YubiKey Enrollment Station

For Yubikey smart card management in Windows Active Directory environment.

Created by Ian Qvist and Michael Bisbjerg
Modified by Jürgen Fechter

Re-modified by Dennis Rahmen and Jonas Gisbertz

Table of Contents

Introduction

This manual describes the CSIS Enrollment Station (ES). It was original located at https://github.com/CSIS/EnrollmentStation and is archived. The Enrollment Station was created to facilitate enrollment of Yubico Smartcards, using the Yubikey NEO, Yubikey 4, Yubikey 5 with CCID functionality in a Windows Active Directory environment with an associated Windows Certificate Authority. The keys are using the standard PIV format for the certificates.

The current version of the Enrollment Station is coded in C#.Net Windows Forms and is a GUI application.

It uses the MetroFramework for a modern design.

Note

The CSIS Enrollment Station is not working with container based the Yubico Windows smartcard minidriver!

Requirements

There are a number of requirements for this system to work.

- A Microsoft Windows Active Directory domain
- A computer running the ES software joined to the domain.
- A Windows Certificate Authority (CA) published in the domain.

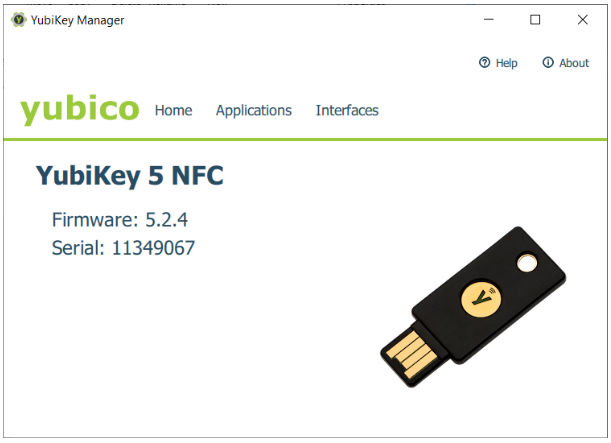
- The user running the ES must have an Enrollment Agent certificate in their personal certificate store.
- The user running the ES must have permissions to manage certificates on the CA server.
- We used .NET Framework 4.6.1 which will run on Windows 10/Windows Server 2016, too.
- We embedded the following libraries/programs into the application.
    - yubikey-manager-qt-1.1.3-win32
    - yubico-piv-tool-1.7.0-win32
      Because ykpiv_get_serial() was added to API.

Preparing a Yubikey for enrollment

Directly from the factory, Yubikey keys are not set up to with the CCID mode, which activates the smartcard applet. You have serveral applications available directly from Yubico to activate the CCID mode, which both are described below.

Using Yubikey Manager (recommended)

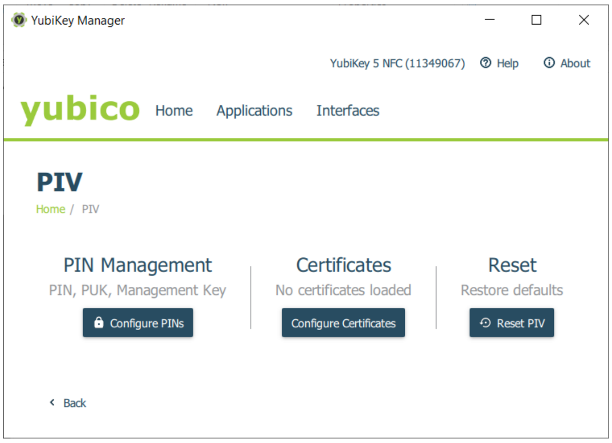
There are two version of this application: One with GUI and other other with commandline (CLI).



YubiKey 5 NFC

Firmware: 5.2.4
Serial: 11349067

Working with newer Yubikey 5



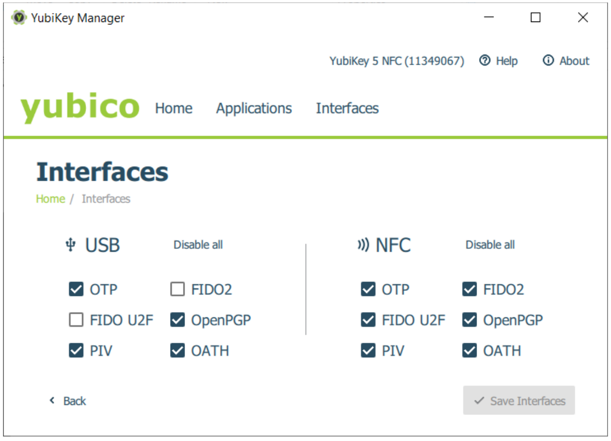
PIV

PIN Management: PIN, PUK, Management Key

Certificates: No certificates loaded

Reset: Restore defaults

Main Konfiguration

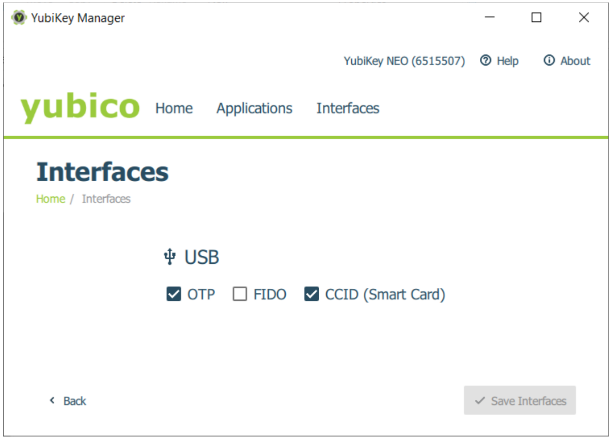


Interfaces

USB: ☑ OTP ☐ FIDO2 ☐ FIDO U2F ☑ OpenPGP ☑ PIV ☑ OATH

NFC: ☑ OTP ☑ FIDO2 ☑ FIDO U2F ☑ OpenPGP ☑ PIV ☑ OATH

CCID is not shown but instead PIV



Interfaces

USB: ☑ OTP ☐ FIDO ☑ CCID (Smart Card)

Support of CCID with older smartcards

Commandline

The name of the tool is ykman.

