



ENTRUST

Hyperledger Fabric

nShield® HSM Integration Guide

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1. Introduction

This document describes how to integrate the Hyperledger Fabric with the Entrust nShield Container Option Pack (nSCOP). This utilizes Entrust nShield hardware security module (HSM) as a Root of Trust for storage encryption, to protect the private keys and meet FIPS 140-2 Level 2 and 3 criteria.

1.1. Product configurations

Entrust has successfully tested nShield HSM integration with Hyperledger Fabric in the following configurations:

Product	Version
Fabric CA	1.5.2
Docker CE	20.10.12
Go	1.16.12
Host OS	Red Hat Enterprise Linux 8
Container OS	Ubuntu Bionic

1.2. Supported nShield hardware and software versions

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

1.2.1. Connect XC

Security World Software	Firmware	Image	OCS	Softcard	Module
12.80.4	12.50.11	12.80.4	✓	✓	✓

1.2.2. Connect +

Security World Software	Firmware	Image	OCS	Softcard	Module
12.80.4	12.50.8	12.80.4	✓	✓	✓

1.3. Supported nShield HSM functionality

Feature	Support
Module-only key	Yes
OCS cards	Yes
Softcards	Yes
nSaaS	Yes
FIPS 140-2 Level 3	Yes

1.4. Requirements

Familiarize yourself with:

- Hyperledger Fabric documentation: [Hyperledger Fabric CA User's Guide](#).
- The nShield HSM: *Installation Guide* and *User Guide*.
- 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, Softcard, or OCS.
 - The level of compliance for the Security World, FIPS 140-2 Level 3.
 - Key attributes such as key size, time-out, or need for auditing key usage.

2. Procedures

Prerequisites:

1. Install the Entrust nShield HSM using the instructions in the *Installation Guide* for the HSM.
2. Configure the Entrust nShield HSM to have the IP address of your container host machine as a client.
3. Install the Entrust nShield Security World Software, and configure the Security World as described in the *User Guide* for the HSM. The Security World and module files will be copied to the container. Instructions for this are detailed later in this guide.
4. Edit or create the `cknfastrc` file located in `/opt/nfast/`:

- If using Module protection:

```
CKNFAST_FAKE_ACCELERATOR_LOGIN=1
```

- If using OCS or Softcard protection:

```
CKNFAST_NO_ACCELERATOR_SLOTS=1  
CKNFAST_LOADSHARING=1
```

5. Install Git, cURL, Go, and Docker. See the Hyperledger Fabric documentation for more information on the prerequisites.
6. Get the Hyperledger Fabric repositories. The following installs both the `fabric-ca-server` and `fabric-ca-client` binaries in `$GOPATH/bin`:

```
go get -u github.com/hyperledger/fabric-ca/cmd/...
```

2.1. Install nSCOP on the host machine

The following is an example installation of nSCOP. See *nShield Container Option Pack User Guide* for more details.

1. Log in to the container host machine server as **root**, and launch a terminal window.
2. Set up the nSCOP working directory:

```
% mkdir -p /opt/nscop  
% tar xf nscop-1.1.1.tar -C /opt/nscop
```

3. Mount the Security World:

```
% mkdir SecWorld-12.80.4
% mount -o loop SecWorld_Lin64-12.80.4.iso SecWorld-12.80.4
```

4. Set up the hardserver image:

```
% cd /opt/nscop
% ./make-nshield-hwsp SecWorld-12.80.4
```

5. Configure **nshield-hwsp**:

a. Set up the hardserver configuration file and directory:

```
% mkdir -p /opt/nscop/config1
% ./make-nshield-hwsp-config --output /opt/nscop/config1/config <hsm ip address>
% cat /opt/nscop/config1/config
```

b. Create a new socket so that application containers can use the hardserver:

```
% docker volume create socket1
```

c. Run the **nshield-hwsp** container:

```
% docker run -d -v /opt/nscop/config1:/opt/nfast/kmdata/config:ro -v socket1:/opt/nfast/sockets nshield-hwsp:12.80.4
```

d. Check the status of **nshield-hwsp** using the **enquiry** command:

```
% NFAST_SERVER=/var/lib/docker/volumes/socket1/_data/nserver /opt/nfast/bin/enquiry
```

2.2. Build Hyperledger with PKCS #11 enabled

The default **Dockerfile** that comes with the Hyperledger Fabric CA software makes an image containing Alpine Linux. nSCOP does not currently support Alpine Linux. The **Dockerfile** will need to be changed to make an image with a supported Operating System.

1. Edit the **Dockerfile**. For example (Ubuntu):

```
% vi /root/go/pkg/mod/github.com/hyperledger/fabric-ca@v1.5.2/images/fabric-ca/Dockerfile

ARG GO_VER
ARG ALPINE_VER
FROM ubuntu:bionic
ARG GO_LDFLAGS
ARG GO_TAGS

RUN apt-get update
RUN apt-get install -y curl gcc git musl-dev
RUN rm -rf /var/lib/apt/lists/*

ENV GOLANG_VERSION 1.13.2
RUN curl -sSL https://storage.googleapis.com/golang/go$GOLANG_VERSION.linux-amd64.tar.gz | tar -v -C /usr/local -xz
ENV PATH /usr/local/go/bin:$PATH
RUN mkdir -p /go/src/go/bin && chmod -R 777 /go
ENV GOROOT /usr/local/go
ENV GOPATH /go
ENV PATH /go/bin:$PATH
ADD . $GOPATH/src/github.com/hyperledger/fabric-ca
RUN go install -tags "${GO_TAGS}" -ldflags "${GO_LDFLAGS}" \
    github.com/hyperledger/fabric-ca/cmd/fabric-ca-server \
    && go install -tags "${GO_TAGS}" -ldflags "${GO_LDFLAGS}" \
    github.com/hyperledger/fabric-ca/cmd/fabric-ca-client

ENV FABRIC_CA_HOME /etc/hyperledger/fabric-ca-server
EXPOSE 7054
CMD fabric-ca-server start -b admin:adminpw
```

