Amazon Web Services KMS External Key Store (XKS)

nShield® HSM Integration Guide

2024-10-21

Table of Contents

Chapter 1. Introduction

This guide describes the integration of the Entrust nShield Hardware Security Module (HSM) with Amazon Web Services KMS External Key Store (XKS).

The HSM is available as an appliance or nShield as a Service (nSaaS). Throughout this guide, the term HSM refers to nShield Solo, nShield Connect, and nShield Edge products.

1.1. Product configuration

Entrust tested the integration with the following versions:

Product	Version
Operating System	AWS Linux

Before proceeding with the integration of the AWS XKS and nShield HSM, note that the following section demonstrates an example of using an AWS Linux EC2 instance as the Operating System. However, the choice of Linux distribution environment may vary based on your organization's preferences and toolset. Adapt the process based on your specific requirements and infrastructure.

1.2. Supported nShield hardware and software versions

Entrust successfully tested with the following nShield hardware and software versions:

1.2.1. nShield

Product	Security World Software	Firmware	Netimage	OCS	Softcard	Module
nSaaS	13.3.2	12.72.1 (FIPS 140-2 certified)	12.80.5	✓		✓

Product	Security World Software	Firmware	Netimage	OCS	Softcard	Module
Connect XC	13.3.2	12.50.11 (FIPS 140-2 certified) & 12.72.1 (FIPS 140-2 certified)	12.80.4 & 12.80.5	✓		✓
nShield 5c	13.3.2	13.2.2	13.3.2	✓		✓

1.3. Requirements

To integrate the HSM and Amazon Web Services KMS External Key Store (XKS), the server must be set up as follows.

The following software must be installed:

- nShield Security World software.

Access to AWS KMS XKS Proxy GitHub is required to download Software: https://github.com/aws-samples/aws-kms-xks-proxy/.

This integration uses a public endpoint connectivity for AWS XKS. The following are required:

- Your external key store proxy must be reachable at a publicly routable endpoint.
- You must obtain a TLS certificate issued by a public certificate authority supported for external key stores. For a list, see https://github.com/aws/aws-kms-xksproxy-api-spec/blob/main/TrustedCertificateAuthorities.
- The subject common name (CN) on the TLS certificate must match the domain name in the proxy URI endpoint for the external key store proxy. For example, if the public endpoint is https://myproxy.xks.example.com, the TLS, the CN on the TLS certificate must be `myproxy.xks.example.com` or `*.xks.example.com`.
- Ensure that any firewalls between AWS KMS and the external key store proxy allow traffic to and from port 443 on the proxy. AWS KMS communicates on port 443 and this value is not configurable.

Familiarize yourself with:

- The nShield HSM: *Installation Guide* and *User Guide*.
- The Amazon Web Services KMS External Key Store (XKS) Documentation https://docs.aws.amazon.com/kms/latest/developerguide/keystore-external.html.
- Your organizational certificate policy and certificate practice statement and a security policy or procedure in place covering administration of the PKI and HSM:
- The number and quorum of Administrator cards in the Administrator Card Set (ACS) and the policy for managing these cards.
- The number and quorum of operator cards in the operator card set (OCS) and the policy for managing these cards.
- The keys protection method: module or OCS.
- The level of compliance for the Security World, FIPS 140 Level 3.
- Key attributes such as key size, time-out, or need for auditing key usage.

1.4. Overview

AWS KMS External Key Store addresses regulatory requirements for storing encryption keys outside the AWS Cloud. With this feature, you can now keep your AWS KMS customer managed keys on your own Entrust nShield Hardware Security Module (HSM) rather than within the AWS data centers.

To enable AWS KMS External Key Store, you will replace the KMS key hierarchy with a new, external root of trust. The root keys will be generated and stored inside your nShield HSM. When encryption or decryption of a data key is required, AWS KMS forwards the request to your nShield HSM via an external key store proxy (XKS proxy) that you manage.

The XKS proxy plays a crucial role in mediating all interactions between AWS KMS and your Entrust nShield HSM. It translates generic AWS KMS requests into a format understandable by your Entrust nShield HSM, facilitating seamless communication between the two.

Chapter 2. Procedures

Steps:

1. Install the HSM
2. Install the nShield Security World Software and create the Security World
3. Generate the OCS
4. Generating a PKCS11 key
5. Clone the Git repository and configure the settings
6. Configure the cknfastrc variables
7. Key Administrators - AWS IAM user
8. Getting started with the XKS proxy
9. Creating the External Key Store on AWS
10. Creating a key in AWS KMS

2.1. Select the protection method

OCS or Module protection can be used to authorize access to the keys protected by the HSM. Follow your organization's security policy to select an authorization access method.

2.2. Install the HSM

Install the nShield Connect HSM locally, remotely, or remotely via the serial console. See the following nShield Support articles and the *Installation Guide* for the HSM:

- How to locally set up a new or replacement nShield Connect
- How to remotely set up a new or replacement nShield Connect
- How to remotely set up a new or replacement nShield Connect XC Serial Console model

Access to the Entrust nShield Support Portal is available to customers under maintenance. To request an account, contact nshield.support@entrust.com.