Parameter info

```
C:\Program Files (x86)\Yubico\YubiKey Manager>ykman info
Device type: YubiKey 5 NFC
Serial number: 11349067
Firmware version: 5.2.4
Form factor: Keychain (USB-A)
Enabled USB interfaces: OTP+CCID
NFC interface is enabled.

Applications    USB             NFC
OTP             Enabled         Enabled
FIDO U2F        Disabled        Enabled
OpenPGP         Enabled         Enabled
PIV             Enabled         Enabled
OATH            Enabled         Enabled
```

```
FIDO2           Disabled        Enabled
```

Parameter mode to get and set the mode

```
C:\Program Files (x86)\Yubico\YubiKey Manager>ykman mode
Current connection mode is: OTP+FIDO+CCID
Supported USB interfaces are: OTP, FIDO, CCID

C:\Program Files (x86)\Yubico\YubiKey Manager>ykman mode OTP+CCID -f

C:\Program Files (x86)\Yubico\YubiKey Manager>ykman mode OTP+CCID
Mode is already OTP+CCID, nothing to do...

C:\Program Files (x86)\Yubico\YubiKey Manager>ykman mode CCID
Set mode of YubiKey to CCID? [y/N]: y

C:\Program Files (x86)\Yubico\YubiKey Manager>ykman mode
Current connection mode is: CCID
Supported USB interfaces are: OTP, FIDO, CCID
```

Parameter mode list

```
C:\Program Files (x86)\Yubico\YubiKey Manager>ykman list -s
11349067

C:\Program Files (x86)\Yubico\YubiKey Manager>ykman list
YubiKey NEO [OTP+CCID] Serial: 6515507
YubiKey 5 NFC [OTP+CCID] Serial: 11349067
```

Parameter piv to manage the smartcard CCID /PIV

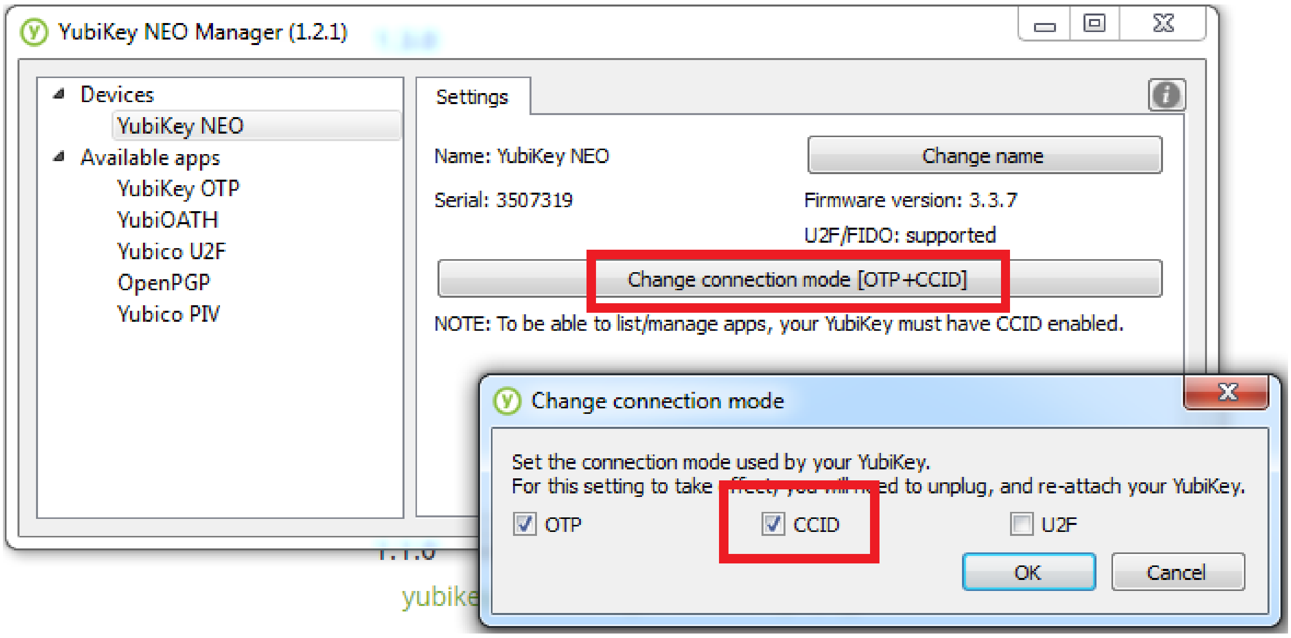
```
C:\Program Files (x86)\Yubico\YubiKey Manager>ykman piv -?
Usage: ykman piv [OPTIONS] COMMAND [ARGS]...
Try "ykman piv -h" for help.

Error: no such option: -?

C:\Program Files (x86)\Yubico\YubiKey Manager>ykman piv -h
Usage: ykman piv [OPTIONS] COMMAND [ARGS]...

  Manage PIV Application.

  Examples:

    Generate an ECC P-256 private key and a self-signed certificate in
    slot 9a:
    $ ykman piv generate-key --algorithm ECCP256 9a pubkey.pem
    $ ykman piv generate-certificate --subject "yubico" 9a pubkey.pem

    Change the PIN from 123456 to 654321:
    $ ykman piv change-pin --pin 123456 --new-pin 654321

    Reset all PIV data and restore default settings:
    $ ykman piv reset

Options:
  -h, --help  Show this message and exit.

Commands:
  attest                 Generate a attestation certificate for a key.
  change-management-key  Change the management key.
  change-pin             Change the PIN code.
  change-puk             Change the PUK code.
  delete-certificate     Delete a certificate.
  export-certificate     Export a X.509 certificate.
  generate-certificate   Generate a self-signed X.509 certificate.
  generate-csr           Generate a Certificate Signing Request (CSR).
  generate-key           Generate an asymmetric key pair.
  import-certificate     Import a X.509 certificate.
  import-key             Import a private key.
  info                   Display status of PIV application.
  read-object            Read arbitrary PIV object.
  reset                  Reset all PIV data.
  set-ccc                Generate and set a CCC on the YubiKey.
  set-chuid              Generate and set a CHUID on the YubiKey.
  set-pin-retries          Set the number of PIN and PUK retries.
  unblock-pin              Unblock the PIN.
  write-object             Write an arbitrary PIV object.
```

