The Scute Manual

Version 1.6.1-beta10
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This is *The Scute Manual* for Scute version 1.6.1-beta10 and was last updated 11 August 2020. Scute is a PKCS#11 provider on top of GnuPG.

Table of Contents

1 Introduction

Scute is a PKCS #11 implementation for the GnuPG Agent using the GnuPG Smart Card Daemon. Currently, OpenPGP and PIV cards are supported.

Scute enables use of the OpenPGP smart card or a PIV smart card in applications supporting PKCS #11 compliant security tokens. The main application at this time is client authentication in Mozilla-based web browsers. In the future, other applications will be supported.

1.1 Getting Started

This manual documents the Scute module, how it can be used for common applications supported by it, and how it can be extended and improved by programmers. It is thus a user manual as well as a developer manual.

The reader is assumed to possess basic knowledge about cryptography in general, and public key cryptography in particular. The underlying cryptographic engines that are used by the library are not explained, but where necessary, special features or requirements are provided.

This manual can be used in several ways. If read from the beginning to the end, it gives a good introduction into the module and how it can be used in an application. Forward references are included where necessary. Later on, the manual can be used as a reference manual to get just the information needed about any particular application of the module.

1.2 Features

Scute is currently the only implementation of PKCS #11 for the OpenPGP smart card. Apart from that, it offers a couple of other benefits:

it's free software
: Anybody can use, modify, and redistribute it under the terms of the GNU General Public License (see [Library Copying], page 23).

it's built to grow
: Although Scute initially provided a single function, client authentication using OpenPGP smart cards in Mozilla-based web browsers, it was built with the intention of supporting other applications as well in the future.

it's easy
: Building and installing Scute is easy, and preparing smart cards for use with Scute is a snatch using the GnuPG 2 framework. The integration of Scute into the application is seamless.

1.3 Overview

Scute is a security device that implements the PKCS #11 interface for security tokens. Applications which know how to use the PKCS #11 interface to access security tokens for cryptographic operations can use Scute to access the OpenPGP smart card. An important example of such an application is the Firefox web browser by the Mozilla project, which uses the Mozilla Network Security Services library (NSS).

Scute itself does not include a driver for the smart card itself. Instead, it uses the GnuPG 2 framework to access the smart cards and associated data like certificates. Scute acts as the glue between the application and GnuPG 2.

Currently supported usages are client authentication over HTTPS with Firefox (allowing users to authenticate themselves to a remote web service without entering their log-in information), email signing with Thunderbird, and document signing with LibreOffice.

2 Preparation

To use Scute, you first have to install the software. You also have to prepare each card you want to use with Scute before it can be used. Furthermore, you need to configure the application to make use of Scute for cryptographic operations. This chapter explains each of these steps in detail.

2.1 Prerequisites

There are two types of dependencies for Scute: compile-time dependencies and run-time dependencies. The compile-time dependencies only need to be fulfilled when Scute is compiled and installed. The run-time dependencies need to be fulfilled when Scute is used in an application.

Scute depends, in addition to the essential build utilities, on the following packages at build time:

`libgpg-error`
: Scute uses the GnuPG 2 framework for error handling, so it depends on the GPG error library. The minimum version required is 1.38.

`libassuan`
: Scute uses the GnuPG framework for communication with the GPG Agent, so it also depends on the Assuan library. The minimum version required is 2.5.0.

At run-time, in addition to the run-time versions of the above libraries, you also need the following packages installed and configured:

GnuPG
: Scute uses the GnuPG 2 framework to access the OpenPGP card and for certificate management. The minimum version required is 2.2.0. For full functionality, in particular for use with the OpenVPN software, GnuPG version 2.3 is required.

Pinentry
: Pinentry is a dependency of GnuPG 2, so it also needs to be installed with it.

Firefox et al.
: Firefox is the first application supported by Scute. In the future, other applications may be supported. The applications are not dependencies of Scute, but Scute can not be used stand-alone, so you can not experience it without an application.

2.2 Building the Source

Scute does comply to the GNU coding standards and thus can be compiled and installed according to the generic installation instructions found in the source package in the file `INSTALL`. There are no Scute specific options to the configure script.

After installation, the `scute.so` module file can be found in the library directory of the installation path.

2.3 Certificate Preparation

To use an OpenPGP card with Scute, it first has to be initialized by generating or loading a key on the card, see the OpenPGP Card How-To. Then a certificate has to be created and imported into GPGSM. This task involves three steps: First, a certificate signing request (CSR) has to be created that matches the key on the card. This certificate signing request then has to be submitted to a certificate authority (CA), which will create the certificate and send it back to you. At last, the certificate has to be imported into GPGSM. This section will explain all of these steps in detail.