2.3. Install the nShield Security World Software and create the Security World

To install the nShield Security World Software and create the Security World:

1. Install the Security World software as described in *Installation Guide* and the *User Guide* for the HSM. This is supplied on the installation disc.
2. Add the Security World utilities path `/opt/nfast/bin` to the system path.
3. Open the firewall port 9004 for the HSM connections.
4. Open a command window and confirm the HSM is `operational`:

```
# enquiry
Server:
 enquiry reply flags  none
 enquiry reply level  Six
 serial number        530E-02E0-D947 7724-8509-81E3 09AF-0BE9-53AA 9E10-03E0-D947
 mode                 operational
...
Module #1:
 enquiry reply flags  none
 enquiry reply level  Six
 serial number        530E-02E0-D947
 mode                 operational
 ...
```

5. Create your Security World if one does not already exist, or copy an existing one. Follow your organization's security policy for this. Create extra ACS cards as spares in case of a card failure or a lost card.

ACS cards cannot be duplicated after the Security World is created.

6. Confirm the Security World is `usable`:

```
# nfkminfo
World
 generation  2
 state       0x37270008 Initialised Usable ...
 ...
Module #1
 generation 2
 state      0x2 Usable
 ...
```

2.4. Generate the OCS

The OCS and associated passphrase will be used to authorize access to the keys protected by the HSM. Typically, one or the other will be used, but rarely both.

When selecting your protection method take your organization's security policy into consideration.

2.4.1. Create the OCS

To create the OCS:

1. Ensure the `/opt/nfast/kmdata/config/cardlist` file contains the serial number of the card(s) to be presented, or the asterisk wildcard (*).
2. Open a command window as an Administrator.
3. Run the `createocs` command as described below, entering a passphrase or password at the prompt.

   Create one card for each person with access privilege, plus the spares.

   After an Operator Card Set has been created, the cards cannot be duplicated.

```
# createocs -m1 -s2 -N testOCS -Q 1/1

FIPS 140-2 level 3 auth obtained.

Creating Cardset:
 Module 1: 0 cards of 1 written
 Module 1 slot 0: Admin Card #1
 Module 1 slot 2: empty
 Module 1 slot 3: empty
 Module 1 slot 2: blank cardSteps:

 Module 1 slot 2:- passphrase specified - writing card
Card writing complete.

cardset created; hkltu = a165a26f929841fe9ff2acdf4bb6141c1f1a2eed
```

4. Verify the OCS was created:

```
# nfkminfo -c
Cardset list - 2 cardsets:  (P)ersistent/(N)ot, (R)emoteable/(L)ocal-only
 Operator logical token hash               k/n timeout  name
 edb3d45a28e5a6b22b033684ce589d9e198272c2  1/5  none-NL testOCS
```

   The `rocs` utility also shows the OCS was created:

```
# rocs
`rocs' key recovery tool
Useful commands: `help', `help intro', `quit'.
rocs> list cardset
No. Name                    Keys (recov) Sharing
  1 testOCS                 2 (2)        1 of 1;
rocs> quit
```

2.5. Generating a PKCS11 key

Creating a PKCS11 key is a crucial step in setting up the integration. This key will be used to generate an AWS KMS key via the external key store proxy on your AWS Linux server. Currently, only module and OCS generated keys are supported.

As per the AWS documentation, you must create keys in your HSM and map them to the external key store resource in KMS. These keys are used with AWS services supporting customer keys or within your applications for data encryption. Refer to https://aws.amazon.com/blogs/aws/announcing-aws-kms-external-key-store-xks/

In an external key store, the key must be a 256-bit AES key, enabled, and capable of performing encryption and decryption. For specific requirements regarding a KMS key in an external key store. For more comprehensive information, refer to the AWS documentation at: https://docs.aws.amazon.com/kms/latest/developerguide/keystore-external.html

Follow these steps to generate the key:

1. Open your terminal and execute the `generatekey pkcs11` command as shown below:

   ```
   generatekey pkcs11
   ```

2. During the key generation process, make sure to specify the following parameters:

   - **Protection Type**: Choose module or token (OCS) protection.
   - **Key Type**: Select AES as the key type.
   - **Key Size**: Use a 256-bit key size.
   - **Key Name**: Enter a descriptive plain name that will be used to identify the `xks_key_id_set` in a later step.
   - **NVRAM**: Leave the default as "no" for now.

   Example of module protected generated key:

   ```
   # generatekey pkcs11
   protect: Protected by? (token, softcard, module) [token] > module
   type: Key type? (DES3, DH, DHEx, DSA, HMACSHA1, HMACSHA256, HMACSHA384,
                    HMACSHA512, RSA, DES2, AES, Rijndael, ECDSA, ECDH) [RSA]
   > AES
   size: Key size? (bits, 128-256) [] > 256
   plainname: Key name? [] > xks-keyset-1
   nvram: Blob in NVRAM (needs ACS)? (yes/no) [no] >
   ```

3. After the key is successfully generated, the system will provide you with the path to the key file. For example:

```
Key successfully generated.
Path to key: /opt/nfast/kmdata/local/key_pkcs11_ua44483047694932fb31383141f6cd8d89a7fc9c3c
```

4. Save and keep track of this key, as it is required for the `settings_nshield.toml` file.

   To verify that the key was generated correctly, you can list the keys created using the `nfkminfo -l` command, as shown below:

```
# nfkminfo -l

Keys with module protection:
 key_pkcs11_ua44483047694932fb31383141f6cd8d89a7fc9c3c `xks-keyset-1`
```

   You can also use the `rocs` tool to view your keys. To list all keys, run the following command in your terminal:

```
# rocs
`rocs' key recovery tool
Useful commands: `help', `help intro', `quit'.
rocs> list keys
  No. Name                    App        Protected by
    1 xks-keyset-1            pkcs11     module
```

Remember to use the correct key when configuring the `settings_nshield.toml` file for seamless integration with AWS KMS.

