How to setup and use Keyman/VSE

Creation and upload of RSA keys and SSL certificates
Creation of PFX and JKS keystores
Export and import of PGP public keys

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Contents

Changes:

November 2010 – initial version.
Sept 2011 – corrected description of CIALCREQ in section 5.5 on page 12 and drawing in section 4.3 on page 9.
Dec 2015 – added information about new features with Keyman/VSE 6.1.0: support for Diffie-Hellman parameters and Elliptic-Curve keys, new functions for comparing certificates and keys, and renewing certificates.
Aug 2016 – added info about Elliptic Curve and the Convert Keyring dialog.
July 2017 – added info on external dependency on Bouncy Castle library.

1 Introduction

This paper describes the setup and use of the Keyman/VSE utility. Keyman/VSE allows managing VSE specific public key infrastructure. This includes the creation of RSA key pairs and SSL certificates, which can be uploaded to VSE and stored in VSE-side key rings. In addition to that, Keyman/VSE supports workstation-based key stores and importing/exporting of PGP public keys.

Keyman/VSE is intended as a System Administrator tool. Although providing wizard dialogs to create VSE key rings, it requires some basic knowledge about RSA keys, SSL certificates, and key stores.

The usage of Keyman/VSE for specific tasks is already described at many places: VSE books, Redbooks, technical papers, presentations. Some examples are given in section "Setting up SSL between a workstation and VSE" on page 14 and section "Setting up the RSA keys for Encryption Facility for z/VSE" on page 14.

This paper tries to add some information that perhaps wasn't mentioned before.

The following software has been used in the test setup.

- z/VSE 6.1.0
- TCP/IP for z/VSE 2.1
- Java 8 from Sun/Oracle
- VSE Connector Client on the workstation side
- VSE Connector Server running on VSE
- Keyman/VSE, latest version from 2017 with external dependency on Bouncy Castle

2 Installing the prerequisite programs

The Keyman/VSE tool requires the installation of the VSE Connector Client and needs some Bouncy Castle jar files.

2.1 VSE Connector Client

You can download the most current versions of the VSE Connector Client from

http://www.ibm.com/systems/z/os/zvse/downloads/

After downloading and unpacking the zip-file, execute one of the contained install scripts:

- Setup.bat – for Windows
- Setup.cmd – for Windows NT
- Setup.sh – for Unix / Linux

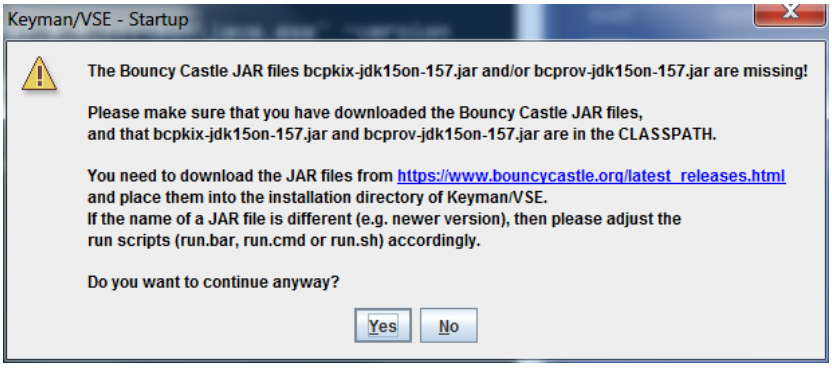
2.2 Bouncy Castle

Bouncy Castle is an Open Source Java class library, providing cryptography related functionality. Refer to the BC website for details (https://www.bouncycastle.org/).

Keyman/VSE needs two Bouncy Castle jar files that you have to download separately from https://www.bouncycastle.org/latest_releases.html for legal reasons:

- bcpkix-jdk15on-152.jar
- bcprov-ext-jdk15on-152.jar

After downloading the jar files, copy them into the Keyman/VSE installation directory. When the jar files are missing, Keyman/VSE displays this message box at startup:

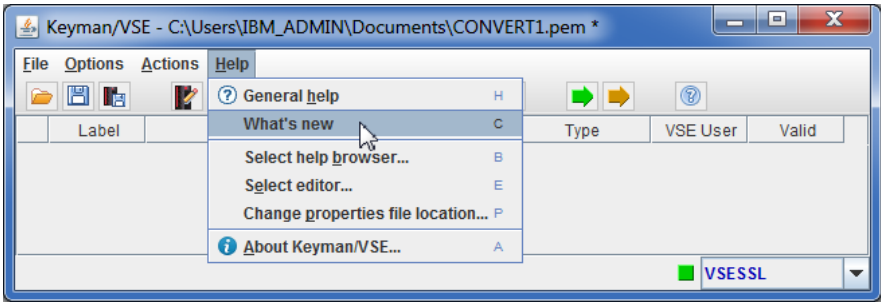


The names of the jar files may change with new BC releases. If the 1.5.7 versions of the jar files are no longer available, just use their successors and change your run script accordingly. The run scripts contain references to the BC jar file names:

```
set CLASSPATH=vkeyman.jar;bcpkix-jdk15on-157.jar;bcprov-jdk15on-157.jar; ...
```

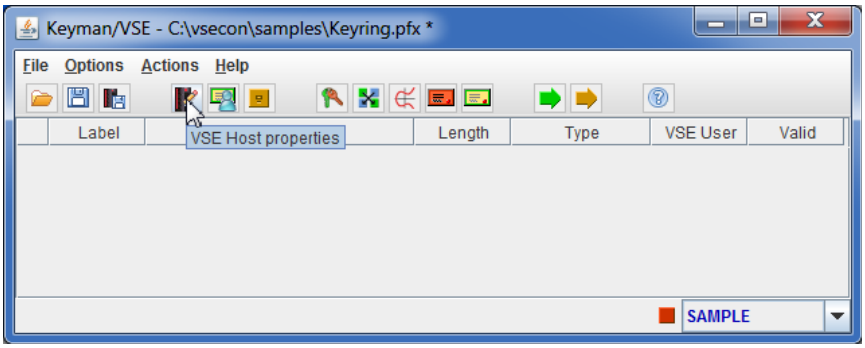
3 Initial Keyman/VSE setup

Before you begin, read the What's new section.

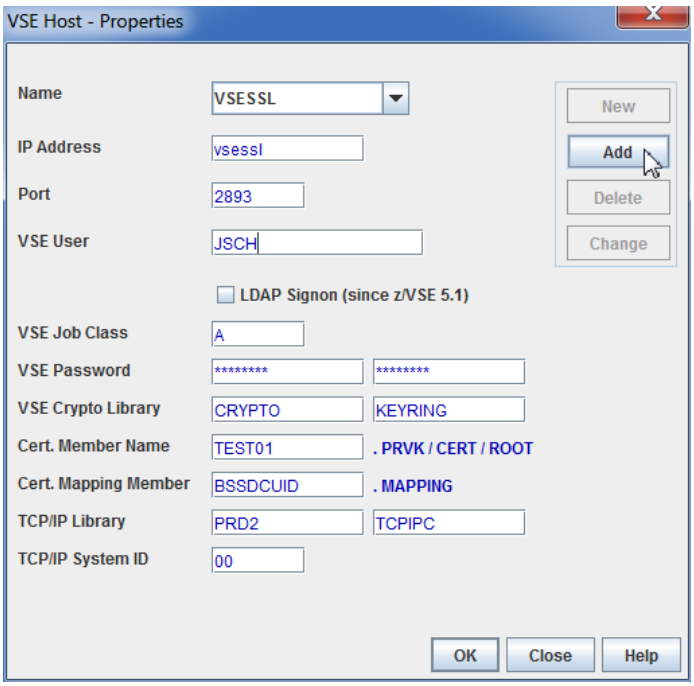


Before you can upload keys to VSE you first have to define your VSE system to Keyman/VSE.

When starting Keyman/VSE the first time, the GUI comes up with no VSE system defined. To define your first VSE system, click on the "VSE Host properties" button.



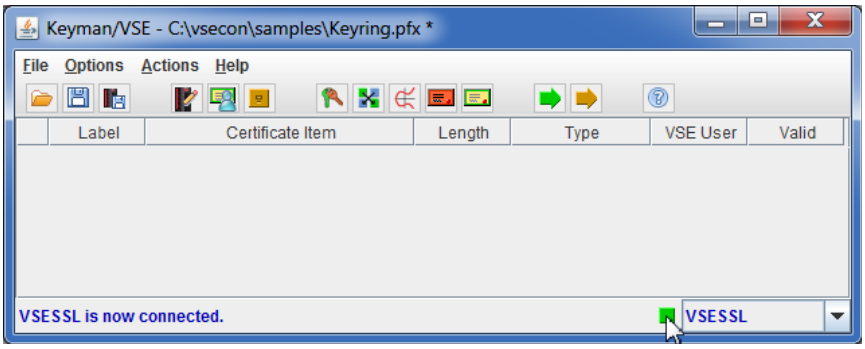
On the VSE Host – Properties dialog box press **New** to define a new VSE host. Then enter the VSE properties like IP address, VSE user and password and so on.



Press **Add** to add this definition to the Keyman/VSE configuration and continue adding further VSE systems or press **OK** to add this definition and leave the dialog box.

Now start the VSE Connector Server on the VSE side.

You may immediately check the connection by pressing the “red light button” left to the hosts drop-down box:



If the light turns to green, the VSE Connector Server is now connected.