2.3.1 Creating a CSR

Before you start, make sure that the GPG Agent is running, see Section 2.1 [Prerequisites], page 3 and that your card is in the reader. There is no need to configure GPGSM, so you can create a CSR with the command:

```
$ gpgsm --gen-key > floppy-head.csr
Please select what kind of key you want:
   (1) RSA
   (2) Existing key
   (3) Existing key from card
Your selection? 3
```

As we create a certificate for the OpenPGP Card, the option "`[3] Direct from card`" should be selected.

```
Serial number of the card: 355F9746499F0D4B4ECEE4928B007D16
Available keys:
   (1) D53137B94C38D9BF6A199706EA6D5253 OPENPGP.1
   (2) B0CD1A9DFC3539A1D6A8B851A11C8665 OPENPGP.2
   (3) 53DB41052CC590A40B403F3E6350E5DC OPENPGP.3
Your selection? 3
Possible actions for a RSA key:
   (1) sign, encrypt
   (2) sign
   (3) encrypt
Your selection? 2
```

The only operation currently supported is client authentication. For this, the authentication key has to be selected. This is the third key on the card, so the options "`[3] OPENPGP.3`" and "`[2] sign`" should be chosen. Note that the key usage is only advisory, and the CA may assign different capabilities.

```
Enter the X.509 subject name: CN=Floppy Head,OU="Webserver Team",O="Snake Oil, Ltd",L=
Enter email addresses (end with an empty line):
> floppy.head@example.org
>
Enter DNS names (optional; end with an empty line):
>
Enter URIs (optional; end with an empty line):
>
Create self-signed certificate? (y/N) n
```

As a last step, the common name and e-mail address of the key owner need to be specified by you. The above are only an example for a fictious person working at a fictious company. DNS names are only meaningful for server certificates and thus should be left empty.

We have now entered all required information and gpgsm will display what it has gathered and ask whether to create the certificate request:

```
These parameters are used:
    Key-Type: card:OPENPGP.3
    Key-Length: 1024
    Key-Usage: sign
    Name-DN: CN=Floppy Head,OU="Webserver Team",O="Snake Oil, Ltd",L="Snake Town",ST="
    Name-Email: floppy.head@example.org

Proceed with creation? (y/N) y
Now creating certificate request.  This may take a while ...
gpgsm: about to sign the CSR for key: &53DB41052CC590A40B403F3E6350E5DC
```

GPGSM will now start working on creating the request. During this time you will be asked once for a passphrase to unprotect the authentication key on the card. A pop up window will appear to ask for it.

When it is ready, you should see the final notice:

```
gpgsm: certificate request created
Ready.  You should now send this request to your CA.
```

Now, you may look at the created request:

```
$ cat floppy-head.csr
-----BEGIN CERTIFICATE REQUEST-----
MIICCDCCAXECAQAwgYExCzAJBgNVBAYTAlhZMRUwEwYDVQQIEwxTbmFrZSBEZXNl
cnQxEzARBgNVBAcTClNuYWtlIFRvd24xFzAVBgNVBAoTDlNuYWtlIE9pbCwgTHRk
MRcwFQYDVQQLEw5XZWJzZXJ2ZXIgVGVhbTEUMBIGA1UEAxMLRmxvcHB5IEhlYWQw
gaAwDQYJKoZIhvcNAQEBBQADgY4AMIGKAoGBANWaM9YS89AOx3GX1Rua+4DUHwbL
wt0rBYdBddlabMMteVjUcOOhbFMirLpLAi1S8fUXNiy84ysOmFStmvSIXDsAgXq5
1ESOU4SNg2zEkPDF1WYJ5BFIXdYq9i2k5W7+ctV8PkKv3e5IeYXTa5qppIPD31de
gM8Qj7tKOhL/eNCfAgQAAQABoEUwQwYJKoZIhvcNAQkOMTYwNDAiBgNVHREEGzAZ
gRdmbG9wcHkuaGVhZEBleGFtcGxlLmNvbTAOBgNVHQ8BAf8EBAMCBsAwDQYJKoZI
hvcNAQEFBQADgYEAFC9q6+ib9YGCLB/2AlZR+/dvb+pEeXR1EbpV/dw/gjP1yPY6
29n8ZIDLUvQvNCtfCcXFxFimVSSB/KmFXXsJbM+NXQyT6Ocn34iHmkf9IVRMWQWg
ZBYfQVeXAd7XlxI6d1wXDLwD/26lTU/rH2JU6H1+zSfZxqwVC4Iu+kiN4Y8=
-----END CERTIFICATE REQUEST-----
$
```

2.3.2 Signing the CSR

The next step is to submit this certificate request to the CA, which can then create a certificate and send it back to you.

If, for example, you use the CA CAcert, then you can log into your account at the CAcert website, choose "Client Certificates -> New", check "Show advanced options", paste the above request block into the text field and click on "Submit". If everything works correctly, a certificate will be shown, which you can cut and paste into a new file `floppy-head.crt`.

Alternatively if, for example, you set up your own CA with OpenSSL, then you can create your own certificate by issueing a command similar `openssl ca -in floppy-head.csr -cert snakeoil-ca-rsa.crt -keyfile snakeoil-ca-rsa.key -out floppy-head.crt`. Please see the OpenSSL documentation for more details on how to set up and administrate a certificate authority infrastructure.

