SafeNet USB HSM 6.3

SDK Reference Guide

security to be free

Document Information

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Revision	Date	Reason
A	14 July 2017	Initial release.

Trademarks, Copyrights, and Third-Party Software

Acknowledgements

This product includes software developed by the OpenSSL Project for use in the OpenSSL Toolkit. (http://www.openssl.org)

This product includes cryptographic software written by Eric Young (eay@cryptsoft.com). This product includes software written by Tim Hudson (tjh@cryptsoft.com).

This product includes software developed by the University of California, Berkeley and its contributors.

This product uses Brian Gladman's AES implementation.

Refer to the End User License Agreement for more information.

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Regulatory Compliance

This product complies with the following regulatory regulations. To ensure compliancy, ensure that you install the products as specified in the installation instructions and use only Gemalto-supplied or approved accessories.

USA, FCC

This device complies with Part 15 of the FCC rules. Operation is subject to the following conditions:

- This device may not cause harmful interference.
- This device must accept any interference received, including interference that may cause undesired operation.

Note: This equipment has been tested and found to comply with the limits for a “Class B” digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help

Changes or modifications not expressly approved by Gemalto could void the user’s authority to operate the equipment.

Canada

This class B digital apparatus meets all requirements of the Canadian interference- causing equipment regulations.

Europe

This product is in conformity with the protection requirements of EC Council Directive 2004/108/EC. Conformity is declared to the following applicable standards for electro-magnetic compatibility immunity and susceptibility; CISPR22 and IEC801. This product satisfies the CLASS B limits of EN 55022.

CONTENTS

PREFACE
About the SDK Reference Guide

This document describes how to use the SafeNet SDK to create applications that interact with SafeNet HSMs. It contains the following chapters:

This preface also includes the following information about this document:

For information regarding the document status and revision history, see "Document Information" on page 2.

Customer Release Notes

The customer release notes (CRN) provide important information about this release that is not included in the customer documentation. It is strongly recommended that you read the CRN to fully understand the capabilities, limitations, and known issues for this release. You can view or download the latest version of the CRN for this release at the following location:

- http://www.securedbysafenet.com/releasenotes/luna/crn_luna_hsm_6-3.pdf

Gemalto Rebranding

In early 2015, Gemalto completed its acquisition of SafeNet, Inc. As part of the process of rationalizing the product portfolios between the two organizations, the Luna name has been removed from the SafeNet HSM product line, with the SafeNet name being retained. As a result, the product names for SafeNet HSMs have changed as follows:

Old product name	New product name
Luna SA HSM	SafeNet Network HSM
Luna PCI-E HSM	SafeNet PCIe HSM
Luna G5 HSM	SafeNet USB HSM
Luna PED	SafeNet PED
Luna Client	SafeNet HSM Client
Luna Dock	SafeNet Dock
Luna Backup HSM	SafeNet Backup HSM
Luna CSP	SafeNet CSP
Luna JSP	SafeNet JSP
Luna KSP	SafeNet KSP

Note: These branding changes apply to the documentation only. The SafeNet HSM software and utilities continue to use the old names.

Audience

This document is intended for personnel responsible for maintaining your organization's security infrastructure. This includes SafeNet HSM users and security officers, key manager administrators, and network administrators.

All products manufactured and distributed by Gemalto are designed to be installed, operated, and maintained by personnel who have the knowledge, training, and qualifications required to safely perform the tasks assigned to them. The information, processes, and procedures contained in this document are intended for use by trained and qualified personnel only.

It is assumed that the users of this document are proficient with security concepts.

Document Conventions

This document uses standard conventions for describing the user interface and for alerting you to important information.

Notes

Notes are used to alert you to important or helpful information. They use the following format:

Note: Take note. Contains important or helpful information.

Cautions

Cautions are used to alert you to important information that may help prevent unexpected results or data loss. They use the following format:

CAUTION: Exercise caution. Contains important information that may help prevent unexpected results or data loss.