4 Some basic knowledge about keys and certificates

This chapter provides some Keyman/VSE related overview on RSA keys and certificates. For a more detailed description on cryptography on z/VSE, refer to *z/VSE TCP/IP Support*, SC34-2706 and IBM Redbook *Security on IBM z/VSE*, chapter 4.

4.1 Symmetric and asymmetric keys

Keyman/VSE 6.1.0 supports the creation and management of two types of asymmetric keys:

- RSA keys

- Elliptic-Curve (EC) keys

Keyman/VSE does not support the creation of symmetric keys. Symmetric keys are created implicitly when opening an SSL/TLS connection. OpenSSL on z/VSE transparently uses crypto hardware (CCA coprocessors or CPACF) for generating random bytes to be used as symmetric session keys.

4.1.1 RSA keys

The term “RSA” is based on the initials of the three inventors of the RSA encryption algorithm: Ron Rivest, Adi Shamir, and Leonard Adleman. They were researchers at the M.I.T. and first described the algorithm in 1978.

RSA keys are so called “asymmetric” keys, because one key is used for encrypting data while a second key is used for decrypting. In contrast to RSA, a second type of digital key is called “symmetric” key. With symmetric keys encryption and decryption of data is performed using the same key. Examples of symmetric encryption algorithms are DES, Triple-DES, and AES.

Usually, RSA keys are not used for encrypting huge amounts of data because of their high computational effort. Instead, data is encrypted using a symmetric encryption algorithm, then the symmetric key, which just consists of a few bytes (normally 8 up to 32 bytes), is encrypted with an RSA key. The encrypted symmetric key is then put together with the encrypted data. This technique is for example used by Encryption Facility for z/VSE (refer to IBM Redbook “Security on IBM z/VSE”).

When using SSL, RSA encryption is used when opening a connection. After establishing the connection, data is symmetrically encrypted.

An RSA key pair consists of two keys: the public key and the private key. The public key consists of the public exponent and the public modulus. The private key can exist in two different formats, the Modulus-Exponent (ME) format and the Chinese-Remainder-Theorem (CRT) format. In the private ME form, the private key consists of the private exponent and the public modulus, in the CRT form, it consists of five CRT parts: first prime p, second prime q, inverse first prime dp, inverse second prime dq, and CRT coefficient U and the public modulus.

The ME format is usually used when encrypting information, while the CRT format is used for decrypting.

The following list shows this structure.

Public key:
- Public exponent (e)
- Public modulus (n)

Private key:
- Private exponent
  - CRT-form: p, q, dp, dq, U
  - ME-form: private exponent (d)
- Public modulus (n)

Note that the public modulus is part of both key parts: the public key and the private key. You will see these key parts when displaying the settings of an RSA key in Keyman/VSE (see section “Displaying key material” on page 21).

For more detailed information and mathematical background refer to the “RSA” section on Wikipedia:

http://en.wikipedia.org/wiki/Rsa

4.1.2 Diffie-Hellman parameters

Diffie-Hellman (DH) parameters consist of two numbers p (a large prime number) and g (the generator value, which is always 2 for OpenSSL). DH parameter generation is CPU expensive, and is therefore not done during the SSL/TLS handshake process. With the help of the DH parameters, the secret symmetric session key can be calculated on both sides without being sent over the network.

4.1.3 EC keys

Elliptic Curve Cryptography (ECC) is an encryption technique that provides public-key encryption similar to RSA. While the security strength of RSA is based on very large prime numbers, ECC uses the mathematical theory of Elliptic Curves and achieves the same security level with much smaller keys. EC keys are based on Elliptic Curves, i.e. a specific EC key is based on a specific Elliptic Curve.

The use of EC keys together with Diffie-Hellman parameters allows the use of additional SSL/TLS cipher suites prefixed with DHE-RSA and ECDHE-RSA. Keyman/VSE 6.1.0 supports the creation and upload of EC keys to a z/VSE system. DHE-RSA and ECDHE-RSA cipher suites can only be used with OpenSSL on z/VSE.

4.2 Types of SSL certificates

In general there are two types of SSL certificates:

- **Root certificates** belong to a Certification Authority (CA) and may be self-signed or signed by an official CA like Thawte or Verisign. They are called *private* when they contain a private/public key pair. They are called *public*, when they only contain a public key. Private root certificates themselves can be used to sign user certificates, establishing trust.

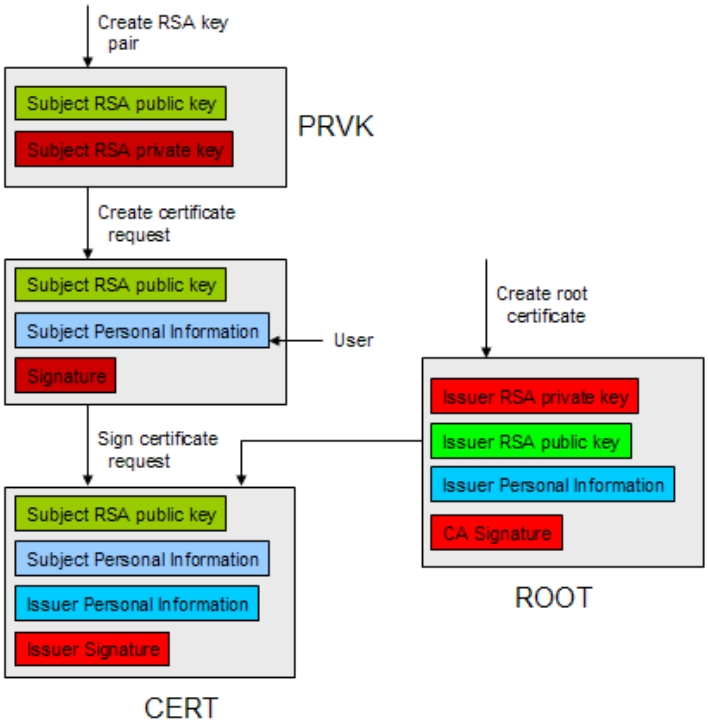
- **User certificates** are signed by a CA root certificate and are a vehicle to securely transport a public key over a network.

Keyman/VSE allows creating self-signed root certificates for testing purposes in a closed environment. Because they are not signed by an official CA, no one outside your test environment would trust them. Keyman/VSE also allows creating of CA-signed root certificates.

Keyman/VSE also allows creating certificate requests that can be signed by an external CA.

4.3 Structure of a key ring

A complete VSE key ring consists of an RSA key pair (the PRVK member), a root certificate (the ROOT member), and a user certificate (the CERT member). Below picture shows how they are related to each other.



The above steps to create a VSE key ring are supported in Keyman/VSE through wizard dialogs; however, each step can also be performed manually. The term “subject” always means the person or site who requests an SSL certificate, while the term “issuer” means the authority which signs a certification request.

5 Relationship to TCP/IP utilities

Keyman/VSE uses utilities provided by TCP/IP for VSE/ESA in order to upload keys and certificates to VSE. These utilities are primarily intended to be used manually, but are used internally by Keyman/VSE.

5.1 CIALSRVR

The CIALSRVR utility is started by Keyman/VSE when uploading an RSA key pair. It is used to receive encrypted key material from a CIAL client program and to store the RSA key in a VSE library member with member type PRVK. Keyman/VSE hereby acts as the CIAL client, i.e. implements the CIAL client/server protocol. Another CIAL client is provided by CSI and can be downloaded from the CSI website.

CIALSRVR is started with a JCL similar to the following.

```
// JOB CIALSRVR
// OPTION SYSPARM='00'
// LIBDEF PHASE,SEARCH=(IJSYSRS.SYSLIB,PRD1.BASE)
// EXEC CIALSRVR,SIZE=CIALSRVR,PARM='CRYPTO.KEYRING.TEST01'
SETPORT 6045
/*
/&
```

When started, CIALSRVR listens on the specified port to receive the RSA key material sent from a CIAL client. After storing the key in a PRVK member, CIALSRVR ends.

5.2 CIALROOT

The CIALROOT utility is used to upload a CA-root certificate to VSE and catalog it as a VSE library member with member type ROOT. Keyman/VSE uses JCL similar to the following.

```
// JOB CIALROOT
// OPTION SYSPARM='00'
// LIBDEF PHASE,SEARCH=(PRD1.BASE)
// EXEC CIALROOT,SIZE=CIALROOT,PARM='CRYPTO.KEYRING.TEST01'
-----BEGIN CERTIFICATE-----
MIICsDCCAhkCBB89tb0wDQYJKoZIhvcNAQEFBQAwgZ4xHjAcBgkqhkiG9w0BCQEW
D3p2c2VAZGUuaWJtLmNvbTELMAkGA1UEBhMCREUxGzAZBgNVBAgTEkJhZGVuLVd1
ZXJ0dGVtYmVyZzETMBEGA1UEBxMKQm9lYmxpbmdlbjEMMAoGA1UEChMDSUJNMRQw
EgYDVQQLEwtJQk0gR2VybWFueTEZMBcGA1UEAxMQUHJpdmF0ZSBLZXkgQ2VydDAe
Fw0xMDA5MTcxMDI5MTdaFw0xNTA2MTcxMDI5MTdaMIGeMR4wHAYJKoZIhvcNAQkB
...
HJ9yorVUeKrvZex2KD8VnDse0/fE98Y2CE255aeVRysozO6KVpYtgksbFL1lIhzG
KlKy08BTiqvh2ZJZZT0TDFFPPrM6nmKT2Y9dqz6i0kKpIkQZ8GcT+oEgiJTg29tB
3wnt+E0jVFzvnprlAgMBAAEwDQYJKoZIhvcNAQEFBQADgYEABPNowitNtANW7rPT
DOGgyv8GovEc5+oF+hP/LmHVaWQi7fArywCeqGPl2AAxtk68bY7rprNh8IP26ezw
X4qva7DeTi6fbLIHW/x7xijmHjqiiX+o+qMcDB6jjuxqKQmMb9hSfnmj/FVBCTJf
irdlc1givE1Cu7t/rupwliqEPhs=
-----END CERTIFICATE-----
/*
/&
```

The certificate data is given in its Base-64 encoded portable text form. A root certificate may be self-signed or signed by an official Certificate Authority (CA) like Thawte or Verisign.

