

# **Black●Vault HSM**

## **Java Jarsigner**

## **Integration Guide**

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### **3. Introduction**

The BlackVault Hardware Security Module (HSM) integrates with Java Jarsigner to enable you to identify the publisher of a software component before running it on your computer and to verify that no one has altered the code after it has been signed. Java Jarsigner relies on proven cryptographic techniques and the use of one or more private keys to sign and time-stamp the published software. It is important to maintain the confidentiality of these keys.

The benefits of using an HSM with Java Jarsigner include:

- Protection for the organizational credentials of the software publisher.
- Secure storage of the private key.
  - Signing code within a cryptographically secure environment
- FIPS 140-2 level 3 validated hardware.

### 3.1. Supported Operating Systems And Java Versions

Supported operating systems

OS Name	Version	32 bit	64 bit
Windows	7	X	X
	Server 2008 R2 x64		X
	8.1	X	X
	Server 2012 x64		X
	Server 2012 R2 x64		X
	10	X	X
	Server 2016 x64		X
Ubuntu	12.04	X	X
	14.04	X	X
	16.04	X	X
Centos	6	X	X
	7 x64		X
Red Hat	6 x64		X
	7 x64		X
Open Suse	13.2	X	X
	42.1 x64		X
Debian	7.9	X	X
	8.4		X

The Java version used must support the Sun PKCS#11 provider. This includes Java 8 and later versions as well as the 32 bit version of Java 7.

## 4. Procedure

To proceed the following is needed:

- BlackVault HSM
- BlackVault Card Set
- BlackVault HSM Setup CD
- A client computer that has a supported Operating System installed.

Additionally, the BlackVault must be Initialized and Configured properly (see section 6.3 and 6.4 of the BlackVault HSM User Guide for more details)

To setup Java with the BlackVault HSM:

- Install the appropriate version of Java (if not already installed)
- Install the BlackVault HSM Libraries onto the Client Machine (included on the Setup CD)
- Run the Setup Wizard
- Validate operation (i.e. create test key .... Etc.)

The following assumes you already initialized the BlackVault HSM and are installing this software on a machine that does not already have java working with the BlackVault.

### 4.1. Install Java

To Install Java please consult the proper Java Documentation typically found here:

[https://www.java.com/en/download/help/download\\_options.xml](https://www.java.com/en/download/help/download_options.xml)

## 4.2. Install BlackVault Library and integrate with Java

The BlackVault communicates over the network using PKCS#11. For a host to communicate with the BlackVault, the BlackVault's PKCS#11 library, TLS certificates, and pkcs.dat must be installed first. Additionally, the Java files nss.cfg and java.security must be correctly setup.

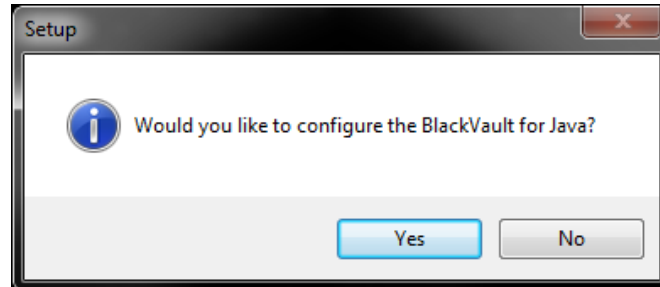
If installing the HSM client application on a Windows client, proceed to Section 4.2.1; if on a Linux Client, proceed to Section 4.2.2.

### 4.2.1. Windows

1. Insert the BlackVault HSM Setup CD into your computer, on it you will find a file called bv-setup.exe
2. Run bv-setup.exe
3. Windows asks if you want the installer to make changes to computer, select yes.

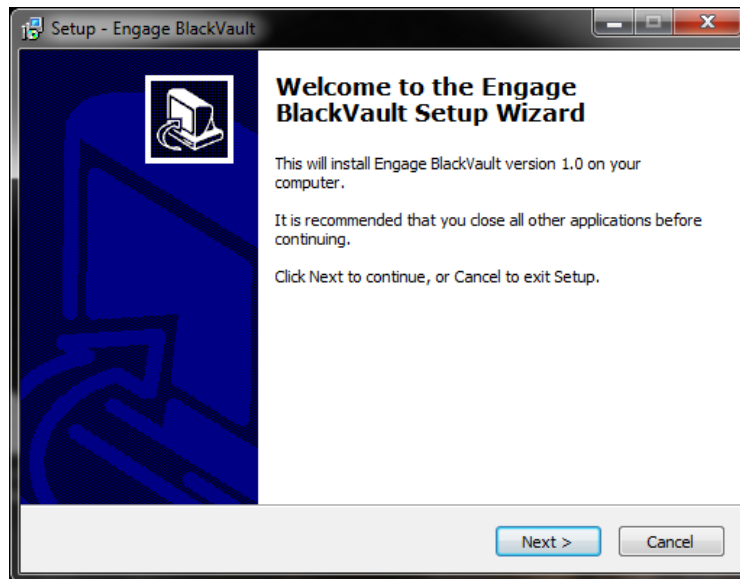
4. The installer asks, "Would you like to configure the BlackVault for Java?" select yes or no.