2. Build the container image:

```
% cd /root/go/pkg/mod/github.com/hyperledger/fabric-ca@v1.5.2

% GO_TAGS=pkcs11 make docker
```

The following images will be generated:

```
% docker images
```

REPOSITORY	TAG	IMAGE ID	CREATED	SIZE
hyperledger/fabric-ca	1.5.2	42c3a53f293f	2 hours ago	832MB
hyperledger/fabric-ca	amd64-1.5.2	42c3a53f293f	2 hours ago	832MB
hyperledger/fabric-ca	latest	42c3a53f293f	2 hours ago	832MB

3. Run the `make-nshield-application` (nSCOP) script to build the final image. For example:

```
% cd /opt/nscop

% ./make-nshield-application --from hyperledger/fabric-ca:amd64-1.5.2 --tag hyperpkcs11nshield:amd64 --java /opt/nfast/SecWorld-12.80.4
```

In this example:

--from This is the Docker images container that you want a source image.

- tag** This is the new image name that will appear in the list of Docker images.
- java** This is an option to install Java, it is optional for this integration.
- /mnt** This is where your Security World ISO is mounted.

2.3. Configure and start the Hyperledger Fabric CA server

The volumes that will be used in the `docker run` command are: In the following steps, `fabric-ca-server-config.yaml` will be generated and then edited within the container. This file can also be created beforehand to simplify these steps.

The volumes that will be used in the `docker run` command are:

-v /opt/nfast/sockets.hwsp:/opt/nfast/sockets

Required for hardserver communication.

-v /opt/nfast/kmdata/local:/opt/nfast/kmdata/local:rw

Used to share `kmdata\local` between Security World and the app container.

-v /opt/nfast/cknfastrc:/opt/nfast/cknfastrc

File used when selecting PKCS #11 key protection type.

1. Run the container interactively with a bash prompt:

```
% docker run -it \  
-v socket1:/opt/nfast/sockets \  
-v /opt/nfast/kmdata/local:/opt/nfast/kmdata/local:rw \  
-v /opt/nfast/cknfastrc:/opt/nfast/cknfastrc \  
hyperpkcs11nshield:amd64-java
```

2. Run `enquiry` and `nfkminfo` within the container. The output should show a usable module and Security World.

```
% /opt/nfast/bin/enquiry  
% /opt/nfast/bin/nfkminfo
```

3. Run `fabric-ca-server` to generate a new config file to edit. Then, type **Control-C** or **X** multiple times to exit.

```
% fabric-ca-server start -b root:root
```


4. Edit the `fabric-ca-server-config.yaml` file:

```
% cd /etc/hyperledger/fabric-ca-server
% vi fabric-ca-server-config.yaml
```

5. Find the "bccsp" section and add the PKCS #11 settings. For example:

```
bccsp:
  default: PKCS11
  pkcs11:
    Library: /opt/nfast/toolkits/pkcs11/libcknfast.so
    Pin: 123456
    Label: fabric
    hash: SHA2
    security: 256
```

In this example:

- The name of the Softcard or OCS is "fabric" and the pin is "123456".
 - If using module protection, the label will be "accelerator".
 - If using module protection with `loadsharing=1` in the `cknfastrc` file, the label will be "loadshared accelerator".
 - The pin can be left empty if using module protection.
6. Delete any keystore in `/etc/hyperledger/fabric-ca-server` such as the `msp` directory and the old `.pem` file so that new ones are generated with the HSM when the server is started.
 7. Start the server:

```
% fabric-ca-server start
```

The new HSM protected PKCS #11 key can be found at `/opt/nfast/kmdata/local`. The cert is in the Hyperledger directory as `ca-cert.pem`.

2.4. Enroll and register a Fabric CA client

1. Edit the `fabric-ca-server-config.yaml` file and change the identity section as needed.
2. Start the server if it is not currently running. It needs to be running for the `enroll` command to work.
3. Create a directory environment variable:

```
% export FABRIC_CA_CLIENT_HOME=$HOME/fabric-ca/clients/admin
```

4. Enroll under the identity in the server YAML file:

```
% fabric-ca-client enroll -u http://root:root@localhost:7054
```

This was done to generate a client YAML file to edit. The client is not yet enrolled through the HSM.

5. Edit the client YAML file in your home directory environment path.
6. Delete the `msp` directory and edit the YAML file in the home directory you exported.
7. Edit the "bccsp" section and mirror the server YAML BCCSP for the HSM.
8. Run the `enroll` command again with the server identity:

```
% fabric-ca-client enroll -u http://root:root@localhost:7054
```

9. Register the client. For example:

```
% fabric-ca-client register --id.name ica.example --id.type client --id.secret root --csr.names  
C=es,ST=madrid,L=Madrid,O=example.com --csr.cn ica.example -m ica.example --id.attrs "hf.IntermediateCA=true" -u  
http://localhost:7054 --loglevel debug
```

2.5. Peers and ordering nodes

To set up peers and ordering nodes with the Entrust nShield HSM:

- Edit one more YAML file for each node. Use the same PKCS #11 BCCSP template as shown above. This will be the `core.yaml` file for a peer node and the `orderer.yaml` file for an ordering node.
- Run the enrollment lines from the peer or ordering nodes to the main fabric CA server to enroll it.

See the Hyperledger Fabric documentation for more information.