2.3.3 Importing the Certificate into GPGSM

Once the CSR has been signed, you should end up with a certificate file `floppy-head.crt`, which you then have to import into GPGSM. It is also recommended that you import the root certificate of the CA first in the same fashion.

```
$ gpgsm --import floppy-head.crt
gpgsm: certificate imported

gpgsm: total number processed: 1
gpgsm:               imported: 1
```

gpgsm tells you that it has imported the certificate. It is now associated with the key you used when creating the request. To see the content of your certificate, you may now enter:

```
$ gpgsm -K Floppy
/home/foo/.gnupg/pubring.kbx
---------------------------
Serial number: 10
       Issuer: /CN=Snake Oil CA/OU=Certificate Authority/O=Snake Oil, Ltd/L=Snake Town
      Subject: /CN=Floppy Head/OU=Webserver Team/O=Snake Oil, Ltd/ST=Snake Desert/C=XY
     validity: 2006-11-11 14:09:12 through 2007-11-11 14:09:12
     key type: 1024 bit RSA
  fingerprint: EC:93:A2:55:C6:58:7F:C9:9E:96:DB:12:6E:64:99:54:BB:E1:94:68
```

The option "`-K`" is used above because this will only list certificates for which a private key is available. To see more details, you may use "`--dump-secret-keys`" instead of "`-K`".

2.3.4 Loading the Certificate onto the Card

This step is optional. You may choose to store the certificate directly into your OpenPGP card. The benefit of doing so is that Scute will then be able to fetch the certificate from the card without having to look into the GPGSM store.

You need your certificate in the DER format. Export it from the GPGSM store with the following command:

```
$ gpgsm -o floppy-head.crt --export Floppy
```

Then, fire up the GnuPG card editor to transfer the certificate to the card (note that the `writecert` command is not listed in the editor's online help):

```
$ gpg2 --card-edit

Application ID ...: D2760001230102000000500001234000
[...]

gpg/card> admin
```

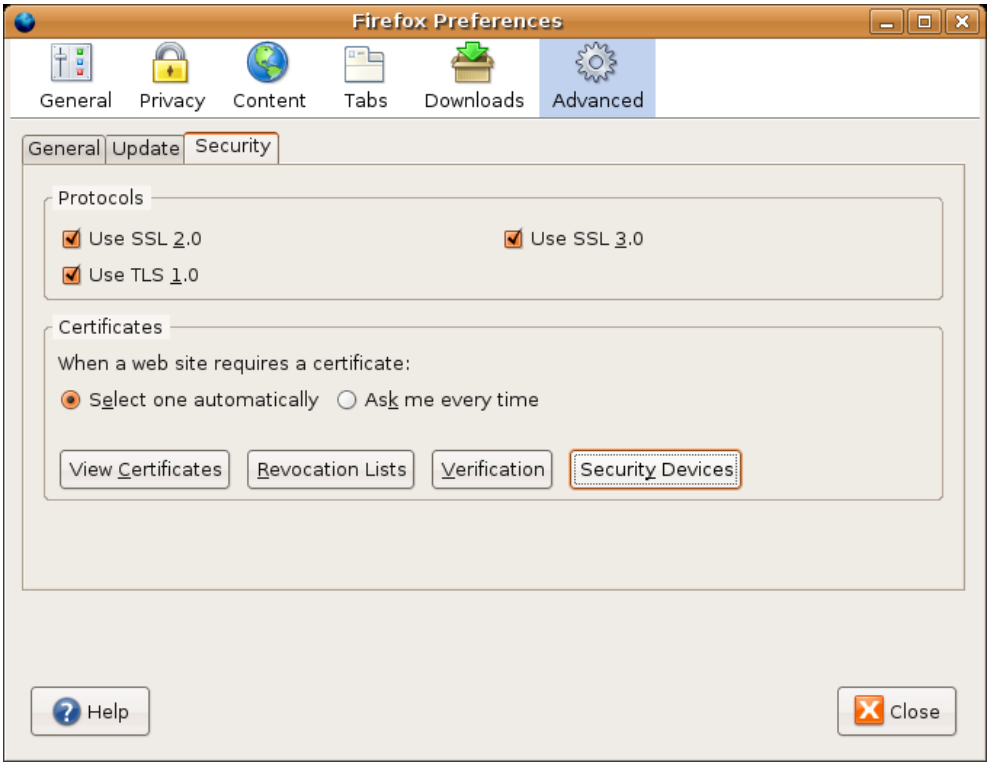
```
Admin commands are allowed

gpg/card> writecert 3 < floppy-head.crt

gpg/card> quit
```

