Instruction – Certum Code Signing - Using Signtool and Jarsigner

Tools for Certum Code Signing

version 2.3

Certum by asseco

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1. Product description

Certum Code Signing certificates protect software against unauthorized modification or tampering by third parties. It is often the case that software downloaded from the web is treated as malware by the computer. This is due to the fact that it does not have a certificate issued by an authorised certification authority such as Certum Certum.
By securing your software with Certum Code Signing certificates, you can protect your software from unauthorized access and theft and minimize the risk of warning messages from SmartScreen ® Application Reputation.

Software secured with Certum Code Signing certificates will result in increased security and customer trust and therefore more software downloads. Code Signing is used to sign code and pre-built code using well-known tools such as signtool.exe and jarsigner.

2. Signtool

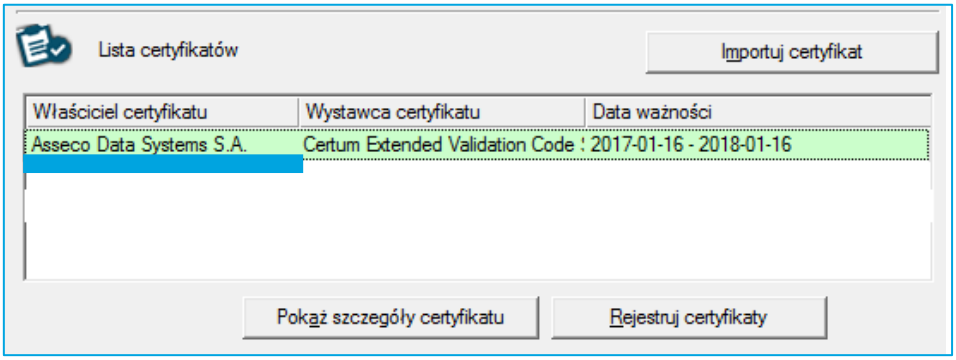
2.1 Tool description

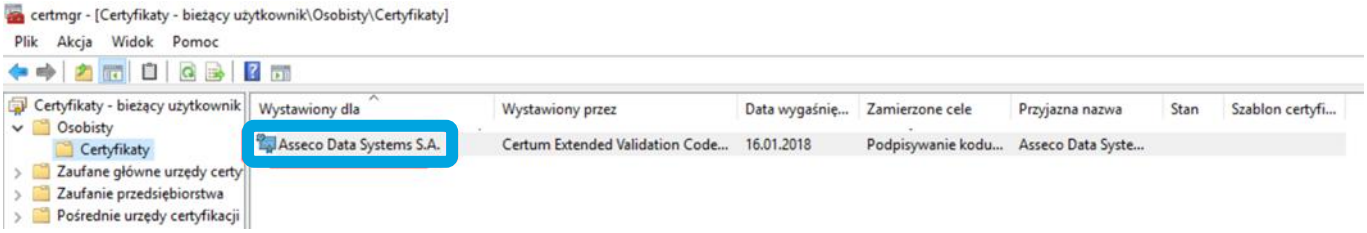
Signtool is a command line tool that digitally signs files, verifies file signatures and timestamps files. This tool can be found in the Windows development package (Windows SDK[Software Development Kit]). All operations performed with Code Signing require a connected reader together with a card on which there is a Code Signing certificate.

2.2 Signing

To sign the file, use the following command on the command line (cmd.exe):
signtool sign /n "[1] " / t [2] /fd [3] /v [4]

[1] – Name or part of the name of the certificate's owner, which can be checked in the proCertum CardManager application or in the system tool certmgr.msc:





[2] – Timestamp Address. For Certum http://time.certum.pl,

[3] – The name of the signature algorithm. Available sha1 and sha256,
[4] – The path to the file to be signed.

Examples of correct commands:
signtool sign /n "Asseco Data Systems S.A." /t http://time.certum.pl/ /fd sha1 /v aplikacja.exe

As a result, cmd.exe console should return a message about the correctness of the file signature

```
The following certificate was selected:
    Issued to: Asseco Data Systems S.A.
    Issued by: Certum Code Signing CA SHA2
    Expires:   Fri Jul 06 10:16:38 2018
    SHA1 hash: E0828DF9D71C4CD87A349460027F0D9CB802BF31

Done Adding Additional Store
Successfully signed: aplikacja.exe

Number of files successfully Signed: 1
Number of warnings: 0
Number of errors: 0
```

signtool sign /n "Asseco Data Systems S.A." /t http://time.certum.pl/ /fd sha256 /v aplikacja.exe

As a result, the cmd.exe console should return a valid file signature message:

```
The following certificate was selected:
    Issued to: Asseco Data Systems S.A.
    Issued by: Certum Code Signing CA SHA2
    Expires:   Fri Jul 06 10:16:38 2018
    SHA1 hash: E0828DF9D71C4CD87A349460027F0D9CB802BF31

Done Adding Additional Store
Successfully signed and timestamped: aplikacja.exe

Number of files successfully Signed: 1
Number of warnings: 0
Number of errors: 0
```

2.3 Verification

To verify the file, use the following command on the command line (cmd.exe):

signtool verify /pa [1]

[1] – The name of the signed file

Example of correct command:

signtool verify /pa aplikacja.exe

As a result, the cmd.exe console returns a message about the correctness of the file signature, for example:

```
File: aplikacja.exe
Index Algorithm Timestamp
========================================
0      sha1       Authenticode

Successfully verified: aplikacja.exe


File: aplikacja.exe
Index Algorithm Timestamp
========================================
0      sha256     Authenticode

Successfully verified: aplikacja.exe
```

Or lack of a signature:

```
File: aplikacja.exe
Index Algorithm Timestamp
========================================
SignTool Error: No signature found.

Number of errors: 1
```

2.4 Batch signing

In order to batch sign multiple files during a single session, they should be given as consecutive command parameters. This eliminates the need to run the command each time in the console and to enter the PIN code when signing subsequent files.