a. if no is selected, skip step 6



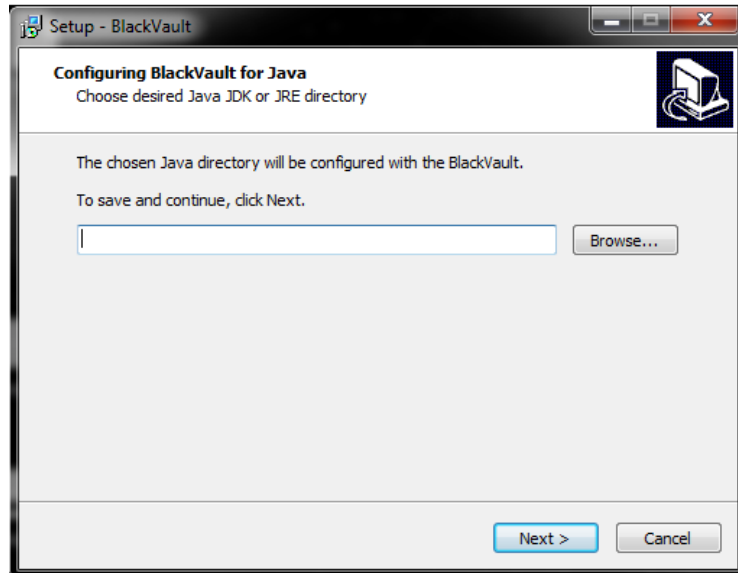
b. If yes is selected, perform step 6

5. The first window you will see is the overview window. It goes over what will be installed. Select Next to continue.

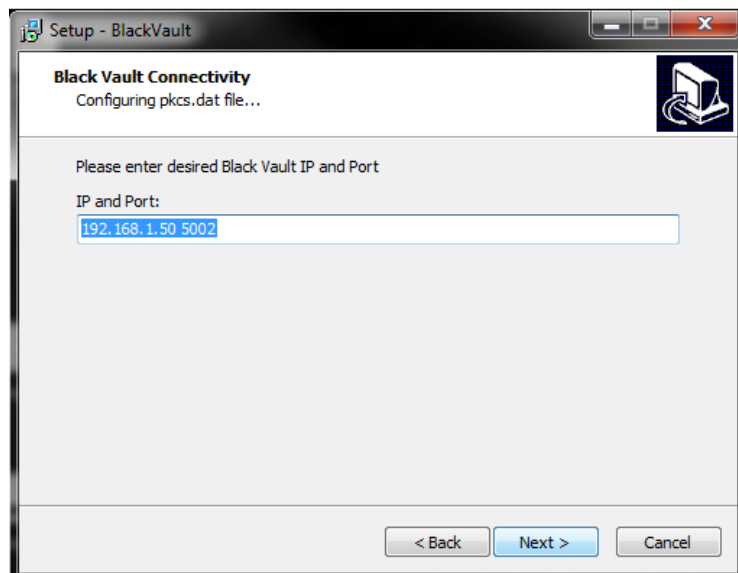




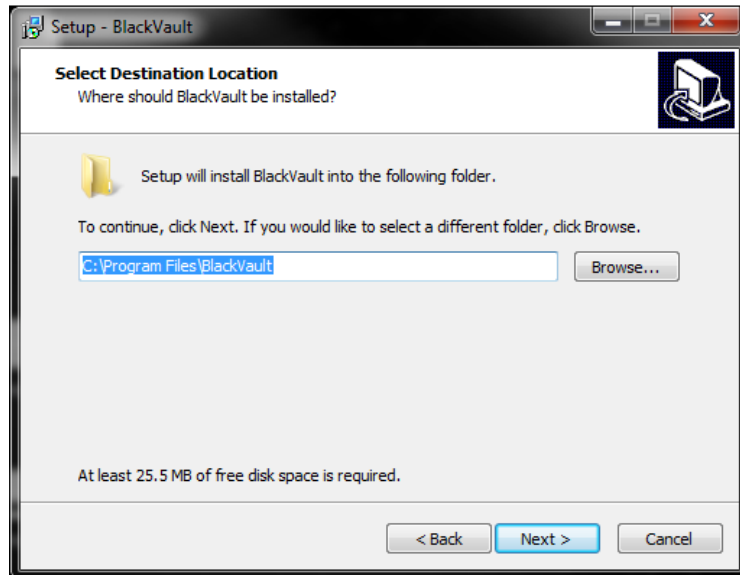
6. Next the installer asks for the Java directory currently being used on Windows. Browse for the desired top-level Java directory (usually in C:/Program Files/Java/jre8 or C:/Program Files(x86)/Java/jre8) then press next



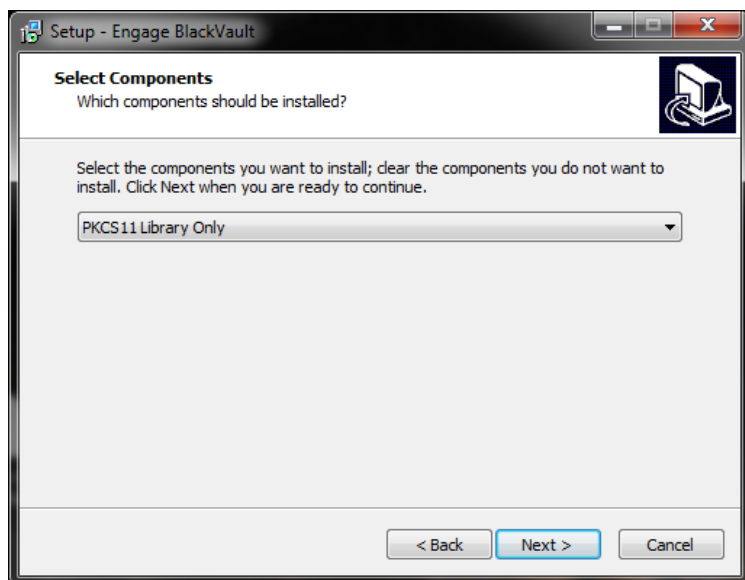
7. Next the installer asks for the BlackVault IP address and TLS Port. Enter those there and press next.



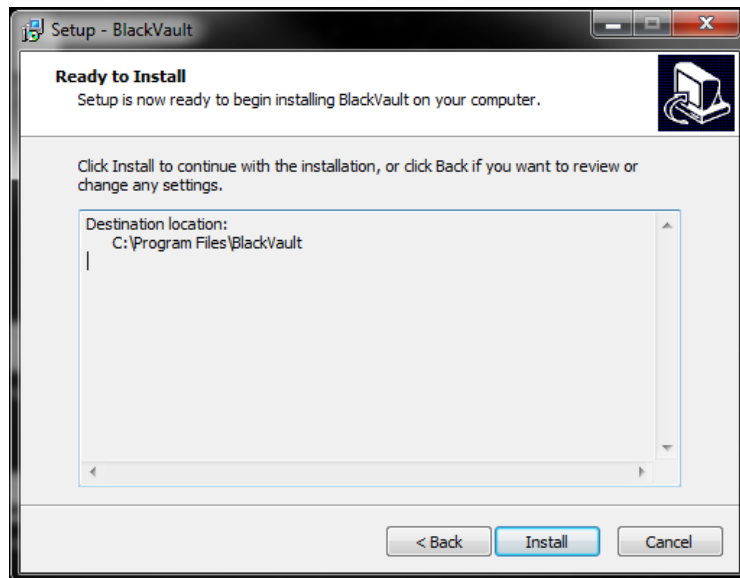
8. Next, the installer asks for the location of the directory to install the necessary files to. Either use the default location, or to select a new location, click browse and specify the new location.