Example to show the PIV contents with multiple devices using the device serial number

```
C:\Program Files (x86)\Yubico\YubiKey Manager>ykman --device=6515507 piv info
PIV version: 1.0.5
PIN tries remaining: 3
Management key is stored on the YubiKey, protected by PIN.
CHUID:
3019d4e739da739ced39ce739d836858210842108421c84210c3eb341005d0cf0e1f51069c189478e5f8cdf7de35083230
3330303130313e00fe00
CCC:
f015a000000116ff020bcddff690cca8620e18892bd33af10121f20121f300f40100f50110f600f700fa00fb00fc00fd00
fe00
Slot 9a:
        Algorithm:      RSA2048
        Subject DN:     DC=zz,DC=corpdir,OU=dev,OU=Users,CN=View User
        Issuer DN:      DC=zz,DC=corpdir,OU=dev,CN=Root-CA-dev
        Serial:         25868864433968267339247894460498288892056699958
        Fingerprint:    4a4f341ecc627f54d0e59c9d04d9156e31e29959479a9fe164b32b1403c7d2eb
        Not before:     2019-08-02 10:18:57
        Not after:      2022-08-01 10:18:57
```

Using NEO Manager (obsolete)

This GUI will allow you to control various aspects of the NEO device. When the GUI is open and the Yubikey has been detected, click the “Change connection mode” and check the “CCID” option. Finally click “Ok” and unplug and plug the device again. It will now be ready for use with the ES application.



Name: YubiKey NEO

Serial: 3507319

Firmware version: 3.3.7

U2F/FIDO: supported

NOTE: To be able to list/manage apps, your YubiKey must have CCID enabled.

Change connection mode

Set the connection mode used by your YubiKey.
For this setting to take effect, you will need to unplug, and re-attach your YubiKey.

☑ OTP ☑ CCID ☐ U2F

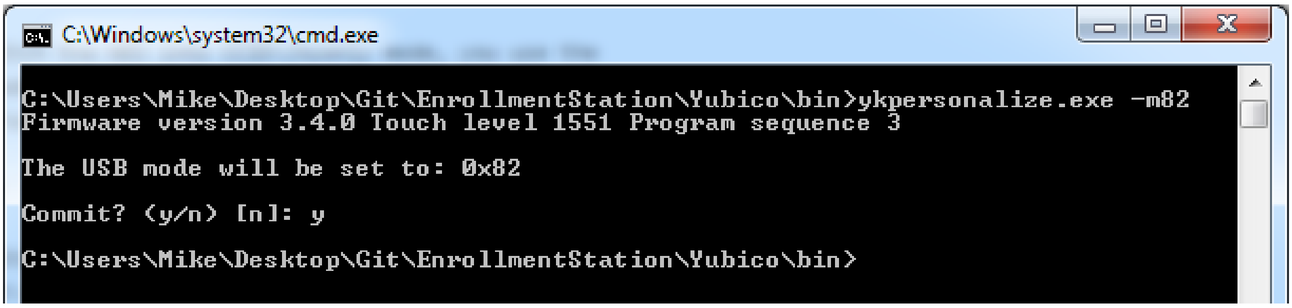
Home page: https://developers.yubico.com/yubikey-neo-manager/
Download page: https://developers.yubico.com/yubikey-neo-manager/Releases/

Using Yubikey Personalize

This command line utility will set the mode for you using a simple argument. When downloaded, open a new command prompt and navigate to the directory. Run the following command:

```
ykpersonalize.exe –m82
```

The “-m” parameter sets the mode of the device, where 82 is an option found in the documentation. 82 enable OTP and CCID and allows for button presses to eject/insert the Smartcard. After running the command, unplug and plug the Yubikey to enable the new mode.