2.6. Clone the Git repository and configure the settings

The Git repository to be cloned plays a significant role in driving the development of XKS, an Open interoperability specification for regulated workloads. It provides essential materials, including the XKS proxy API specification, enabling Entrust to create an XKS proxy for their nShield Hardware Security Module (HSM).

Additionally, it offers a reference implementation of an XKS proxy and a test client to ensure compliance with the specification. Integrating this repository with AWS KMS XKS Proxy enhances security and fosters standardized security practices for secure workloads. For more information, refer to: https://github.com/aws/aws-kms-xksproxy-api-spec.

To set up the integration with AWS KMS XKS Proxy, follow these steps:

1. Clone the Git repository to your AWS Linux Server by executing the following command:

```
git clone https://github.com/aws-samples/aws-kms-xks-proxy/
```

2. Next, configure the `settings_nshield.toml` file located under `aws-kms-xks-proxy/xks-axum/configuration/settings_nshield.toml`.
3. Start by configuring the `[server]` section of the file. To do this:

    a. Enter the IP of your server and set the port to 443.

    b. Keep the other settings as default.

    c. Ensure that any firewalls between AWS KMS and the external key store proxy allow traffic to and from port 443 on the proxy. AWS KMS communicates on port 443.

```
[server]
ip = "10.0.11.48"
port = 443
region = "us-east-1"
service = "kms-xks-proxy"
```

4. Now, configure the `[security]` section of the file. Enable `is_sigv4_auth_enabled` and `is_tls_enabled`.

```
[security]
is_sigv4_auth_enabled = true
is_tls_enabled = true
is_mtls_enabled = false
```

5. Proceed to configure the `[external_key_stores]` section of the file. For the `uri_path_prefix`, use `/nshield/xks`. Generate the `sigv4_access_key_id` and `sigv4_secret_access_key` with the specified character requirements. Set the `xks_key_id_set` to match the plain name of the PKCS11 key you generated in the previous step.

Before generating the keys, ensure that you follow your organizations's policy and guidelines for key generation. These keys securing your system, so adhere to the specified character requirements and security best practices during the process.

```
[[external_key_stores]]
uri_path_prefix = "/nshield/xks"
sigv4_access_key_id = "2J6C4RFB3A5XMWYTHPKX"
sigv4_secret_access_key = "rD5/fh6yK4dDjnrj4g9znwTJxYnPhB99Qemv71g5Wv38QoO6vuR/+ba6rgsD0ap"
```

```
xks_key_id_set = ["xks-keyset-1"]
```

If there is another `[external_key_stores]` section, you can delete it and keep the one you configured.

6. Now, configure the `[tls]` section of the file for TLS communication during the integration process. You must obtain a TLS certificate issued by a public certificate authority supported for external key stores. For a list, see https://github.com/aws/aws-kms-xksproxy-api-spec/blob/main/TrustedCertificateAuthorities.

   a. First, ensure that you have obtained the necessary certificate files required for TLS communication.

   b. Copy these certificate files to the designated folder `/aws-kms-xks-proxy/xks-axum/tls`, which will be utilized by the xks-proxy for TLS communication.

   c. Make sure the certificate chain is in a single file called `tls_cert_pem`.

   d. Confirm that the `tls_key_pem` specified in the configuration file matches the key used when generating the Certificate Signing Request (CSR) for the certificate. This ensures the proper functioning of the TLS communication.

   After completing these steps, your `[tls]` section in the configuration file should look like this:

```
[tls]
# Applicable when is_tls_enabled = true
tls_cert_pem = "tls/combined.crt"
tls_key_pem = "tls/private.key"
# Applicable when is_mtls_enabled = true
mtls_client_ca_pem = ""
mtls_client_dns_name = ""
```

   By adhering to these configurations, your TLS communication will be successfully set up for AWS KMS XKS Proxy integration.

7. If you are using OCS protection, provide the passphrase of the OCS in the `user_pin` section of the `settings_nshield.toml` file. If there is no passphrase, leave it blank ("").

```
[pkcs11]
user_pin = "standard"
```

8. Keep the rest of the settings as default and save the file.

2.6.1. Configure the cknfastrc variables

To configure the cknfastrc variables:

1. Ensure that you have edited the `cknfastrc` file found under `/opt/nfast/cknfastrc` to enable module protection:

```
CKNFAST_FAKE_ACCELERATOR_LOGIN=1
```

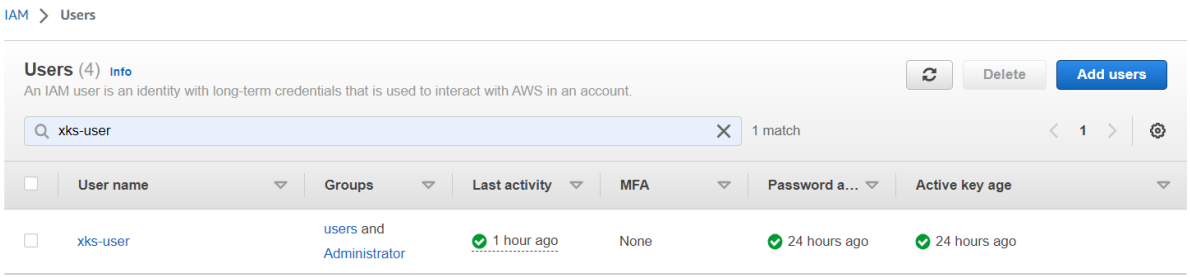
2. If you are using OCS protection, edit the `cknfastrc` to include this variable:

```
CKNFAST_NO_ACCELERATOR_SLOTS=1
```

2.7. Key Administrators - AWS IAM user

To enable the integration, you must designate an IAM user as a key Administrator. This user will have permissions to manage and use the KMS key for cryptographic operations.