Example command:

signtool sign /n "Asseco Data Systems S.A." /t http://time.certum.pl/ /fd sha1 /v aplikacja1.exe aplikacja2.exe aplikacja3.exe

As a result, the cmd.exe console returns a message about the correctness of the file signature:

```
Done Adding Additional Store
Successfully signed and timestamped: aplikacja1.exe
Successfully signed and timestamped: aplikacja2.exe
Successfully signed and timestamped: aplikacja3.exe

Number of files successfully Signed: 3
Number of warnings: 0
Number of errors: 0
```

2.5 Dual signature

In order to create a dual signature (using both algorithms: SHA-1 and SHA-2 the following procedure should be carried out:

1. Perform an application signature using the SHA-1 algorithm with the example command:

signtool sign /n "Asseco Data Systems S.A." /t http://time.certum.pl/ /fd sha1 /v aplikacja.exe

2. Then perform a signature on the same application using the SHA-2 algorithm and the /as switch:

signtool sign /n "Asseco Data Systems S.A." /t http://time.certum.pl/ /fd sha256 /as /v aplikacja.exe

The result of the verification of the dual-signed file should be the following console message:

```
File: aplikacja.exe
Index Algorithm Timestamp
========================================
0      sha1       Authenticode
1      sha256     RFC3161

Successfully verified: aplikacja.exe
```

Windows 8 or higher is required to perform and verify a dual signature. To perform or verify a dual signature on Windows 7 systems, please refer to this article published by Microsoft: https://technet.microsoft.com/en-us/library/security/2949927.

3 Jarsigner

3.1 Tool description

Jarsigner is a command line tool that digitally signs files and verifies signatures. This tool can be found in the Oracle development package (JDK [Java Development Kit]). All operations performed with Code Signing require a connected reader with a card on which there is a certificate.

3.2 Configuration

3.2.1 Create a configuration file provider.cfg

Before using jarsigner, additional configuration is needed. The first step is to create a provider configuration file for PKCS#11. To do so, create a new file with the extension *.cfg (example: provider.cfg). Its content looks like this:

name=[1]
library=[2]
slot=[3]

[1] – Provider Name. Preferably Crypto3PKCS.
[2] – The path to the PKCS library. If you have installed proCertum CardManager the default path is: C:\Windows\System32\crypto3PKCS.dll
[3] – The slot number in which the card is located. The default value is -1 which automatically detects the first available slot.

Example configuration for ordinary profile of cryptoCertum card:

name=Crypto3PKCS
library=C:\Windows\System32\crypto3PKCS.dll
slot=-1

Example configuration for Certum virtual card:

name=SimplySignPKCS.dll
library=C:\Windows\System32\SimplySignPKCS.dll
slot=-1

3.2.2 Create certificate path file bundle.pem

The next step is to create a certificate path file with extension*.pem (example: bundle.pem). Its contents looks like this:

1. "Above": User Certificate
2. "Below": intermediate certificate for user certificate
3. "Bottom": cross certificate*

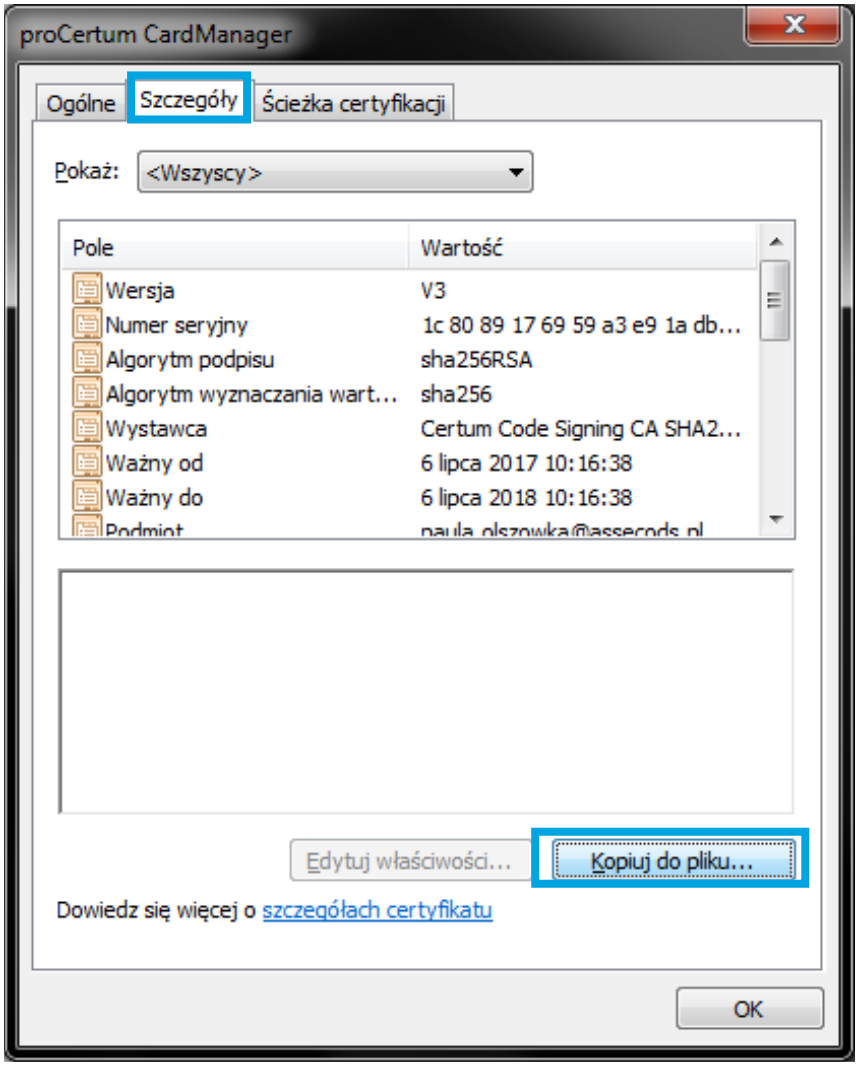
***Note**: cross certificate must be downloaded from:
https://www.certum.eu/en/cert_expertise_root_certificates/(certificate serial number: 1bb58f252adf23004928c9ae3d7eed27)

Note: The contents of the bundle.pem file must necessarily be in the order listed above.