3 Client Authentication

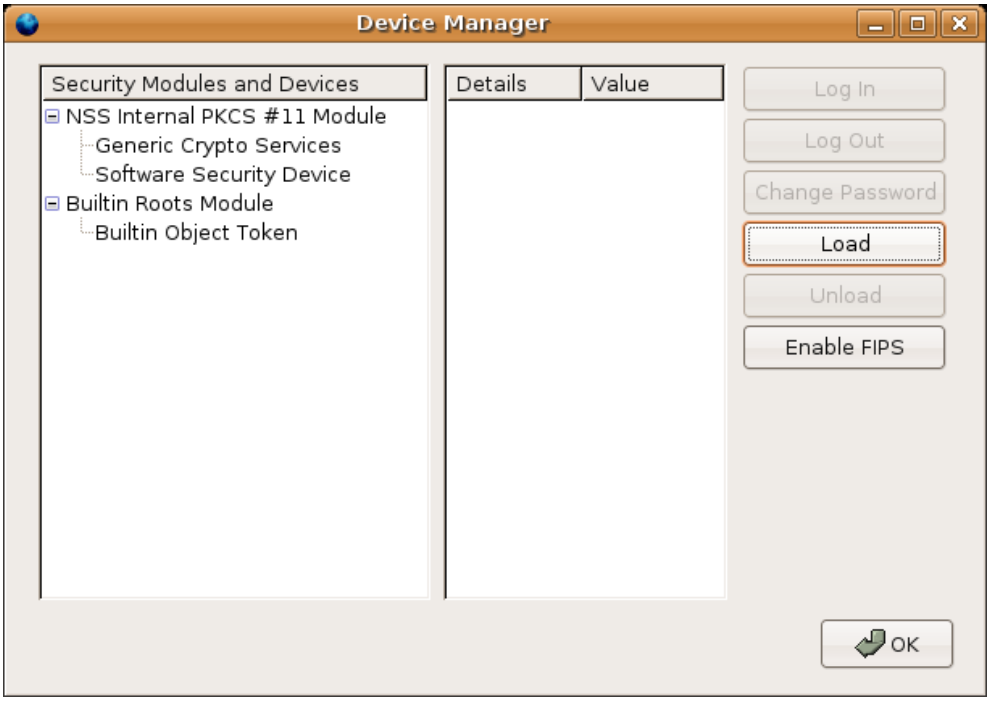
Scute allows you to authenticate yourself to a website securely without entering a username or password by simply using your OpenPGP card. Currently, only Mozilla-based browsers like Firefox are supported, although other applications using Mozilla NSS or supporting PKCS #11 modules may work.

3.1 Application Configuration

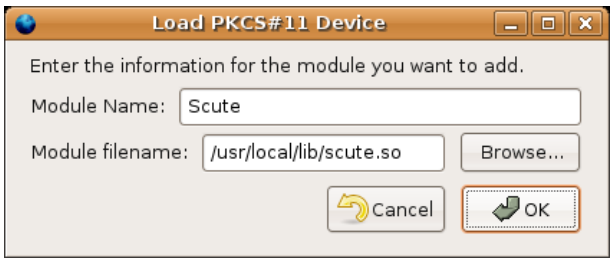
To prepare your application for use with Scute, you have to load the Scute module as a PKCS #11 module into the application. With Firefox, this can be done by choosing `Edit->Preferences` in the menu. In the preferences configuration dialog, you should select the `Advanced` configuration section, then the `Security` tab, and then select `Security Devices` in the category `Certificates`.



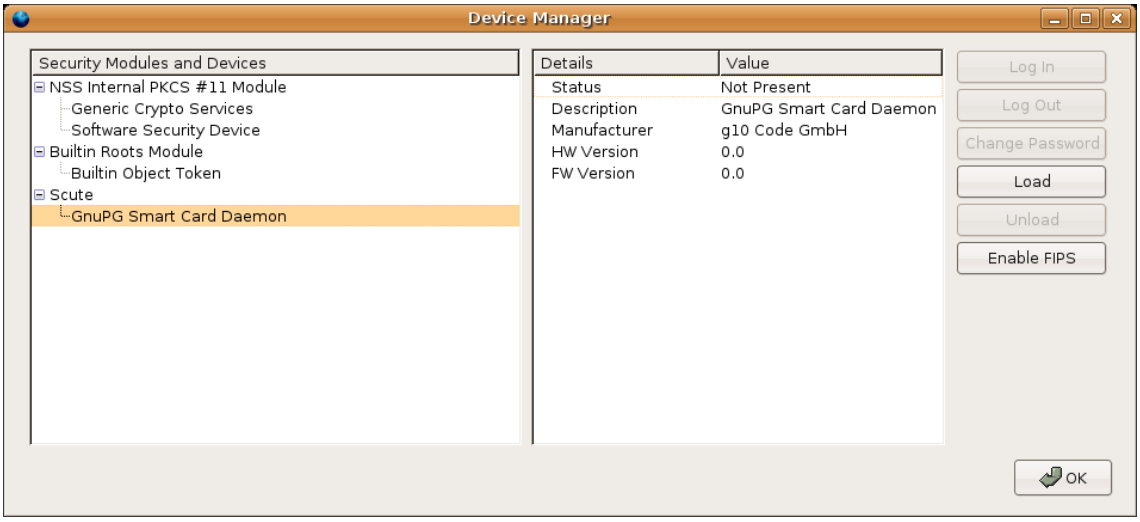
In the devices manager dialog, you can select `Load` to load a new PKCS #11 device.