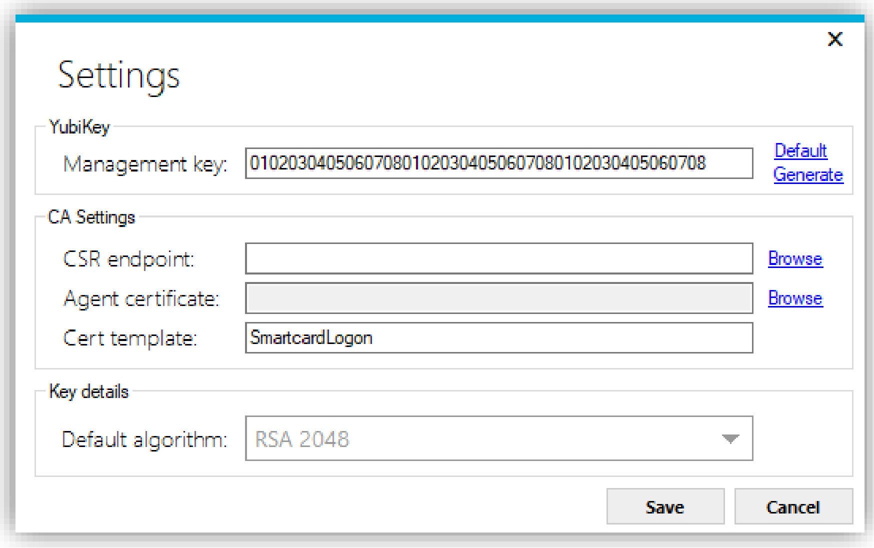


```
C:\Users\Mike\Desktop\Git\EnrollmentStation\Yubico\bin>ykpersonalize.exe -m82
Firmware version 3.4.0 Touch level 1551 Program sequence 3

The USB mode will be set to: 0x82

Commit? (y/n) [n]: y

C:\Users\Mike\Desktop\Git\EnrollmentStation\Yubico\bin>
```

Home page: https://developers.yubico.com/yubikey-personalization/
Download page: https://developers.yubico.com/yubikey-personalization/Releases/
Documentation: https://yubico.github.io/yubikey-personalization/ykpersonalize.1.html

Using the Enrollment Station application

On the first run of the application, you will be asked to fill out settings for the application. Here you can create a management key used to configure Yubikeys. You can click *Generate* to have the application securely generate a new key for you. If a YubiHSM is attached to the machine, the secure random number generator on the device will automatically be used for added security.



Settings

YubiKey

Management key: 010203040506070801020304050607080102030405060708

CA Settings

CSR endpoint:

Agent certificate:

Cert template: SmartcardLogon

Key details

Default algorithm: RSA 2048

Set the Certificate Signing Request (CSR) endpoint to the Active Directory published Certificate Authority server. You can also click the *Browse* button to pick among a list of published CA in your domain.

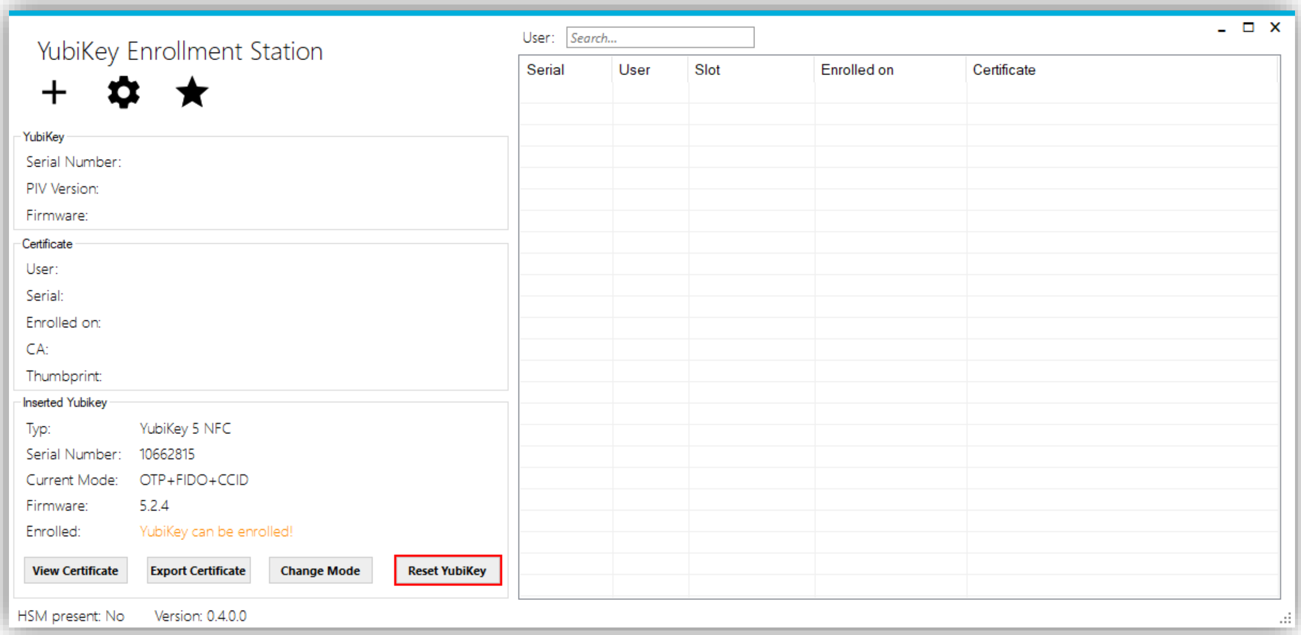
To be able to send signing requests on behalf of another user, you will have to have an enrollment agent certificate. See the guide here for more information on how to enroll an agent certificate. Once it is installed in your personal certificate store, you can select it using the *Browse* button next to the field.

The cert template field defines what kind of template to use in the CA. Smartcard Logon and Smartcard User templates are the most commonly used.

Fill out all the field and click *Save* to save the settings. The settings will be stored in the *settings.json* file.

Main interface

Once you have filled out the settings, you will be presented with the main interface. To the right there is a list of enrolled users, and once a user is selected, detailed information is presented to the left.