Obtaining a user Certificate

The user's certificate can be obtained by starting the proCertum CardManager program, clicking on the Read Card button and going to the Common Profile tab.

Then select the certificate you want to save from the list and use the "Show certificate details" button. The certificate will be displayed, using the "Copy to file" button on the "Details" tab you can save the certificate:

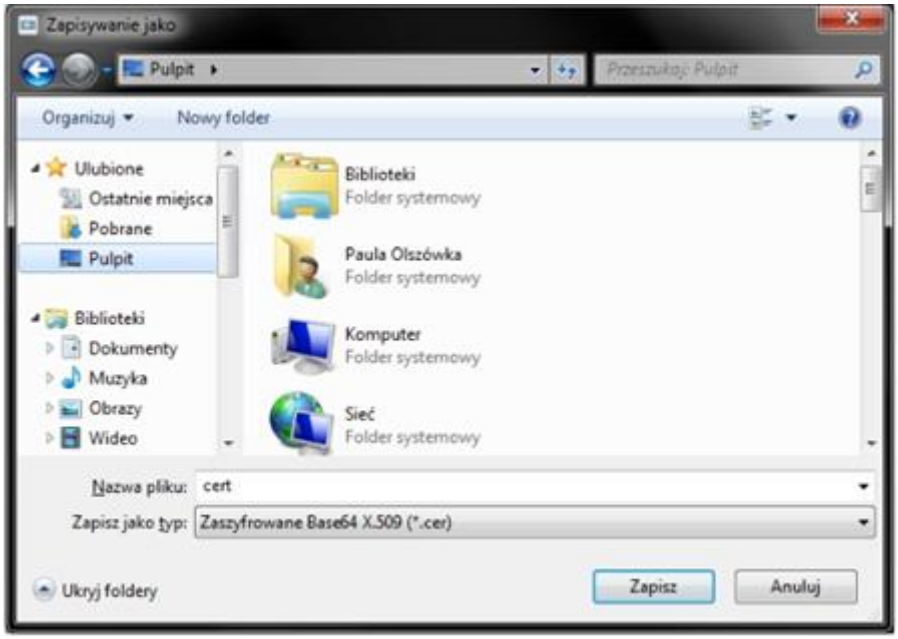


It is a good idea to write down the contents of the Issuer field in this step. This will help you later in selecting the intermediate certificate

When you click "Copy to File", the Save Wizard is launched:

Click Next. In the next step, select "X.509 encrypted with Base-64 algorithm (.CER)" and click Next:

Next, select where to save the file and name it. To do this, click Browse, select a location and enter a name for the file, then click Save, and in the wizard window go to the next step by clicking Next and then Finish. The wizard will confirm the export of the file.



Obtaining an Intermediate Certificate

Intermediate certificates should be downloaded from Certum's website:

https://www.certum.eu/en/cert_expertise_root_certificates/

The name of the Issuer in the "Issuer" field of the user's certificate can be used to select the correct intermediate certificate(s). Please find the issuer of your certificate on the Certum website and save his certificate in the PEM text format..

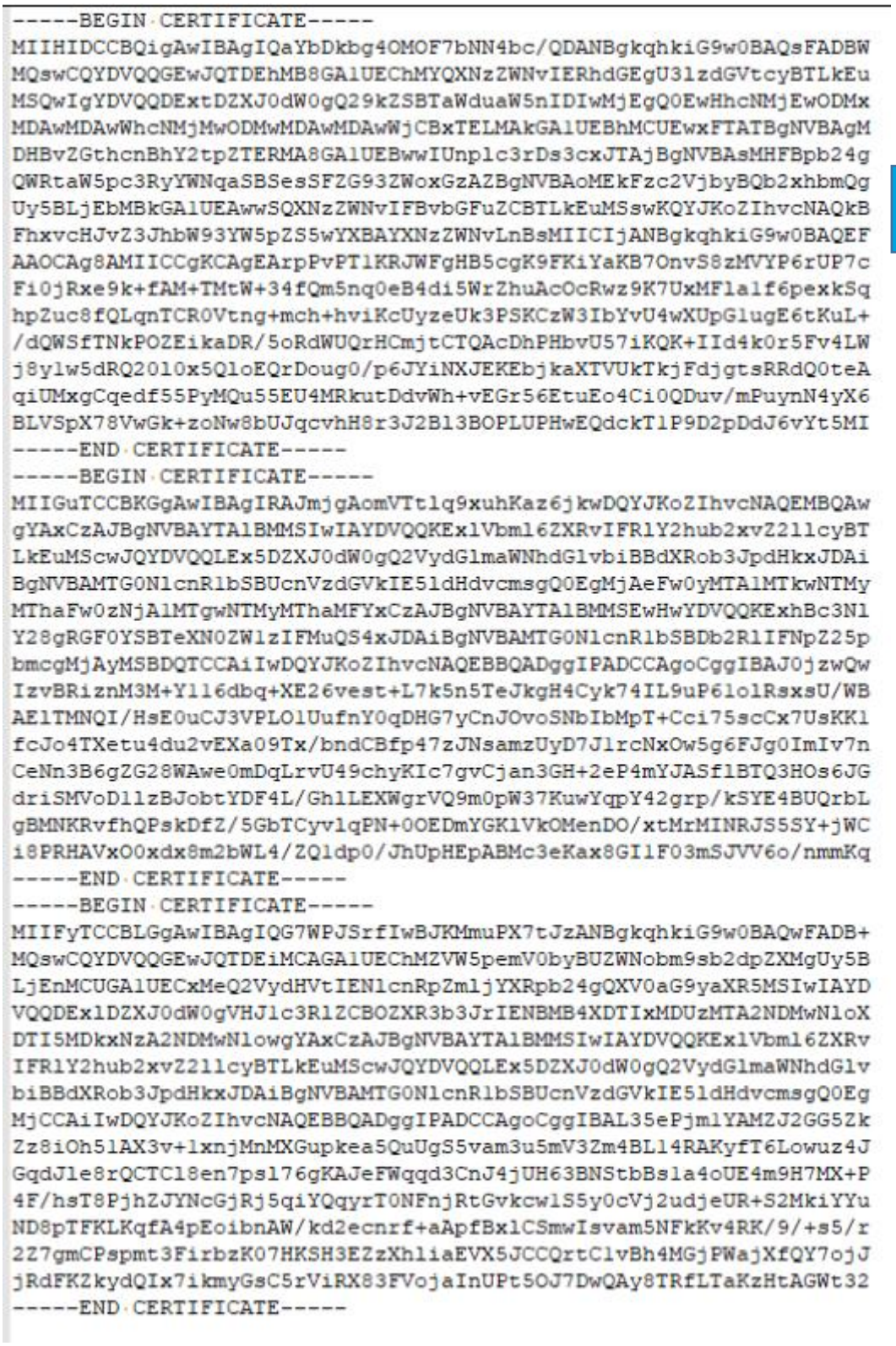
Then, having two certificate files, create a new text file. Paste the content of the two files you got earlier (the user certificate and intermediate certificate) into one text file in the order mentioned above:

1. „Above": User Certificate
2. "Below": intermediate certificate for user certificate
3. "Bottom": cross certificate*

***Note**: cross certificate must be downloaded from:
https://www.certum.eu/en/cert_expertise_root_certificates/ (certificate serial number: 1bb58f252adf23004928c9ae3d7eed27)

Save the file and change its extension to *.pem.

Below is a sample bundle.pem file:



3.2.3 Change the user alias (label) on a card (only for users with diacritical marks in the Common Name (CN) field in a certificate)

A user certificate alias is used to indicate the certificate to be used to sign the application using the Jarsigner tool.

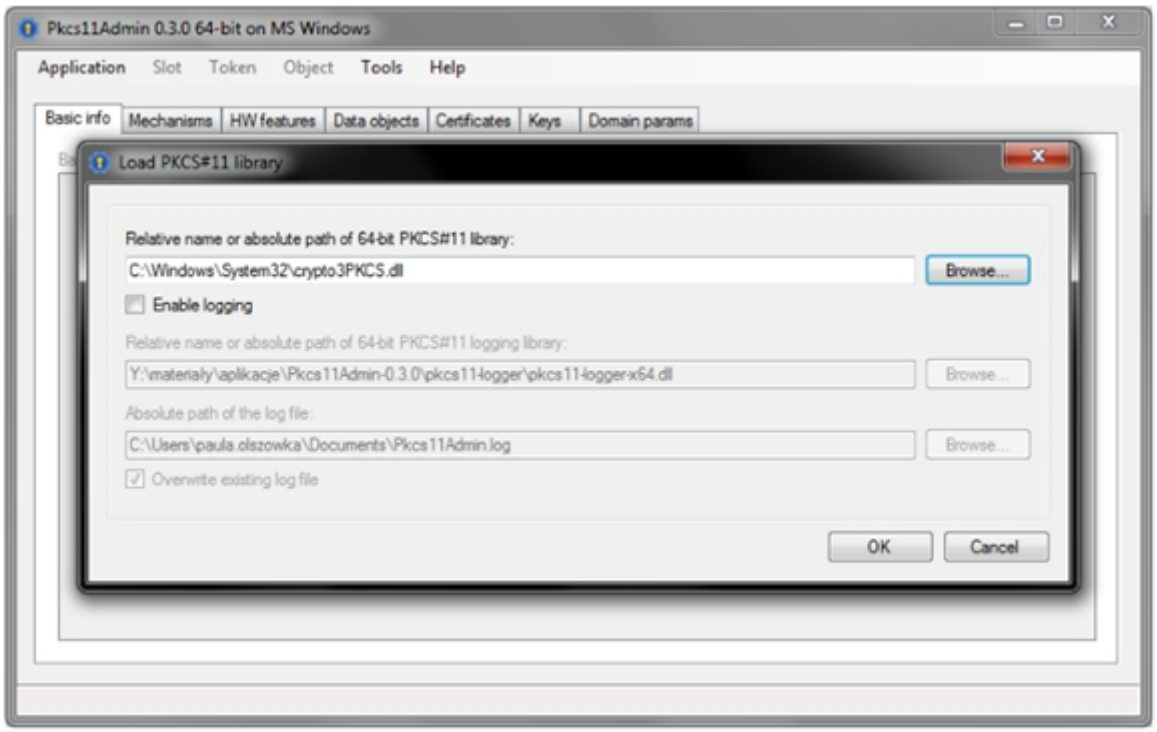
By default, the certificate alias is created based on the contents of the Common Name field from the Entity field of the certificate. If the Common Name field contains a string containing diacritics, it must be replaced with a string that does not contain diacritics.
Example:
Alias (label) before the change: Urząd
Alias (label) after the change: Urzad

Note: Changing the alias does not change the certificate. Only the identifier of the certificate on the card is subject to editing. The signed application in the signature field will still contain the Subscriber's data containing diacritical marks.