5.3 CIALCERT

The CIALCERT utility is used to upload a user certificate to VSE and catalog it as a VSE library member with member type CERT. Typically, a user cert contains the public key part of the related PRVK member and is signed by the related ROOT certificate.

CIALCERT is used with JCL similar to the following.

```
// JOB CIALCERT
// OPTION SYSPARM='00'
// LIBDEF PHASE,SEARCH=(PRD1.BASE)
// EXEC CIALCERT,SIZE=CIALCERT,PARM='CRYPTO.KEYRING.TEST01'
-----BEGIN CERTIFICATE-----
MIICpjCCAg8CBB9OyGgwDQYJKoZIhvcNAQEFBQAwgZ4xHjAcBgkqhkiG9w0BCQEW
D3p2c2VAZGUuaWJtLmNvbTELMAkGA1UEBhMCREUxGzAZBgNVBAgTEkJhZGVuLVd1
ZXJ0dGVtYmVyZzETMBEGA1UEBxMKQm9lYmxpbmdlbjEMMAoGA1UEChMDSUJNMRQw
EgYDVQQLEwtJQk0gR2VybWFueTEZMBcGA1UEAxMQUHJpdmF0ZSBLZXkgQ2VydDAe
Fw0xMDA5MTcxMDQ3NTdaFw0xMTA5MTcxMDQ3NTdaMIGUMR4wHAYJKoZIhvcNAQkB
...
jKFxoWqF04OhJPVOb3vy0Rg2KJOoNm160byHNRq0WBbF1jcpOqOUTHppLjA8lzFj
e9gAC2j+bGbK4X2/qNd89YMH4zNjQdr24QNLQ/KTA4/kH0QXMjO/E/5iqtGkl88Z
MPMCAwEAATANBgkqhkiG9w0BAQUFAAOBgQBEeREKsunbLAHCo36IN8N1K2Ly7rf6
yaABtu01z77jw3K1aRlSVp9/Rynzi57jKVvh8Ow4E0G87IUCZKwb8RUmt1l9BC3i
852CEKo1X6zE0JYlnqF73oXVMuFVLJplrOXPY1uCfYdv8RYeAYyGEVOiOL7hY99W
m0JiBdh8Dwa1AA==
-----END CERTIFICATE-----
/*
/&
```

5.4 CIALSIGV

The CIALSIGV utility is used to verify the signature of a VSE keyring. A keyring consists of three VSE library members with member types

- PRVK: contains the RSA key pair.
- CERT: contains the public key of the PRVK together with some personal information and a signature created by the ROOT certificate.
- ROOT: is either a self-signed or CA-signed root certificate.

After creating a complete VSE keyring, CIALSIGV can be used to verify its correctness. CIALSIGV is used with JCL similar to the following.

```
// JOB CIALSIGV VERIFY SIGNATURE
// OPTION SYSPARM='00'             SYSID OF MAIN TCP/IP PARTITION
// LIBDEF *,SEARCH=(PRD2.TCP15G,PRD2.CONFIG,PRD1.BASE)
// EXEC CIALSIGV,SIZE=CIALSIGV,PARM='CRYPTO.KEYRING.TEST01'
/*
/&
$$ EOJ
```

In Keyman/VSE, the CIALSIGV utility is used when selecting **Actions** – **Validate VSE keyring**.

5.5 CIALCREQ

The CIALCREQ utility is used to create a certificate request from a given PRVK member. Basically this means to take the public key of the member PRVK and add some user provided personal information. Then, a hash value is calculated from public key and personal information, and finally signed with the private key. The certificate request (personal information, public key, hash algorithm, and signature) is then sent to a Certification Authority (CA), which constructs a x.509 certificate from the given information. The obtained x.509 certificate is then cataloged as a CERT member on VSE. Refer to RFC 2314, which describes the syntax for certification requests in detail. Also refer to section “Using a PRVK member on z/VSE” on page 19 for how to create a certificate request from a given RSA key pair.

Restriction: CIALCREQ cannot create a certificate request from a 4096-bit key.

CIALCREQ is used with JCL similar to the following.

```
// JOB CIALCREQ CREATE CERT REQUEST
// OPTION SYSPARM='00'             SYSID OF MAIN TCP/IP PARTITION
// LIBDEF *,SEARCH=(PRD2.CONFIG,PRD1.BASE)
// EXEC CIALCREQ,SIZE=CIALCREQ,PARM='CRYPTO.KEYRING.TEST01'
Common-name: www.ssl4vse.com
Organization Unit: Development
Organization: Connectivity Systems
Locality: Columbus
State: Ohio
Country: US
/*
/&
```

In Keyman/VSE, the CIALCREQ utility is used when creating a certificate request from an RSA key that is already stored on VSE in a PRVK member (pop-up menu of a root certificate – Create VSE cert via CIALCREQ).

6 Overview on key stores

There are many different types of key stores used on workstation platforms. However, three formats represent some common standard and are supported by Keyman/VSE.

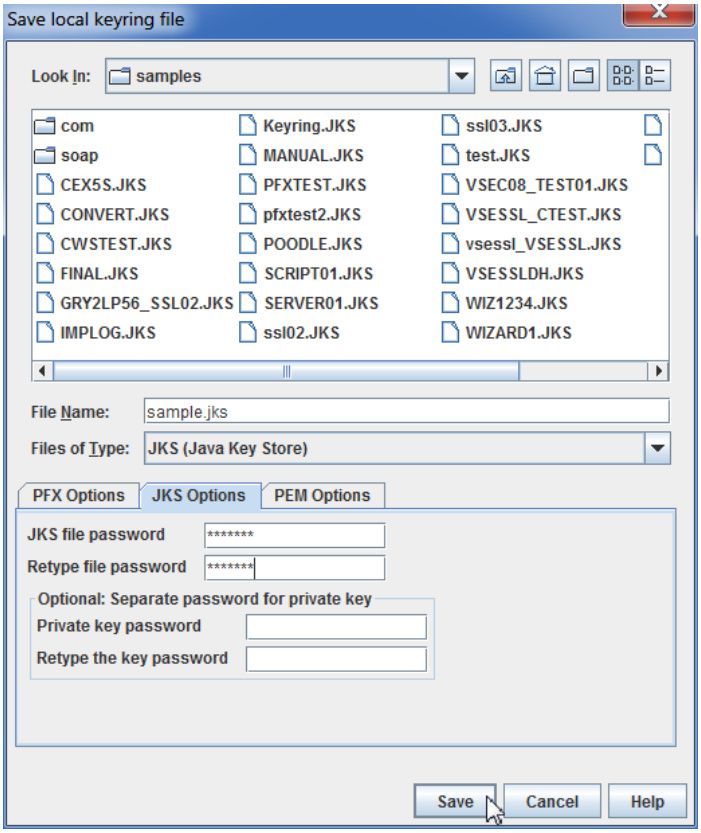
1. **PFX**: The PFX (Personal Information Exchange) format was initially defined by RSA Security and conforms to the PKCS#12 standard. PFX files can contain multiple keys and certificates and are themselves password-protected. PFX files are supported by Web Browsers like Microsoft Internet Explorer and Mozilla Firefox. Sometimes the file extension p12 is also used for the PFX format.

2. **JKS**: The JKS (Java Key Store) format is provided by Sun Microsystems and is the standard key store format for Java applications. Also JKS files are protected by a password. JKS files usually cannot be handled by Web Browsers. Part of each Java installation is the keytool.exe, which can also be used for maintaining JKS key stores.

3. **PEM:** The Privacy-enhanced mail (PEM) format is used by OpenSSL. PEM files can contain an RSA key pair, an SSL certificate or both. It can but must not be password protected. Whereas other keystore formats are just binary, the PEM file content is base-64 encoded

All three formats can be used for storing SSL certificates on a workstation when setting up an SSL connection to VSE. On the VSE side, the related keys and certificates are stored in a VSE key ring consisting of VSE library members.

You can specify the type of key store when saving certificate items in Keyman/VSE.



PGP (Pretty Good Privacy) uses another key store format (KDB: Key Data Base) that is not supported by Keyman/VSE, however, section “Setting up the RSA keys for Encryption Facility for z/VSE” on page 14 shows that Keyman/VSE can make PGP public keys usable for VSE.

7 Using Keyman/VSE

In general you will use Keyman/VSE for two main tasks: setting up SSL between a workstation and VSE, and setting up the RSA keys for Encryption Facility for z/VSE.

