key manager passphrase after a reboot. For NVE, if you set cc-mode-enabled=yes, volumes you create with the volume create and volume move start commands are automatically encrypted. The - cc-mode-enabled option is not supported in MetroCluster configurations.

   The security key-manager onboard enable command replaces the security key-manager setup command.

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 onboard enable
   Enter the cluster-wide passphrase for onboard key management in Vserver "cluster1": <32..256 ASCII characters long text>
   Reenter the cluster-wide passphrase: <32..256 ASCII characters long text>
   ```

2. 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.

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

4. Verify that the authentication keys have been created:

   security key-manager key query -node node

   **Note:** The security key-manager key query command replaces the security key-manager query key command. For complete command syntax, see the man page.

Example

The following example verifies that authentication keys have been created for cluster1:

   ```
   cluster1::> security key-manager key query
   Vserver: cluster1
   Key Manager: onboard
   Node: node1
   Key Tag                               Key Type  Restored
   ------------------------------------  --------  --------
   node1                                 NSE-AK    yes
   Key ID:
   000000000000000002000000000001000c11b3863f78c2273343d7ec5a67762e0000000000000000
   node1                                 NSE-AK    yes
   Key ID:
   000000000000000002000000000001006f4e2513353a674305872a4c9f3bf79700000000000000
   ```
### 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 48

### Enabling onboard key management in ONTAP 9.5 and earlier (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.

### 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 63
- 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 yes option to require that users enter the passphrase after a reboot.

For NVE, if you set -enable-cc-mode yes, volumes you create with the volume create and volume move start commands are automatically encrypted. For volume create, you need not specify -encrypt true. For volume move start, you need not specify -encrypt-destination true.
**Note:** After a failed passphrase attempt, you must reboot the node again.

**Steps**

1. **Start the key manager setup wizard:**

   ```
   security key-manager setup -enable-cc-mode yes|no
   ```

   **Note:** Starting with ONTAP 9.4, you can use the `-enable-cc-mode yes` option to require that users enter the key manager passphrase after a reboot. For NVE, if you set `-enable-cc-mode yes`, volumes you create with the `volume create` and `volume move start` commands are automatically encrypted.

   **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
   ---------------------------------------------------------------
   0000000000000000000000000000000010059851742AF2703FC91369B7DB47C4722 NSE-AK
   000000000000000000000000000000001008C07CC0AF1EF49E0105300EFC83004BF NSE-AK
   Node: node2
   Key Store: onboard
   Key ID                                                           Used By
   ---------------------------------------------------------------
   0000000000000000000000000000000010059851742AF2703FC91369B7DB47C4722 NSE-AK
   000000000000000000000000000000001008C07CC0AF1EF49E0105300EFC83004BF 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 48

**Encrypting volume data with NVE**
Starting with ONTAP 9.7, aggregate and volume encryption is enabled by default when you have the NVE license and onboard or external key management. For ONTAP 9.6 and earlier, 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 aggregate-level encryption with NVE license**
Starting with ONTAP 9.7, newly created aggregates and volumes are encrypted by default when you have the NVE license and onboard or external key management. Starting with ONTAP 9.6, you can use aggregate-level encryption to assign keys to the containing aggregate for the volumes to be encrypted. Volumes you create in the aggregate are encrypted by default. You can override the default when you encrypt the volume.

**Before you begin**
You must be a cluster administrator to perform this task.

**About this task**
You must use aggregate-level encryption if you plan to perform inline or background aggregate-level deduplication. Aggregate-level deduplication is otherwise not supported by NVE.

An aggregate enabled for aggregate-level encryption is called an NAE volume (for NetApp Aggregate Encryption). Plain text volumes are not supported in NAE aggregates.

**Steps**
1. **Enable or disable aggregate-level encryption:**

<table>
<thead>
<tr>
<th>To...</th>
<th>Use this command...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create an NAE aggregate with ONTAP 9.7 or later</td>
<td><code>storage aggregate create -aggregate aggregate_name -node node_name</code></td>
</tr>
<tr>
<td>Create an NAE aggregate with ONTAP 9.6</td>
<td><code>storage aggregate create -aggregate aggregate_name -node node_name -encrypt-with-aggr-key true</code></td>
</tr>
<tr>
<td>Convert a non-NAE aggregate to an NAE aggregate</td>
<td><code>storage aggregate modify -aggregate aggregate_name -node node_name -encrypt-with-aggr-key true</code></td>
</tr>
<tr>
<td>Convert an NAE aggregate to a non-NAE aggregate</td>
<td><code>storage aggregate modify -aggregate aggregate_name -node node_name -encrypt-with-aggr-key false</code></td>
</tr>
</tbody>
</table>

For complete command syntax, see the man pages.
Example

The following command enables aggregate-level encryption on `aggr1`:

- ONTAP 9.7 or later:

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

- ONTAP 9.6 or earlier:

  ```
  cluster1::> storage aggregate create -aggregate aggr1 -encrypt-with-aggr-key true
  ```

2. Verify that the aggregate is enabled for encryption:

   ```
   storage aggregate show -fields encrypt-with-aggr-key
   ```

   For complete command syntax, see the man page.

   Example

   The following command verifies that `aggr1` is enabled for encryption:

   ```
   cluster1::> storage aggregate show -fields encrypt-with-aggr-key
   aggregate        encrypt-aggr-key
   ----------------- ----------------
   aggr0_vsim4      false
   aggr1            true
   2 entries were displayed.
   ```

After you finish

Run the `volume create` command to create the encrypted volumes.

If you are using a KMIP server to store the encryption keys for a node, ONTAP automatically “pushes” an encryption key to the server when you encrypt a volume.

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.

Starting with ONTAP 9.4, if you enable “cc-mode” when you set up the Onboard Key Manager, volumes you create with the `volume create` command are automatically encrypted, whether or not you specify `-encrypt true`.

Starting with ONTAP 9.6, you can use aggregate-level encryption to assign keys to the containing aggregate for the volumes to be encrypted. Volumes you create in the aggregate are encrypted by default. You can use the `-encrypt` option to override the default when you create the volume.

Starting with ONTAP 9.7, newly created volumes are encrypted by default when you have the NVE license and onboard or external key management.

A volume encrypted with a unique key is called an NVE volume. A volume encrypted with an aggregate-level key is called an NAE volume (for NetApp Aggregate Encryption). Plaintext volumes are not supported in NAE aggregates.

Steps

1. Create a new volume and specify whether encryption is enabled on the volume:
To create... | Use this command...
---|---
*An ONTAP 9.7 or later NAE volume* | `volume create -vserver SVM_name -volume volume_name -aggregate aggregate_name`

*An ONTAP 9.6 NAE volume (assuming aggregate-level encryption is enabled)* | `volume create -vserver SVM_name -volume volume_name -aggregate aggregate_name`

*An ONTAP 9.7 or later NVE volume* | `volume create -vserver SVM_name -volume volume_name -aggregate aggregate_name`

*An ONTAP 9.6 or earlier NVE volume* | `volume create -vserver SVM_name -volume volume_name -aggregate aggregate_name -encrypt true`

*A plain text volume* | `volume create -vserver SVM_name -volume volume_name -aggregate aggregate_name -encrypt false`

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

**Example**

Starting with ONTAP 9.7 or later, the following command creates an NAE volume named *vol1* on *aggr1*:

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

**Example**

Using ONTAP 9.6, assuming aggregate-level encryption is enabled, the following command creates an NAE volume named *vol1* on *aggr1*:

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

**Example**

Starting with ONTAP 9.7 or later, the following command creates an NVE volume named *vol2* on *aggr1*:

```
cluster1::> volume create -vserver vs1 -volume vol2 -aggregate aggr1
```

**Example**

Using ONTAP 9.6 or earlier, the following command creates an NVE volume named *vol2* on *aggr1*:

```
cluster1::> volume create -vserver vs1 -volume vol2 -aggregate aggr1 -encrypt true
```

**Example**

The following command creates a plaintext volume named *vol3* on *aggr1*:

```
cluster1::> volume create -vserver vs1 -volume vol3 -aggregate aggr1 -encrypt false
```
2. Verify that volumes are 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 `cluster2`:

```
cluster2::> volume show -is-encrypted true
```

<table>
<thead>
<tr>
<th>Vserver</th>
<th>Volume</th>
<th>Aggregate</th>
<th>State</th>
<th>Type</th>
<th>Size</th>
<th>Available</th>
<th>Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>vs1</td>
<td>vol1</td>
<td>aggr2</td>
<td>online</td>
<td>RW</td>
<td>200GB</td>
<td>160.0GB</td>
<td>20%</td>
</tr>
</tbody>
</table>

**Result**

If you are using a KMIP server to store the encryption keys for a node, ONTAP automatically “pushes” an encryption key to the server when you encrypt a volume.

**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 of an existing volume "in place," without having to move the volume to a different location.

**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 resume` command to resume the operation.

**Note:** You cannot use `volume encryption conversion start` to convert a SnapLock 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:
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
```

<table>
<thead>
<tr>
<th>Vserver</th>
<th>Volume</th>
<th>Aggregate</th>
<th>State</th>
<th>Type</th>
<th>Size</th>
<th>Available</th>
<th>Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>vs1</td>
<td>vol1</td>
<td>aggr2</td>
<td>online</td>
<td>RW</td>
<td>200GB</td>
<td>160.0GB</td>
<td>20%</td>
</tr>
</tbody>
</table>

Result

If you are using a KMIP server to store the encryption keys for a node, ONTAP automatically “pushes” an encryption 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 by moving 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 43

About this task

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

Starting with ONTAP 9.4, if you enable “cc-mode” when you set up the Onboard Key Manager, volumes you create with the `volume move start` command are automatically encrypted. You need not specify `-encrypt-destination true`.

Starting with ONTAP 9.6, you can use aggregate-level encryption to assign keys to the containing aggregate for the volumes to be moved. A volume encrypted with a unique key is called an NVE volume. A volume encrypted with an aggregate-level key is called an NAE volume (for NetApp Aggregate Encryption). Plaintext volumes are not supported in NAE aggregates.

Steps

1. Move an existing volume and specify whether encryption is enabled on the volume:

<table>
<thead>
<tr>
<th>To convert...</th>
<th>Use this command...</th>
</tr>
</thead>
<tbody>
<tr>
<td>A plaintext volume to an NVE volume</td>
<td><code>volume move start -vserver SVM_name -volume volume_name -destination-aggregate aggregate_name -encrypt-destination true</code></td>
</tr>
<tr>
<td>To convert...</td>
<td>Use this command...</td>
</tr>
<tr>
<td>---------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>An NVE or plaintext volume to an NAE volume (assuming aggregate-level encryption is enabled on the destination)</td>
<td><code>volume move start -vserver SVM_name -volume volume_name -destination-aggregate aggregate_name -encrypt-with-aggr-key true</code></td>
</tr>
<tr>
<td>An NAE volume to an NVE volume</td>
<td><code>volume move start -vserver SVM_name -volume volume_name -destination-aggregate aggregate_name -encrypt-with-aggr-key false</code></td>
</tr>
<tr>
<td>An NAE volume to a plaintext volume</td>
<td><code>volume move start -vserver SVM_name -volume volume_name -destination-aggregate aggregate_name -encrypt-destination false -encrypt-with-aggr-key false</code></td>
</tr>
<tr>
<td>An NVE volume to a plaintext volume</td>
<td><code>volume move start -vserver SVM_name -volume volume_name -destination-aggregate aggregate_name -encrypt-destination false</code></td>
</tr>
</tbody>
</table>

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

**Example**

The following command converts a plaintext volume named `vol1` to an NVE volume:

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

**Example**

Assuming aggregate-level encryption is enabled on the destination, the following command converts an NVE or plaintext volume named `vol1` to an NAE volume:

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

**Example**

The following command converts an NAE volume named `vol2` to an NVE volume:

```
cluster1::> volume move start -vserver vs1 -volume vol2 -destination-aggregate aggr2 -encrypt-with-aggr-key false
```

**Example**

The following command converts an NAE volume named `vol2` to a plaintext volume:

```
cluster1::> volume move start -vserver vs1 -volume vol2 -destination-aggregate aggr2 -encrypt-destination false -encrypt-with-aggr-key false
```

**Example**

The following command converts an NVE volume named `vol2` to a plaintext volume:

```
cluster1::> volume move start -vserver vs1 -volume vol2 -destination-aggregate aggr2 -encrypt-destination false
```
2. View the encryption type of cluster volumes:
   
   ```
   volume show -fields encryption-type none|volume|aggregate
   ```
   
   The encryption-type field is available in ONTAP 9.6 and later.
   