1. Log into the AWS Management Console.
2. Search for the **Identity and Access Management (IAM)** service and select it.
3. In the IAM console, select **Access Management** in the left tab and then choose **Users**.
4. You can either select an existing user or create a new user to be the Key Administrator. In this example integration, a new user named `xks-user` is created as the Key Administrator.



2.8. Getting started with the XKS proxy

Before proceeding with the integration of the AWS XKS and nShield HSM, note

that the following section demonstrates an example of deploying the XKS Proxy using Rust Cargo. However, the choice of build and deployment environment may vary based on your organization's preferences and toolset.

The provided steps illustrate how to set up the XKS Proxy using Rust Cargo as a reference implementation for this integration guide. This is an example utilizing the tools available at the time of testing. There are various other build and deployment options. Adapt the process based on your specific requirements and infrastructure.

To use the XKS Proxy, follow these steps:

1. Install Rust Cargo. This command may differ based on your setup:

```
# yum install rust cargo
```

2. Create an executable file named `xks_nshield_run` with the following contents:

```
# cat xks_nshield_run
cd <directory>/aws-kms-xks-proxy/xks-axum
XKS_PROXY_SETTINGS_TOML=configuration/settings_nshield.toml cargo run
```

3. Run the executable `xks_nshield_run` by executing the following command:

```
# ./xks_nshield_run
```

Upon successful execution, you should see the XKS Proxy start and display relevant information:

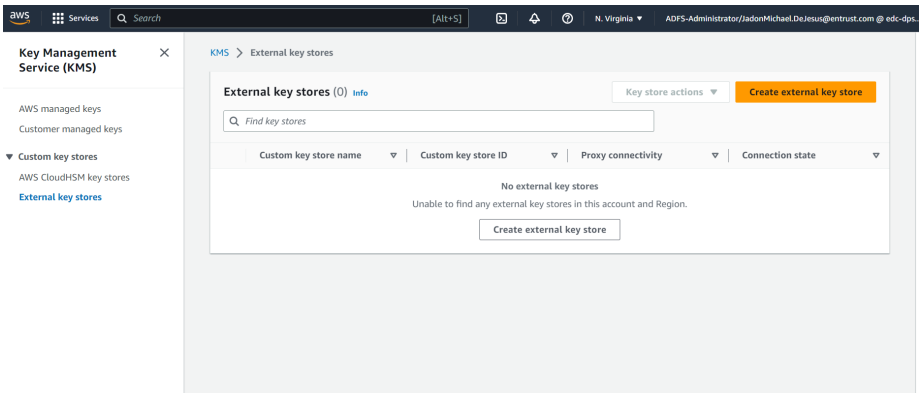
```
    Finished dev [unoptimized + debuginfo] target(s) in 0.22s
     Running `target/debug/xks-proxy`
2023-07-19T17:53:24.718713Z  INFO main xks_proxy: 276: Tracing level="DEBUG" is_file_writer_enabled=true
2023-07-19T17:53:24.719126Z  INFO main xks_proxy: 278: Tracing file rotation_kind="HOURLY"
2023-07-19T17:53:24.719224Z  INFO main xks_proxy: 67: Starting service="kms-xks-proxy" region="us-east-1"
2023-07-19T17:53:24.719744Z  INFO tokio-runtime-worker xks_proxy: 195: http://10.0.11.48:80/ping available for
health check
2023-07-19T17:53:24.719868Z  INFO tokio-runtime-worker xks_proxy: 113: is_sigv4_enabled=true is_tls_enabled=true
is_mtls_enabled=false secondary_auth=None
2023-07-19T17:53:24.720202Z  INFO tokio-runtime-worker xks_proxy: 133: Ciphertext Metadata is not configured.
2023-07-19T17:53:24.720397Z  INFO tokio-runtime-worker xks_proxy: 144: TCP Keepalive secs=Some(60s)
interval_secs=Some(1s) retries=Some(3)
2023-07-19T17:53:24.720599Z  INFO tokio-runtime-worker xks_proxy: 149: v3.1.2-unknown listening on 10.0.11.48:443
for traffic
```

With these instructions, you now have the XKS Proxy up and running, ready to handle your KMS-related tasks.

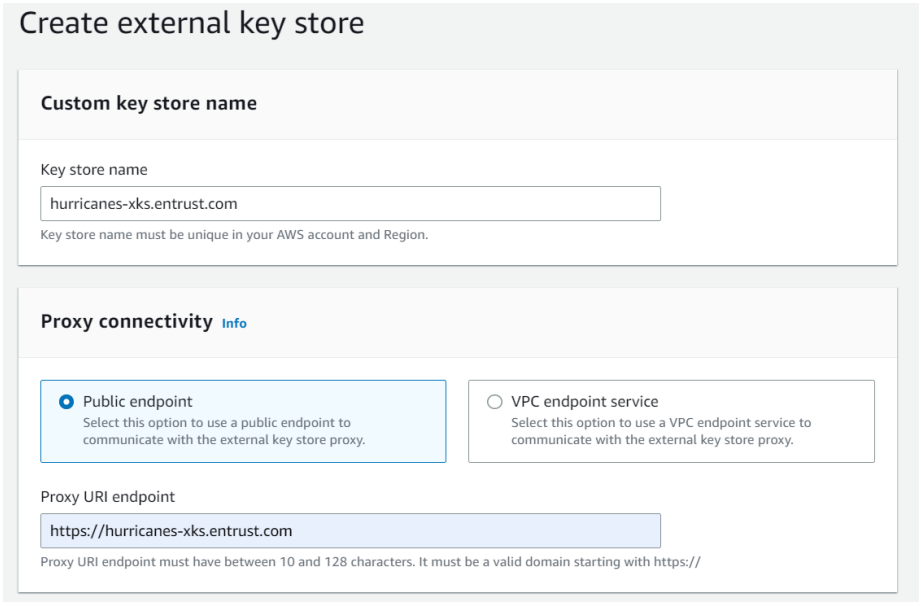
2.9. Creating the External Key Store on AWS

