BIG-IP® System and Thales HSM: Implementation

Version 13.0
# Table of Contents

## Setting Up the Thales HSM
- Overview: Setting up the Thales HSM................................................................. 5
- Prerequisites for setting up Thales nShield Connect with BIG-IP systems........... 5
- Task summary........................................................................................................ 6
  - Installing Thales nShield Connect components on the BIG-IP system............. 6
  - Setting up the RFS on the BIG-IP system (optional)....................................... 6
  - Setting up the Thales nShield Connect client on the BIG-IP system.............. 7
  - Setting up the Thales nShield Connect client on a newly added or activated blade (optional).......................................................... 8
  - Configuring the Thales nShield Connect client for multiple HSMs in an HA group.......................................................... 8

## Managing External HSM Keys for LTM
- Overview: Managing external HSM keys for LTM................................................ 11
- Task summary........................................................................................................ 11
  - Configuring the key protection type............................................................... 11
  - Generating a token-, module-, or softcard-protected key/certificate using Thales nShield Connect.................................................. 13
  - Configuring hardware-protected HSM keys using tmsh................................... 13
  - Adding certificates using tmsh....................................................................... 14
  - Creating a client SSL profile to use an external HSM key and certificate ......... 14
  - Migrating existing software-protected or unprotected keys to the Thales HSM.... 14
  - Importing existing SSL keys into Thales nShield device for use by the BIG-IP system......................................................................... 15

## Generating External HSM Key-Cert Pairs for DNSSEC
- Overview: Generating external HSM key and certificate pairs for manually managed DNSSEC keys................................................................. 19
  - Generating an external key for creating manually managed DNSSEC keys...... 19
  - Configuring hardware-protected HSM keys using tmsh................................... 19
  - Adding certificates using tmsh....................................................................... 20
  - Creating a DNSSEC key using an external HSM key and certificate.............. 20

## Additional Information
- Creating a backup of the Thales RFS................................................................. 21
- Upgrading the BIG-IP software when using the Thales HSM......................... 21
- Uninstalling Thales nShield Connect components from the BIG-IP system..... 21
- Replacing a broken Thales HSM without breaking existing keys..................... 22
- fipskey.nethsm utility options........................................................................... 22
- nethsm-thales-install.sh utility options.............................................................. 23
- nethsm-thales-rfs-install.sh utility options....................................................... 23

## Legal Notices
- Legal notices.......................................................................................................... 25
Setting Up the Thales HSM

Overview: Setting up the Thales HSM

The Thales nShield Connect is an external HSM that is available for use with BIG-IP® systems. Because it is network-based, you can use the Thales nShield Connect solution with all BIG-IP platforms, including VIPRION® Series chassis and BIG-IP Virtual Edition (VE).

The Thales nShield Connect architecture includes a component called the Remote File System (RFS) that stores and manages the encrypted key files. The RFS can be installed on the BIG-IP system or on another server on your network.

The BIG-IP system is a client of the RFS, and all BIG-IP systems that are enrolled with the RFS can access the encrypted keys from this central location.

Only RSA-based cipher suites use the network HSM.

After you install the Thales nShield Connect client on the BIG-IP system, the keys stored in the Thales HSM and the corresponding certificates are available for use with Access Policy Manager® and Application Security Manager™.

For additional information about using Thales nShield Connect, refer to the Thales website: (https://www.thales-esecurity.com).

Note: If you are installing Thales nShield Connect on a BIG-IP system that will be licensed for Appliance mode, you must install the Thales nShield Connect software prior to licensing the BIG-IP system for Appliance mode.

Prerequisites for setting up Thales nShield Connect with BIG-IP systems

Before you can use Thales nShield Connect with the BIG-IP® system, you must make sure that these requirements are in place:

• The Thales nShield Connect device is installed on your network.
• The IP address of the BIG-IP client that is visible to the Thales HSM is on the allowed list of clients on the Thales nShield Connect device. If you are implementing Thales nShield Connect with a VIPRION® system, you need to add the cluster and management IP addresses and the cluster member IP address for each blade installed in the chassis to the allowed list. This applies to using the management network. If you use a TMM interface with a floating IP address, only that IP address is required.
• The RFS server is installed. This could be an external server on your network or on the local BIG-IP system.
• The Thales nShield Connect device, the RFS, and the BIG-IP system can initiate connections with each other through port 9004 (default).
• You have created the Thales Security World (security architecture).
• The BIG-IP system is licensed for "External Interface and Network HSM."

Important: You cannot run the BIG-IP system with both internal and external HSMs at the same time.

Note: BIG-IP TMOS with Thales HSM only supports IPv4.
Additionally, before you begin the installation process, make sure that you can locate these items on the installation DVD that ships with the Thales hardware unit:

- The Thales Security World Software for Linux 64bit
- The nShield_Connect_and_netHSM_User_Guide.pdf

Note: For supported Thales client and HSM versions with BIG-IP TMOS versions information, see the Interoperability Matrix for BIG-IP TMOS with Thales and HSM supplemental document available on AskF5.

Task summary

The implementation process involves preparation of the Thales nShield Connect device.

Task list

Installing Thales nShield Connect components on the BIG-IP system
Setting up the RFS on the BIG-IP system (optional)
Setting up the Thales nShield Connect client on the BIG-IP system
Setting up the Thales nShield Connect client on a newly added or activated blade (optional)
Configuring the Thales nShield Connect client for multiple HSMs in an HA group

Installing Thales nShield Connect components on the BIG-IP system

Before you can set up the Thales nShield Connect components on a BIG-IP® system, you must obtain the Thales 64-bit Linux ISO CD and copy files from the CD to specific locations on the BIG-IP system using secure copy (SCP). F5 Networks has tested these integration steps with Thales security World Software for Linux 64bit. For questions about Thales components, consult your Thales representative.