   For complete command syntax, see the man page for the command.
   
   **Example**
   
   The following command displays the encryption type of volumes in `cluster2`:
   
   ```
   cluster2::> volume show -fields encryption-type
   vserver volume encryption-type
   ------- ------ -------------------
   vs1 vol1 none
   vs2 vol2 volume
   vs3 vol3 aggregate
   ```

3. Verify that volumes are 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 `cluster2`:
   
   ```
   cluster2::> 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 store the encryption keys for a node, ONTAP automatically “pushes” an encryption key to the server when you encrypt a volume.*
Configuring NetApp hardware-based encryption

NetApp hardware-based encryption supports full-disk encryption (FDE) of data as it is written. The data cannot be read without an encryption key stored on the firmware. The encryption key, in turn, is accessible only to an authenticated node.

Understanding NetApp hardware-based encryption

A node authenticates itself to a self-encrypting drive 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). It is a best practice to configure external key management servers on a different storage system from your data.
- The Onboard Key Manager is a built-in tool that serves authentication keys to nodes from the same storage system as your data.

You can use NetApp Volume Encryption with hardware-based encryption to “double encrypt” data on self-encrypting drives.

Note: AFF A220, AFF A800, FAS2720, FAS2750, and later systems store core dumps on their boot device. When self-encrypting drives are enabled on these systems, the core dump is also encrypted.

Supported drive types

Two types of self-encrypting drive are supported:

- Self-encrypting FIPS-certified SAS or NVMe drives are supported on all FAS and AFF systems. These drives, called FIPS drives, conform to the requirements of Federal Information Processing Standard Publication 140-2, level 2. The certified capabilities enable protections in addition to encryption, such as preventing denial-of-service attacks on the drive. FIPS drives cannot be mixed with other types of drives on the same node or HA pair.

- Starting with ONTAP 9.6, self-encrypting NVMe drives that have not undergone FIPS testing are supported on AFF A800 and A320 systems. These drives, called SEDs, offer the same encryption capabilities as FIPS drives, but can be mixed with non-SEDs on the same node or HA pair.

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 FIPS 140-2 level 2 or higher.
- You need a multi-cluster solution, 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.

Support details

The following table shows important hardware encryption support details. See the Interoperability Matrix for the latest information about supported KMIP servers, storage systems, and disk shelves.
<table>
<thead>
<tr>
<th>Resource or feature</th>
<th>Support details</th>
</tr>
</thead>
</table>
| Non-homogeneous disk sets| • FIPS drives cannot be mixed with other types of drives on the same node or HA pair. Conforming HA pairs can coexist with non-conforming HA pairs in the same cluster.  
  • SEDs can be mixed with non-SEDs on the same node or HA pair. |
| Drive type               | • FIPS drives can be SAS or NVMe drives.  
  • SEDs must be NVMe drives. |
| 10 Gb network interfaces | Starting with ONTAP 9.3, KMIP key management configurations support 10 Gb network interfaces for communications with external key management servers. |
| Ports for communication  | 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. |
| the key management server|                                                                                                                                                   |
| MetroCluster (MCC)       | • NVMe drives support MCC.  
  • SAS drives do not support MCC. |

**Related information**

*NetApp Interoperability Matrix Tool*

**Hardware-based encryption workflow**

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

**Note:** NetApp Volume Encryption (NVE) supports Onboard Key Manager in ONTAP 9.1 and later. In ONTAP 9.3 and later, NVE supports external key management (KMIP) and Onboard 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.

<table>
<thead>
<tr>
<th>Item</th>
<th>Notes</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key management network interface name</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Key management network interface IP address</td>
<td>IP address of node management LIF, in IPv4 or IPv6 format</td>
<td></td>
</tr>
<tr>
<td>Key management network interface IPv6 network prefix length</td>
<td>If you are using IPv6, the IPv6 network prefix length</td>
<td></td>
</tr>
<tr>
<td>Key management network interface subnet mask</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Key management network interface gateway IP address</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IPv6 address for the cluster network interface</td>
<td>Required only if you are using IPv6 for the key management network interface</td>
<td></td>
</tr>
<tr>
<td>Port number for each KMIP server</td>
<td>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.</td>
<td></td>
</tr>
<tr>
<td>Key tag name</td>
<td>Optional. The key tag name is used to identify all keys belonging to a node. The default key tag name is the node name.</td>
<td></td>
</tr>
</tbody>
</table>
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 for the cluster.
- You must have obtained the private key associated with the SSL KMIP client certificate 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) 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 cluster1 -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 cluster1 -type server-ca -subtype kmip-cert
   ```
Enabling external key management in ONTAP 9.6 and later (HW-based)

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.

Steps

1. Configure key manager connectivity for the cluster:

   ```bash
   security key-manager external enable -vserver admin_SVM -key-servers
   host_name|IP_address:port,... -client-cert client_certificate -server-ca-cert server_CA_certificates
   ```

   **Note:** The `security key-manager external enable` command replaces the `security key-manager setup` command. You can run the `security key-manager external modify` command to change the external key management configuration. For complete command syntax, see the man pages.

   **Example**

   The following command enables external key management for `cluster1` with three external key servers. The first key server is specified using its hostname and port, the second is specified using an IP address and the default port, and the third is specified using an IPv6 address and port:

   ```bash
   cluster1::> security key-manager external enable -key-servers
   ks1.local:15696,10.0.0.10,[fd20:8b1e:b255:814e:32bd:f35c:832c:5a09]:
   1234 -client-cert AdminVserverClientCert -server-ca-certs
   AdminVserverServerCaCert
   ```

2. Verify that all configured KMIP servers are connected:

   ```bash
   security key-manager external show-status -node node_name -vserver SVM -key-server host_name|IP_address:port -key-server-status available|not-responding|unknown
   ```

   **Note:** The `security key-manager external show-status` command replaces the `security key-manager show -status` command. For complete command syntax, see the man page.

   **Example**

   ```bash
   cluster1::> security key-manager external show-status
   Node Vserver Key Server                                     Status
   ---- ----- -------------------------------        ------------
   node1 cluster1 10.0.0.10:5696 available
   fd20:8b1e:b255:814e:32bd:f35c:832c:5a09:1234 available
   ks1.local:15696 available
   node2 cluster1 10.0.0.10:5696 available
   fd20:8b1e:b255:814e:32bd:f35c:832c:5a09:1234 available
   ks1.local:15696 available
   ```

   6 entries were displayed.
Enabling external key management in ONTAP 9.5 and earlier

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.