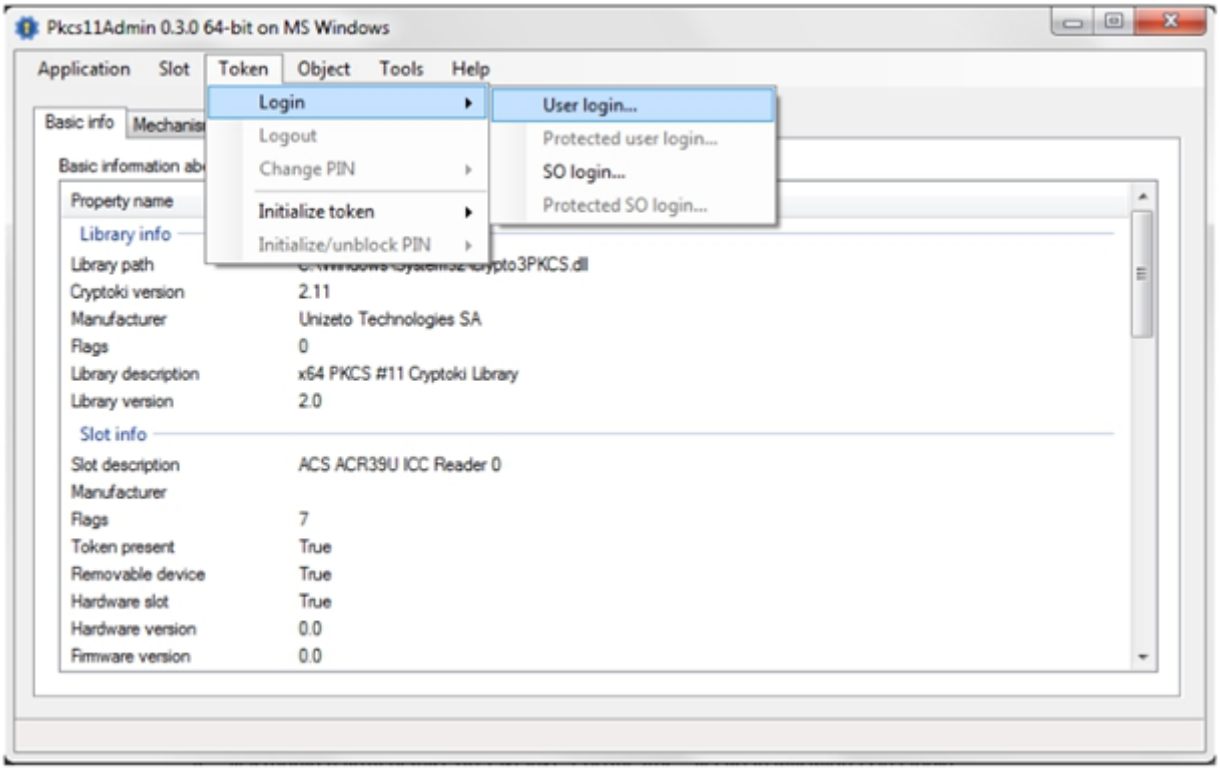
Changes to the alias (label) can be made using software provided free of charge PKCS11Admin, downloadable here: http://www.pkcs11admin.net/

The presented method of changing the label has been implemented in PKCS11Admin software version 0.3.0. Procedure of changing label looks as follows:

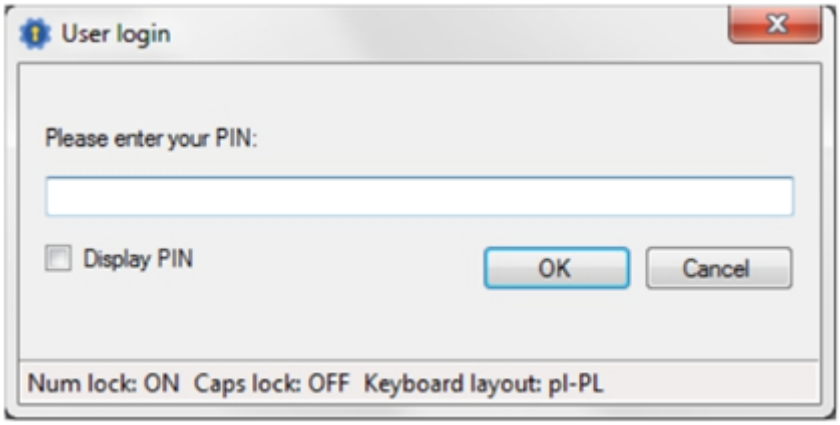
1. Download and extract PKCS11Admin to a directory of your choice.
2. Then enter the directory containing the extracted PKCS11Admin software and run the PKCS11Admin-x86 or PKCS11Admin-x64 application, depending on your operating system version. The launch results in the opening of the program and the selection window of the library supporting the card. For Certum cards choose the crypto3PKCS.dll library located in the C:Windows\System32 directory and click OK:



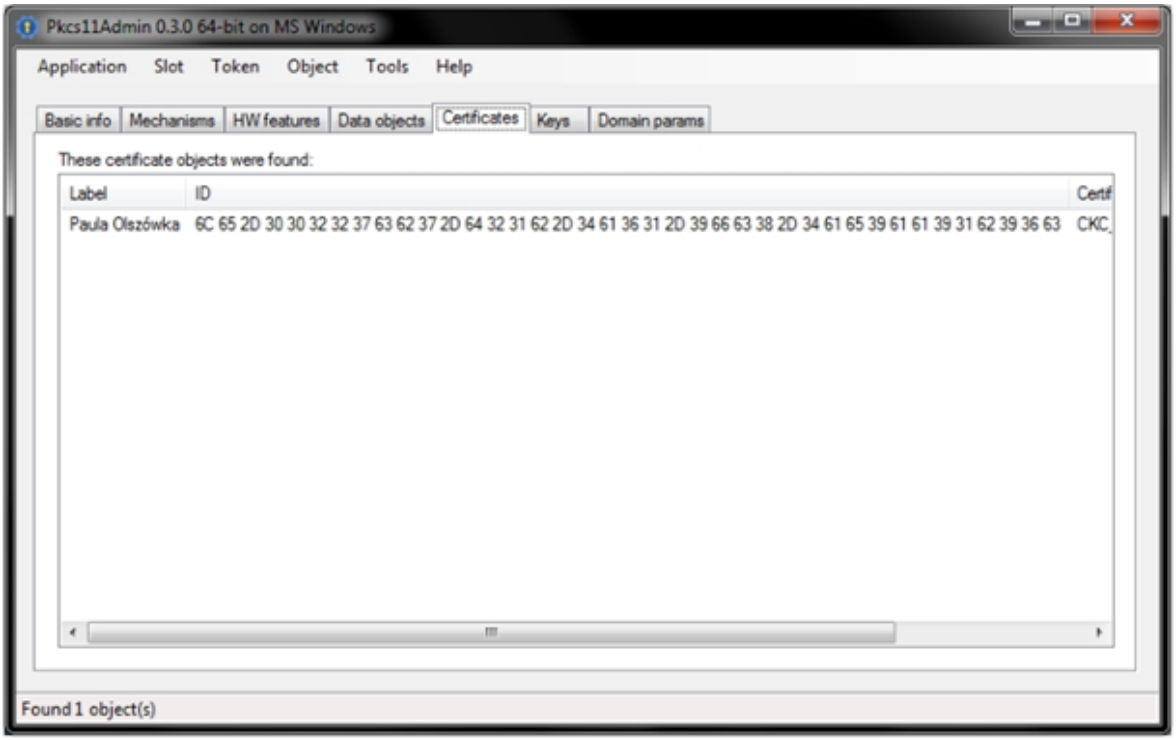
3. When the program loads the contents of the cryptographic card, select Token >Login > User login from the bar:



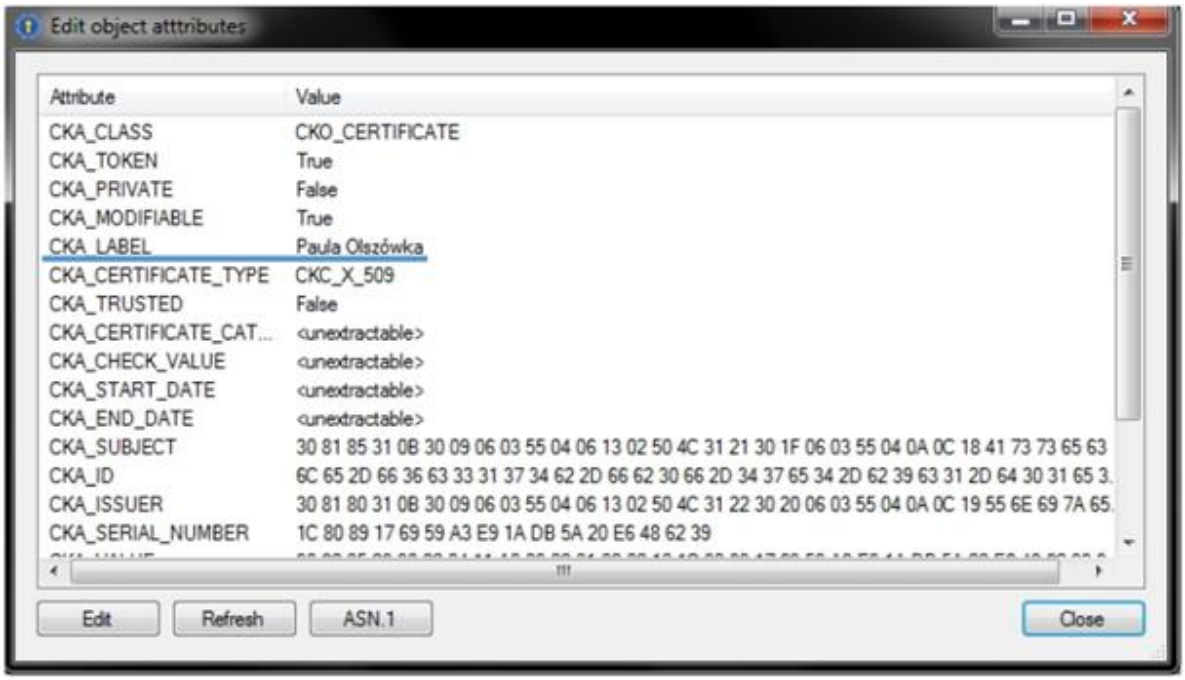
4. The program will prompt you to enter the PIN code for the regular card profile. Enter it and confirm with OK button:

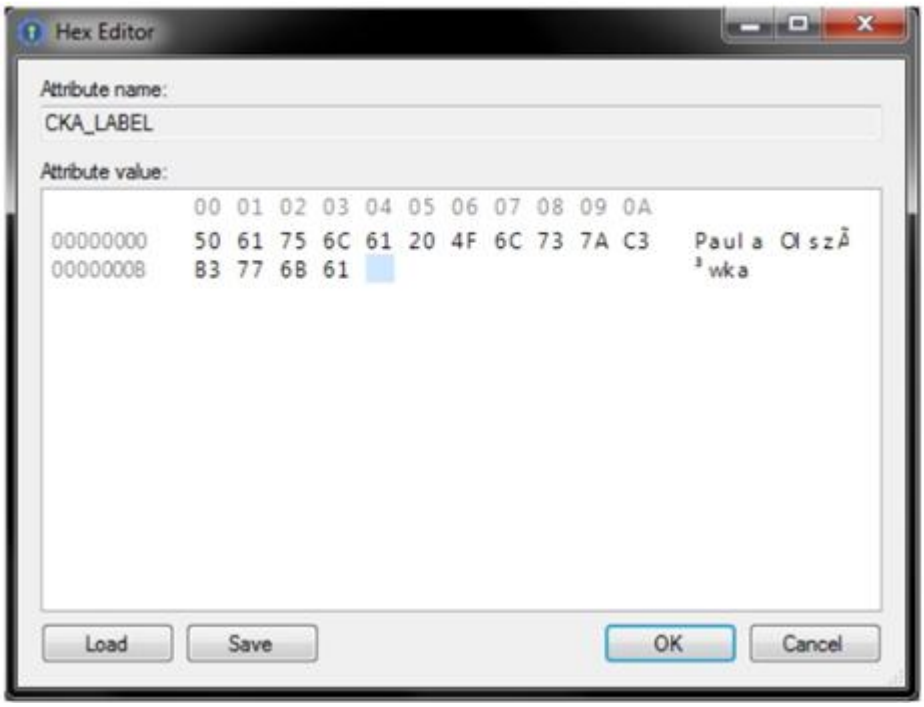


5. Then go to the Certificates tab. The list will display the labels of certificates for which the change will be made (here, for example, the user label containing a diacritical mark „ó”):

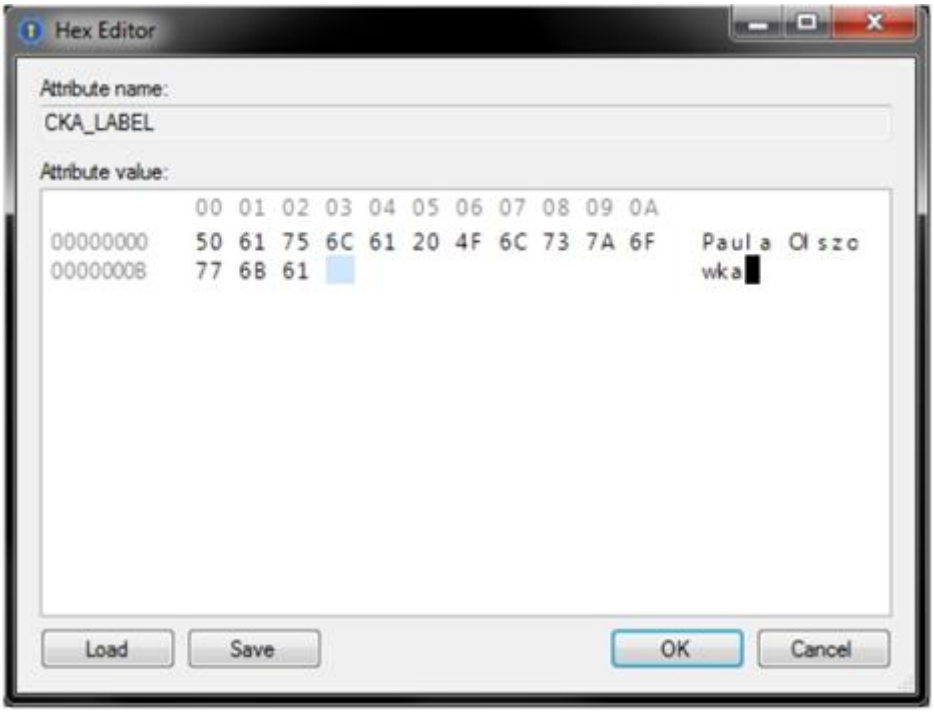


6. Right-clicking on the label calls up a menu from which you can select the Edit attributes… .
7. In the window that appears, presenting the attributes of an entry, find the entry CKA_LABEL. Then select the CKA_LABEL entry and use the Edit button to change the incorrect content of the entry:





8. The label field is now editable. Simply correct the label by removing the diacritical marks and confirm with OK:



9. The change process is now complete. Thanks to this when selecting a certificate to sign you will be able to provide an alias without diacritics and thus the correct use of the certificate.

Before signing, the result of changing the user alias can be checked with the command:

keytool -list -keystore NONE -storetype PKCS11 –providerclass sun.security.pkcs11.SunPKCS11 -providerArg provider.cfg

As a result, the instruction returns the contents of the key store:

```
Picked up _JAVA_OPTIONS: -Xms256m -Xmx1024m
Enter keystore password:

Keystore type: PKCS11
Keystore provider: SunPKCS11-Crypto3CSP

Your keystore contains 1 entry

Paula Olszowka, PrivateKeyEntry,
Certificate                    fingerprint                          (SHA1):
E0:82:8D:F9:D7:1C:4C:D8:7A:34:94:60:02:7F:0D:9C:B8:02:BF:31
```

3.3 Signing

To sign the file, use the following command on the command line (cmd.exe):

Jarsigner -keystore NONE -tsa "[1]" -certchain "[2]" -storetype PKCS11 -providerClass sun.security.pkcs11.SunPKCS11 -providerArg "[3]" -storepass "[4]" "[5]" "[6]"

[1] – Timestamp Address. For Certum http://time.certum.pl,
[2] – The path to the certificate path file (Section "Configuration"),
[3] – The path to the provider's configuration file (Section "Configuration"),
[4] – Password for common card profile,
[5] – The path to the file to be signed,
[6] – The name of the certificate owner which can be checked in the proCertum CardManager or with the Keytool too

Example of correct command:

jarsigner -keystore NONE -certchain "bundle.pem" -tsa "http://time.certum.pl" - storetype PKCS11 -providerClass sun.security.pkcs11.SunPKCS11 -providerArg "provider.cfg" -storepass "123456" "aplikacja.jar" "Asseco Data Systems S.A."