You can install files from the Thales 64 bit Linux ISO CD to the BIG-IP system.

1. Log in to the command-line interface of the system using an account with administrator privileges.
2. Create a directory under /shared named theales_install/amd64/nfast.
   
    mkdir -p /shared/thales_install/amd64/nfast

3. In the new directory, create subdirectories named ctl, hwcrh, hwsp, and pkcs11.
4. Copy files from the CD and place them in the specified directories:

<table>
<thead>
<tr>
<th>File to copy from the CD</th>
<th>Location to place file on BIG-IP</th>
</tr>
</thead>
<tbody>
<tr>
<td>/linux/libc6_3/amd64/nfast/ctls/agg.tar</td>
<td>/shared/thales_install/amd64/nfast/ctls/agg.tar</td>
</tr>
<tr>
<td>/linux/libc6_3/amd64/nfast/hwcrh/user.tar</td>
<td>/shared/thales_install/amd64/nfast/hwcrh/user.tar</td>
</tr>
<tr>
<td>/linux/libc6_3/amd64/nfast/hwsp/agg.tar</td>
<td>/shared/thales_install/amd64/nfast/hwsp/agg.tar</td>
</tr>
<tr>
<td>/linux/libc6_3/amd64/nfast/pkcs11/user.tar</td>
<td>/shared/thales_install/amd64/nfast/pkcs11/user.tar</td>
</tr>
</tbody>
</table>

Setting up the RFS on the BIG-IP system (optional)

Before you set up the Remote File System (RFS) on the BIG-IP® system, make sure that the Thales nShield Connect device is installed on your network.

Note: Setting up the RFS on the BIG-IP system is optional. If the RFS is running on another server on your network, you do not need to perform this task.
If the RFS is not running on another server in your network, you need to set up the RFS on the BIG-IP system.

1. Log in to the command-line interface of the BIG-IP system using an account with administrator privileges.
2. Run the script to set up the RFS.
   ```bash
   nethsm-thales-rfs-install.sh --hsm_ip_addr=<Thales_nShield Connect device IP address> --rfs_interface=<local interface name>
   ```
   This example sets up the RFS to run on the BIG-IP system, where the IP address of the Thales nShield Connect device has an IP address of 192.27.13.59:
   ```bash
   nethsm-thales-rfs-install.sh --hsm_ip_addr=192.168.13.59 --rfs_interface=eth0
   ```
   The RFS interface option is the interface the BIG-IP uses to connect to the HSM.

After you have set up the RFS, you must setup a Security World before attempting to connect to the BIG-IP as a client.

### Setting up the Thales nShield Connect client on the BIG-IP system

Before you set up the Thales client, make sure that the Thales nShield Connect client is installed on the BIG-IP system and that the Security World has been set up. Additionally, make sure that the RFS is installed and set up on either a remote server or on the BIG-IP system on your network.

**Note:** If the Thales nShield Connect client was installed on a BIG-IP system before the RFS was installed on the network, then you must reinstall the client on the BIG-IP system.

**Note:** The BIG-IP system IP address might not be the same as the IP address of the outgoing packet, such as when a firewall modifies the IP address.

To use the Thales nShield Connect device with the BIG-IP system, you must first set up the Thales client on the BIG-IP system. For the enrollment to work properly, the IP address of the BIG-IP system must be a client of the networked HSM. In the case of the VIPRION system and connecting over the admin interfaces, each blade and the chassis IP address need to be added as a client. You set up the IP address using the front panel of the nShield Connect device, or by pushing the client configuration. For details about how to add, edit, and view clients, refer to the Thales documentation.

If you are setting up the Thales client on a VIPRION system, you run the configuration script only on the primary blade, and then the system propagates the configuration to the additional active blades.

1. Log in to the command-line interface of the BIG-IP system using an account with administrator privileges.
2. Verify that the F5 interface you will use to communicate with the nShield Connect has been entered on the front panel of the HSM; that is, the Thales nShield Connect must permit connections from the F5 source IP address.
3. Set up the Thales nShield Connect client, using one of these options:
   - Option 1: Set up the client when the RFS is remote.
     ```bash
     nethsm-thales-install.sh
     --hsm_ip_addr=<nShield_Connect_device_IP_address>
     --rfs_ip_addr=<remote_RFS_server_IP_address>
     --rfs_username=<remote_RFS_server_username_for_SSH_login>
     ```
     The following example sets up the client where the Thales nShield Connect device has an IP address of 192.168.13.59, the remote RFS has an IP address of 192.168.13.58, the user
name for an SSH login to the RFS is root, and the Thales client interface is the management interface:

```
```

• Option 2: Set up the client when the RFS is set up on the local BIG-IP system:

```
nethsm-thales-install.sh --hsm_ip_addr=<nShield_Connect_device_IP_address> --rfs_interface=<local_RFS_server_interface>
```

The following example sets up the client where the Thales nShield Connect device has an IP address of 172.168.13.59 and the RFS is installed on the BIG-IP system using the eth0 interface:

```
nethsm-thales-install.sh --hsm_ip_addr=172.168.13.59 --rfs_interface=eth0
```

In addition, the RFS installed on the BIG-IP system may use the TMM interface (namely a VLAN):

```
nethsm-thales-install.sh --hsm_ip_addr=10.20.20.1 --rfs_interface=<VLAN_name>
```

4. Reload the PATH environment variable.
   If you are installing the Thales nShield Connect on a VIPRION system, you need to reload the PATH environment variable on any blades with already-open sessions: `source ~/.bash_profile`.