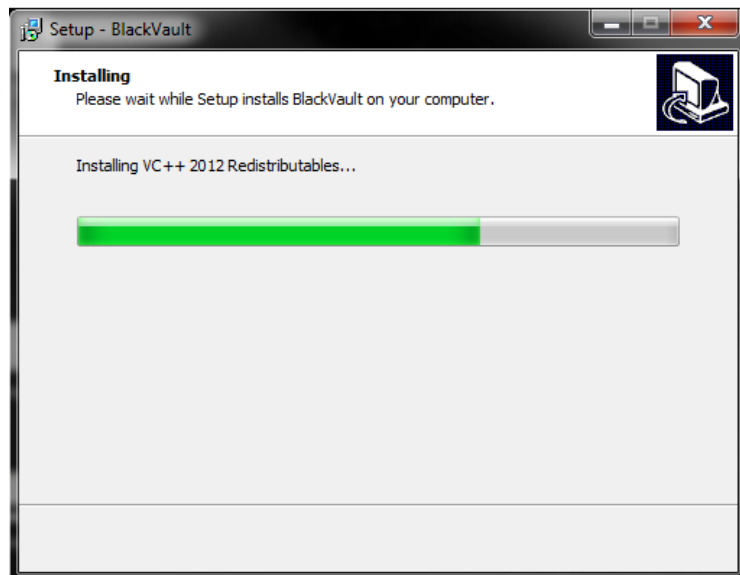
9. Next, the installer asks for which components to install, the Engage BlackVault Cryptography Provider (CNG/Authenticode and PKCS#11 libraries), or just the PKCS#11 Library