If the signature operation was successful, the console will display the following result:

```
Picked up _JAVA_OPTIONS: -Xms256m -Xmx1024m
jar signed.
```

3.4 Verification

To verify the file, use the following command on the command line (cmd.exe):

jarsigner -verify "[1]"

[1] – The path to the file to be signed,

Example of correct command:

jarsigner -verify "aplikacja.jar"

If the file is verified correctly, the console will display:

```
Picked up _JAVA_OPTIONS: -Xms256m -Xmx1024m
jar verified.
```

If there is no signature, the result is as follows:

```
Picked up _JAVA_OPTIONS: -Xms256m -Xmx1024m
jar is unsigned.
```

3.5 Batch signing

In order to batch sign multiple files in a single session, it is necessary to create a *.bat file containing as many entries as the number of files to be signed during one signing process. This eliminates the need to call the command in the console each time and to enter the PIN code when signing subsequent files..

To create a file, create a new text file *.txt, paste the file signing entries, save the file, and change its extension from *.txt to *.bat.

The following example shows the contents of the *.bat file for signing three applications simultaneously:

jarsigner -keystore NONE -certchain "bundle.pem" -tsa "http://time.certum.pl" - storetype PKCS11 -providerClass sun.security.pkcs11.SunPKCS11 -providerArg "provider.cfg" -storepass "123456" "aplikacja1.jar" "Asseco Data Systems S.A."

jarsigner -keystore NONE -certchain "bundle.pem" -tsa "http://time.certum.pl" - storetype PKCS11 -providerClass sun.security.pkcs11.SunPKCS11 -providerArg "provider.cfg" -storepass "123456" "aplikacja2.jar" "Asseco Data Systems S.A."

jarsigner -keystore NONE -certchain "bundle.pem" -tsa "http://time.certum.pl" - storetype PKCS11 -providerClass sun.security.pkcs11.SunPKCS11 -providerArg "provider.cfg" -storepass "123456" "aplikacja3.jar" "Asseco Data Systems S.A."

You can run this file in cmd.exe console or by double-clicking it, and the result will be starting the signing of subsequent files contained in the *.bat file.

The result of running the *.bat file in the console will be information about the next command invocation and file signature:

```
C:\Users\user\Desktop\jarsigner>jarsigner -keystore NONE -certchain
"bundle.pem" -tsa http://time.certum.pl -storetype PKCS11 -
providerClass sun.security.pkcs11.SunPKCS11 -providerArg
"provider.cfg" -storepass "123456" "aplikacja1.jar" "Asseco Data
Systems S.A"
Picked up _JAVA_OPTIONS: -Xms256m -Xmx1024m
jar signed.

C:\Users\user\Desktop\jarsigner>jarsigner -keystore NONE -certchain
"bundle.pem" -tsa http://time.certum.pl -storetype PKCS11 -
providerClass sun.security.pkcs11.SunPKCS11 -providerArg
"provider.cfg" -storepass "123456" "aplikacja2.jar" "Asseco Data
Systems S.A"

Picked up _JAVA_OPTIONS: -Xms256m -Xmx1024m
jar signed.

C:\Users\user\Desktop\jarsigner>jarsigner -keystore NONE -certchain
"bundle.pem" -tsa http://time.certum.pl -storetype PKCS11 -
providerClass sun.security.pkcs11.SunPKCS11 -providerArg
"provider.cfg" -storepass "123456" "aplikacja3.jar" "Asseco Data
Systems S.A"
Picked up _JAVA_OPTIONS: -Xms256m -Xmx1024m
jar signed.
```

4. Most common problems

1. During signing with Signtool tool using SHA-2 algorithm there is a problem with signing:

```
Done Adding Additional Store
SignTool Error: An unexpected internal error has occurred.
Error information: "Error: SignerSign() failed." (-
2146893784/0x80090028)
```

Solution: In the proCertum CardManager software select the Options button > check the option EV Code Signing - replace CSP with minidriver library. Then restart the system and try to sign again.

2. When signing with Jarsigner, the following message appears:

```
Picked up _JAVA_OPTIONS: -Xms256m -Xmx1024m
jar signed.

Warning:
The signer's certificate chain is not validated.
```

Solution: Verify the contents of the bundle.pem file. The file probably contains invalid certificates or certificates in the wrong order.
The bundle.pem file should contain certificates:

1. Subscriber's Certificate,
2. Appropriate intermediate certificate.

More about the bundle.pem file in section 3.2.2.

3. When verifying the signature with the Jarsigner tool, a message appears:

```
Picked up _JAVA_OPTIONS: -Xms256m -Xmx1024m
jarsigner: java.lang.SecurityException: cannot verify signature
block file META-INF/PAULA_OL
```

PAULA_OL is a sample signature that depends on the user's alias. For more on aliases, see section 3.2.3.

Solution: Verify the contents of the bundle.pem file. The file probably contains invalid certificates or certificates in the wrong order.
The bundle.pem file should contain certificates:
1. Subscriber's Certificate,
2. Appropriate intermediate certificate.

4. When signing with the Jarsigner tool, a message appears:

```
Picked up _JAVA_OPTIONS: -Xms256m -Xmx1024m
jar signed.

Warning:
The signer certificate's KeyUsage extension doesn't allow code
signing.
```

Solution: Verify the contents of the bundle.pem file. The file probably contains invalid certificates or certificates in the wrong order.
The bundle.pem file should contain certificates:
1. Subscriber's Certificate,
2. Appropriate intermediate certificate.

More about the bundle.pem file in section 3.2.2.