To set up the External Key Store on AWS, follow these steps:

1. Log in to the AWS console and navigate to the Key Management Server (KMS) section.
2. In KMS, go to **Custom key stores** > **External key stores**.
3. Select **Create external key store**.



4. Provide the Fully Qualified Domain Name (FQDN) for the Key store name.
5. Choose the Public endpoint option.
6. Enter the HTTPS URL for the server, for example:

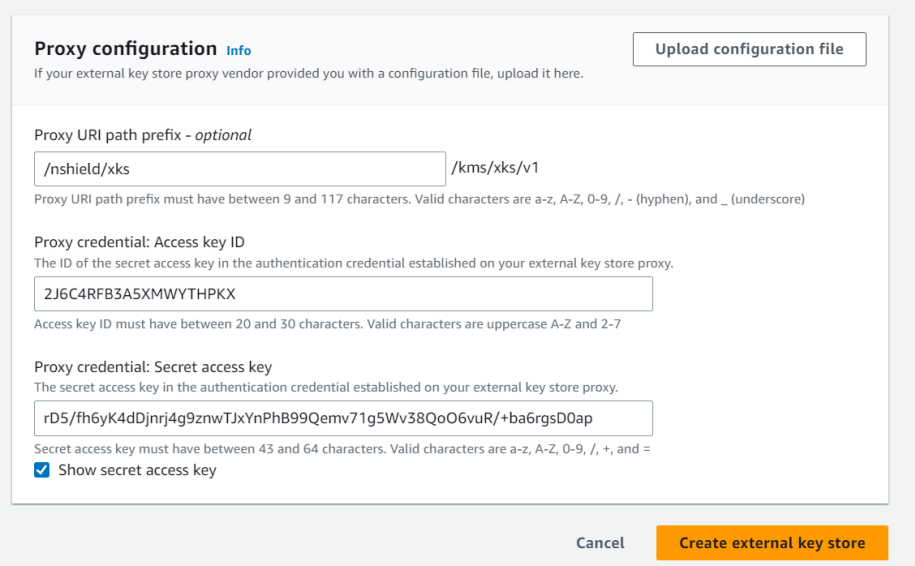


7. For the proxy configuration, provide the following details:

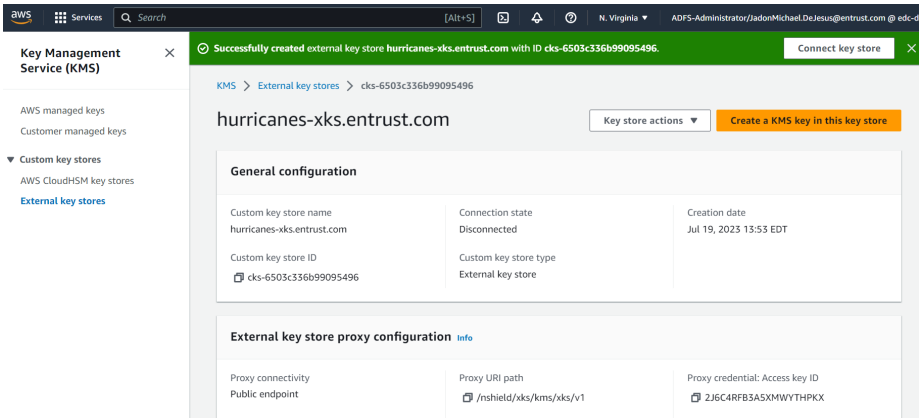
    a. Enter the URI path prefix as specified in the `settings_nshield.toml` file: "/nshield/xks".

b. Enter the Access key ID generated earlier (Ensure it matches the one in `settings_nshield.toml`).

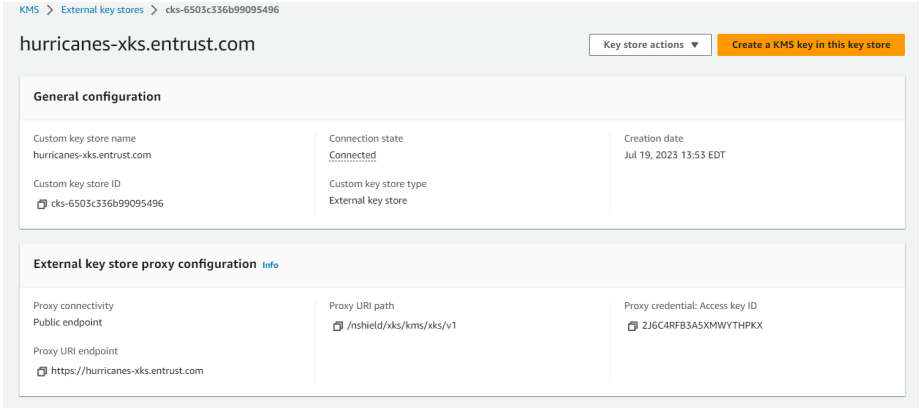
c. Enter the secret access key generated earlier (Ensure it matches the one in `settings_nshield.toml`).