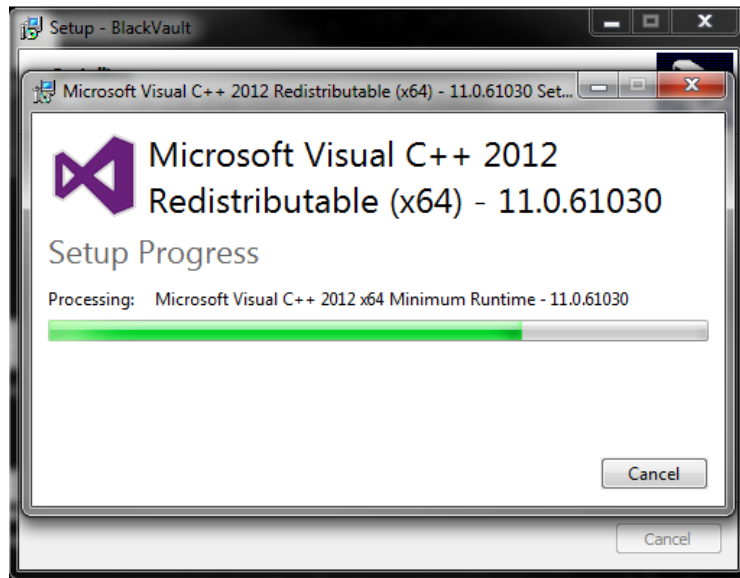


10. The installer then gives a summary of items to be installed press install to continue.

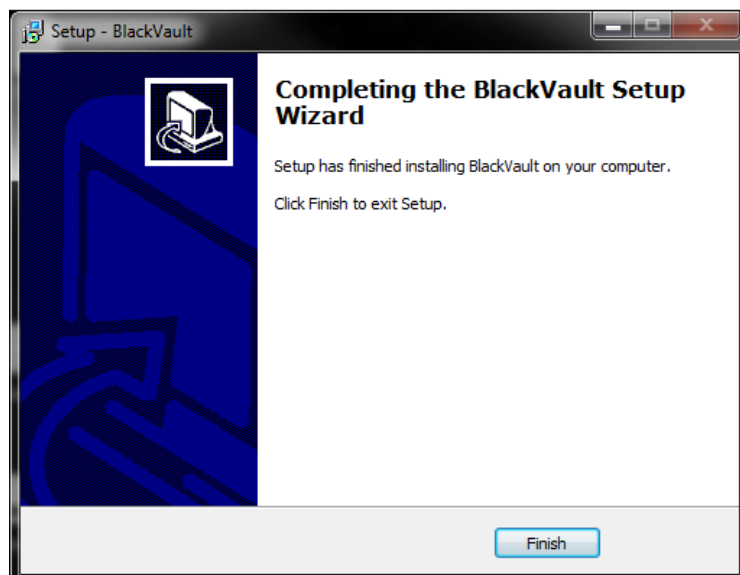


11. The installer then installs all the components, including a Microsoft Visual C++ Redistributable.



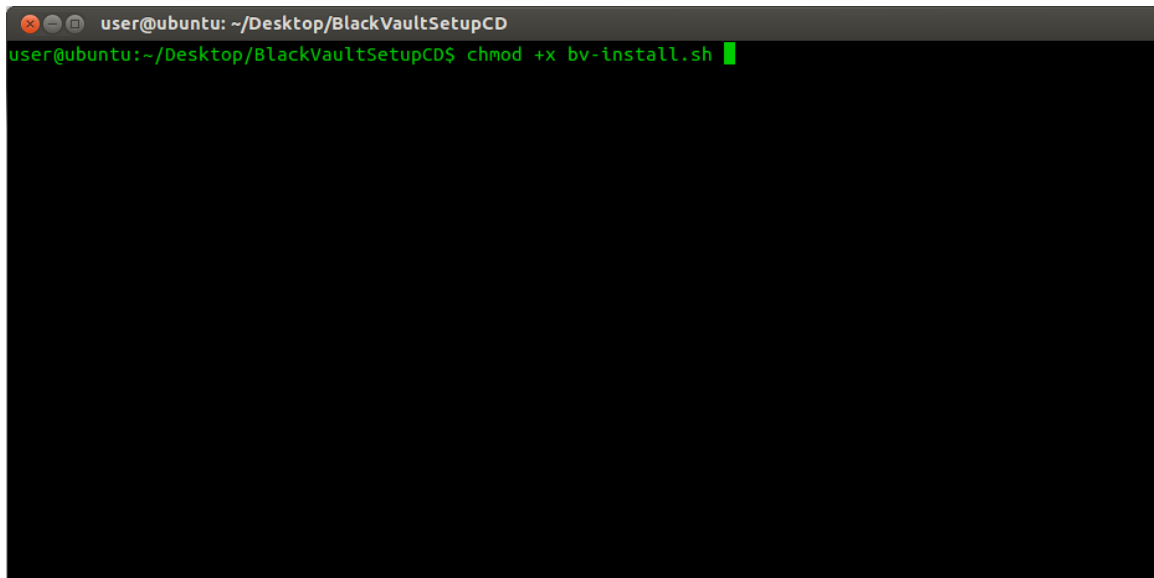


12. Once the installer finishes press finish.



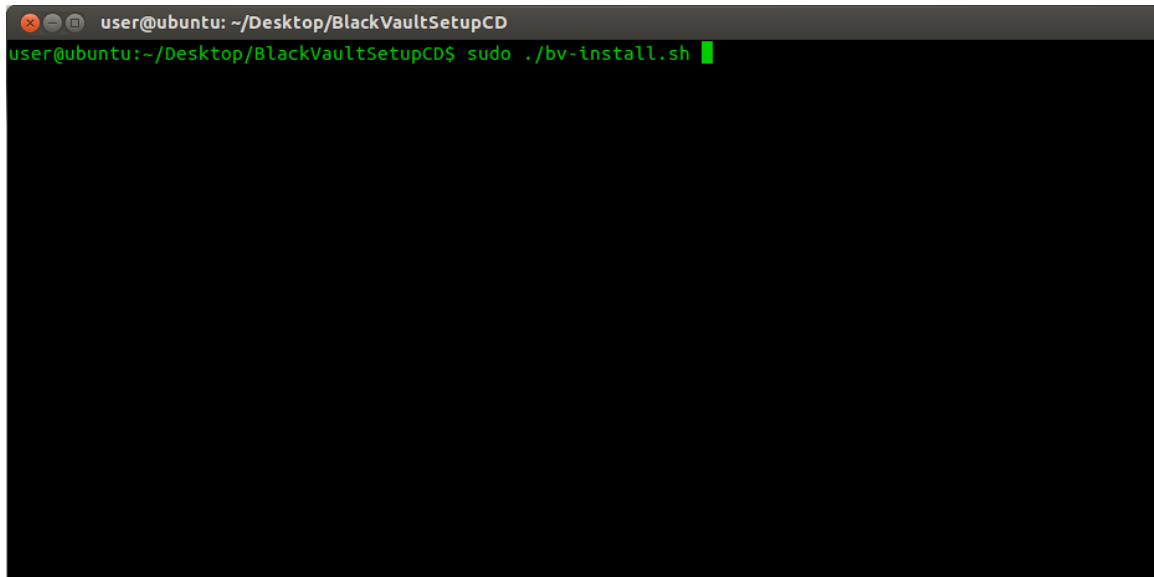
## 4.2.2. Linux

1. Copy the BlackVault Setup CD to a directory on your system. In that directory do the following:
2. `chmod +x bv-install.sh`

A terminal window with a dark background. The title bar at the top reads "user@ubuntu: ~/Desktop/BlackVaultSetupCD". The terminal shows a green prompt "user@ubuntu:~/Desktop/BlackVaultSetupCD\$" followed by the command "chmod +x bv-install.sh" and a green cursor. The rest of the terminal area is empty.

```
user@ubuntu: ~/Desktop/BlackVaultSetupCD
user@ubuntu:~/Desktop/BlackVaultSetupCD$ chmod +x bv-install.sh
```

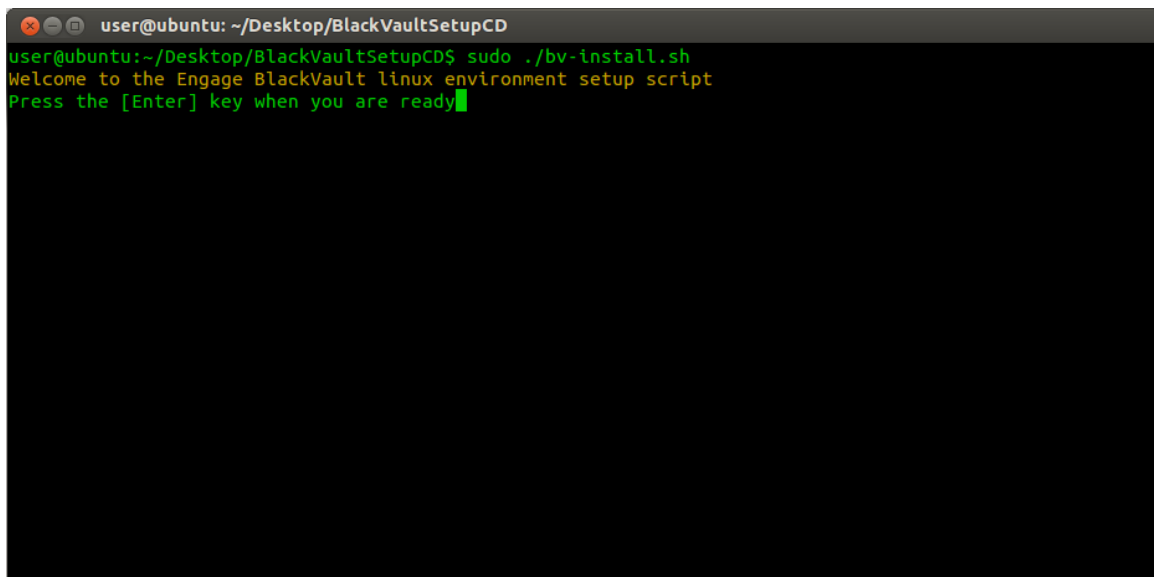
3. `sudo ./bv-install.sh`



```
user@ubuntu: ~/Desktop/BlackVaultSetupCD
user@ubuntu:~/Desktop/BlackVaultSetupCD$ sudo ./bv-install.sh
```

A terminal window with a dark background. The title bar shows 'user@ubuntu: ~/Desktop/BlackVaultSetupCD'. The prompt is 'user@ubuntu:~/Desktop/BlackVaultSetupCD\$' and the command 'sudo ./bv-install.sh' has been entered, followed by a green cursor.