Steps

1. Configure key manager connectivity for cluster nodes:

```
security key-manager setup
```

The key manager setup wizard opens.

2. Enter the appropriate response at each prompt.

3. Add a KMIP server:

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

Example

```
cluster1::> security key-manager add -address 20.1.1.1
```

4. Add an additional KMIP server for redundancy:

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

Example

```
cluster1::> 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
```

<table>
<thead>
<tr>
<th>Node</th>
<th>Port</th>
<th>Registered Key Manager</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>cluster1-01</td>
<td>5696</td>
<td>20.1.1.1</td>
<td>available</td>
</tr>
<tr>
<td>cluster1-02</td>
<td>5696</td>
<td>20.1.1.2</td>
<td>available</td>
</tr>
<tr>
<td>cluster1-01</td>
<td>5696</td>
<td>20.1.1.1</td>
<td>available</td>
</tr>
<tr>
<td>cluster1-02</td>
<td>5696</td>
<td>20.1.1.2</td>
<td>available</td>
</tr>
</tbody>
</table>
Creating authentication keys in ONTAP 9.6 and later

You can use the `security key-manager key create` 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 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 key create -key-tag passphrase_label -prompt-for-key true|false`

   **Note:** Setting `prompt-for-key=true` causes the system to prompt the cluster administrator for the passphrase to use when authenticating encrypted drives. Otherwise, the system automatically generates a 32-byte passphrase.

   The `security key-manager key create` command replaces the `security key-manager create-key` command. For complete command syntax, see the man page.

   **Example**

   The following example creates the authentication keys for `cluster1`, automatically generating a 32-byte passphrase:

   ```bash
   cluster1::> security key-manager key create
   Key ID:
   000000000000000000000000000000000000000000000000000000000000000
   ```

2. Verify that the authentication keys have been created:

   `security key-manager key query -node node`

   **Note:** The `security key-manager key query` command replaces the `security key-manager query key` command. For complete command syntax, see the man page.

   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**

   The following example verifies that authentication keys have been created for `cluster1`:
Creating authentication keys in ONTAP 9.5 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 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

The following example creates the authentication keys for `cluster1`:

```
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

The following example verifies that authentication keys have been created for cluster1:

```
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
```

Assigning a data authentication key to a FIPS drive or SED (external key management)

You can use the `storage encryption disk modify` command to assign a data authentication key to a FIPS drive or SED. Cluster nodes use this key to lock or unlock encrypted data on the drive.

Before you begin

You must be a cluster administrator to perform this task.

About this task

A self-encrypting drive is protected from unauthorized access only if its authentication key ID is set to a non-default value. The manufacturer secure ID (MSID), which has key ID 0x0, is the standard default value for SAS drives. For NVMe drives, the standard default value is a null key, represented as a blank key ID. When you assign the key ID of a self-encrypting drive, the system changes its authentication key ID to a non-default value.

Steps

1. Assign a data authentication key to a FIPS drive or SED:

```
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 -key-type NSE-AK command to view key IDs.`

Example

```
cluster1::> storage encryption disk modify -disk 0.10.* -data-key-id F1CB30AFF1CB30B0010100000000000A68B167F92DD54196297159B5968923C
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 F1CB30AFF1CB30B0010100000000000A68B167F92DD54196297159B5968923C
0.0.1    data F1CB30AFF1CB30B0010100000000000A68B167F92DD54196297159B5968923C
[...]```

Configuring onboard key management

You can use the Onboard Key Manager to authenticate cluster nodes to a FIPS drive or 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 in ONTAP 9.6 and later

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.

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 63

- You must be a cluster administrator to perform this task.

About this task

You must run the `security key-manager onboard enable` command each time you add a node to the cluster. In MetroCluster configurations, you must run `security key-manager onboard enable` on the local cluster first, then on the remote cluster, using the same passphrase on each.

By default, you are not required to enter the key manager passphrase when a node is rebooted. Except in MetroCluster, you can use the `cc-mode-enabled=yes` option to require that users enter the passphrase after a reboot.

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

1. Start the key manager setup wizard:

   ```bash
   security key-manager onboard enable -cc-mode-enabled yes|no
   ```

   **Note:** Set `cc-mode-enabled=yes` to require that users enter the key manager passphrase after a reboot. The `- cc-mode-enabled` option is not supported in MetroCluster configurations.

   The `security key-manager onboard enable` command replaces the `security key-manager setup` command.

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 onboard enable
Enter the cluster-wide passphrase for onboard key management in Vserver "cluster1": <32..256 ASCII characters long text>
Reenter the cluster-wide passphrase: <32..256 ASCII characters long text>
```

2. 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.

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

4. Verify that the authentication keys have been created:

   ```bash
   security key-manager key query -node node
   ```

   **Note:** The `security key-manager key query` command replaces the `security key-manager query key` command. For complete command syntax, see the man page.

Example

The following example verifies that authentication keys have been created for `cluster1`:

```
cluster1::> security key-manager key query
  Vserver: cluster1
    Key Manager: onboard
    Node: node1
    Key Tag                               Key Type  Restored
    ------------------------------------  --------  --------
    node1                                 NSE-AK    yes
        Key ID:
        000000000000000002000000000001000c11b3861f78c2273343d7ec5a67762e0000000000000000
    node1                                 NSE-AK    yes
        Key ID:
        00000000000000000200000000000106f4e2513353a674305872a4c9f3bf797000000000000000

  Vserver: cluster1
    Key Manager: onboard
    Node: node2
    Key Tag                               Key Type  Restored
    ------------------------------------  --------  --------
    node1                                 NSE-AK    yes
        Key ID:
        000000000000000002000000000001000c11b3861f78c2273343d7ec5a67762e0000000000000000
    node2                                 NSE-AK    yes
        Key ID:
        00000000000000000200000000000106f4e2513353a674305872a4c9f3bf797000000000000000
```
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 48

Enabling onboard key management in ONTAP 9.5 and earlier

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.

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 63
- 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 yes` option to require that users enter the passphrase after a reboot.

For NVE, if you set `-enable-cc-mode yes`, volumes you create with the `volume create` and `volume move start` commands are automatically encrypted. For `volume create`, you need not specify `-encrypt true`. For `volume move start`, you need not specify `-encrypt-destination true`.