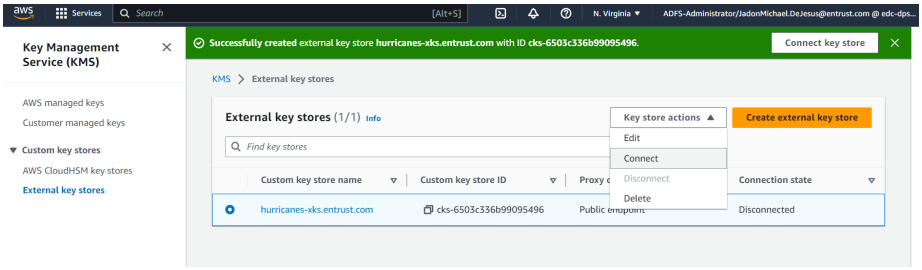
8. Select "Create external key store". AWS will notify you when the external keystore has been created.



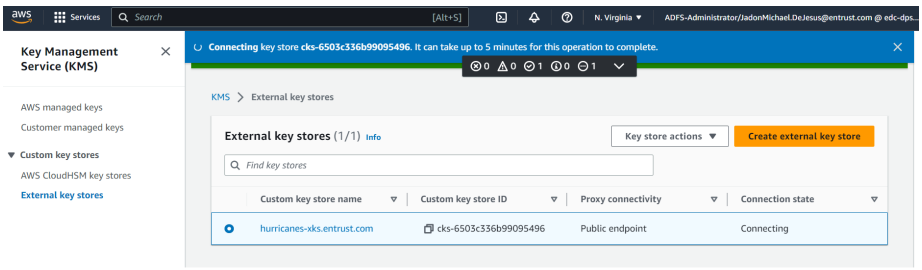
9. After the external key store is created, you can view its details, including the connection state:



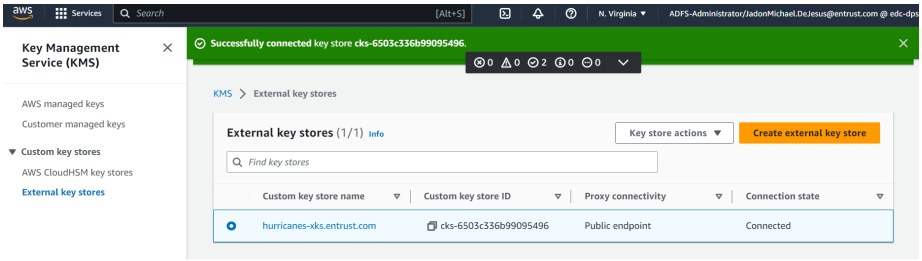
10. Connect the newly created External Keystore. Under Key store actions, select "Connect."



The connection process may take up to 5 minutes to complete.



11. After connection, the connection state will change to "Connected."

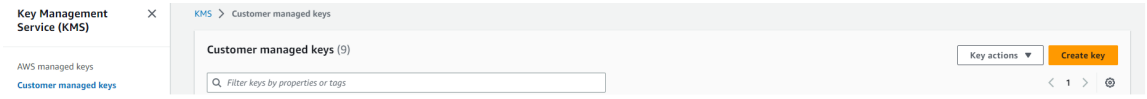


With the External Key Store successfully created and connected, you can now utilize its functionality to securely manage and store keys in your AWS environment.

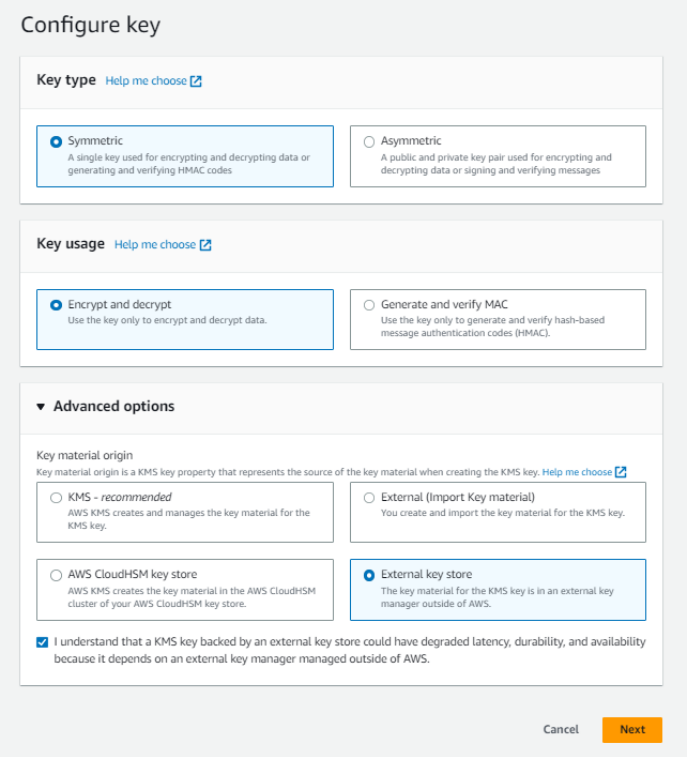
2.10. Creating a key in AWS KMS

To create a new key in AWS Key Management Service (KMS), follow these steps:

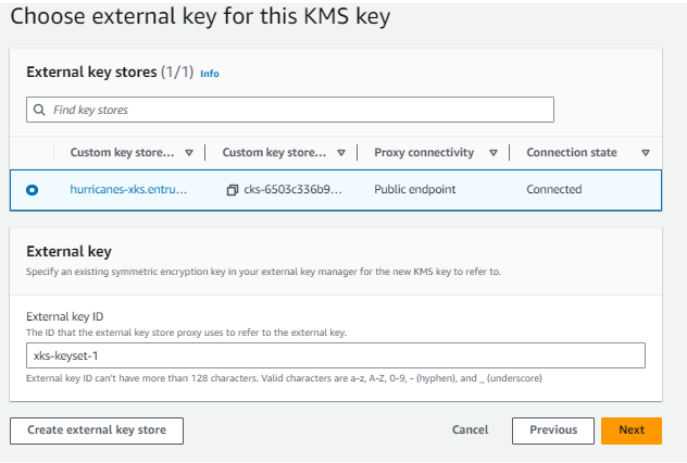
1. Go to the Key Management Server (KMS) section in the AWS console and select **Customer managed keys**.



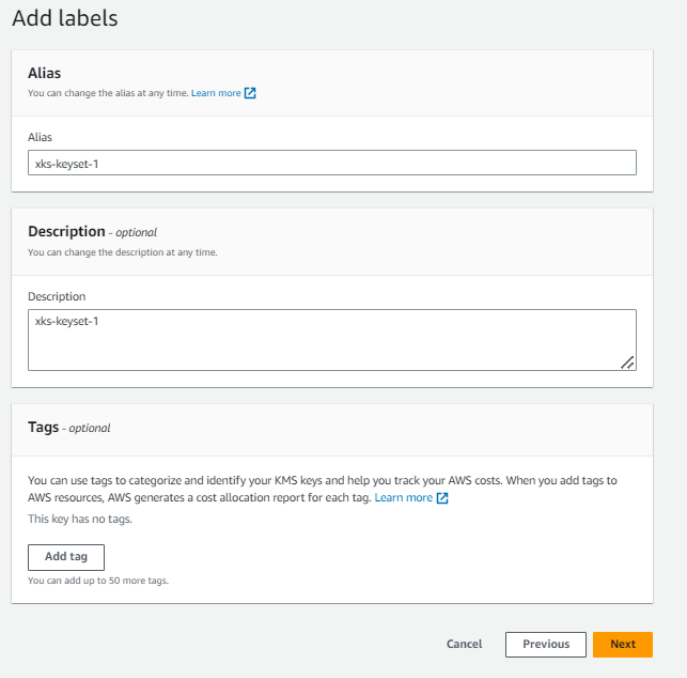
2. Choose **Symmetric** as the key type.
3. Select **Encrypt and decrypt** for the key usage.
4. In the **Advanced options**, choose **External key store** and check the agreement.



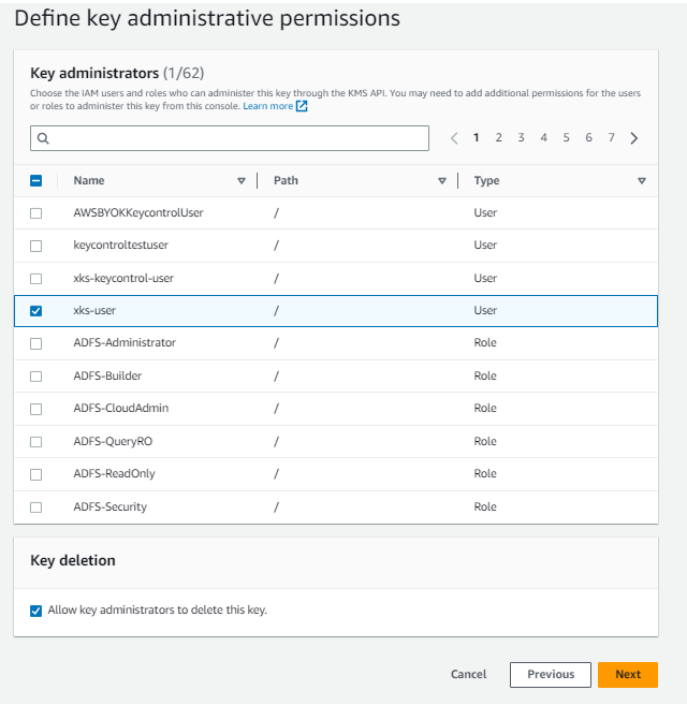
5. Select the external key store created earlier.
6. Enter the plainname that was defined for the key when it was generated, and ensure it matches the one in the `settings_nshield.toml` file under `xks_key_id_set`. For this example, `xks-keyset-1` was used.