7.1 Setting up SSL between a workstation and VSE

Setting up SSL in various VSE environments is described in detail in IBM Redbook “Security on IBM z/VSE”, available online at

http://www.redbooks.ibm.com/abstracts/sg247691.html?Open

This includes setting up SSL for

- CICS Web Support (CWS)
- Secure Telnet
- Secure FTP
- WebSphere MQ for z/VSE
- SSL with z/VSE e-business connectors

Also, refer to other technical papers on the VSE homepage:

http://www.ibm.com/systems/z/os/zvse/documentation/security.html#howto

7.2 Setting up the RSA keys for Encryption Facility for z/VSE

Encryption Facility for z/VSE is an optional priced feature available for z/VSE 4.1 and later. It provides encryption of tapes (real tapes and virtual tapes) and VSE datasets on disk (SAM files, VSAM files, VSE Library members). Encryption Facility requires the CPACF (CPU Assist for Cryptographic Function, feature code #3863), i.e. runs on a z890 or higher.

Encryption can be done either by specifying a password or by using an RSA key to protect the encryption key used for encrypting the data. When RSA public-key encryption is used, Keyman/VSE allows creating and uploading the necessary RSA keys to VSE.

Encryption Facility for z/VSE V1.2 provides support for the OpenPGP message format (refer to RFC 4880). Therefore, support for importing PGP public keys and converting them into the x.509 certificate format has been added to Keyman/VSE. This is necessary for exchanging PGP public keys with other platforms, such as workstations and z/OS.

This is described in detail in IBM Redbook “Security on IBM z/VSE”, available online at

http://www.redbooks.ibm.com/abstracts/sg247691.html?Open

Refer to Chapter 4.6 “Software-based encryption with Encryption Facility for z/VSE V1R2”.

7.3 Creating self-signed and CA-signed key rings

The Keyman/VSE help section contains detailed descriptions of how to create VSE-side key rings. Open the Keyman/VSE “General Help” and click on the “How to...” link.

7.4 Support for a CIALEXIT phase

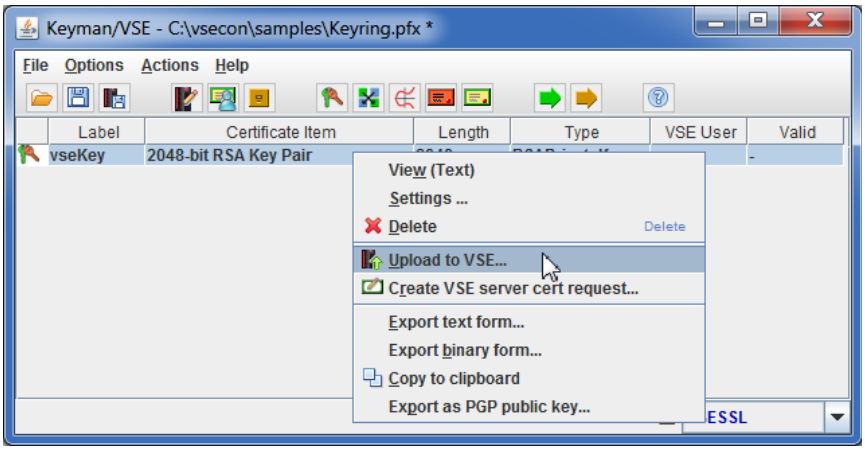
With the currently latest version of Keyman/VSE from Oct. 2010, support for a CIALEXIT phase is provided. A CIALEXIT phase allows defining a custom passphrase that must be entered whenever uploading a private key to VSE via the CIALSRVR utility.

When not using a CIALEXIT, a CIAL client encrypts the created binary key material with a hard-coded Triple-DES or AES key. A SHA-1 hash of a hard-coded passphrase is appended to the key material and sent to CIALSRVR, which verifies the passphrase hash before writing the key into a PRVK member.

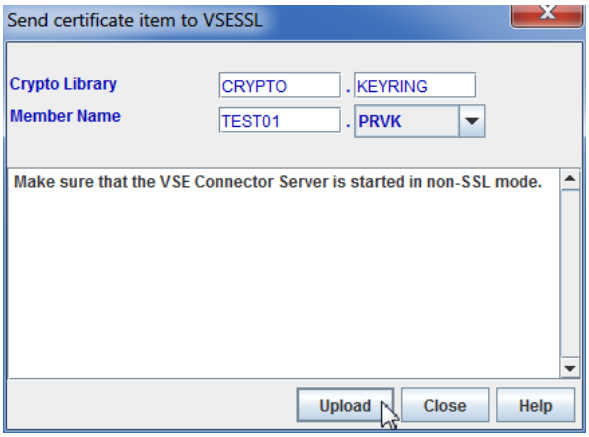
With a CIALEXIT, this process gets much more secure, because the passphrase and involved encryption keys are under full control of the customer. A sample CIALEXIT program is provided with the Keyman/VSE installation package.

If a CIALEXIT phase is cataloged on VSE, CIALSRVR enforces Keyman/VSE to display a password prompt. The entered passphrase is then SHA-1 hashed and sent to CIALSRVR, which verifies the password hash with the password in CIALEXIT.

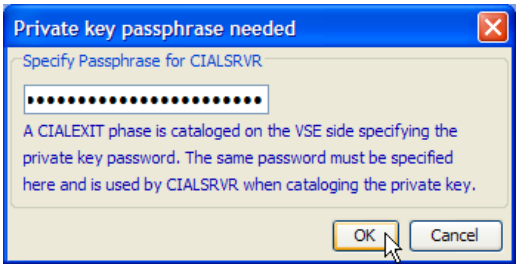
The following dialog sequence results.



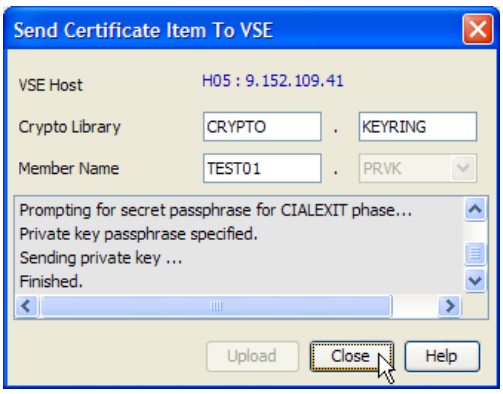
First, you create an RSA key and select “Upload to VSE”.



Press **Upload**.



The “Private key passphrase needed” dialog box is displayed. Here enter the secret passphrase specified in CIALEXIT.



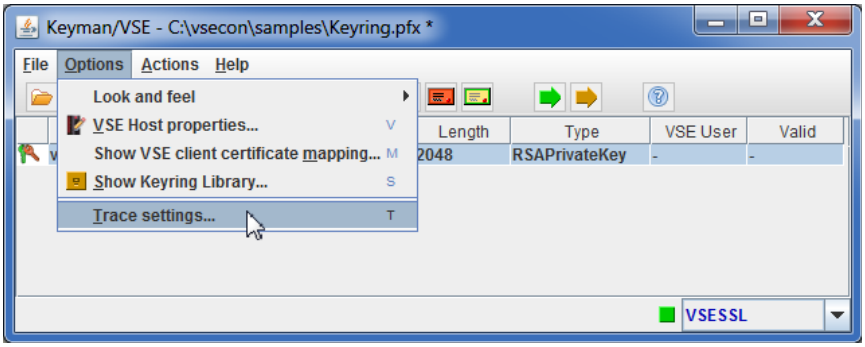
Press **Close** to end the procedure.

When using a CIALEXIT phase you have to consider the following.

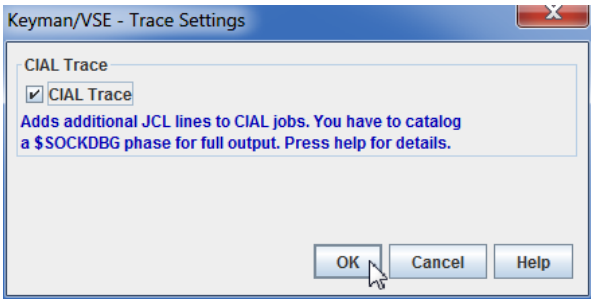
- CIALEXIT not only requests a secret passphrase from the user to be allowed for storing the key data, but also uses the hard-coded TDES or AES key in CIALEXIT to encrypt the RSA key data in the PRVK member. This causes the key and CIALEXIT phase tied together and makes it impossible to simply punch or restore a key at another site.
- As a consequence, if the CIALEXIT phase ever gets lost or is changed accidentally, the related RSA key is no more usable.
- Regardless whether using a CIALEXIT phase or not, Keyman/VSE does encrypt the RSA key with a hard-coded TDES or AES key before sending the key blob to CIALSRVR. CIALSRVR then re-encodes the RSA key with the TDES/AES key in CIALEXIT before writing it to the PRVK member.

7.5 Activating a CIAL trace

If you have any problems cataloging keys or certificates, you can activate a CIAL trace. On the Keyman/VSE main window select Options – Trace settings.



On the Trace Settings box just mark checkbox CIAL Trace.



Press **OK**.