YubiKey
Serial Number:
PIV Version:
Firmware:

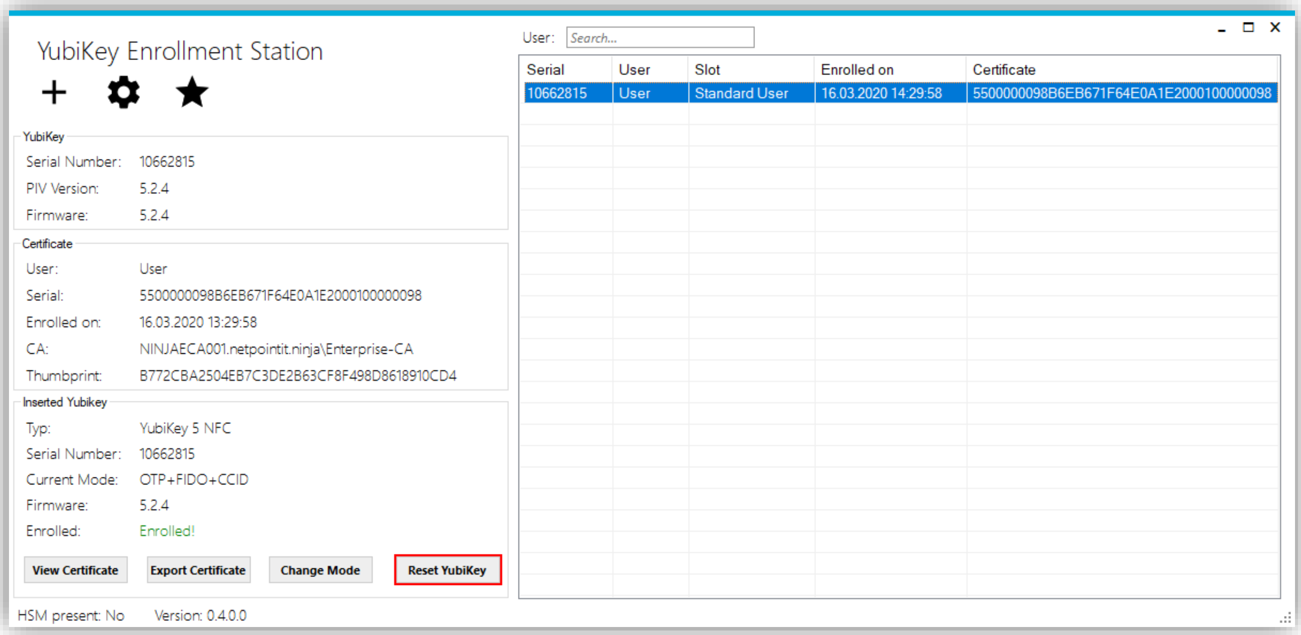
Certificate
User:
Serial:
Enrolled on:
CA:
Thumbprint:

Inserted Yubikey
Typ: YubiKey 5 NFC
Serial Number: 10662815
Current Mode: OTP+FIDO+CCID
Firmware: 5.2.4
Enrolled: YubiKey can be enrolled!

Serial	User	Slot	Enrolled on	Certificate

HSM present: No Version: 0.4.0.0

if several keys are added the displayed one will be enrolled. In this way you can add an administrative key for authentication and a second one to deploy. Maybe you have to change the USB-slots.



YubiKey
Serial Number: 10662815
PIV Version: 5.2.4
Firmware: 5.2.4

Certificate
User: User
Serial: 5500000098B6EB671F64E0A1E2000100000098
Enrolled on: 16.03.2020 13:29:58
CA: NINJAECA001.netpointit.ninja\Enterprise-CA
Thumbprint: B772CBA2504EB7C3DE2B63CF8F498D8618910CD4

Inserted Yubikey
Typ: YubiKey 5 NFC
Serial Number: 10662815
Current Mode: OTP+FIDO+CCID
Firmware: 5.2.4
Enrolled: Enrolled!

Serial	User	Slot	Enrolled on	Certificate
10662815	User	Standard User	16.03.2020 14:29:58	5500000098B6EB671F64E0A1E2000100000098

HSM present: No Version: 0.4.0.0

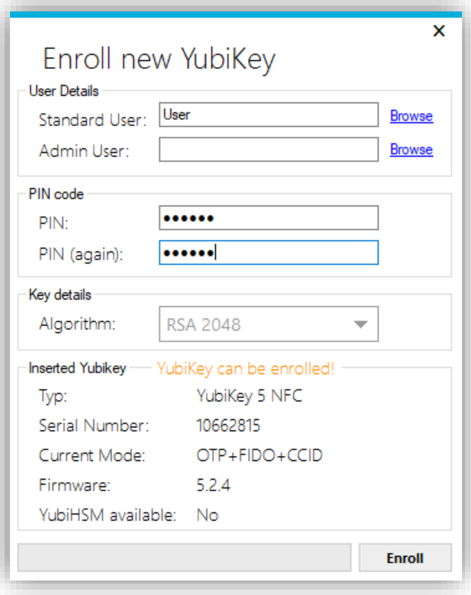
There are 3 buttons in the toolbar for common actions. The first one to the left is *enroll user*, see the section titled “Enrolling a Yubikey Smartcard” for more information. The second button shows the *settings*.

See the “Using the application” section above for more information. The third button is *about*, which shows information about the application.

Once a Yubikey is inserted, its information will be displayed in the lower left corner of the application. Here you can quickly change the mode of the Yubikey, view the associated certificate or export the certificate to a file.

Enrolling a Yubikey Smartcard

Enrolling a new Smartcard will present a window requiring you to enter the user information. Enter the username, or click the *Browse* button to select from a list of Active Directory users, and then select a new PIN code for the user, from 6 to 8 in length. PUK code will be automatically generated and saved along with the user. If a YubiHSM is inserted in the machine, it will automatically be used to generate the PUK code for added security. If you want, you can select a second user like the first user.