5. You can use the default number of threads provided, or you can specify the number of threads using the num-threads option. This can also be adjusted later using `tmsh`.

**Setting up the Thales nShield Connect client on a newly added or activated blade (optional)**

After you set up the Thales nShield Connect client on the primary blade of a VIPRION® system, the system propagates the configuration to the additional active blades. If you subsequently add a secondary blade, activate a disabled blade, or power-on a powered-off blade, you need to run a script on the new secondary blade.

1. Log in to the command-line interface of the system using an account with administrator privileges.
2. Run this script on any new or re-activated secondary blade:
   ```bash
   thales-sync.sh
   ```
3. If you make the new blade a primary blade before running the synchronization script, you need to run the regular client setup procedure on the new primary blade only.
   ```bash
   nethsm-thales-install.sh
   ```

**Configuring the Thales nShield Connect client for multiple HSMs in an HA group**

Before starting this task, you need to set up the Thales nShield Connect client on the BIG-IP® system. You can perform these additional steps to configure the Thales nShield Connect client for multiple HSMs.

1. Log in to the command-line interface of the system using an account with administrator privileges.
2. Enroll each additional HSM in the HA group.
   ```bash
   /opt/nfast/bin/nethsmenroll --force <HSM_ip_address> $(anonkneti <HSM_ip_address>)
   ```
   Perform this step for each of the additional HSMs in the HA group. For the enrollment to work properly, the IP address of the BIG-IP system must be a client of each networked HSM. You set up
the IP address using the front panel of the nShield Connect device, or by pushing the client configuration. For details about how to add, edit, and view clients, refer to the Thales documentation.

3. Update the permissions.

<table>
<thead>
<tr>
<th>Command</th>
</tr>
</thead>
<tbody>
<tr>
<td>chmod 755 -R /opt/nfast/bin</td>
</tr>
<tr>
<td>chown -R nfast:nfast /opt/nfast/kmdata/</td>
</tr>
<tr>
<td>chmod 700 -R /opt/nfast/kmdata/tmp/nfpriv_root</td>
</tr>
<tr>
<td>chown -R root:root /opt/nfast/kmdata/tmp/nfpriv_root</td>
</tr>
</tbody>
</table>

4. Verify installation.

   /opt/nfast/bin/enquiry

   This command displays all the installed modules that have the status Operational. Note that three HSMs are operational in this example.

<table>
<thead>
<tr>
<th>Server:</th>
</tr>
</thead>
<tbody>
<tr>
<td>:</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>serial number</td>
</tr>
<tr>
<td>mode</td>
</tr>
</tbody>
</table>

5. Restart the pkcs11 service.

   tmsh restart sys service pkcs1ld

6. Restart the TMM service.

   tmsh restart sys service tmm

7. Wait until the TMM is active.

8. Verify installation.

   /opt/nfast/bin/enquiry
Managing External HSM Keys for LTM

Overview: Managing external HSM keys for LTM

You can use the Thales nShield Connect to store and manage token-, module-, and softcard-protected keys.

For additional information about using Thales nShield Connect, refer to the Thales website: (https://www.thales-esecurity.com).

About key protection

There are three types of key protection available for use with the BIG-IP® system and Thales Connect:

- **Module-protected keys** are directly protected by the external HSM through the security world and can be used at any time without further authorization.
- **Softcard-protected keys** are protected by a softcard and can be used by only an operator who possesses the assigned passphrases.
- **Token-protected keys** are protected by a cardset and can be used by only an operator who possesses the Operator Card Set (OCS) token and any assigned passphrases.

All options are equally secure, and the main difference is the authorization requirement. As a general rule, if you have no particular security or regulatory requirement, you can default to module protection. Thales prefers the use of physical tokens for authorization. In the case of Operator Cards, Thales recommends making a 1/N card set, where N is greater than the total number of nShield Connects. For more information about card sets, refer to the Thales user guides.

Task summary

The implementation process involves configuring a key protection type, and then creating and loading token-, module-, or softcard-protected keys and certificates, and creating a client SSL profile to use the key and certificate.

Task list

*Configuring the key protection type*
- Generating a token-, module-, or softcard-protected key/certificate using Thales nShield Connect
- Configuring hardware-protected HSM keys using tmsh
- Adding certificates using tmsh
- Creating a client SSL profile to use an external HSM key and certificate
- Migrating existing software-protected or unprotected keys to the Thales HSM
- Importing existing SSL keys into Thales nShield device for use by the BIG-IP system

Configuring the key protection type

On the BIG-IP® system, you can choose among the Thales-supported types of key protection: module, softcard, and OCS. By default, the installation script sets up the appliance to create and use module-
protected keys. F5 recommends that you keep only one set of card files (cards* or softcard*) in the $NFAST_KMDATA/local directory.

In this release, only one type of key protection (PKCS#11 slot) can be configured for active use. You need to configure the key protection type for a slot by enabling the type you want, and disabling the others.