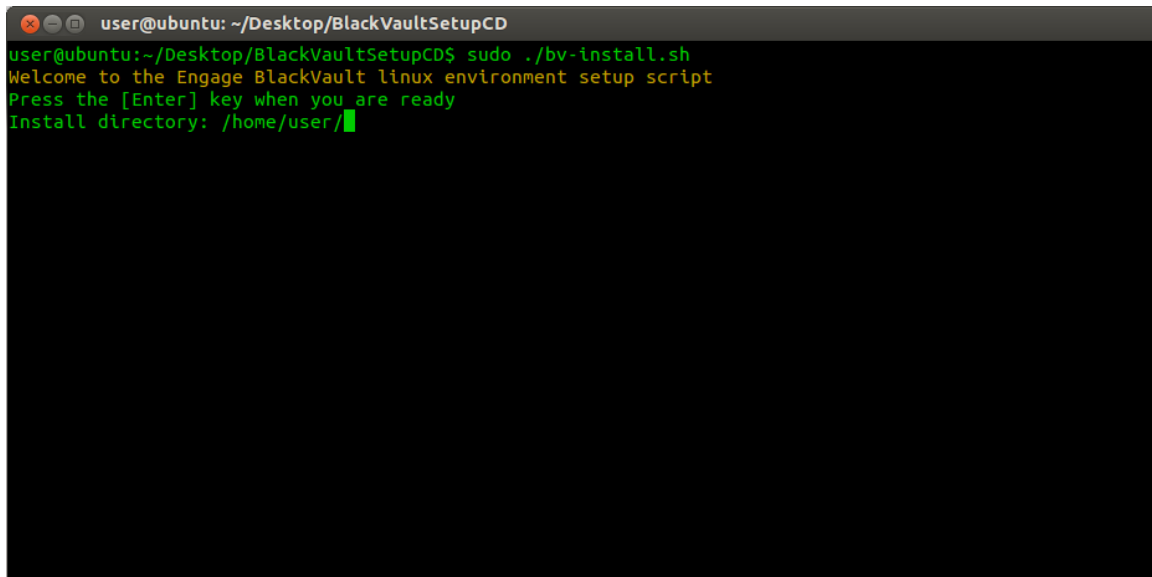
4. press enter



```
user@ubuntu: ~/Desktop/BlackVaultSetupCD
user@ubuntu:~/Desktop/BlackVaultSetupCD$ sudo ./bv-install.sh
Welcome to the Engage BlackVault linux environment setup script
Press the [Enter] key when you are ready
```

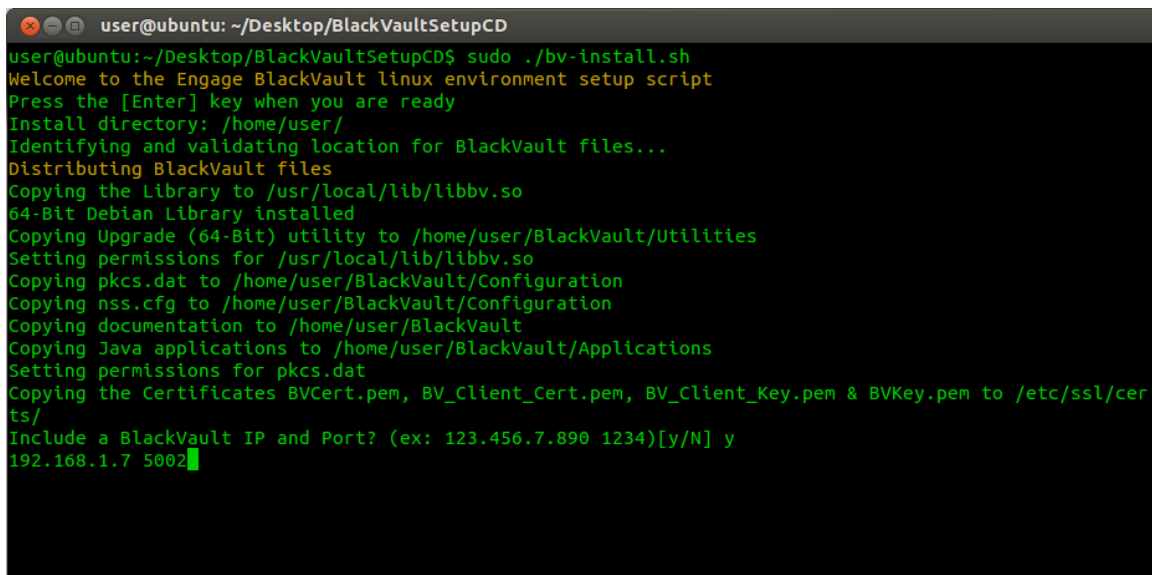
A terminal window with a dark background. The title bar shows 'user@ubuntu: ~/Desktop/BlackVaultSetupCD'. The prompt is 'user@ubuntu:~/Desktop/BlackVaultSetupCD\$'. The command 'sudo ./bv-install.sh' has been executed, and the output is displayed: 'Welcome to the Engage BlackVault linux environment setup script' and 'Press the [Enter] key when you are ready', followed by a green cursor.

5. The appropriate PKCS11 library libbv is installed in /usr/local/lib. Then the script asks for an install directory (default to your home folder). Enter the install directory (or leave blank for default and press enter).

A terminal window titled 'user@ubuntu: ~/Desktop/BlackVaultSetupCD' shows the execution of a script. The prompt is 'user@ubuntu:~/Desktop/BlackVaultSetupCD\$ sudo ./bv-install.sh'. The script outputs: 'Welcome to the Engage BlackVault linux environment setup script', 'Press the [Enter] key when you are ready', and 'Install directory: /home/user/'.

```
user@ubuntu: ~/Desktop/BlackVaultSetupCD
user@ubuntu:~/Desktop/BlackVaultSetupCD$ sudo ./bv-install.sh
Welcome to the Engage BlackVault linux environment setup script
Press the [Enter] key when you are ready
Install directory: /home/user/
```

6. The script then asks for if you would like to "Include a BlackVault IP and Port? (ex: 123.456.789 1234) {y/N}" for the pkcs.dat file. To continue, press "y", then the enter key. Next type the ip address and port number of the BlackVault and press the enter key again.