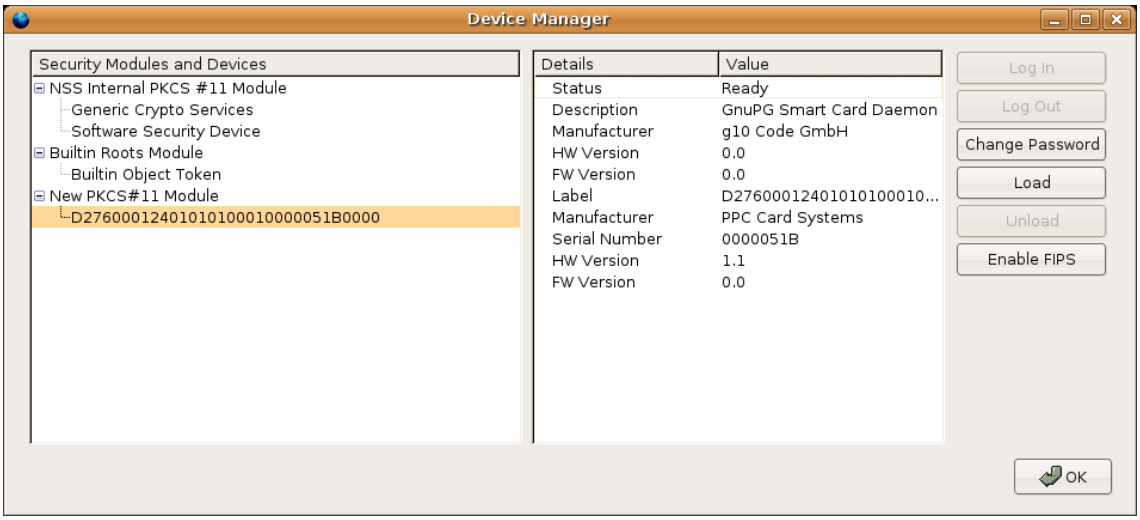
In the pop-up dialog that follows, you can give a module name (e.g. "`Scute`") and a module filename. The latter should correspond to the full file name of the installed Scute module file `scute.so`. The default installation path is `/usr/local/lib`, which would mean that you have to provide the file name `/usr/local/lib/scute.so`. If you or your system administrator installed Scute in a different location, you have to adjust the file name correspondingly.



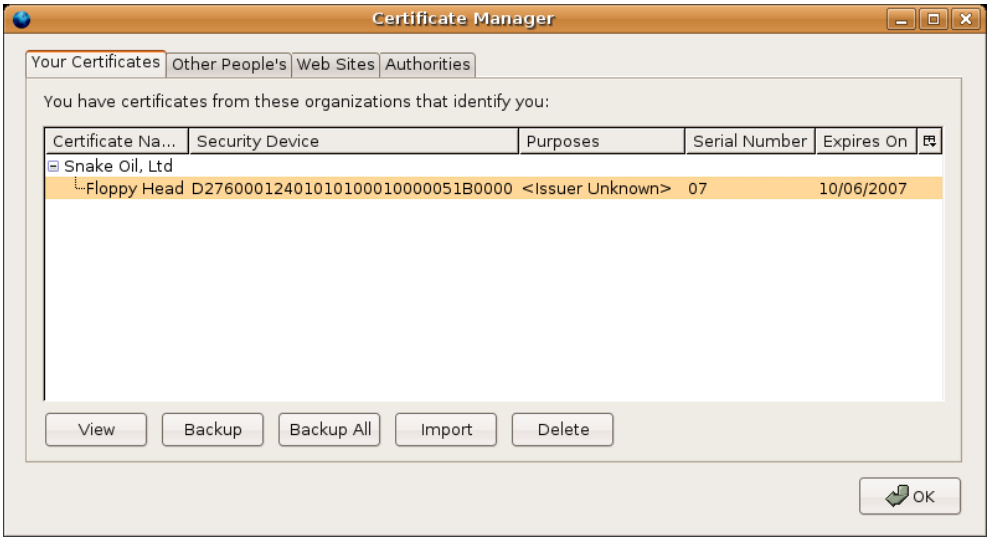
After confirming installation of the security device, a pop-up window should confirm that the module was successfully loaded, and an entry for the security device should appear in the device manager list of `Security Modules and Devices`.



When you insert the OpenPGP card for which you generated and imported a certificate earlier (see Section 2.3 [Certificate Preparation], page 4), the device manager should detect this security token and display some information about it in the `Details` list when you select it from the module list.



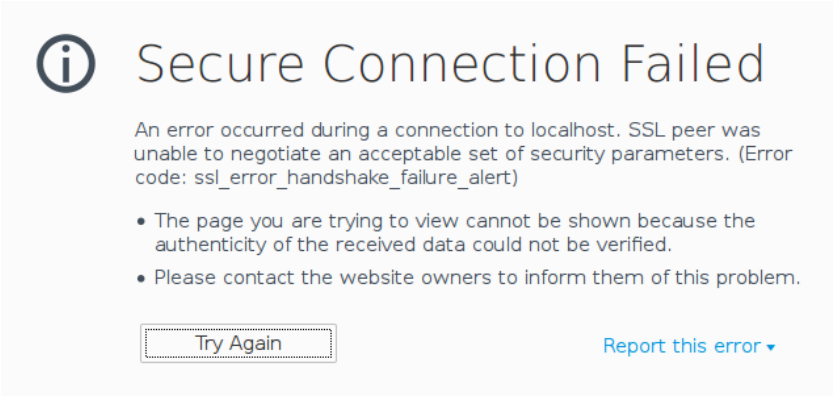
The client certificate will show up in the `Certificate Manager` under `Your Certificates`:



3.2 Authentication With Service

Before you access a web service which requires client authentication, for instance a fictious web service `https://example.com`, the OpenPGP card should be present. In this case, a pop-up window will appear that requests you to enter the PIN number protecting the authentication key on the OpenPGP card. After entering the PIN number, your browser will be authenticated to the server. If the server accepts your request and certificate, this is all which is required. You should leave the card in the reader as long as the connection persists. Depending on how aggressively GPG Agent caches your PIN number, you may have to enter the PIN number again later to keep up the connection to the server.