1. Log in to the command-line interface of the BIG-IP system using an account with administrator privileges.

2. Complete one of these steps, depending on your preferred key protection option:

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>module</td>
<td>The module-protected key option is enabled by default. To enable this protection type, no further action is required, and you can proceed to the next section.</td>
</tr>
</tbody>
</table>
| OCS    | 1. Disable module key protection by opening the configuration file `/opt/nfast/cknfastrc` and changing the value of the following parameter to 1, as shown.  
CKNFAST_NO_ACCELERATOR_SLOTS=1  
2. Disable softcard key protection by moving any previously created softcard* files from the `/opt/nfast/kmdata/local` directory to the `/opt/nfast/kmdata` directory.  
3. Enable OCS key protection by creating the OCS cardset using the Thales-provided createocs utility. |
| softcard | 1. Disable module protection by opening the configuration file `/opt/nfast/cknfastrc` and changing the value of the following parameter to 1, as shown.  
CKNFAST_NO_ACCELERATOR_SLOTS=1  
2. Disable OCS key protection by moving any previously created cards* files from the `/opt/nfast/kmdata/local` directory to the `/opt/nfast/kmdata` directory.  
3. Enable softcard key protection by creating the softcard cardset using the Thales-provided ppmk utility. |

Note: The softcard passphrase used in the ppmk command must match the passphrase used for setting up the Thales nShield Connect client on the BIG-IP system (used in the command `tmsh create/modify sys crypto fips external-hsm password <password>`).  

Note: If OCS is configured with a passphrase for Thales HSM, the user must enter it when prompted for Thales HSM slot password, even if the user only wants to use module keys.  

Note: To revert back to module protection, change  
CKNFAST_NO_ACCELERATOR_SLOTS=1 to CKNFAST_NO_ACCELERATOR_SLOTS=0 and remove any softcard or OCS files out of `/opt/nfast/kmdata/local`.  

3. After you make any configuration changes, you must restart the pkcs11 and tmm services.

```bash
tmsh restart sys service pkcs11d  
tmsh restart sys service tmm```
Generating a token-, module-, or softcard-protected key/certificate using Thales nShield Connect

Before you generate a token-, module-, or softcard-protected key/certificate, make sure that the Thales nShield Connect client is running on the BIG-IP® system.

You can use the fipskey.nethsm utility to generate token-, module-, or softcard-protected private keys and self-signed certificates on the BIG-IP system. You can use the generated .csr file to request a signed certificate from a certificate authority (CA).

1. Log in to the command-line interface of the system using an account with administrator privileges.

2. Generate a key, using one of these options:
   - Generate a token-protected key (the default method):
     ```bash
     fipskey.nethsm --genkey -o <output_file> -c token
     ```
   - Generate a module-protected key:
     ```bash
     fipskey.nethsm --genkey -o <output_file> -c module
     ```
   - Generate a softcard-protected key:
     ```bash
     fipskey.nethsm --genkey -o <output_file> -c softcard
     ```

This example generates the four files that follow, using the default protection type (token):

```bash
fipskey.nethsm --genkey -o my_key -c token
```

- `/config/ssl/ssl.key/my_key.key` (local key)
- `/config/ssl/ssl.csr/my_key.csr` (CSR file)
- `/config/ssl/ssl.crt/my_key.crt` (self-signed certificate)
- `/opt/nfast/kmdata/local/<filename>` (protected key)

The local key points to the protected key, which is encrypted.

**Note:** When you create a new Thales key for BIG-IP HA, you must run command `'rfs-sync --update' on all standby BIG-IP devices to update the local Thales encrypted file object cache. Without this action, SSL traffic using this key will fail when BIG-IP fails over to one of the unsynced standby devices.

After you generate a key and certificates, you need to load the local key into the BIG-IP configuration using tmsh.

### Configuring hardware-protected HSM keys using tmsh

You can use the Traffic Management Shell (tmsh) to load the corresponding local HSM (FIPS) keys into the BIG-IP® system.

**Note:** This procedure loads the local key, not the actual hardware key, which never leaves the HSM.

1. Log in to the command-line interface of the system using an account with administrator privileges.
2. Open the TMOS Shell (tmsh).
3. Configure the local key.

```
install sys crypto key <key_object_name> from-local-file <keyname>
```
This example loads the external HSM key named `my_key.key` from a local key file stored in the `/config/ssl/ssl.key/` directory:

```
install sys crypto key my_key.key from-local-file /config/ssl/ssl.key/my_key.key
```

The Thales client software maps the local key to the appropriate protected key.

### Adding certificates using tmsh

You can use the Traffic Management Shell (`tmsh`) to add existing certificates to the BIG-IP® system configuration.

1. Log in to the command-line interface of the system using an account with administrator privileges.
2. Open the TMOS Shell (`tmsh`).
   ```
tmsh
   ```
3. Add the certificate.
   ```
install sys crypto cert <cert_object_name> from-local-file <path_to_cert_file>
```
   This example loads the certificate named `my_key.crt` from a local certificate file stored in the `/config/ssl/ssl.crt/` directory:
   ```
install sys crypto cert my_key.crt from-local-file /config/ssl/ssl.crt/my_key.crt
```

### Creating a client SSL profile to use an external HSM key and certificate

After you have added the external HSM key and certificate to the BIG-IP® system configuration, you can use the key and certificate as part of a client SSL profile. This task describes using the browser interface. Alternatively, you can use the Traffic Management Shell (`tmsh`) command-line utility.

1. On the Main tab, click **Local Traffic > Profiles > SSL > Client**.
   
   The Client screen opens.
2. Click **Create**.
   
   The New Client SSL Profile screen opens.
3. In the **Name** field, type a name for the profile.
4. From the **Parent Profile** list, select `clientssl`.
5. From the **Configuration** list, select **Advanced**.
   
   This selection makes it possible for you to modify additional default settings.
6. For the Configuration area, select the **Custom** check box.
   
   The settings in the Configuration area become available for modification.
7. Using the **Certificate Key Chain** setting, specify one or more certificate key chains:
   a) From the **Certificate** list, select the name of a certificate that you imported.
   b) From the **Key** list, select the name of the key that you imported.
   c) From the **Chain** list, select the chain that you want to include in the certificate key chain.
   d) Click **Add**.
8. Click **Finished**.

After you have created the client SSL profile, you must assign the profile to a virtual server, so that the virtual server can process SSL traffic according to the specified profile settings.

### Migrating existing software-protected or unprotected keys to the Thales HSM

Before you begin this task, make sure that the Thales nShield Connect client is installed and configured on the BIG-IP® system.
If you already have regular RSA keys, you can migrate them to the Thales HSM.

**Note:** A Thales HSM device that is configured with the **Strict FIPS 140-2 Level 3 compliance flag** prevents importation of extraneous private keys.

1. Log in to the command-line interface of the system using an account with administrator privileges.
2. Migrate the key.

   ```bash
   fipskey.nethsm --export -i <input_key_full_path_filename> -o output_key_filename
   ```

   This example generates the four files that follow:

   ```bash
   fipskey.nethsm --export -i regular_key -o hsm_key
   ```
   - /config/ssl/ssl.key/hsm_key.key (local key)
   - /config/ssl/ssl.csr/hsm_key.csr (CSR file)
   - /config/ssl/ssl.crt/hsm_key.crt (self-signed certificate)
   - /opt/nfast/kmdata/local/protected_key_filename (protected key)

   If you migrated a key that has a certificate that is already issued by a reputable issuing CA, you should migrate the key, but continue using the old certificate. After you migrate the existing key to the Thales HSM, you must load the key into the BIG-IP system using `tmsh`, and then modify the client SSL profile, or create a new client SSL profile that uses the new key and the existing certificate.

### Importing existing SSL keys into Thales nShield device for use by the BIG-IP system

You import existing SSL keys when you have pre-existing keys you want the BIG-IP® system to use. You need to perform these steps for each key you want to import into the Thales system.

1. Log in to the command-line interface of the system using an account with administrator privileges.
2. Copy certificate(s) and key(s) you want to import onto the BIG-IP system and place them in the `/var/tmp` directory on the BIG-IP system.

   ```bash
   /var/tmp/user.key
   /var/tmp/user.crt
   ```

3. Ensure adequate permissions are set so that other users on the system are not able to view the `.key` files copied.

   ```bash
   chmod 600 /var/tmp/user.key
   ```

4. Import the key into Thales nShield Connect external HSM using the `generatekey` utility.

   ```bash
   /opt/nfast/bin/generatekey --import pkcs11 certreq=yes
   ```

   The system interactively prompts you for information.

5. When prompted to enter the name of the PEM file that contains the RSA key, enter the full path to the key copied to the BIG-IP system (pemreadfile).

   For example, `/var/tmp/user.key`.

6. When prompted to enter the file name where the key will be written, enter the full path to the pseudo key (embedsavefile).

   This is the pseudo key required by BIG-IP system.

   For example, `/var/tmp/imported_user.key`.

7. When prompted to enter the key name, type a name for the key (plainname).

   This is the name with which the key is associated in the nShield RFS. No path is required, as plainname is not written to a file on disk.

   For example, `userkey`.

   When the key import is complete, the `generatekey` utility will generate two files.
8. Modify the ownership and permissions of the key you created. After successful import, take note of
the path to key to modify ownership.

```
chown nfast:nfast /opt/nfast/kmdata/local/key_pkcs11_udcd028e5251b7b6891e7e59dec5428d871f92241b-c70e6451e8d793ca80a497267cc9bc73bd55ed
chmod 755 /opt/nfast/kmdata/local/key_pkcs11_udcd028e5251b7b6891e7e59dec5428d871f92241b-c70e6451e8d793ca80a497267cc9bc73bd55ed
```

**Important:** *If this step is omitted, you might see permission errors when running rfs-sync.*

9. Sync the nShield generated pseudo-key (embedsavefile) to the RFS.

```
[root@LBHAS64:Active:Standalone] tmp # rfs-sync --update
[root@LBHAS64:Active:Standalone] tmp # rfs-sync --commit
```

If the BIG-IP system this procedure is performed on is also the RFS, the `rfs-sync` commands above
will report 0 committed. This is expected behavior, as the keys imported are automatically stored
in the RFS directory.

10. Import the pseudo key and SSL certificate using `tmsh` for use by BIG-IP client SSL profile using this
syntax:

```
tmsh install sys crypto key [name] from-local-file [/path/to/pseudo_key.key]
tmsh install sys crypto cert [name] from-local-file [/path/to/real_certificate.crt]
```

For example:

```
tmsh install sys crypto key import.key from-local-file /var/tmp/imported_user.key
tmsh install sys crypto cert import.crt from-local-file /var/tmp/user.crt
```

11. Save the configuration.
```
tmsh save sys config
```

If you need to import more SSL certificates and keys, repeat all preceding steps for each certificate
and key pair.

12. Create an SSL profile that references the above key and certificate.

13. Create a virtual server that uses the above SSL profile (or assign to an existing virtual server).

14. Verify that the virtual server passes traffic correctly.

15. You can safely remove the certificates and keys from `/var/tmp` directory used in this procedure as
they are no longer required by the BIG-IP system.

**Note:** *Once the pseudo key has been installed with tmsh, the copy in `/var/tmp` is no longer used.*

**Note:** *Unless the SSL key file is deleted in a secure manner, it might be possible for someone to
recover the file from the disk. Consider using the shred utility (type: `man shred` at the command
line for details) to delete any key files copied to the BIG-IP system once they have been successfully
imported into the Thales nShield device.*

**Note:** *When you create a new Thales key for BIG-IP HA, you must run command ‘rfs-sync --
update’ on all standby BIG-IP devices to update the local Thales encrypted file object cache.
Without this action, SSL traffic using this key will fail when BIG-IP fails over to one of the unsynced
standby devices.*

**Task summary**

*Migrating existing software-protected or unprotected keys to the Thales HSM*
Overview: Generating external HSM key and certificate pairs for manually managed DNSSEC keys
Generating External HSM Key-Cert Pairs for DNSSEC

Overview: Generating external HSM key and certificate pairs for manually managed DNSSEC keys

When the BIG-IP® system is a BIG-IP DNS (previously Global Traffic Manager), you can use the Thales nShield Connect to store and manage DNSSEC keys.

For additional information about using Thales nShield Connect, refer to the Thales website: (https://www.thales-esecurity.com).

Task list

Generating an external key for creating manually managed DNSSEC keys
Configuring hardware-protected HSM keys using tmsh
Adding certificates using tmsh
Creating a DNSSEC key using an external HSM key and certificate

Generating an external key for creating manually managed DNSSEC keys

Before you generate the key, make sure that the Thales nShield Connect client is running on all BIG-IP® DNS devices in the configuration synchronization group.

You can use the fipskey.nethsm utility to generate keys and self-signed certificates to be used to create manually managed DNSSEC private keys. You can use the generated .csr file to request a signed certificate from a certificate authority (CA).

Tip: For information about creating automatically managed DNSSEC private keys, see Configuring DNSSEC with an external HSM in BIG-IP® DNS Services: Implementations at http://support.f5.com.

1. Log in to the command-line interface of the system using an account with administrator privileges.
2. Generate a key:

   fipskey.nethsm --genkey -o <output_file>

   This example generates four files, using the default protection type (token):

   fipskey.nethsm --genkey -o my_key

   • /config/ssl/ssl.key/my_key.key (local key)
   • /config/ssl/ssl.csr/my_key.csr (CSR file)
   • /config/ssl/ssl.crt/my_key.crt (self-signed certificate)
   • /opt/nfast/kmdata/local/filename (protected key)

   The local key points to the protected key, which is encrypted.

   After you generate a key and certificates, you need to load the local key into the BIG-IP configuration using tmsh.

Configuring hardware-protected HSM keys using tmsh

You can use the Traffic Management Shell (tmsh) to load the corresponding local HSM (FIPS) keys into the BIG-IP® system.
Note: This procedure loads the local key, not the actual hardware key, which never leaves the HSM.

1. Log in to the command-line interface of the system using an account with administrator privileges.
2. Open the TMOS Shell (tmsh).
3. Configure the local key.

   install sys crypto key <key_object_name> from-local-file <keyname>

This example loads the external HSM key named my_key.key from a local key file stored in the /config/ssl/ssl.key/ directory:

   install sys crypto key my_key.key from-local-file /config/ssl/ssl.key/my_key.key

The Thales client software maps the local key to the appropriate protected key.

Adding certificates using tmsh

You can use the Traffic Management Shell (tmsh) to add existing certificates to the BIG-IP® system configuration.

1. Log in to the command-line interface of the system using an account with administrator privileges.
2. Open the TMOS Shell (tmsh).
3. Add the certificate.

   install sys crypto cert <cert_object_name> from-local-file <path_to_cert_file>

This example loads the certificate named my_key.crt from a local certificate file stored in the /config/ssl/ssl.crt/ directory:

   install sys crypto cert my_key.crt from-local-file /config/ssl/ssl.crt/my_key.crt

Creating a DNSSEC key using an external HSM key and certificate

Before you create a DNSSEC key using an external key and certificate, make sure that you have generated a key and certificate using Thales nShield Connect, and that you have loaded the key and certificate.

You can create manually managed DNSSEC zone-signing and key-signing keys for use with an external HSM. For more information, see Configuring DNSSEC with an external HSM in BIG-IP® DNS Services: Implementations at http://support.f5.com.
**Creating a backup of the Thales RFS**

Before you back up the RFS, make sure that the Thales nShield Connect Remote File System (RFS) server is installed on your network.

You back up the `/shared/nfast/kmdata/local/` directory of the RFS to a secure location, so that you can recover the RFS state, if needed. The RFS contains all of the Thales nShield Connect keys.

1. If the RFS is not installed on the BIG-IP system, rename the `/shared/nfast` directory to `/shared/nfast.org`.
   This directory can be used to recover old data, if necessary.
2. Follow the Thales best practices for backing up the RFS server.