A terminal window titled 'user@ubuntu: ~/Desktop/BlackVaultSetupCD' shows the continuation of the script. It outputs various status messages: 'Identifying and validating location for BlackVault files...', 'Distributing BlackVault files', 'Copying the Library to /usr/local/lib/libbv.so', '64-Bit Debian Library installed', 'Copying Upgrade (64-Bit) utility to /home/user/BlackVault/Utilities', 'Setting permissions for /usr/local/lib/libbv.so', 'Copying pkcs.dat to /home/user/BlackVault/Configuration', 'Copying nss.cfg to /home/user/BlackVault/Configuration', 'Copying documentation to /home/user/BlackVault', 'Copying Java applications to /home/user/BlackVault/Applications', 'Setting permissions for pkcs.dat', and 'Copying the Certificates BV Cert.pem, BV\_Client\_Cert.pem, BV\_Client\_Key.pem & BVKey.pem to /etc/ssl/certs/'. It then prompts 'Include a BlackVault IP and Port? (ex: 123.456.7.890 1234)[y/N] y' and shows the input '192.168.1.7 5002'.

```
user@ubuntu: ~/Desktop/BlackVaultSetupCD
user@ubuntu:~/Desktop/BlackVaultSetupCD$ sudo ./bv-install.sh
Welcome to the Engage BlackVault linux environment setup script
Press the [Enter] key when you are ready
Install directory: /home/user/
Identifying and validating location for BlackVault files...
Distributing BlackVault files
Copying the Library to /usr/local/lib/libbv.so
64-Bit Debian Library installed
Copying Upgrade (64-Bit) utility to /home/user/BlackVault/Utilities
Setting permissions for /usr/local/lib/libbv.so
Copying pkcs.dat to /home/user/BlackVault/Configuration
Copying nss.cfg to /home/user/BlackVault/Configuration
Copying documentation to /home/user/BlackVault
Copying Java applications to /home/user/BlackVault/Applications
Setting permissions for pkcs.dat
Copying the Certificates BV Cert.pem, BV_Client_Cert.pem, BV_Client_Key.pem & BVKey.pem to /etc/ssl/certs/
Include a BlackVault IP and Port? (ex: 123.456.7.890 1234)[y/N] y
192.168.1.7 5002
```

7. The TLS certificates are installed in /etc/ssl/certs.

8. At this point the BlackVault is setup to work with any non-Java application written to the PKCS11 API such as applications written in C or C++. Select y and press enter to continue setting up java.

```
user@ubuntu: ~/Desktop/BlackVaultSetupCD
user@ubuntu:~/Desktop/BlackVaultSetupCD$ sudo ./bv-install.sh
Welcome to the Engage BlackVault linux environment setup script
Press the [Enter] key when you are ready
Install directory: /home/user/
Identifying and validating location for BlackVault files...
Distributing BlackVault files
Copying the Library to /usr/local/lib/libbv.so
64-Bit Debian Library installed
Copying Upgrade (64-Bit) utility to /home/user/BlackVault/Utilities
Setting permissions for /usr/local/lib/libbv.so
Copying pkcs.dat to /home/user/BlackVault/Configuration
Copying nss.cfg to /home/user/BlackVault/Configuration
Copying documentation to /home/user/BlackVault
Copying Java applications to /home/user/BlackVault/Applications
Setting permissions for pkcs.dat
Copying the Certificates BVCert.pem, BV_Client_Cert.pem, BV_Client_Key.pem & BVKey.pem to /etc/ssl/certs/
Include a BlackVault IP and Port? (ex: 123.456.7.890 1234)[y/N] y
192.168.1.7 5002
Do you wish to configure Java for the BlackVault?[y/N] y
```

9. The Script asks for the "Java JRE/JDK directory" then displays the environment variable \$JAVA\_HOME. Press enter if this is the correct directory. If it is not change it now then press enter.

```
user@ubuntu: ~/Desktop/BlackVaultSetupCD
user@ubuntu:~/Desktop/BlackVaultSetupCD$ sudo ./bv-install.sh
Welcome to the Engage BlackVault linux environment setup script
Press the [Enter] key when you are ready
Install directory: /home/user/
Identifying and validating location for BlackVault files...
Distributing BlackVault files
Copying the Library to /usr/local/lib/libbv.so
64-Bit Debian Library installed
Copying Upgrade (64-Bit) utility to /home/user/BlackVault/Utilities
Setting permissions for /usr/local/lib/libbv.so
Copying pkcs.dat to /home/user/BlackVault/Configuration
Copying nss.cfg to /home/user/BlackVault/Configuration
Copying documentation to /home/user/BlackVault
Copying Java applications to /home/user/BlackVault/Applications
Setting permissions for pkcs.dat
Copying the Certificates BVCert.pem, BV_Client_Cert.pem, BV_Client_Key.pem & BVKey.pem to /etc/ssl/certs/
Include a BlackVault IP and Port? (ex: 123.456.7.890 1234)[y/N] y
192.168.1.7 5002
Do you wish to configure Java for the BlackVault?[y/N] y
Starting Java Configuration
Java JRE/JDK directory: /usr/lib/jvm/java-8-oracle/jre/
```



10. The script now asks, "Verify installation? [y/N]". Choose "y" if you wish to have the script run Java keytool to list the keys stored on the BlackVault.

```
user@ubuntu: ~/Desktop/BlackVaultSetupCD
Welcome to the Engage BlackVault linux environment setup script
Press the [Enter] key when you are ready
Install directory: /home/user/
Identifying and validating location for BlackVault files...
Distributing BlackVault files
Copying the Library to /usr/local/lib/libbv.so
64-Bit Debian Library installed
Copying Upgrade (64-Bit) utility to /home/user/BlackVault/Utilities
Setting permissions for /usr/local/lib/libbv.so
Copying pkcs.dat to /home/user/BlackVault/Configuration
Copying nss.cfg to /home/user/BlackVault/Configuration
Copying documentation to /home/user/BlackVault
Copying Java applications to /home/user/BlackVault/Applications
Setting permissions for pkcs.dat
Copying the Certificates BV_Cert.pem, BV_Client_Cert.pem, BV_Client_Key.pem & BVKey.pem to /etc/ssl/certs/
Include a BlackVault IP and Port? (ex: 123.456.7.890 1234)[y/N] y
192.168.1.7 5002
Do you wish to configure Java for the BlackVault?[y/N] y
Starting Java Configuration
Java JRE/JDK directory: /usr/lib/jvm/java-8-oracle/jre/
Searching for sun.security.pkcs11.SunPKCS11 nss.cfg in java.security file...
Added provider to the java.security provider
Verify installation with (Java) Keytool?[y/N] y
```