If the card is not present, or you enter the wrong PIN, or the server does not admit your certificate, you will get an error message. This error message is generated by the application and Scute can not influence it. Unfortunately, in Firefox (at least up to version 38.5.0), this error message is not very user friendly. For example, entering a bad PIN results in the following generic error message, and the `Try Again` button does not work as expected:

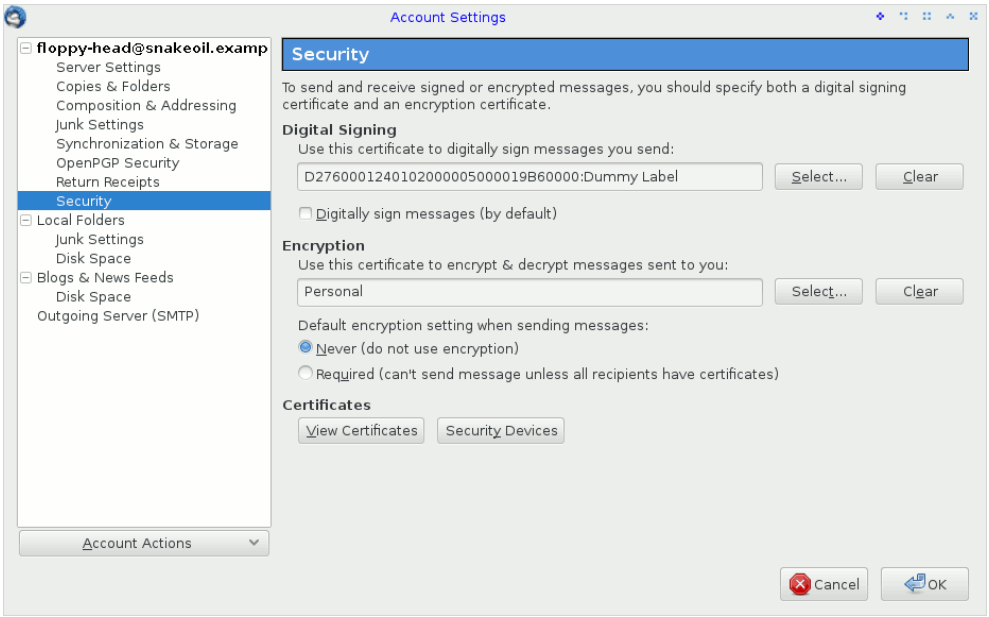


4 Email Signing

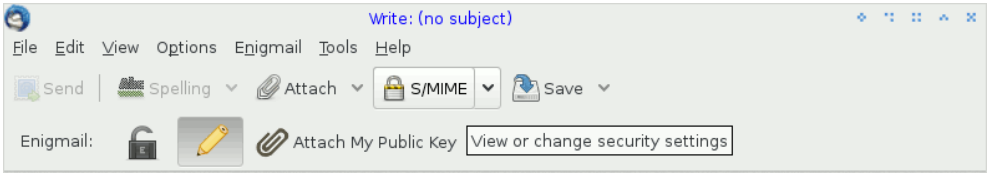
Scute also allows you to use your card-based X.509 certificate to sign your emails with the S/MIME signature format. This has been tested with Mozilla Thunderbird only, but should work with any mail client with support for PKCS #11 (notably GNOME Evolution).

You must first load the Scute module into your mail client. With Mozilla Thunderbird, the procedure is the same as the one described above for Mozilla Firefox.

Then, open your account configuration dialog (`Edit->Account Settings`), and in the `Security` tab, under the section `Digital Signing`, use the `Select...` button to associate your card-based certificate with your account.



When writing a new message, you may then use the `S/MIME` button and select `Digitally sign this message` in the popup menu. You will be prompted for your User PIN before the message is sent.