**Upgrading the BIG-IP software when using the Thales HSM**

After a BIG-IP® system software or hotfix upgrade, you must run the Thales client setup script to restore your default Thales configuration. Any local keys and certificates you loaded into the BIG-IP system before upgrading (using the command `tmsh install sys crypto`) appear in the upgrade partition, but they are usable only after you run the Thales client setup script. If you are restoring the Thales client on a VIPRION® system, you run the configuration script only on the primary blade, and then the system propagates the configuration to the additional active blades.

*Note: If you will need CSRs, keys, or certs that were not loaded into the BIG-IP system, before you upgrade, copy the files into the `/shared` directory. After the upgrade, copy them back to their appropriate directories in the new partition: `/config/ssl/ssl.key`, `/config/ssl/ssl.crt`, or `/config/ssl/ssl.csr`.*

1. Log in to the command-line interface of the BIG-IP system using an account with administrator privileges.
2. Run one of these scripts, using the arguments that are appropriate for your configuration:
   - If the BIG-IP is an RFS server in addition to being a Thales client, use: `nethsm-thales-rfs-install.sh` and `nethsm-thales-install.sh`
   - If the BIG-IP is only a Thales client use: `nethsm-thales-install.sh`

The protected keys, which are stored in `/opt/nfast/kmdata/`, are available in the new partition, regardless of whether the keys and certs were loaded into the BIG-IP system.

**Uninstalling Thales nShield Connect components from the BIG-IP system**

If you no longer need to use the Thales nShield Connect on a BIG-IP® system, you should uninstall the files.

1. Log in to the command-line interface of the system using an account with administrator privileges.
2. Uninstall the client and clean up.

   `nethsm-thales-install.sh -u [-v]`
Replacing a broken Thales HSM without breaking existing keys

You can replace a broken Thales HSM without destroying existing keys.

1. Turn on the new HSM, and give it an IP address, netmask, and default route.
   
   `nethsm-thales-install.sh -u [-v]

2. Reconfigure the RFS, so that you can point the HSM to it. If the RFS is a BIG-IP system, use
   
   `nethsm-thales-rfs-install.sh --hsm_ip_addr=<new HSM IP>

   When the script asks if you want to uninstall, type yes. When the script asks if you want to overwrite the config, type yes. When the script asks if you want to use the existing Security World, type yes.

3. Using the front panel on the HSM, configure the HSM to know its RFS. Once this is done, using the front panel again, add at least the BIG-IP system and the RFS to the HSM as clients.

4. Using the front panel of the HSM and a quorum of the ACS, load the Security World onto the HSM.

5. On the RFS, unenroll the old HSM, because otherwise it will still show up in enquiry results.
   
   `nethsmenroll --force -r <old HSM IP> <old HSM ESM> <old HSM hash>

   Note that this requires the ESM and HSM hash from the broken machine. The command `anonkneti` will not work because the old HSM is broken or already removed from the network. This needs to be done even if the RFS is a BIG-IP system and the `nethsm-thales-rfs-install.sh` command was used.

6. Rerun the install script on any BIG-IP systems that use the HSM. When that script asks if you want to uninstall, type yes. When that script asks if you want to backup, type whichever you prefer.

7. On each BIG-IP system, unenroll the old HSM, because it will still show up in enquiry results.
   
   `nethsmenroll --force -r <old HSM IP> <old HSM ESM> <old HSM hash>

   Note that this requires the ESM and HSM hash from the broken machine. The command `anonkneti` will not work, since the old HSM is broken or already removed from the network.

---

fipskey.nethsm utility options

The fipskey.nethsm utility includes these options:

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>-o</code></td>
<td>Name applied to .key, .csr, and .crt output files</td>
</tr>
<tr>
<td>`-c [token</td>
<td>module</td>
</tr>
<tr>
<td><code>-e [hex]</code></td>
<td>Public exponent to use when generating RSA keys only.</td>
</tr>
<tr>
<td><code>--g [sha1]</code></td>
<td>Digest used to sign key and certificate</td>
</tr>
<tr>
<td><code>-k [name]</code></td>
<td>Key name</td>
</tr>
<tr>
<td>`-m [yes</td>
<td>no]`</td>
</tr>
</tbody>
</table>

**Important:** This parameter is required.

**Note:** Do not provide a value for this option, unless advised to do so by F5® Technical Support.
<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-n [integer]</td>
<td>Slot number to read cards from</td>
</tr>
<tr>
<td>-r [yes</td>
<td>no]</td>
</tr>
<tr>
<td>-s [integer]</td>
<td>Size of key/certificate pair (in bits)</td>
</tr>
<tr>
<td>-t [RSA]</td>
<td>Key type</td>
</tr>
<tr>
<td>-v [yes</td>
<td>no]</td>
</tr>
<tr>
<td>-C</td>
<td>Country identifier</td>
</tr>
<tr>
<td>-D</td>
<td>Domain name</td>
</tr>
<tr>
<td>-E</td>
<td>Email address for key contact</td>
</tr>
<tr>
<td>-L</td>
<td>Locality identifier</td>
</tr>
<tr>
<td>-N</td>
<td>Substitute alternative name</td>
</tr>
</tbody>
</table>

*Note: Applies only to SafeNet Luna HSM.*

- O
- P
- U

**nethsm-thales-install.sh utility options**

The `nethsm-thales-install.sh` utility includes these options:

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-h</td>
<td>Displays help</td>
</tr>
<tr>
<td>-v</td>
<td>Prints verbose output about operations</td>
</tr>
<tr>
<td>--hsm_ip_addr=&lt;ip_addr&gt;</td>
<td>Thales HSM IP address</td>
</tr>
<tr>
<td>--rfs_interface=&lt;interface_name&gt;</td>
<td>Interface identifier for the Remote File System (RFS) server. Default is the management interface (eth0).</td>
</tr>
<tr>
<td>--verbose=&lt;level&gt;</td>
<td>Indicates message verbosity level. The default value is zero, and all levels greater than zero indicate verbose output.</td>
</tr>
</tbody>
</table>

**nethsm-thales-rfs-install.sh utility options**

The `nethsm-thales-rfs-install.sh` utility includes these options:

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-h</td>
<td>Displays help</td>
</tr>
<tr>
<td>-v</td>
<td>Prints verbose output about operations</td>
</tr>
<tr>
<td>--hsm_ip_addr=&lt;ip_addr&gt;</td>
<td>Thales HSM IP address</td>
</tr>
<tr>