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

Steps

1. Start the key manager setup wizard:

   `security key-manager setup -enable-cc-mode yes|no`

   Note: Starting with ONTAP 9.4, you can use the `-enable-cc-mode yes` option to require that users enter the key manager passphrase after a reboot. For NVE, if you set `-enable-cc-mode yes`, volumes you create with the `volume create` and `volume move start` commands are automatically encrypted.

Example

The following example starts the key manager setup wizard on cluster1 without requiring that the passphrase be entered after every reboot:
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
  000000000000000002000000000001008C07CC0AF1EF49E0105300EFCB300BF  NSE-AK

Node: node2
  Key Store: onboard
  Key ID Used By
  0000000000000000020000000000010059851742AF2703FC91369B7DB47C4722  NSE-AK
  000000000000000002000000000001008C07CC0AF1EF49E0105300EFCB300BF  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 48

Assigning a data authentication key to a FIPS drive or SED (onboard key management)

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

Before you begin

You must be a cluster administrator to perform this task.
About this task

A self-encrypting drive is protected from unauthorized access only if its authentication key ID is set to a non-default value. The manufacturer secure ID (MSID), which has key ID 0x0, is the standard default value for SAS drives. For NVMe drives, the standard default value is a null key, represented as a blank key ID. When you assign the key ID of a self-encrypting drive, the system changes its authentication key ID to a non-default value.

Steps

1. Assign a data authentication key to a FIPS drive or SED:

   `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 -key-type NSE-AK` command to view key IDs.

   **Example**

   ```
   cluster1::> storage encryption disk modify -disk 0.10.* -data-key-id F1CB30AFF1CB30B0010100000000000A68B167F92DD54196297159B5968923C
   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 F1CB30AFF1CB30B0010100000000000A68B167F92DD54196297159B5968923C
   0.0.1    data F1CB30AFF1CB30B0010100000000000A68B167F92DD54196297159B5968923C
   [...]
   ```

Assigning a FIPS 140-2 authentication key to a FIPS drive

You can use the `storage encryption disk modify` command with the `-fips-key-id` option to assign a FIPS 140-2 authentication key to a FIPS drive. Cluster nodes use this key for drive operations other than data access, such as preventing denial-of-service attacks on the drive.

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 when connecting to KMIP servers.

**Before you begin**

- The storage controller must be configured in FIPS-compliant mode.
- 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 use only TLS1.2 and FIPS-validated cipher suites. 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:

```bash
    security config show -supported-protocols
```

For complete command syntax, see the man page.

**Example**

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

3. Enable cluster-wide FIPS-compliant mode:

```bash
    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:

```bash
    security config show
```

**Example**

```
cluster1::> security config show
Cluster                              Interface FIPS Mode Supported Protocols Supported Ciphers Config Ready
--------- ----------------- ----------------------- ----------------- ----------------
SSL      true            TLSv1.2, TLSv1.1 ALL:!LOW:!EXP:!aNULL:!eNULL yes
```
**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 move and 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 43

**Steps**

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

   ```bash
   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:

   ```bash
   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:

   ```bash
   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:

   ```bash
   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 start` command on page 43

About this task

The move will fail if the destination node or destination volume does not support volume encryption.

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 encrypted 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
   ```

<table>
<thead>
<tr>
<th>Vserver</th>
<th>Volume</th>
<th>Aggregate</th>
<th>State</th>
<th>Type</th>
<th>Size</th>
<th>Available</th>
<th>Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>vs1</td>
<td>vol1</td>
<td>aggr3</td>
<td>online</td>
<td>RW</td>
<td>200GB</td>
<td>160.0GB</td>
<td>20%</td>
</tr>
</tbody>
</table>
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 resume` 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 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:

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

2. Verify the status of the rekey operation:

```bash
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:

```bash
cluster1::> volume encryption rekey show
```

<table>
<thead>
<tr>
<th>Vserver</th>
<th>Volume</th>
<th>Start Time</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>vs1</td>
<td>vol1</td>
<td>9/18/2017 17:51:41</td>
<td>Phase 2 of 2 is in progress.</td>
</tr>
</tbody>
</table>

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

```bash
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:

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

<table>
<thead>
<tr>
<th>Vserver</th>
<th>Volume</th>
<th>Aggregate</th>
<th>State</th>
<th>Type</th>
<th>Size</th>
<th>Available</th>
<th>Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>vs1</td>
<td>vol1</td>
<td>aggr2</td>
<td>online</td>
<td>RW</td>
<td>200GB</td>
<td>160.0GB</td>
<td>20%</td>
</tr>
</tbody>
</table>

## 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.

### 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:

```bash
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
```

<table>
<thead>
<tr>
<th>Vserver</th>
<th>Volume</th>
<th>Aggregate</th>
<th>State</th>
<th>Type</th>
<th>Size</th>
<th>Available</th>
<th>Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>vs1</td>
<td>vol1</td>
<td>aggr2</td>
<td>online</td>
<td>RW</td>
<td>200GB</td>
<td>160.0GB</td>
<td>20%</td>
</tr>
</tbody>
</table>

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 43
- 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`:  

```bash
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:

```bash
volume encryption secure-purge show
```

Example

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

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

### Changing the onboard key management passphrase

It is a security best practice to change the onboard key management passphrase periodically. You should copy the new onboard key management passphrase to a secure location outside the storage system for future use.

**Before you begin**

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

**Steps**

1. Change to advanced privilege level:
   ```bash
   set -privilege advanced
   ```

2. Change the onboard key management passphrase:

<table>
<thead>
<tr>
<th>For this ONTAP version...</th>
<th>Use this command...</th>
</tr>
</thead>
<tbody>
<tr>
<td>ONTAP 9.6 and later</td>
<td><code>security key-manager onboard update-passphrase</code></td>
</tr>
<tr>
<td>ONTAP 9.5 and earlier</td>
<td><code>security key-manager update-passphrase</code></td>
</tr>
</tbody>
</table>

   For complete command syntax, see the man pages.

**Example**

The following ONTAP 9.6 command lets you change the onboard key management passphrase for `cluster1`:

```bash
cluster1::> security key-manager onboard update-passphrase
```

Warning: This command will reconfigure the cluster passphrase for onboard key management for Vserver "cluster1".

Do you want to continue? [y|n]: y

Enter current passphrase:

Enter new passphrase:
3. Enter y at the prompt to change the onboard key management passphrase.

4. Enter the current passphrase at the current passphrase prompt.

5. At the new 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.

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

After you finish

In a MetroCluster environment, you must update the passphrase on the partner cluster:

• In ONTAP 9.5 and earlier, you must run `security key-manager update-passphrase` with the same passphrase on the partner cluster.

• In ONTAP 9.6 and later, you are prompted to run `security key-manager onboard sync` with the same passphrase on the partner cluster.

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 48

### Backing up onboard key management information manually

You should copy onboard key management information to a secure location outside the storage system whenever you configure the Onboard Key Manager passphrase.

#### Before you begin

• You must be a cluster administrator to perform this task.

• Advanced privileges are required for 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.

#### Steps

1. Change to advanced privilege level:

   `set -privilege advanced`

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

<table>
<thead>
<tr>
<th>For this ONTAP version...</th>
<th>Use this command...</th>
</tr>
</thead>
<tbody>
<tr>
<td>ONTAP 9.6 and later</td>
<td><code>security key-manager onboard show-backup</code></td>
</tr>
<tr>
<td>ONTAP 9.5 and earlier</td>
<td><code>security key-manager backup show</code></td>
</tr>
</tbody>
</table>

   For complete command syntax, see the man pages.
Example

The following 9.6 command displays the key management backup information for `cluster1`:

```
cluster1::> security key-manager onboard show-backup
--------------------------BEGIN BACKUP--------------------------
```

3. Copy the backup information to a secure location outside the storage system for use in case of a disaster.

Restoring onboard key management encryption keys

Occasionally, you may need to restore an onboard key management encryption key. Once you have verified that a key needs to be restored, you can run the Onboard Key Manager setup wizard 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.

Before transitioning to onboard key management from external key management on page 63

- You must be a cluster administrator to perform this task.

Steps

1. Verify that a key needs to be restored:

<table>
<thead>
<tr>
<th>For this ONTAP version...</th>
<th>Use this command...</th>
</tr>
</thead>
<tbody>
<tr>
<td>ONTAP 9.6 and later</td>
<td><code>security key-manager key query -node node</code></td>
</tr>
<tr>
<td>ONTAP 9.5 and earlier</td>
<td><code>security key-manager key show</code></td>
</tr>
</tbody>
</table>

For complete command syntax, see the man pages.
Example

The following ONTAP 9.6 command lets you verify that an onboard key management encryption key needs to be restored in `cluster1`:

```
cluster1::> security key-manager key query
Vserver: cluster_1
Key Manager: onboard
Node: node1
Key Server: **

Key Tag  Key Type Restored
------- -------- --------
nodem1 NSE-AK false
Key ID: 0000000000000000020000000000010003c135e9a2beaf817f69d72f33663c0000000000000
node1 NSE-AK true
Key ID: 00000000000000000200000000000100fb5fc42e004f32b2f77f7f439fe77c5000000000000000
```

2. If the “Restored” column shows “false” for a key, restore the key:

<table>
<thead>
<tr>
<th>For this ONTAP version...</th>
<th>Use this command...</th>
</tr>
</thead>
<tbody>
<tr>
<td>ONTAP 9.6 and later</td>
<td><code>security key-manager onboard sync</code></td>
</tr>
<tr>
<td>ONTAP 9.5 and earlier</td>
<td><code>security key-manager setup -node node</code></td>
</tr>
</tbody>
</table>

For complete command syntax, see the man pages.

Example

The following ONTAP 9.6 command synchronize the keys in the onboard key hierarchy:

```
cluster1::> security key-manager onboard sync
```

Enter the cluster-wide passphrase for onboard key management in Vserver "cluster1": <32..256 ASCII characters long text>

3. At the passphrase prompt, enter the onboard key management passphrase for the cluster.

Restoring external key management encryption keys

You can manually restore external key management encryption 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 or SVM administrator to perform this task.

Steps

1. Verify that a key needs to be restored:
For this ONTAP version... Use this command...

<table>
<thead>
<tr>
<th>ONTAP 9.6 and later</th>
<th>security key-manager key query -node node</th>
</tr>
</thead>
<tbody>
<tr>
<td>ONTAP 9.5 and earlier</td>
<td>security key-manager key show</td>
</tr>
</tbody>
</table>

For complete command syntax, see the man pages.

**Example**

The following ONTAP 9.6 command lets you verify that an external key management encryption key needs to be restored in `cluster1`:

```
class1::> security key-manager key query
Vserver: cluster_1
Key Manager: external
Node: node1
Key Server: ''

<table>
<thead>
<tr>
<th>Key Tag</th>
<th>Key Type</th>
<th>Restored</th>
</tr>
</thead>
<tbody>
<tr>
<td>node1</td>
<td>NSE-AK</td>
<td>false</td>
</tr>
<tr>
<td>Key ID: 000000000000000002000000000001c23139e9a2beaf81ff69d72f33663c0000000000000000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>node1</td>
<td>NSE-AK</td>
<td>true</td>
</tr>
<tr>
<td>Key ID: 000000000000000002000000000001c23139e9a2beaf81ff69d72f33663c0000000000000000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Vserver: cluster_1
Key Manager: external
Node: node2
Key Server: ''

<table>
<thead>
<tr>
<th>Key Tag</th>
<th>Key Type</th>
<th>Restored</th>
</tr>
</thead>
<tbody>
<tr>
<td>node2</td>
<td>NSE-AK</td>
<td>true</td>
</tr>
<tr>
<td>Key ID: 000000000000000002000000000001c23139e9a2beaf81ff69d72f33663c0000000000000000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>node2</td>
<td>NSE-AK</td>
<td>true</td>
</tr>
<tr>
<td>Key ID: 000000000000000002000000000001c23139e9a2beaf81ff69d72f33663c0000000000000000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4 entries were displayed.
```

2. If the “Restored” column shows “false” for a key, restore the key:

For this ONTAP version... Use this command...

| ONTAP 9.6 and later | security key-manager external restore -vserver SVM -node node -key-server host_name| IP_address:port -key-id key_id -key-tag key_tag |
|---------------------|------------------------------------------------------------------------------------------|
| ONTAP 9.5 and earlier| security key-manager restore -node node -address IP_address -key-id key_id -key-tag key_tag |

**Note:** node defaults to all nodes. For complete command syntax, see the man pages. This command is not supported when onboard key management is enabled.

**Example**

The following ONTAP 9.6 command restores external key management authentication keys to all nodes in `cluster1`:

```
class1::> security key-manager external restore
```
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.
- You must be a cluster or SVM administrator to perform this task.

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:

   For this ONTAP version... Use this command...
   
   ONTAP 9.6 and later
   
   security key-manager external remove-servers -vserver SVM -key-servers host_name|IP_address:port,...
   
   ONTAP 9.5 and earlier
   
   security key-manager delete -address key_management_server_ipaddress

   For complete command syntax, see the man pages.

   Example

   The following ONTAP 9.6 command disables the connections to two external key management servers for cluster1, the first named ks1, listening on the default port 5696, the second with the IP address 10.0.0.20, listening on port 24482:

   ```
   cluster1::> security key-manager external remove-servers -vserver cluster-1 -key-servers ks1,10.0.0.20:24482
   ```

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 11

5. Connect to the KMIP server.

Replacing a FIPS drive or SED

You can replace a FIPS drive or SED the same way you replace an ordinary disk. Make sure to assign new data authentication keys to the replacement drive. For a FIPS drive, you may also want to assign a new FIPS 140-2 authentication key.

**Before you begin**

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

**Steps**

1. Ensure that the disk has been marked as failed:
   ```bash
   storage disk show -broken
   ```
   For complete command syntax, see the man page.

   **Example**
   ```bash
   cluster1::> storage disk show -broken
   Original Owner: cluster1-01
   Checksum Compatibility: block
   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 FIPS drive or SED, following the instructions in the hardware guide for your disk shelf model.

3. Assign ownership of the newly replaced disk:
   ```bash
   storage disk assign -disk disk_name -owner node
   ```
   For complete command syntax, see the man page.

   **Example**
   ```bash
   cluster1::> storage disk assign -disk 2.1.1 -owner cluster1-01
   ```

4. Confirm that the new disk has been assigned:
   ```bash
   storage encryption disk show
   ```
   For complete command syntax, see the man page.

   **Example**
   ```bash
   cluster1::> storage encryption disk show
   Disk    Mode Data Key ID
   ------ ---- ------------------
   0.0.0   data F1CB30AFF1CB30B0010100000000000A68B167F92D054196297159B5968923C
   0.0.1   data F1CB30AFF1CB30B0010100000000000A68B167F92D054196297159B5968923C
   1.10.0  data F1CB30AFF1CB30B00101000000000000CF0EFDC818A9F6324EA97B369351C56AC
   ```
5. Assign the data authentication keys to the FIPS drive or SED.

Assigning a data authentication key to a FIPS drive or SED (external key management) on page 33

6. If necessary, assign a FIPS 140-2 authentication key to the FIPS drive.

Assigning a FIPS 140-2 authentication key to a FIPS drive on page 38

Making data on a FIPS drive or SED inaccessible

If you want to make data on a FIPS drive or SED permanently inaccessible, but keep the drive’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 drive, you can destroy it.

- **Disk sanitization**
  When you sanitize a self-encrypting drive, 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 a default value, either the manufacturer secure ID 0x0 (SAS drives) or a null key (NVMe drives). 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 a FIPS drive or 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 self-encrypting drives, or all the self-encrypting drives for a node.

**Choices**

- Sanitizing a FIPS drive or SED on page 54
- Destroying a FIPS drive or SED on page 55
- Emergency shredding of data on an FIPS drive or SED on page 57

Sanitizing a FIPS drive or SED

If you want to make data on a FIPS drive or SED permanently inaccessible, but keep the drive’s unused space available for new data, you can use the storage encryption disk sanitize command to sanitize the drive.

**Before you begin**

You must be a cluster administrator to perform this task.

**About this task**

When you sanitize a self-encrypting drive, 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 a default value, either the manufacturer secure ID 0x0 (SAS drives) or a null key (NVMe drives). 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 FIPS drive or SED to be sanitized:
   ```bash
   storage aggregate delete -aggregate aggregate_name
   ```
   For complete command syntax, see the man page.

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

3. Identify the disk ID for the FIPS drive or SED to be sanitized:
   ```bash
   storage encryption disk show
   ```
   For complete command syntax, see the man page.

   Example
   ```bash
   cluster1::> storage encryption disk show
   Disk | Mode | Data Key ID
   ---- | ---- | -------------------------------
   0.0.0 | data | F1CB30AFF1CB30B0010100000000000A68B167F92DD54196275159B5968923C
   0.0.1 | data | F1CB30AFF1CB30B00101000000000000A68B167F92DD54196275159B5968923C
   1.10.2 | data | F1CB30AFF1CB30B00101000000000000CF0EFD81EA9F6324EA978369351C56AC
   ```

4. Sanitize the drive:
   ```bash
   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
   ```bash
   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 a FIPS drive or SED

If you want to make data on a FIPS drive or SED permanently inaccessible and you do not need to reuse the drive, 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 a FIPS drive or SED, the system sets the disk encryption key to an unknown random value and locks the drive irreversibly. Doing so renders the disk virtually unusable and the data on it permanently inaccessible. However, you can reset the disk to its factory-configured settings using the PSID printed on the disk’s label. For more information, see Returning a FIPS drive or SED to service when authentication keys are lost on page 58.

**Note:** You should not destroy a FIPS drive or SED unless you have the Non-Returnable Disk Plus service (NRD Plus). Destroying a disk voids its warranty.

Steps

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

2. **Delete the aggregate on the FIPS drive or SED to be destroyed:**

   ```bash
   storage aggregate delete -aggregate aggregate_name
   ```

   For complete command syntax, see the man page.

   **Example**

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

3. **Identify the disk ID for the FIPS drive or SED to be destroyed:**

   ```bash
   storage encryption disk show
   ```

   For complete command syntax, see the man page.

   **Example**

   ```bash
   cluster1::> storage encryption disk show
   Disk    Mode Data Key ID
   -----   ---- ----------------------------------------------------------------
   0.0.0   data F1CB30AFF1CB30B00101000000000000A68B167F92DD54196297159B5968923C
   0.0.1   data F1CB30AFF1CB30B00101000000000000A68B167F92DD54196297159B5968923C
   1.10.2  data F1CB30AFF1CB30B00101000000000000CF0EFD01EA9F6324EA97B369351C56AC
   [...]```

4. **Destroy the disk:**

   ```bash
   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**

   ```bash
   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
   ```
Emergency shredding of data on an FIPS drive or SED

In case of a security emergency, you can instantly prevent access to a FIPS drive or SED, 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 a FIPS drive or 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 drive is 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.
If... Then...