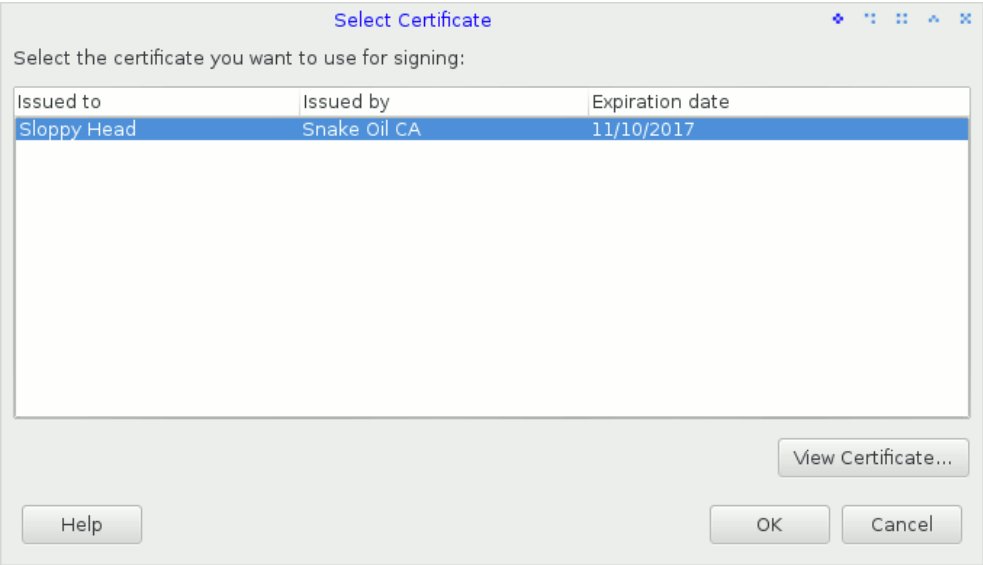
5 Document Signing

Scute can also be used with LibreOffice to sign OpenDocument files.

First, you must load the Scute module into Mozilla Firefox according to the above procedure. Then, configure LibreOffice to use Firefox's certificate store by defining the `MOZILLA_CERTIFICATE_FOLDER` environment variable to your Firefox profile directory.

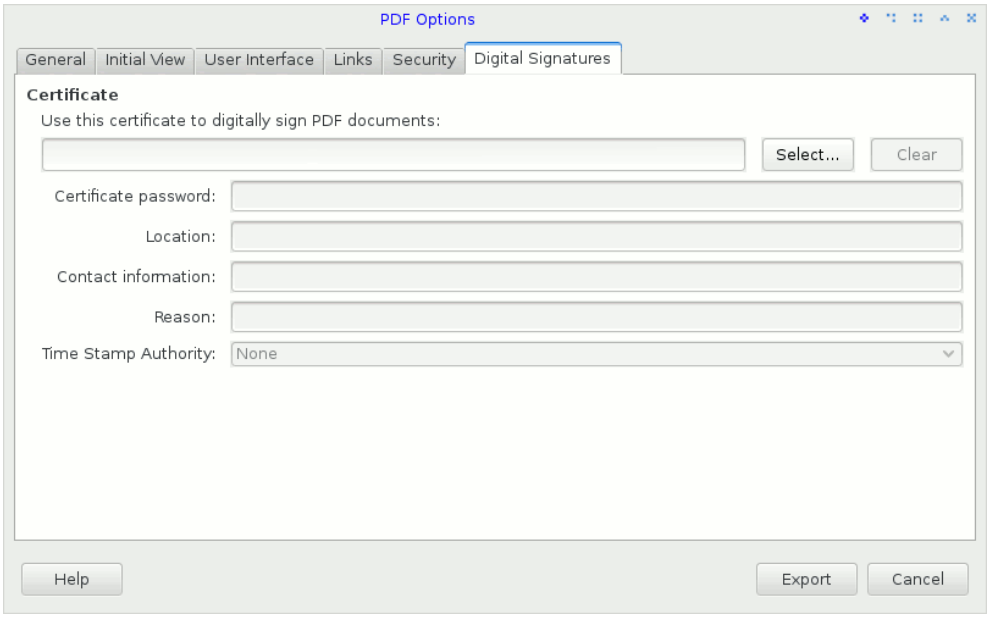
Then, to sign the document you are editing, select the `File->Digital Signatures...` menu option to open the `Digital Signatures` dialog.

Click the `Sign Document` button to open the certificate selection dialog. Select your card-based certificate, then validate. Enter your User PIN when prompted by GPG Agent.



You may also sign a PDF export of your document. Select the `File->Export as PDF...` menu option to open the `PDF Options` dialog. In the `Digital Signatures` tab, use the

`Select` button to open the certificate selection dialog as above. You will be prompted for your User PIN when you will click the `Export` button.



6 Troubleshooting

Symptom: Loading the Scute security device in the security device manager of Firefox fails with "Unable to load module".

Solution: Make sure that Scute is correctly installed, and that all libraries and executables are available. If you are using GnuPG 2.0 (instead of 2.1), you may need to make sure that the GPG Agent is running and can be found via the environment variable `GPG_AGENT_INFO`. See Section "Invoking GPG-AGENT" in *Using the GNU Privacy Guard*, for details on how to run the GPG Agent.

Symptom: Client authentication fails with "<example.com> has received an incorrect or unexpected message. Error code: -12227".

Solution: Make sure that the correct OpenPGP card is inserted and the certificate available in GPGSM. Check that the OpenPGP card is detected correctly in the security device manager and the corresponding certificate is displayed in the certificate manager of Firefox. See Section 3.2 [Authentication With Service], page 12.

Symptom: The OpenPGP card is detected and displayed in the security device manager in Firefox, but no corresponding certificate is displayed in the certificate manager of Firefox.

Solution: Make sure that the corresponding certificate is imported in GPGSM.