<td>Option</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>--rfs_ip_addr=&lt;ip_addr&gt;</td>
<td>Remote File System (RFS) server IP address</td>
</tr>
<tr>
<td>--rfs_username=&lt;ssh_user_name&gt;</td>
<td>RFS server username for SSH login</td>
</tr>
<tr>
<td>--rfs_interface=&lt;interface_name&gt;</td>
<td>Interface identifier for the BIG-IP® system used as the Thales HSM client. Default is the management interface (eth0).</td>
</tr>
<tr>
<td>--verbose=&lt;level&gt;</td>
<td>Indicates message verbosity level. The default value is zero, and all levels greater than zero indicate verbose output.</td>
</tr>
</tbody>
</table>
Legal Notices

Publication Date
This document was published on May 25, 2017.

Publication Number
MAN-0495-04

Copyright
Copyright © 2017, F5 Networks, Inc. All rights reserved.

F5 Networks, Inc. (F5) believes the information it furnishes to be accurate and reliable. However, F5 assumes no responsibility for the use of this information, nor any infringement of patents or other rights of third parties which may result from its use. No license is granted by implication or otherwise under any patent, copyright, or other intellectual property right of F5 except as specifically described by applicable user licenses. F5 reserves the right to change specifications at any time without notice.

Trademarks
For a current list of F5 trademarks and service marks, see http://www.f5.com/about/guidelines-policies/trademarks.

All other product and company names herein may be trademarks of their respective owners.

Patents
This product may be protected by one or more patents indicated at: https://f5.com/about-us/policies/patents.

Link Controller Availability
This product is not currently available in the U.S.

Export Regulation Notice
This product may include cryptographic software. Under the Export Administration Act, the United States government may consider it a criminal offense to export this product from the United States.

RF Interference Warning
This is a Class A product. In a domestic environment this product may cause radio interference, in which case the user may be required to take adequate measures.

FCC Compliance
This equipment has been tested and found to comply with the limits for a Class A digital device pursuant to Part 15 of FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This unit generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a
residential area is likely to cause harmful interference, in which case the user, at his own expense, will be required to take whatever measures may be required to correct the interference.

Any modifications to this device, unless expressly approved by the manufacturer, can void the user's authority to operate this equipment under part 15 of the FCC rules.

**Canadian Regulatory Compliance**

This Class A digital apparatus complies with Canadian ICES-003.

**Standards Compliance**

This product conforms to the IEC, European Union, ANSI/UL and Canadian CSA standards applicable to Information Technology products at the time of manufacture.
Index

A
Appliance mode
and installation requirement 5

B
BIG-IP system software upgrade
restoring Thales client configuration 21

C
CA, See certificate authority (CA).
certificate
generating for use with LTM 13
generating module-protected keys 13
generating softcard-protected keys 13
generating token-protected keys 13
certificate authority (CA)
requesting a signed certificate 13, 19
certificates
adding using tmsh 14, 20
client SSL profile
using with external HSM key and certificate 14

D
DNSSEC
using with Thales HSM 19
DNSSEC keys
creating 20

E
external HSM
and Thales nShield Connect solution 5
using key and certificate with client SSL profile 14
external HSM key
loading local key using tmsh 13, 19

F
FIPS card, See internal HSM.
FIPS key, See external HSM key.
fipskey.nethsm utility
generating certificates 13
generating keys for DNSSEC 19
generating module-protected keys 13
generating softcard-protected keys 13
generating token-protected keys 13
options 22

H
hardware security module (HSM)
using external 5

I
importing keys 15

K
key
generating for DNSSEC 19
generating for use with LTM 13
generating module-protected keys 13
generating softcard-protected keys 13
generating token-protected keys 13
migrating software-created keys 14
key management
for module-protected keys 11
for softcard-protected keys 11
for token-protected keys 11
key protection
about 11
choosing a method 11
generating module-protected keys 13
generating softcard-protected keys 13
generating token-protected keys 13
keys
about module-protected 11
about softcard-protected 11
about token-protected 11

M
module-protected key
about 11
about managing 11
choosing 11
generating 13
task summary 11

N
nethsm-thales-install.sh
options 23
nethsm-thales-rfs-install.sh utility
options 23

O
OCS, See Operator Card Set.
Operator Card Set (OCS) 11

P
prerequisites
for Thales HSM setup 5

R
recovery
recovery (continued)
of Thales RFS 21
Remote File System (RFS)
   and server operating system requirement 5
defined 5
   setting up on BIG-IP 6
RFS, See Remote File System (RFS).

S
self-signed certificate
   generating 13
softcard-protected key
   about 11
   about managing 11
   choosing 11
   generating 13
   task summary 11
software-generated keys
   migrating to Thales HSM 14
SSL keys
   importing into Thales nShield device 15

T
Thales HSM
   configuring for HA 8
   generating certificates 13
   generating DNSSEC keys 19
   generating module-protected keys 13
   generating softcard-protected keys 13
   generating token-protected keys 13
   installing components 6
   migrating software-created keys to 14
   replacing 22
   restoring client on upgraded BIG-IP system 21
   setting up 5
   setting up client on added blade 8
   setting up client on BIG-IP system 7
   uninstalling the client 21
   using with an internal HSM (FIPS card) 5
Thales HSM and DNSSEC
   generating keys for manually managed DNSSEC keys 19
Thales HSM device setup
   overview 5
   task summary 6
   using with Appliance mode 5
Thales RFS
   creating a backup 21
tmsh commands
   adding certificates 14, 20
   configuring hardware-protected HSM keys 13, 19
token-protected key
   about 11
   about managing 11
   choosing 11
   generating 13
   task summary 11