11. Log in as User on the BlackVault. Provided no keys have been created, the expected result would look something like the following:

```
user@ubuntu: ~/Desktop/BlackVaultSetupCD
Copying nss.cfg to /home/user/BlackVault/Configuration
Copying documentation to /home/user/BlackVault
Copying Java applications to /home/user/BlackVault/Applications
Setting permissions for pkcs.dat
Copying the Certificates BV_Cert.pem, BV_Client_Cert.pem, BV_Client_Key.pem & BVKey.pem to /etc/ssl/certs/
Include a BlackVault IP and Port? (ex: 123.456.7.890 1234)[y/N] y
192.168.1.7 5002
Do you wish to configure Java for the BlackVault?[y/N] y
Starting Java Configuration
Java JRE/JDK directory: /usr/lib/jvm/java-8-oracle/jre/
Searching for sun.security.pkcs11.SunPKCS11 nss.cfg in java.security file...
Added provider to the java.security provider
Verify installation with (Java) Keytool?[y/N] y
Keytool: listing keystore...

Keystore type: PKCS11
Keystore provider: SunPKCS11-Engage Black Vault

Your keystore contains 0 entries

Installation process completed
You may need to restart your shell/system to apply environment changes
user@ubuntu:~/Desktop/BlackVaultSetupCD$
```

12. In order for full settings to take restart the system, as environment variables were changed.

## 4.3. Signing with Java Jarsigner and the BlackVault HSM

To do code signing per industry best practices, along with creating and storing the key inside a secure HSM, a code signing certificate associated with the key is required. This section first describes how to create a key, and then how to create the certificate.

If a key already has been created by Java, you can skip the first section and move onto Jarsigner operation

### 4.3.1. Key and Certificate Creation

Before signing code, you need a key and certificate for that key. Keytool is used for this purpose as described below.

Keytool is a key and certificate management utility that allows users to administer their own public/private key pairs and associated certificates. It is used in self-authentication or data integrity and authentication services, using digital signatures. It also allows users to cache public keys (in the form of certificates) of their communicating peers.

If you have completed the previous steps in this guide (Java configured correctly, and PKCS#11 library installed), perform the following using a command terminal:

1. To create a key:
  - a. `keytool -genkey -keystore NONE -storetype PKCS11 -alias KeyNameHere -keyalg RSA -keysize 2048 -storepass 123456`
    - i. keystore and storetype is telling Java to use the PKCS#11 functions of Java
    - ii. alias is the name of the key
    - iii. keyalg is what key algorithm you want to use
    - iv. keysize is the size of the algorithm
    - v. Although Java requires a storepass entry (typically used for authenticating the keystore), the BlackVault HSM authenticates itself and does not use this password.

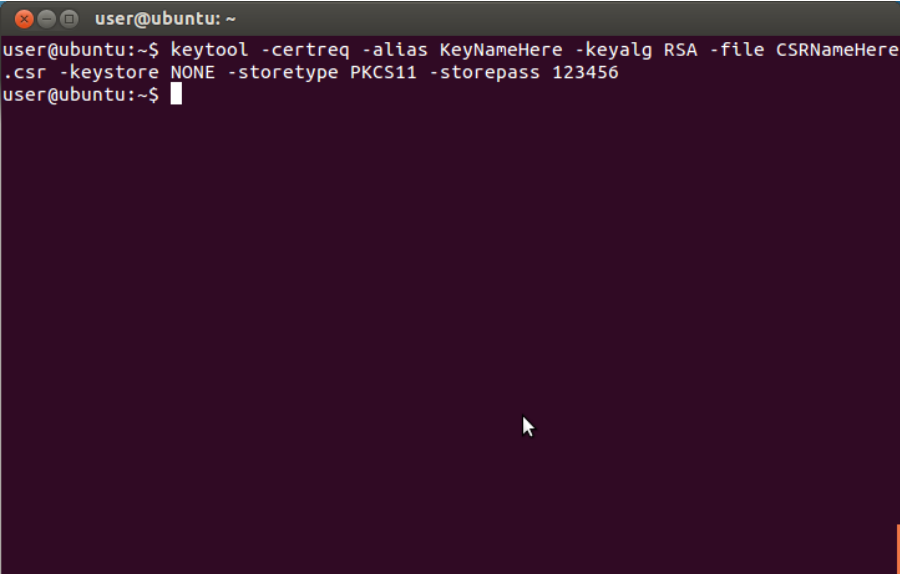
```
user@ubuntu: ~  
user@ubuntu:~$ keytool -genkey -keystore NONE -storetype PKCS11 -alias KeyNameHere -keyalg RSA -keysize 2048 -storepass 123456  
What is your first and last name?  
[Unknown]: Charlie Brown  
What is the name of your organizational unit?  
[Unknown]: Security  
What is the name of your organization?  
[Unknown]: Acme Inc.  
What is the name of your City or Locality?  
[Unknown]: Springfield  
What is the name of your State or Province?  
[Unknown]: Anywhere  
What is the two-letter country code for this unit?  
[Unknown]: US  
Is CN=Charlie Brown, OU=Security, O=Acme Inc., L=Springfield, ST=Anywhere, C=US correct?  
[no]: yes  
  
*hObject = 83 *hObject = 84 user@ubuntu:~$
```

- b. After entering the keytool command Java will prompt for Identifying information. This is used for the self-signed certificate that is created by the BlackVault HSM at the same time the key is created.
  - c. It will then prompt if all entries are correct. When you are sure the information is correct, type yes and then press the enter key.
2. After creating the key, verify the key is stored in the BlackVault by listing the keys from the BlackVault with the following command.
- a. For java keytool has a list key function
    - i. `keytool -list -keystore NONE -storepass 123456 -storetype PKCS11`

```
user@ubuntu: ~  
user@ubuntu:~$ keytool -list -keystore NONE -storepass 123456 -storetype PKCS11  
Keystore type: PKCS11  
Keystore provider: SunPKCS11-Engage Black Vault  
  
Your keystore contains 1 entry  
  
KeyNameHere, PrivateKeyEntry,  
  
user@ubuntu:~$
```

If a self-signed certificate is sufficient skip to the next section, if you would like a certificate signed by an independent certificate Authority perform the following:

1. Next a certificate signing request (CSR) is generated from the key just created by performing the following steps.
  - a. For Java enter the following command:  
keytool -certreq -alias KeyNameHere -keyalg RSA -file  
CSRNameHere.csr -keystore NONE -storetype PKCS11
    - i. keystore and storetype is telling Java to use the PKCS#11 functions of Java
    - ii. alias is the name of the key
    - iii. keyalg is what key algorithm you want to use
    - iv. keysize is the size of the algorithm
    - v. storepass is normally used for authenticating the keystore, but the BlackVault HSM authenticates itself and does not use this password. Java requires it anyways
    - vi. file is the filename that the CSR will output to.