Enroll new YubiKey

User Details

Standard User: User

Admin User:

PIN code

PIN: ••••••

PIN (again): ••••••

Key details

Algorithm: RSA 2048

Inserted Yubikey — YubiKey can be enrolled!

Typ: YubiKey 5 NFC

Serial Number: 10662815

Current Mode: OTP+FIDO+CCID

Firmware: 5.2.4

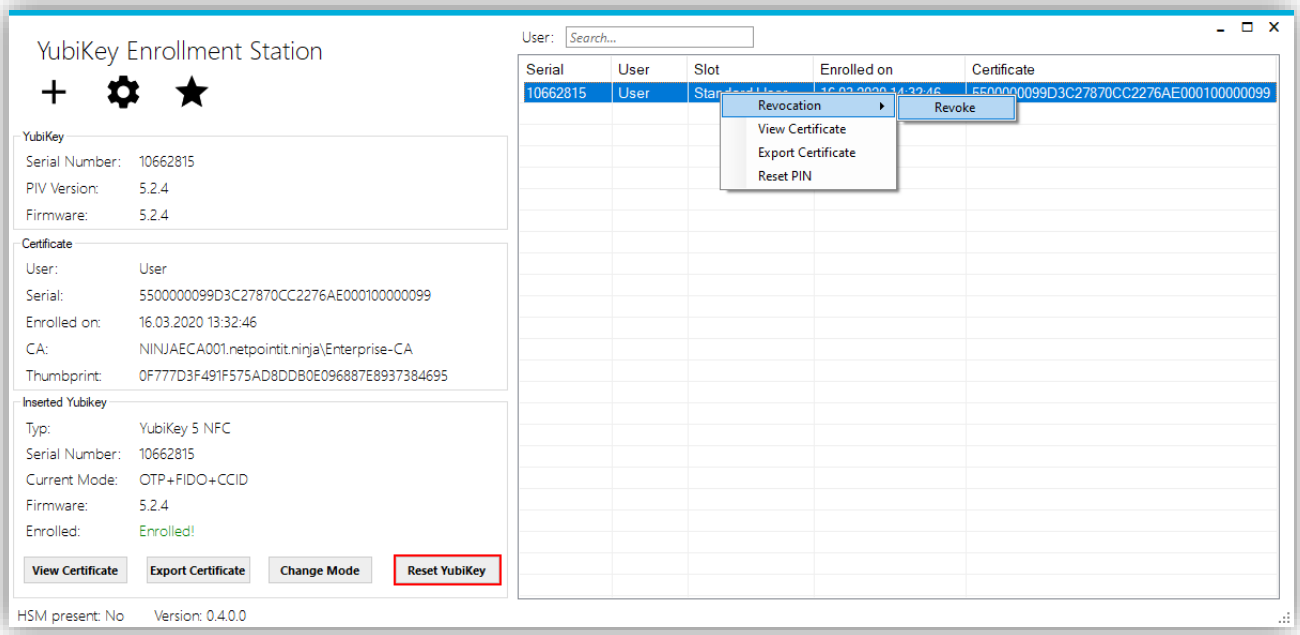
YubiHSM available: No

The enrollment process can take a little while, so a progress bar will indicate the progress. Once successful, the dialog will close and the newly enrolled Yubikey is displayed in the users list. Users will be saved in the *store.json* file inside the application directory.

Note: The PIN must be at least 6 characters in length.

Revoking a Yubikey Certificate

If you wish to simply revoke the certificate (in case the Yubikey has been lost), right click the user, click *Revocation* and then *Revoke*. You will then be presented with a confirmation dialog to revoke the certificate.



YubiKey
Serial Number: 10662815
PIV Version: 5.2.4
Firmware: 5.2.4

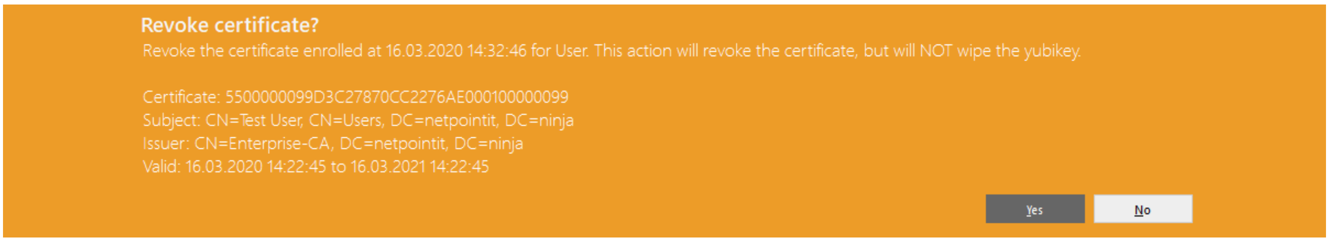
Certificate
User: User
Serial: 5500000099D3C27870CC2276AE000100000099
Enrolled on: 16.03.2020 13:32:46
CA: NINJAECA001.netpointit.ninja\Enterprise-CA
Thumbprint: 0F777D3F491F575AD8DDB0E096887E8937384695

Inserted Yubikey
Typ: YubiKey 5 NFC
Serial Number: 10662815
Current Mode: OTP+FIDO+CCID
Firmware: 5.2.4
Enrolled: Enrolled!

Serial	User	Slot	Enrolled on	Certificate
10662815	User	Stan	16.03.2020 14:32:46	5500000099D3C27870CC2276AE000100000099

HSM present: No Version: 0.4.0.0

The application will ask to confirm the operation.



Revoke certificate?
Revoke the certificate enrolled at 16.03.2020 14:32:46 for User. This action will revoke the certificate, but will NOT wipe the yubikey.