The CIAL trace generates SDUMPS in the output of all CIAL utilities. Additional JCL statements are added to the JCL created by Keyman/VSE:

```
// OPTION NOSYSDMP
// UPSI 1
```

In addition to activating the trace in Keyman/VSE, you have to catalog a $SOCKDBG phase for full list output.

```
// JOB $SOCKDBG
// OPTION CATAL
// LIBDEF *,CATALOG=PRD1.BASE
// EXEC ASMA90,SIZE=ASMA90
         PUNCH    ' PHASE $SOCKDBG,* '
$SOCKDBG CSECT
         SOCKDBG  CSECT,         GENERATE A PHASE                        X
               FL01=$DBGWLST,  +DBGWLOG, MESSAGES TO SYSLST AND SYSLOG X
               FL02=$DBGISON,    DEBUG IS ON                           X
               FL03=$DBGNONE,    NONE                                  X
               MSGT=$DBGALL,     ISSUE ALL DIAGNOSTIC MESSAGES         X
               DUMP=$DBGNONE,    NO  DIAGNOSTIC SDUMPS FOR IPNRBSDC    X
               SSLD=$DBGSDMP,    YES DIAGNOSTIC SDUMPS FOR IPCRYPTO    X
               CIAL=$DBGSDMP,    YES DIAGNOSTIC SDUMPS FOR IPDSCIAL    X
               CECZ=$DBGNONE     NO  DIAGNOSTIC SDUMPS FOR CIALCECZ
         END   $SOCKDBG
/*
// EXEC LNKEDT,SIZE=512K
/*
/&
```

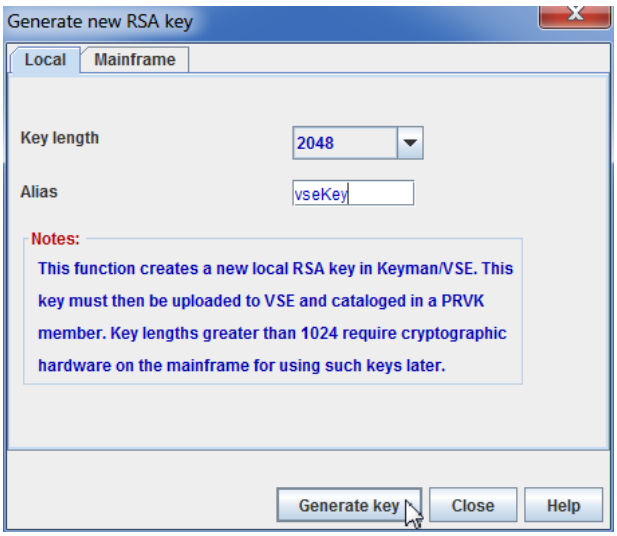
8 Overview of selected functions

This chapter adds some information about Keyman/VSE that might not be explicitly mentioned in other books.

8.1 Creating keys

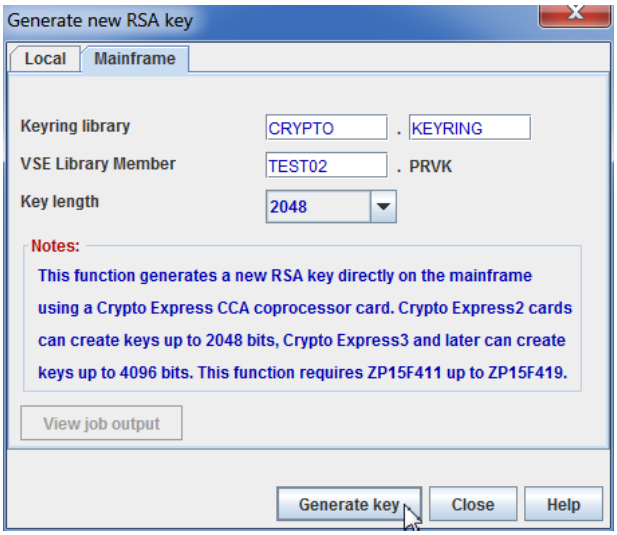
Keyman/VSE provides two functions for generating RSA keys.

1. A key can be created locally in Keyman/VSE using Java functionality. The key must then be uploaded to VSE in a separate step. Although the key material gets encrypted before sending it over the network, this is clearly a security exposure. You may consider using a CIALEXIT phase in this case (refer to section “Support for a CIALEXIT phase” on page 14).



2. A key can be created directly on the mainframe via the CIALSRVR utility. This function requires cryptographic hardware on the host side:

   - Creating keys up to 2048-bit key length requires a Crypto Express2 card
   - Creating keys with 4096-bit key length requires a Crypto Express3 card



   This function uses the new command GENRSAPK provided by the CIALSRVR utility.

For more information about System z cryptographic hardware refer to

http://www.ibm.com/systems/z/security/cryptography.html

Note that the usage of keys greater than 1024 bits always requires a crypto card on the host side. TCP/IP for VSE/ESA only provides a software implementation of the RSA algorithm for 512 and 1024 bit keys.

8.2 Creating certificates

Actually there are three ways of creating a certificate on the basis of a given RSA key, some personal information to be specified by the user, and a root certificate used to create the signature.

8.2.1 Using the wizard dialogs

The easiest way of creating a complete VSE key ring is using the wizard dialogs. Pressing the green arrow button creates a self-signed key ring, i.e. uses a self-signed root certificate. Pressing the yellow arrow button allows interacting with an external Certificate Authority (CA), like Thawte or Verisign.

8.2.2 Doing it locally in Keyman/VSE

This option requires some knowledge about the relationship between RSA key, certificate request, and root certificate, but allows manipulating all items manually. All actions are performed locally in Keyman/VSE. There are no CIAL utilities used.

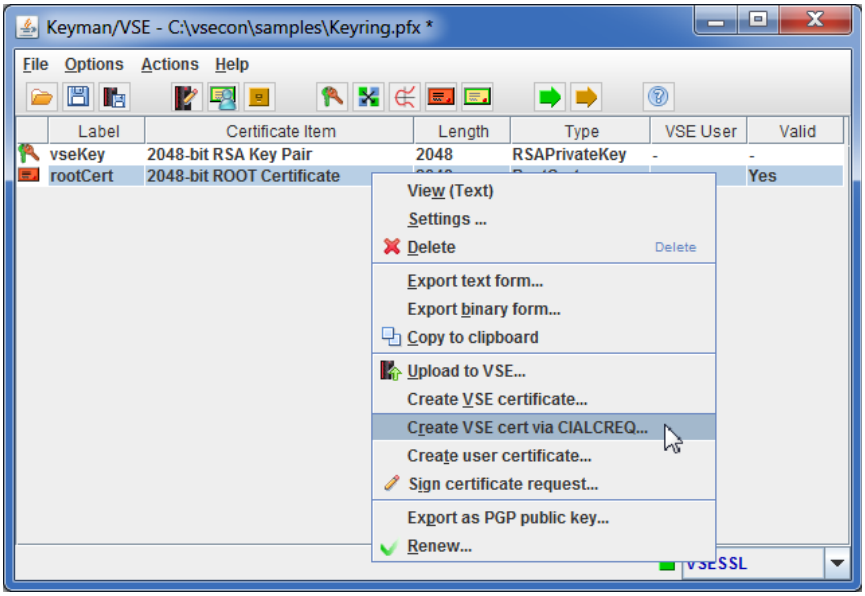
The steps are:

1. Create a new RSA key
2. Create a self-signed root certificate
3. Create a certificate request with the public key from the RSA key pair.
4. Sign the certificate request with the root certificate.
5. Delete the certificate request.

The steps are described in detail in the Keyman/VSE “How to” help section.

8.2.3 Using a PRVK on VSE

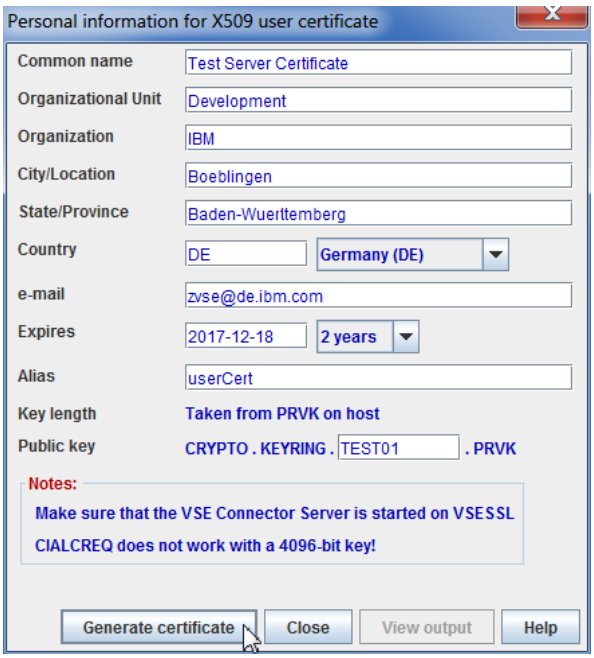
While the two above alternatives assume the RSA key being present in Keyman/VSE, this option allows using a remote PRVK for creating the certificate request.



Select option “Create VSE cert via CIALCREQ”.

On the next dialog box, the PRVK to be used can be specified.

Restriction: this function does not work with a 4096-bit key, because the CIALCREQ utility cannot handle this key length. Use the native Keyman/VSE function instead (pop-up menu of an RSA key – Create VSE server cert request).