A terminal window with a dark purple background and a light blue title bar. The title bar contains the text 'user@ubuntu: ~'. The terminal shows the command 'keytool -certreq -alias KeyNameHere -keyalg RSA -file CSRNameHere.csr -keystore NONE -storetype PKCS11 -storepass 123456' being entered and executed. The prompt 'user@ubuntu:~\$' is visible at the end of the line.

```
user@ubuntu:~$ keytool -certreq -alias KeyNameHere -keyalg RSA -file CSRNameHere.csr -keystore NONE -storetype PKCS11 -storepass 123456
user@ubuntu:~$
```

2. Get the CSR signed by a Certificate Authority (i.e. Digicert, Verisign, etc)
3. After obtaining the certificate from a Certificate Authority it will need to be attached to the key from which it is derived. To do this it must be imported into the BlackVault
  - a. For Java enter the following command:  
keytool -import -trustcacerts -alias KeyNameHere -file CaFileHere.pem  
-keystore NONE -storetype PKCS11

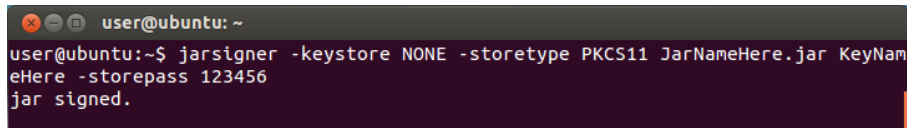
- i. keystore and storetype is telling Java to use the PKCS#11 functions of Java
- ii. alias is the name of the key
- iii. file is the location and file name of the certificate that was created by a certificate authority

```
user@ubuntu: ~  
user@ubuntu:~$ keytool -import -trustcacerts -alias KeyNameHere -file CaFileHere  
.pem -keystore NONE -storetype PKCS11 -storepass 123456  
  
Top-level certificate in reply:  
  
Owner: CN=Your Organisation CA, OU=Certification Authority, O=Your Organisation  
Name, C=US  
Issuer: CN=Your Organisation CA, OU=Certification Authority, O=Your Organisation  
Name, C=US  
Serial number: 158dad514f2  
Valid from: Wed Dec 07 11:49:07 PST 2016 until: Tue Dec 08 11:49:20 PST 2026  
Certificate fingerprints:  
    MD5: BF:97:54:67:1E:6E:44:E3:9C:2A:5B:87:2D:71:7C:F6  
    SHA1: 8C:11:AC:19:37:12:9D:8E:31:50:97:BC:BF:AA:34:AA:AC:4B:66:3C  
    SHA256: 22:C3:10:F6:D4:C8:30:3A:F4:79:71:D9:80:57:94:3D:EE:1F:21:49:68:  
83:E0:6A:DC:9E:9A:32:F1:79:9A:1F  
    Signature algorithm name: SHA256withRSA  
    Version: 3  
  
Extensions:  
  
#1: ObjectId: 2.5.29.35 Criticality=false  
AuthorityKeyIdentifier [  
  KeyIdentifier [  
    0000: E3 57 8C B0 96 C6 BF E4 BF 7C EB CE AD 3E A6 5A .W.....>.Z  
    0010: 3B B8 C3 91 ;...  
  ]  
]  
  
#2: ObjectId: 2.5.29.19 Criticality=false  
BasicConstraints:[  
  CA:true  
  PathLen:2147483647  
]  
  
#3: ObjectId: 2.5.29.15 Criticality=true  
KeyUsage [  
  DigitalSignature  
  Key_CertSign  
  CrI_Sign  
]  
  
#4: ObjectId: 2.5.29.14 Criticality=false  
SubjectKeyIdentifier [  
  KeyIdentifier [  
    0000: E3 57 8C B0 96 C6 BF E4 BF 7C EB CE AD 3E A6 5A .W.....>.Z  
    0010: 3B B8 C3 91 ;...  
  ]  
]  
  
... is not trusted. Install reply anyway? [no]: yes  
Certificate reply was installed in keystore  
user@ubuntu:~$
```

## 4.3.2. Jarsigner Operation

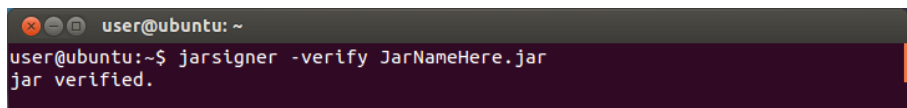
Everything is setup now to start code signing. To do a sample code signing to verify everything is working do the following:

1. sign code
  - a. In Java, use the following command  
jarsigner -keystore NONE -storetype PKCS11 /Path/To/Your/Jar  
KeyNameHere
    - i. keystore and storetype is telling Java to use the PKCS#11 functions of Java
    - ii. KeyNameHere is the name of the key on the BlackVault
    - iii. /Path/To/Your/Jar is the location and file name of the jar that is needing to be signed.



```
user@ubuntu: ~  
user@ubuntu:~$ jarsigner -keystore NONE -storetype PKCS11 JarNameHere.jar KeyNameHere -storepass 123456  
jar signed.
```

2. Verify code
  - a. In Java, use the following command  
jarsigner -verify /Path/To/Your/Jar
    - i. /Path/To/Your/Jar is the path to the jar that needs to be verified
  - b. Provided everything was set up correctly, the output will show the information of your certificate as well as the information of the CA that signed the certificate.



```
user@ubuntu: ~  
user@ubuntu:~$ jarsigner -verify JarNameHere.jar  
jar verified.
```

- c. If the output is something different than the Verify failed and the code that you try to verify was changed from what was originally signed.