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.

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 FIPS drives or SEDs that contain 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 a FIPS drive or SED to service when authentication keys are lost**

The system treats a FIPS drive or 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 FIPS drive or SED are permanently lost and that you cannot recover them.

**Step**

1. **Return a FIPS drive or SED to service:**
<table>
<thead>
<tr>
<th>If the SEDs are...</th>
<th>Use these steps...</th>
</tr>
</thead>
</table>
| 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 disk 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 PSID of the disk from the disk label.**
| | b. **Set the privilege level to advanced:**
   ```
   set -privilege advanced
   ```
| | c. **Reset the disk 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 disk 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 a FIPS drive or SED to unprotected mode

A FIPS drive or SED is protected from unauthorized access only if the authentication key ID for the node is set to a value other than the default. You can return a FIPS drive or SED to unprotected mode by using the `storage encryption disk modify` command to set the key ID to the default.

**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 a FIPS drive is running in FIPS-compliance mode, set the FIPS authentication key ID for the node back to the default MSID 0x0:
   ```
   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 0x0:
   ```
   storage encryption disk modify -disk disk_id -data-key-id 0x0
   ```
   The value of `-data-key-id` should be set to 0x0 whether you are returning a SAS or NVMe drive to unprotected mode.
   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

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 or SVM 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:**

<table>
<thead>
<tr>
<th>For this ONTAP version...</th>
<th>Use this command...</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ONTAP 9.6 and later</strong></td>
<td>`security key-manager external remove-servers -vserver SVM -key-servers host_name</td>
</tr>
<tr>
<td><strong>ONTAP 9.5 and earlier</strong></td>
<td><code>security key-manager delete -address key_management_server_ipaddress</code></td>
</tr>
</tbody>
</table>

For complete command syntax, see the man pages.

Example

The following ONTAP 9.6 command disables the connections to two external key management servers for `cluster1`, the first named `ks1`, listening on the default port 5696, the second with the IP address 10.0.0.20, listening on port 24482:

```bash
cluster1::> security key-manager external remove-servers -vserver cluster-1 -key-servers ks1,10.0.0.20:24482
```

Modifying external key management server properties

Starting with ONTAP 9.6, you can use the `security key-manager external modify-server` command to change the I/O timeout and username of an external key management server.

**Before you begin**

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

**Steps**

1. **On the storage system, change to advanced privilege level:**
   ```bash
   set -privilege advanced
   ```

2. **Modify external key manager server properties for the cluster:**
   ```bash
   security key-manager external modify-server -vserver admin_SVM -key-server host_name|IP_address:port,... -timeout 1...60 -username user_name
   ```

   **Note:** The timeout value is expressed in seconds. If you modify the user name, you are prompted to enter a new password.

   If you run the command at the cluster login prompt, `admin_SVM` defaults to the admin SVM of the current cluster. You must be the cluster administrator to modify external key manager server properties.
Example

The following command changes the timeout value to 45 seconds for the **cluster1** external key management server listening on the default port 5696:

```
cluster1::> security key-manager external modify-server -vserver cluster1 -key-server ks1.local -timeout 45
```

3. Modify external key manager server properties for an SVM (NVE only):

```
security key-manager external modify-server -vserver SVM -key-server host_name|IP_address:port,... -timeout 1...60 -username user_name
```

**Note:** The timeout value is expressed in seconds. If you modify the user name, you are prompted to enter a new password.

If you run the command at the SVM login prompt, **SVM** defaults to the current SVM. You must be the cluster or SVM administrator to modify external key manager server properties.

Example

The following command changes the username and password of the **svml** external key management server listening on the default port 5696:

```
svml::> security key-manager external modify-server -vserver svml -key-server ks1.local -username svmluser
Enter the password:
Reenter the password:
```

4. Repeat the last step for any additional SVMs.

**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**

- For hardware-based encryption, you must reset the data keys of all FIPS drives or SEDs to the default value.  
  *Returning a FIPS drive or SED to unprotected mode* on page 60
- For software-based encryption, you must unencrypt all volumes.  
  *Unencrypting volume data* on page 41
- You must be a cluster administrator to perform this task.

**Step**

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

<table>
<thead>
<tr>
<th>For this ONTAP version...</th>
<th>Use this command...</th>
</tr>
</thead>
<tbody>
<tr>
<td>ONTAP 9.6 and later</td>
<td>security key-manager onboard disable -vserver SVM</td>
</tr>
<tr>
<td>ONTAP 9.5 and earlier</td>
<td>security key-manager delete-key-database</td>
</tr>
</tbody>
</table>

For complete command syntax, see the man pages.
Example

The following ONTAP 9.6 command deletes the onboard key management configuration for cluster1:

```
cluster1::> security key-manager onboard disable
```

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

- For hardware-based encryption, you must reset the data keys of all FIPS drives or SEDs to the default value.  
  [Returning a FIPS drive or SED to unprotected mode on page 60](#)
- You must have deleted all external key manager connections.  
  [Deleting an external key manager connection on page 60](#)
- 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
```

<table>
<thead>
<tr>
<th>For this ONTAP version...</th>
<th>Use this command...</th>
</tr>
</thead>
<tbody>
<tr>
<td>ONTAP 9.6 and later</td>
<td>security key-manager external disable -vserver admin_SVM</td>
</tr>
<tr>
<td>ONTAP 9.5 and earlier</td>
<td>security key-manager delete-kmip-config</td>
</tr>
</tbody>
</table>

**Note:** For complete command syntax, see the man pages. The ONTAP 9.6 version of the command requires advanced privilege level.

Example

The following ONTAP 9.6 commands delete the external key management configurations for cluster1:

```
cluster1::> set -privilege advanced
cluster1::> security key-manager external disable
```

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:

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

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.
Disabling encryption by default with ONTAP 9.7 and later

Starting with ONTAP 9.7, aggregate and volume encryption is enabled by default if you have a volume encryption (VE) licence and use an onboard or external key manager. You can disable encryption by default if required.

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.

Step

1. To disable encryption by default in ONTAP 9.7 or later run the following command:

   ```bash
   options -option-name
   encryption.data_at_rest_encryption.disable_by_default true
   
   For complete command syntax, see the man page for the command.
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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