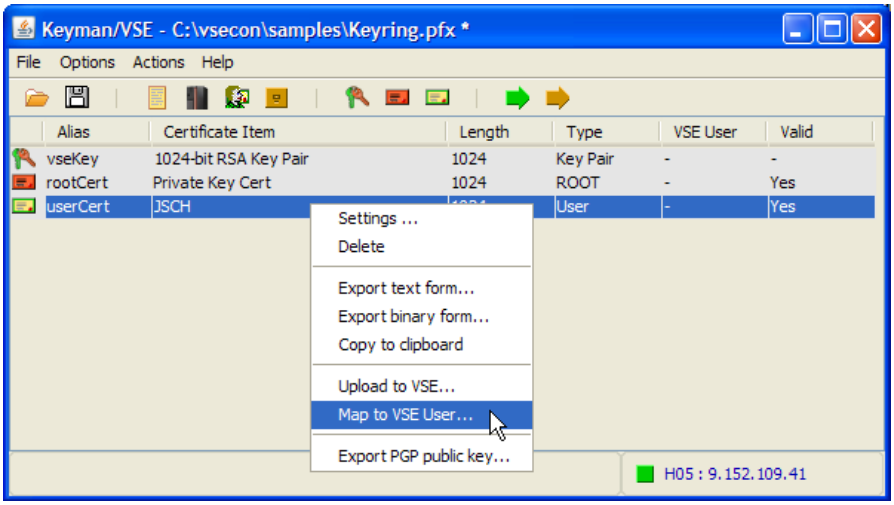
Press **Generate certificate**.

8.3 Using certificate mappings

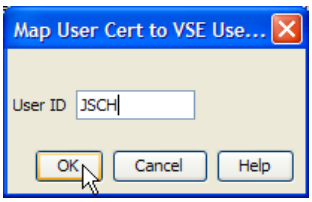
Keyman/VSE supports mapping of SSL client certificates to VSE user IDs. This is mainly used by CICS Web Support (CWS) together with SSL client authentication. When a CWS SSL client tries to invoke a CICS transaction, the mapping between SSL client certificate and VSE user ID allows deciding whether to grant or deny access.

The VSE Java-based connector also supports certificate mapping. The VSE Navigator application is an example for using certificate mapping in order to logon to VSE without being prompted for a password.

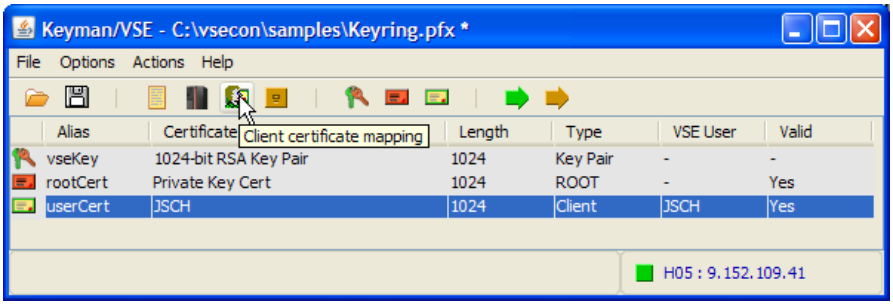
Mapped SSL client certificates are not uploaded to VSE via CIAL utilities. Instead, the BSSDCERT utility provided by the Basic Security Manager (BSM) is used. How to use BSSDCERT manually is described in the z/VSE Administration Guide. However, Keyman/VSE can create and submit all jobs automatically. From the GUI perspective there is no difference between uploading mapped and unmapped certificates. Just select “Upload to VSE” from the pop-up menu of the certificate.



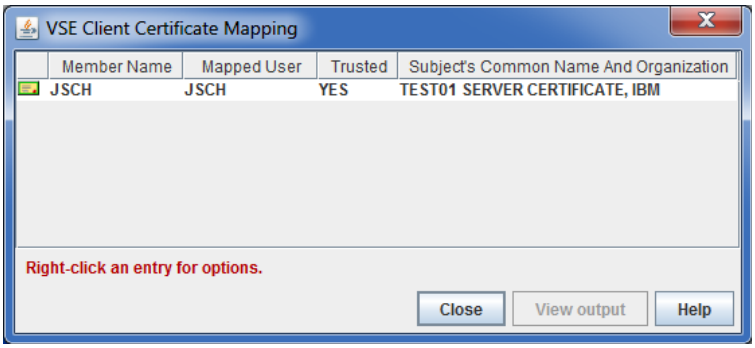
On the next dialog box enter the VSE user ID to which this client certificate shall be mapped.



After uploading a mapped certificate to VSE, the mapping can be displayed via the “Client certificate mapping” function.



The following dialog box basically shows the same information as the Interactive Interface dialog "MAINTAIN CERTIFICATE - USERID LIST" (fast path 2.8.4).

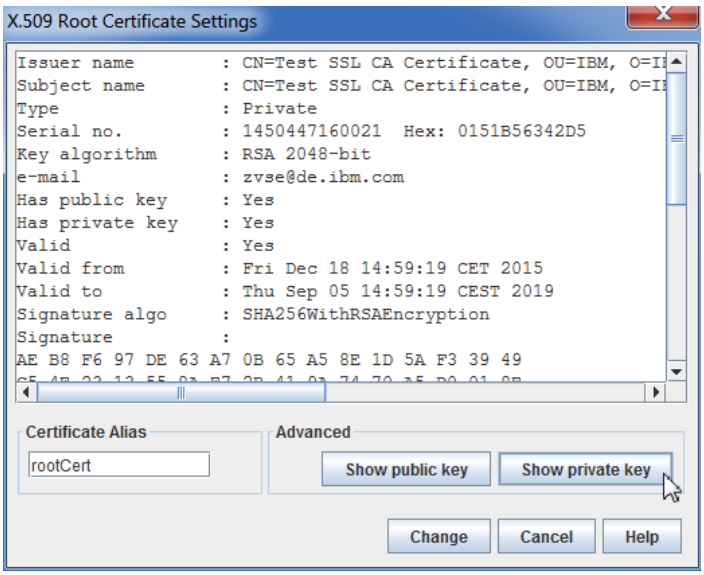


The next section describes some advanced functions that are normally not needed when just maintaining keys and certificates.

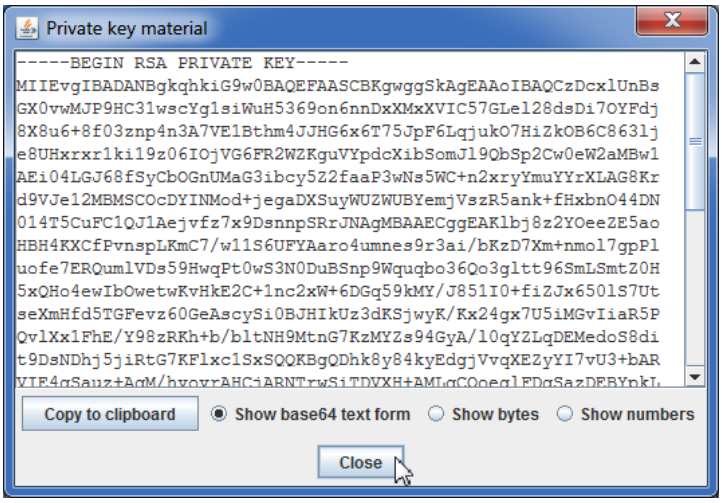
8.4 Displaying key material

The key parts of an RSA key or SSL certificate can be displayed and exported via the pop-up menu “Settings” function. This can help comparing the key parts of different keys or certificates for debug purposes. Just double-click an item in the Keyman/VSE main window to open the Settings dialog box.

For certificates, the public and private key parts can be displayed separately.



For example, press the **Show private key** button.

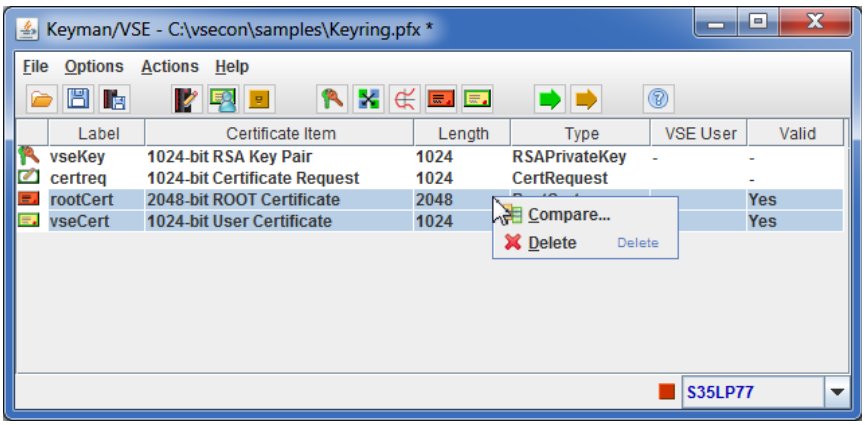


The displayed information can be copied to the clipboard.

8.5 Comparing keys and certificates

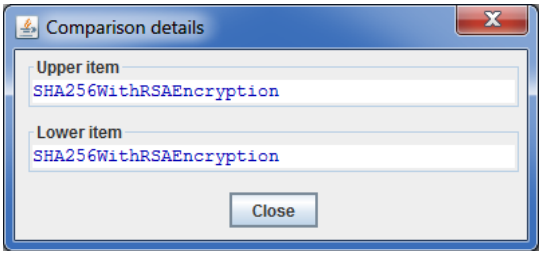
Sometimes it is useful to compare two keys or certificates in order to verify the correctness of your setup. Keyman/VSE 6.1.0 provides a dialog to compare two keys or certificates.

Select the two items in the Keyman/VSE main window and select Compare.