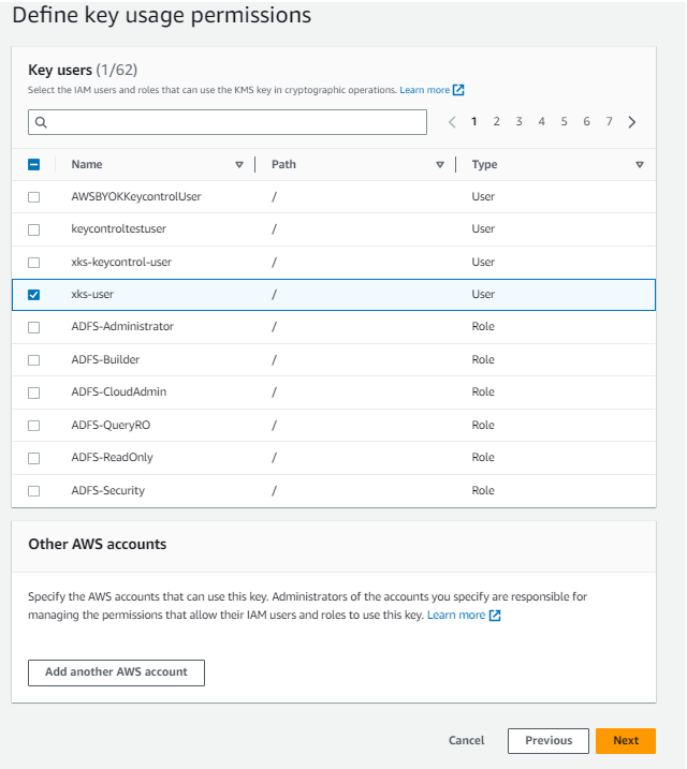
7. Enter the External key id for Alias and description.



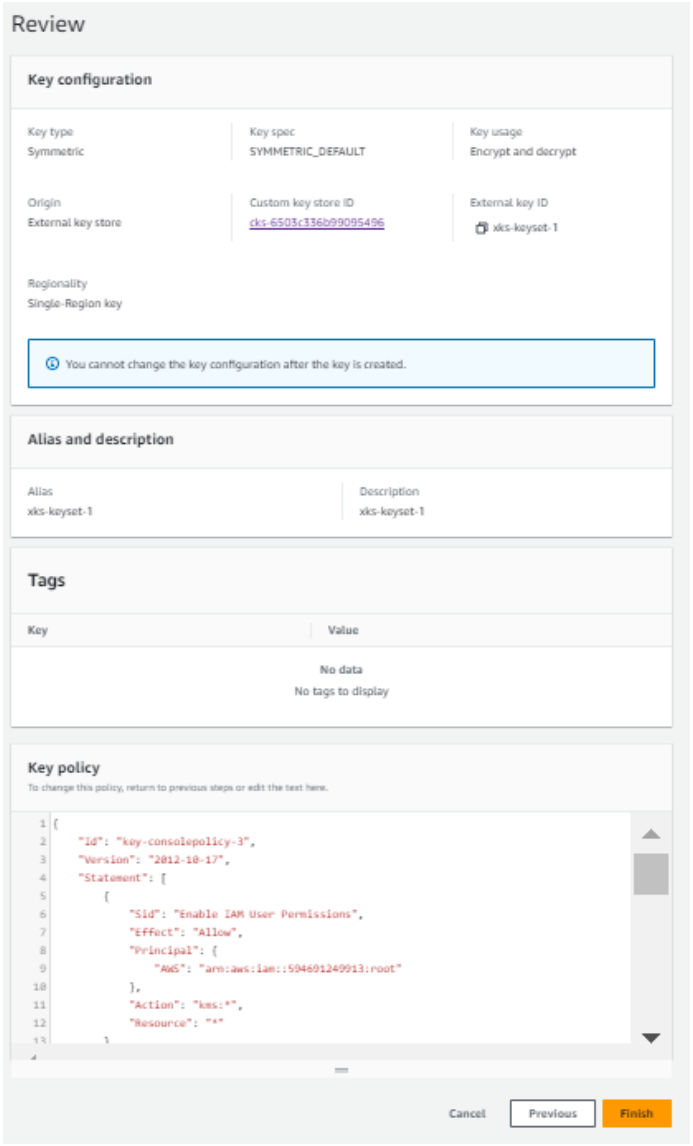
8. For key administrators, select the `xks-user` from the IAM step.



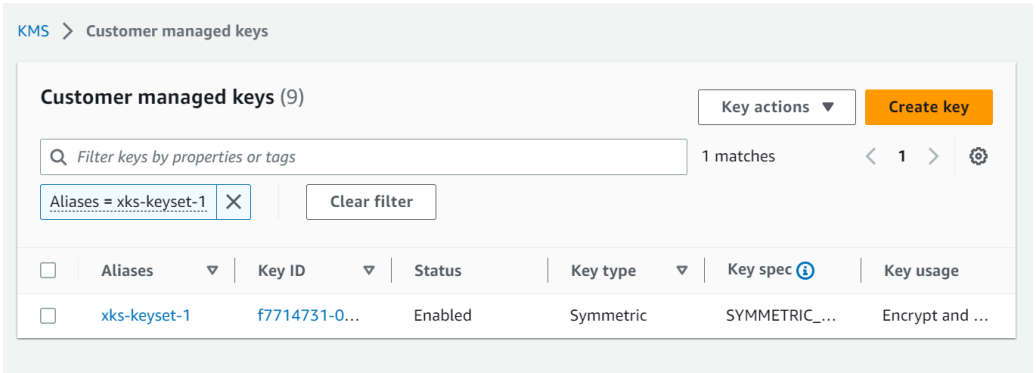
9. Select the `xks-user` for key-usage permissions as well.



10. Review the details of the key creation and select **Finish** to create the key.



11. After completing the creation process, you will find your new key listed under **Customer managed keys**.



With the new key successfully created and managed by the External Key Store, you have completed the integration.

Chapter 3. Additional resources and related products

3.1. nShield Connect

3.2. nShield as a Service

3.3. Entrust digital security solutions

3.4. nShield product documentation