7 Internals

The following notes are intended for people interested in more technical details about Scute and its implementation. They give an overview about its scope and potential compatibility issues with applications.

7.1 Features and Limitations

Scute implements version 2.20 of the PKCS #11 specification.

The OpenPGP smart card application is supported in read-only mode.

The following functions are not supported:

`C_Initialize`
: No support for native thread package. Locking callbacks must be provided if multi-threaded operation is desired.

`C_WaitForSlotEvent`
: Not implemented. The interface as specified by PKCS #11 is broken anyway, as the function can not safely be canceled. Thus, we require polling.

`C_GetOperationState`
`C_SetOperationState`
: Not supported.

`C_InitToken`
`C_InitPIN`
`C_SetPIN` Not supported. No write operations are allowed. To configure the token, please use the tools accompanying the GnuPG software suite.

`C_Login`
`C_Logout` Not supported. No login into the token by the software is required. Passphrase queries are implemented by the use of GPG Agent and Pinentry.

`C_EncryptInit`
`C_Encrypt`
`C_EncryptUpdate`
`C_EncryptFinal`
`C_DigestInit`
`C_Digest`
`C_DigestUpdate`
`C_DigestKey`
`C_DigestFinal`
`C_VerifyInit`
`C_Verify`
`C_VerifyUpdate`
`C_VerifyFinal`
`C_VerifyRecoverInit`
`C_VerifyRec`
: Not supported. Only secret key operations are supported.

`C_DecryptInit`
`C_Decrypt`
: Not yet supported, but will be in the future.

`C_SignUpdate`
`C_SignFinal`
`C_DecryptUpdate`
`C_DecryptFinal`
: No progressive crypto-operations are supported.

`C_SignRecoverInit`
`C_SignRecover`
: Not supported.

`C_DigestEncryptUpdate`
`C_DecryptDigestUpdate`
`C_SignEncryptUpdate`
`C_DecryptVerifyUpdate`
: Dual-purpose cryptographic functions are not supported.

`C_GenerateKey`
`C_GenerateKeyPair`
`C_WrapKey`
`C_UnwrapKey`
`C_DeriveKey`
: Key management functions are not supported. Please use the tools accompanying the GnuPG software suite to generate and import keys for use with the token.

`C_SeedRandom`
: Not supported.

`C_CreateObject`
`C_CopyObject`
`C_DestroyObject`
`C_SetAttributeValue:`
: Only read-only operations are supported on objects.

`C_GetObjectSize`
: Not supported.

`CKO_CERTIFICATE`
: The label specifies the key on the card used (e.g. `OPENPGP.3`). The ID is the fingerprint.

`CKO_PRIVATE_KEY:`
: The `CKA_LOCAL` attribute can not be supported by the OpenPGP card. It is always set to false (as the key on the card may be copied to the card from an external source).

7.2 Developing Scute

Scute is single-threaded. There is a global lock that is taken in all entry points of Scute, except for `C_Initialize`, `C_Finalize`, `C_GetFunctionList`, and stubs.

Here are a couple of hints on how to develop PKCS #11 modules for Mozilla:

`libopensc2` ships with a `pkcs11-spy` library that can be loaded as a wrapper around the PKCS #11 library you want to use to log all functions invoked by Mozilla. Here is how to use it:

Set the `PKCS11SPY_OUTPUT` environment variable to a filename. `pkcs11-spy` appends its log messages at the end of this file. Set the `PKCS11SPY` environment variable to the filename of the PKCS #11 module you actually want to use. Start Mozilla within this environment.

There is a different, probably more powerful way to debug Mozilla PKCS #11 libraries. However, to be able to use it, you need to configure and compile the Mozilla NSS sources with `--enable-debug`. Instructions can be found at: https://developer.mozilla.org/en-US/docs/Mozilla/Projects/NSS/nss_tech_notes

Here are a couple of links to more information about implementing a PKCS #11 module for Mozilla:

https://developer.mozilla.org/en-US/docs/Mozilla/Projects/NSS/PKCS11_Implement
: Guidelines for implementors of PKCS #11 modules targeting Mozilla

http://www-archive.mozilla.org/projects/security/pki/pkcs11/
: PKCS #11 Conformance Testing

https://developer.mozilla.org/en-US/docs/Mozilla/Projects/NSS
: The Mozilla NSS web page

7.3 Mozilla Compatibility

Mozilla has a bug that causes the wrong security device to be unloaded when unloading a security device. Also, the displayed list becomes corrupt. When closing and reopening the security device manager, the list displayed is correct, but in anyway the wrong security module is unloaded.

Library Copying

Version 2.1, February 1999

[This is the first released version of the Lesser GPL. It also counts as the successor of the GNU Library Public License, version 2, hence the version number 2.1.]

Preamble

The licenses for most software are designed to take away your freedom to share and change it. By contrast, the GNU General Public Licenses are intended to guarantee your freedom to share and change free software—to make sure the software is free for all its users.

This license, the Lesser General Public License, applies to some specially designated software—typically libraries—of the Free Software Foundation and other authors who decide to use it. You can use it too, but we suggest you first think carefully about whether this license or the ordinary General Public License is the better strategy to use in any particular case, based on the explanations below.

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