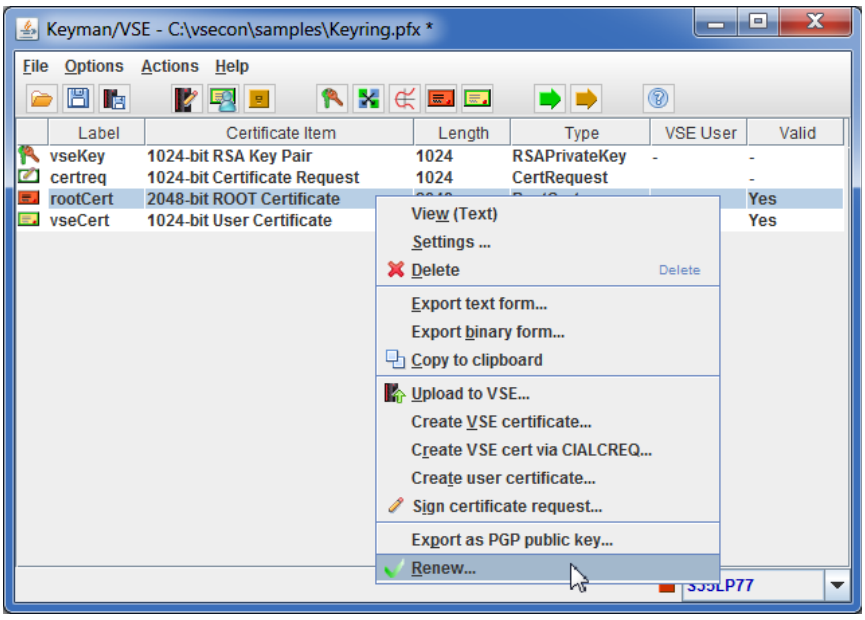
In this example, the certificate request was created from the RSA key, so both items have the same public key.

Click on one of the push buttons on the right to see comparison details:

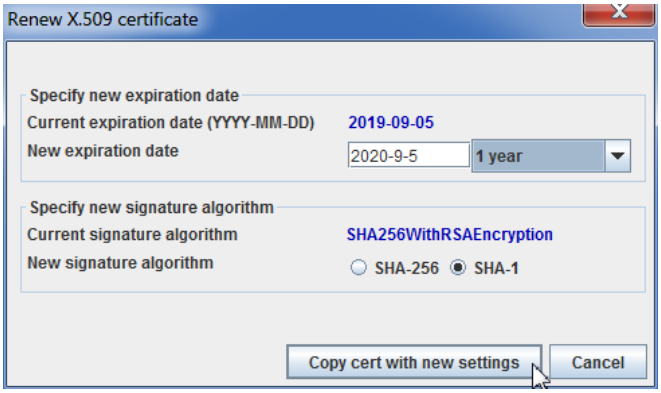


8.6 Renewing a certificate

Sometimes it even might be helpful to extend the validity period of a certificate or recreate it with a different signature algorithm. This is now supported by dialog Renew certificate.



Right-click a certificate and select **Renew**.



Renewing a certificate makes a copy of the certificate with all properties like private/public keys, issuer and subject information, serial number and so on. However, when changing the signature algorithm, a new signature is created

The following prerequisites must be fulfilled when renewing a certificate:

1. A self-signed private certificate can be renewed without additional information, because the new signature can be created using its private key.

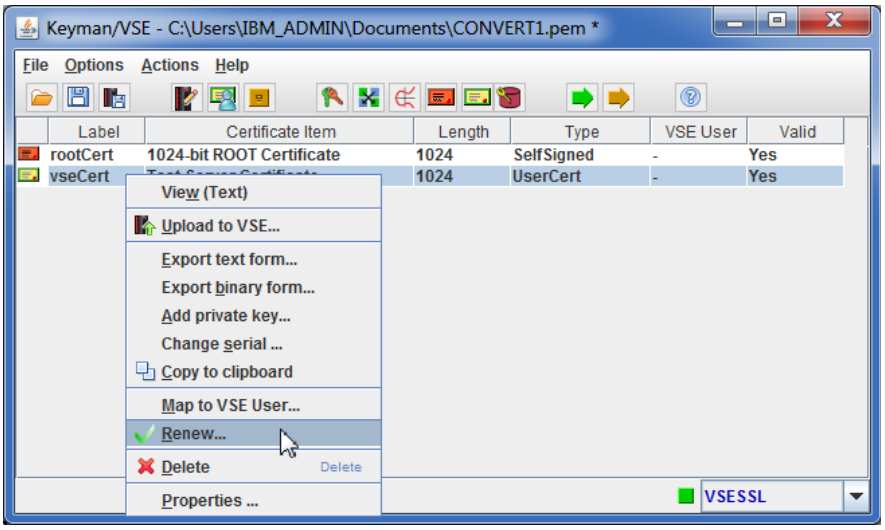
2. Renewing a user certificate *with an own private key* requires a new signature from the original CA certificate that was used to sign the certificate before. Therefore, Keyman/VSE just creates a new Certification Request that can then be signed by a CA in a separate step.

3. A user certificate *without an own private key* cannot be renewed unless the original private/public key pair is available in Keyman/VSE. If this private/public key pair is available, a new Certification Request is created with a signature from the private key.

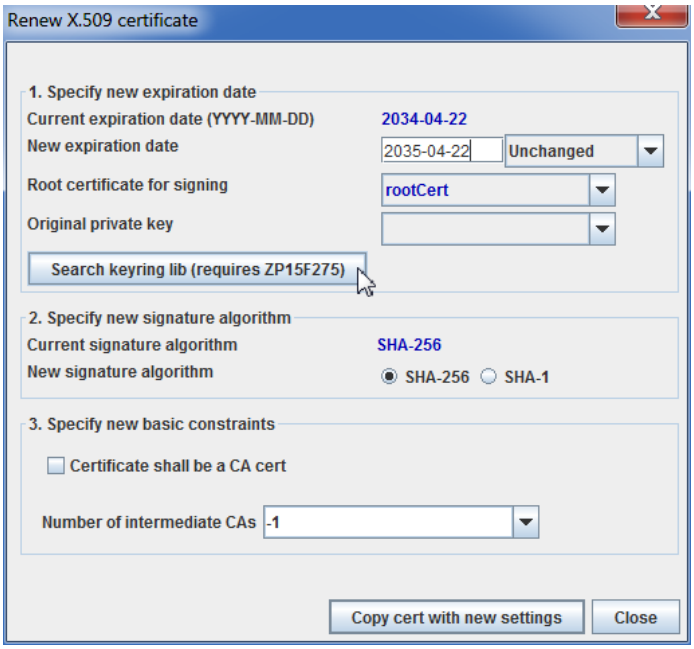
8.7 Renewing a certificate using a host-side PRVK

As said in the previous section, a user certificate *without an own private key* cannot be renewed unless the original private/public key pair is available in Keyman/VSE. However, if the original RSA key is available on a VSE system as a PRVK member, you can either download this key into the Keyman/VSE tool, or let Keyman/VSE search the host-side keyring library for a matching RSA key.

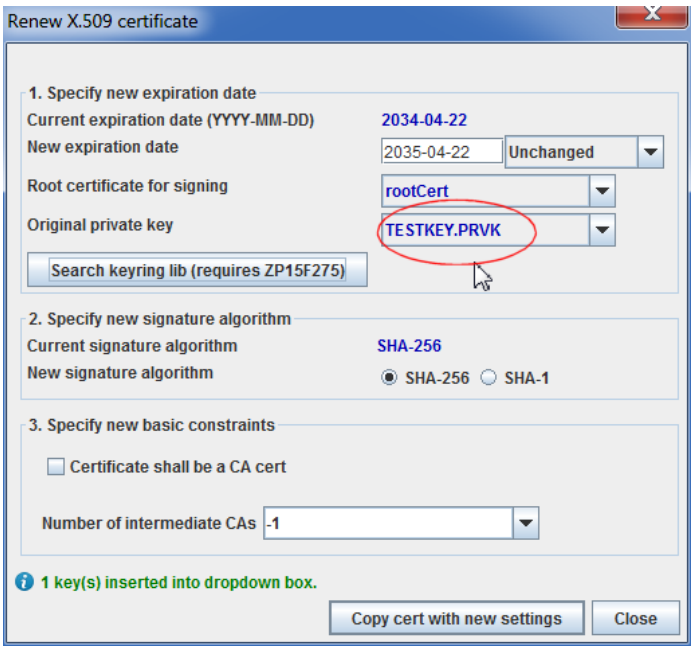
Let's assume you have a user certificate and the related CA root certificate in Keyman/VSE, but the corresponding RSA key that was used to create the user certificate's request, is no longer available locally.