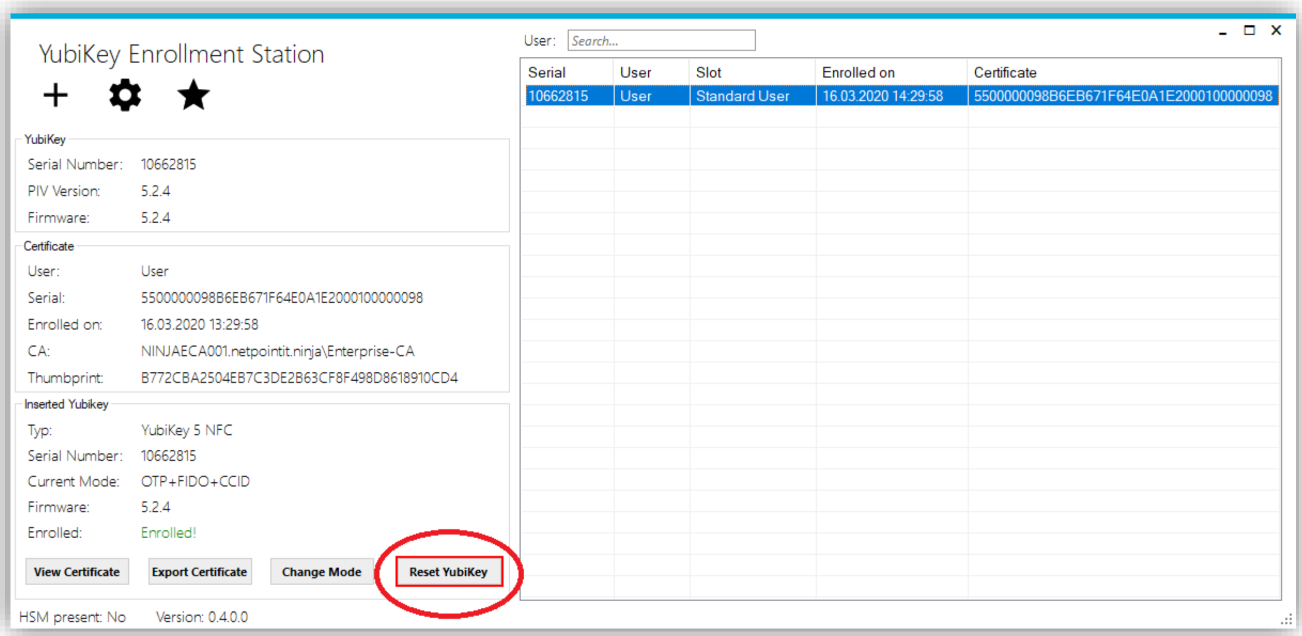
Certificate: 5500000099D3C27870CC2276AE000100000099
Subject: CN=Test User, CN=Users, DC=netpointit, DC=ninja
Issuer: CN=Enterprise-CA, DC=netpointit, DC=ninja
Valid: 16.03.2020 14:22:45 to 16.03.2021 14:22:45

Resetting a YubiKey Smartcard

If you wish to Reset the YubiKey, just click on the button *Reset YubiKey*. This action will wipe the YubiKey completely wether there is one or two certificates.

Attention!

The certificate is still published and has to be revoked manually. See above.



YubiKey
Serial Number: 10662815
PIV Version: 5.2.4
Firmware: 5.2.4

Certificate
User: User
Serial: 5500000098B6EB671F64E0A1E2000100000098
Enrolled on: 16.03.2020 13:29:58
CA: NINJAECA001.netpointit.ninja\Enterprise-CA
Thumbprint: B772CBA2504EB7C3DE2B63CF8F498D8618910CD4

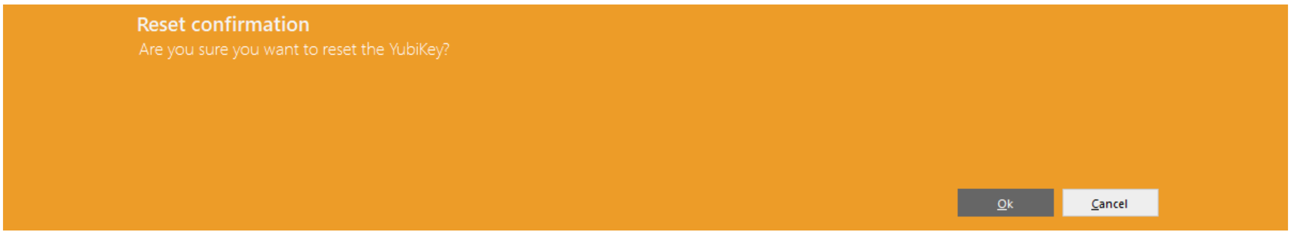
Inserted Yubikey
Typ: YubiKey 5 NFC
Serial Number: 10662815
Current Mode: OTP+FIDO+CCID
Firmware: 5.2.4
Enrolled: Enrolled!

HSM present: No Version: 0.4.0.0

User: Search...

Serial	User	Slot	Enrolled on	Certificate
10662815	User	Standard User	16.03.2020 14:29:58	5500000098B6EB671F64E0A1E2000100000098

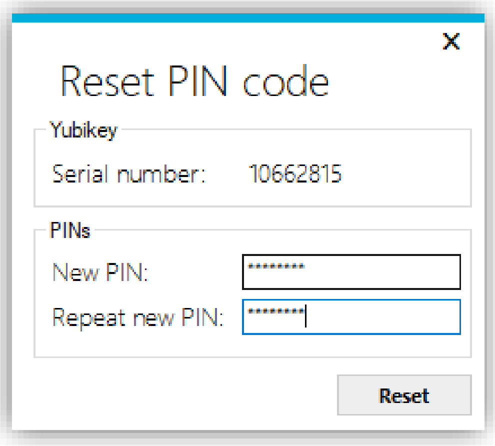
The application will ask to confirm the operation.