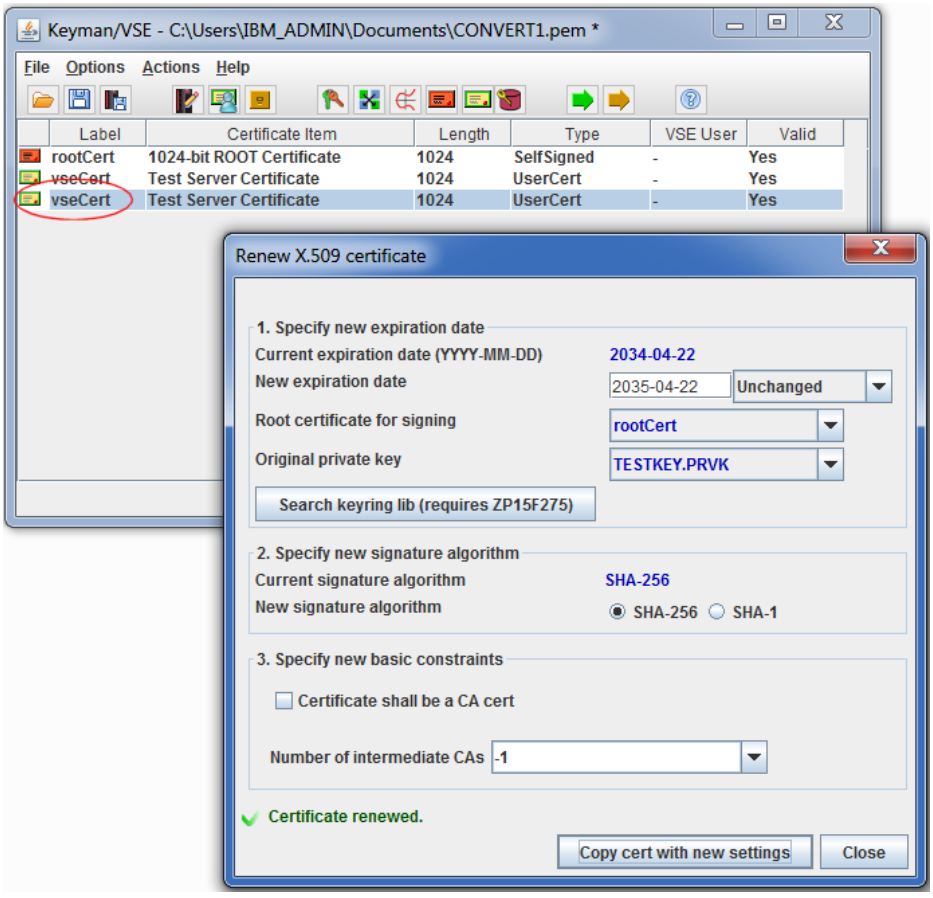
Right-click the user certificate and select **Renew…**



The **Renew X.509 certificate** box already shows your local CA root certificate to be used for applying the signature to the renewed certificate. Now press the **Search keyring lib** button to scan the host-side keyring library for matching PRVKs.



Matching keys are now displayed in the **Original private key** drop-down list box. You may now change the expiration date, and/or signature algorithm, and/or basic constraints. Finally press the **Copy cert with new settings** button.



The user certificate is now renewed with changed expiration period and/or signature algorithm.

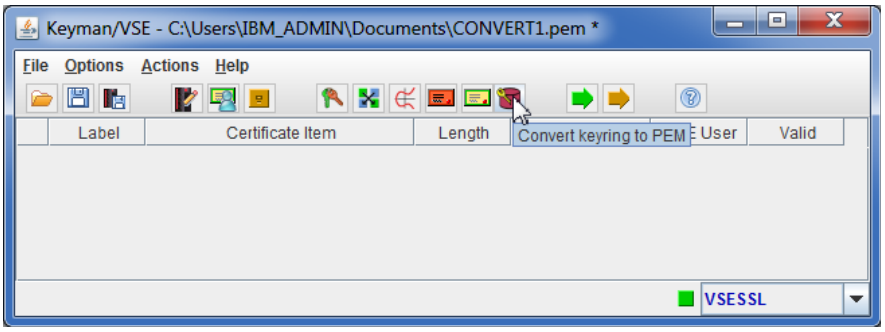
8.8 Converting keyrings

VSE keyrings, consisting of a set of three VSE library members with member types PRVK, CERT, and ROOT, can be converted to a keyring usable by OpenSSL. The contents of the three members is extracted and saved in a PEM file.

Note: This function requires either

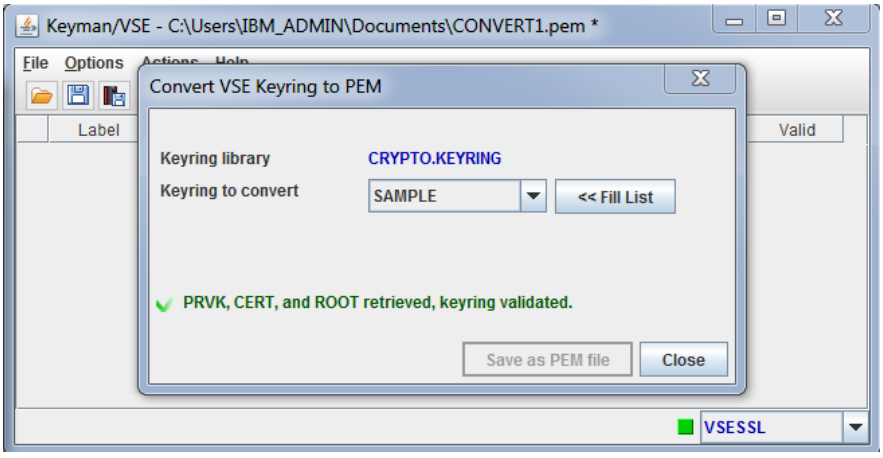
- TCP/IP for z/VSE V2.1 or
- TCP/IP for VSE V1.5F with APAR PI59039, PTFs UI37730 (5.1), or UI37731 (5.2).

On the Keyman/VSE main window, click on **Convert keyring to PEM** toolbar button.

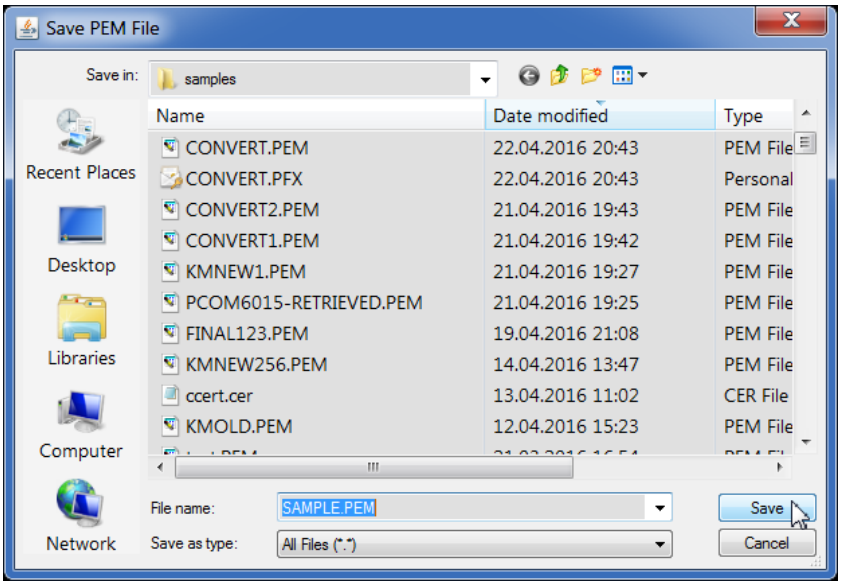


On the **Convert VSE keyring to PEM** dialog box, click on button **<< Fill List.**

Complete VSE keyrings, consisting of the three members .prvk, .cert, and .root, are added to the list. You can then save each keyring as a separate PEM file by pressing the **Save as PEM file** button.



When the keyring is validated, i.e. checked for consistency, a platform dependent **Save dialog** opens.



Specify the name and location of the PEM file and press **Save**. You may repeat these steps for further keyrings.

9 Known problems

This section describes some known problems.

9.1 SSL203E RSAD failed

Symptom:

Message SSL203E RSAD failed RC=0000002E(RSADNOHC) reason=000004B2 is issued when trying to open an SSL connection.

Reason:

Return code RSADNOHC indicates “no hardware crypto” when performing an RSA decryption. Most likely you are using an RSA key with a key length greater than 1024 bits. TCP/IP for VSE/ESA has a software implementation of the RSA algorithm up to 1024 bits. Greater keys require a crypto card installed in your mainframe. Supported cards are currently: PCICA, PCIXCC, Crypto Express2 (CEX2C and CEX2A), and Crypto Express3 (CEX3C and CEX3A). For more information on cryptographic hardware for System z refer to

http://www.ibm.com/systems/z/security/cryptography.html

10 More information

You can find more information in these books and web sites:

VSE Homepage
http://www.ibm.com/servers/eserver/zseries/zvse/

Keyman/VSE tool and VSE Connector Client
http://www.ibm.com/servers/eserver/zseries/zvse/downloads/

z/VSE Administration
http://www.ibm.com/systems/z/os/zvse/documentation/#vse

z/VSE e-business Connectors User's Guide
http://www.ibm.com/systems/z/os/zvse/documentation/#conn

Redbook: Security on IBM z/VSE, SG24-7691
http://www.redbooks.ibm.com/abstracts/sg247691.html?Open

Technical papers on VSE homepage
http://www.ibm.com/systems/z/os/zvse/documentation/security.html#howto

RFC 4880, OpenPGP message format
http://tools.ietf.org/html/rfc4880

CSI International Homepage
http://www.csi-international.com/

CSI provided CIALClient
http://www.csi-international.com/download.htm
Here click on link "Download SSL components"

Wikipedia article on RSA
http://en.wikipedia.org/wiki/Rsa

Overview on System z cryptographic hardware
http://www.ibm.com/systems/z/security/cryptography.html