Reset confirmation
Are you sure you want to reset the YubiKey?

Resetting a PIN code

When a user has forgotten their PIN code or wishes to change it, it is possible directly in the application to reset the PIN. When the Yubikey was enrolled in the application, a PUK code was automatically created, which is then used to reset the PIN code of the Yubikey without losing the details on the Smartcard,



Reset PIN code

Yubikey

Serial number: 10662815

PINs

New PIN: *********

Repeat new PIN: *********

Enter the new PIN code and click *Reset*. The new PIN code will take effect immediately.

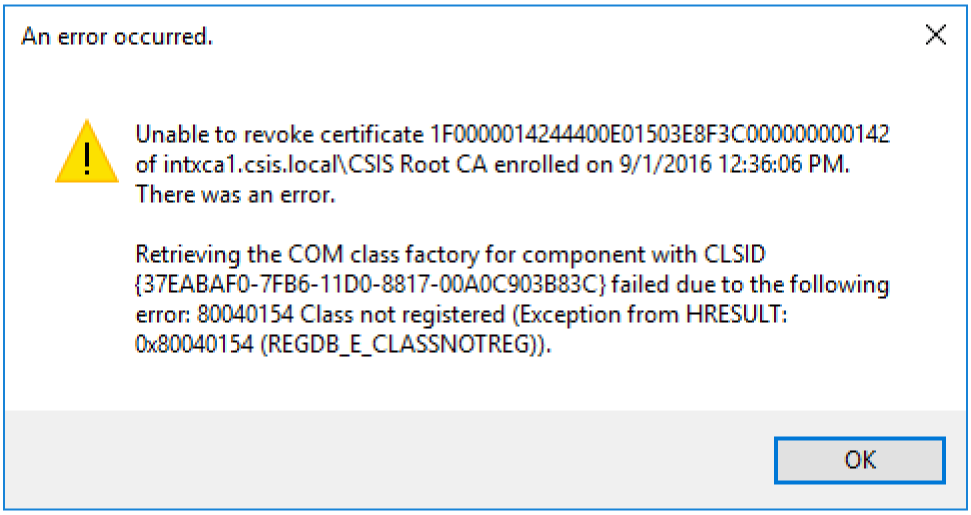
Note: The PIN must be at least 6 characters in length.

Troubleshooting

Occasionally, something will happen that prevents a successful enrollment or revocation of a Smart Card. This section will detail some of the more common cases, and the solutions for them.

COM Class not registered

This error typically occurs when the enrollment program is run for the first time on a computer. It will occur either when enrolling or revoking certificates, and indicates that a library used by the CSIS Enrollment Agent to communicate with the Microsoft AD CS.



An error occurred.

Unable to revoke certificate 1F0000014244400E01503E8F3C000000000142 of intxca1.csis.local\CSIS Root CA enrolled on 9/1/2016 12:36:06 PM. There was an error.

Retrieving the COM class factory for component with CLSID {37EABAF0-7FB6-11D0-8817-00A0C903B83C} failed due to the following error: 80040154 Class not registered (Exception from HRESULT: 0x80040154 (REGDB_E_CLASSNOTREG)).

Cause

The Microsoft CertAdmin library is not present and registered.

Resolution

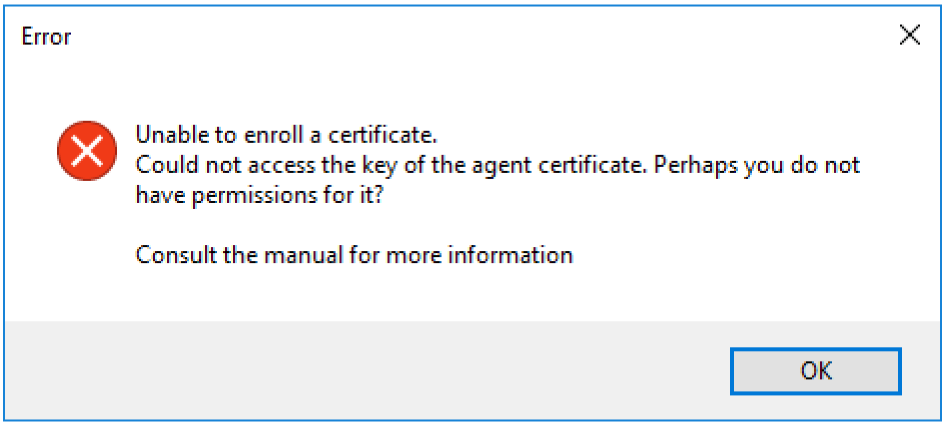
Install the Windows RSAT (Remote Server Administration Toolkit - KB2693643) on the computer. This should also install the Certificate management tools, which will include this library.

MSVCP140.dll not found

This error typically occurs when the Visual C Redist Package is not found. Please install yubikey-manager-qt-1.1.3-win32.exe. Currently the project is using the 32 Bit version of ykman. The 64 Bit version is working, too.

Could not access the key of the agent certificate

This error has to do with permissions.



Unable to enroll a certificate.
Could not access the key of the agent certificate. Perhaps you do not have permissions for it?

Consult the manual for more information

Cause

Most commonly the agent certificate will be stored in the LocalMachine's certificate store. Usually, regular users do not have permissions to use these certificates for signing.

Resolution

Grant the user permissions by locating the certificate in the certificate store and managing its private keys. To utilize a certificate, a given user must have the Read permission.