Warnings

Warnings are used to alert you to the potential for catastrophic data loss or personal injury. They use the following format:

WARNING! Be extremely careful and obey all safety and security measures. In this situation you might do something that could result in catastrophic data loss or personal injury.

Command Syntax and Typeface Conventions

<table>
<tr><th>Format</th><th>Convention</th></tr>
<tr><td>bold</td><td>The bold attribute is used to indicate the following:
• Command-line commands and options (Type dir /p.)
• Button names (Click Save As.)
• Check box and radio button names (Select the Print Duplex check box.)
• Dialog box titles (On the Protect Document dialog box, click Yes.)
• Field names (User Name: Enter the name of the user.)
• Menu names (On the File menu, click Save.) (Click Menu > Go To > Folders.)
• User input (In the Date box, type April 1.)</td></tr>
<tr><td>italics</td><td>In type, the italic attribute is used for emphasis or to indicate a related document. (See the Installation Guide for more information.)</td></tr>
<tr><td><variable></td><td>In command descriptions, angle brackets represent variables. You must substitute a value for command line arguments that are enclosed in angle brackets.</td></tr>
<tr><td>[optional]
[<optional>]</td><td>Represent optional keywords or <variables> in a command line description. Optionally enter the keyword or <variable> that is enclosed in square brackets, if it is necessary or desirable to complete the task.</td></tr>
<tr><td>{a|b|c}
{<a>|<b>|<c>}</td><td>Represent required alternate keywords or <variables> in a command line description. You must choose one command line argument enclosed within the braces. Choices are separated by vertical (OR) bars.</td></tr>
<tr><td>[a|b|c]
[<a>|<b>|<c>]</td><td>Represent optional alternate keywords or variables in a command line description. Choose one command line argument enclosed within the braces, if desired. Choices are separated by vertical (OR) bars.</td></tr>
</table>

Support Contacts

Contact method	Contact	
Phone (Subject to change. An up-to-date list is maintained on the Technical Support Customer Portal)	Global	+1 410-931-7520
	Australia	1800.020.183
	India	000.800.100.4290
	Netherlands	0800.022.2996
	New Zealand	0800.440.359
	Portugal	800.863.499
	Singapore	800.1302.029
	Spain	900.938.717
	Sweden	020.791.028
	Switzerland	0800.564.849
	United Kingdom	0800.056.3158
	United States	(800) 545-6608
Web	https://safenet.gemalto.com	
Technical Support Customer Portal	https://supportportal.gemalto.com Existing customers with a Technical Support Customer Portal account can log in to manage incidents, get the latest software upgrades, and access the Knowledge Base. To create a new account, click the **Register** link at the top of the page. You will need your Customer Identifier number.	

1
SafeNet SDK Overview

This chapter provides an overview of the SafeNet Software Development Kit (SDK), a development platform you can use to integrate a SafeNet HSM into your application or system. It contains the following topics:

- "Supported Cryptographic Algorithms" below
- "Application Programming Interface (API) Overview" on page 20
- "What Does 'Supported' Mean?" on page 22
- "Frequently Asked Questions" on page 22

Supported Cryptographic Algorithms

The K6 Cryptographic engine supports cryptographic algorithms that include:

- RSA
- DSA
- Diffie-Hellman
- DES and triple DES
- MD2 and MD5
- SHA-1, SHA-224, SHA-256, SHA-384, SHA-512
- RC2, RC4 and RC5
- AES
- PBE
- ECC
- ECIES
- ARIA, SEED

Application Programming Interface

The major API provided with SafeNet Product Software Development Kit conforms to RSA Laboratories' Public-Key Cryptography Standards #11 (PKCS #11) v2.20. A set of API services (called PKCS #11 Extensions) designed by SafeNet, augments the services provided by PKCS#11. The API is a library – a DLL in Windows, a shared object in Solaris, AIX and Linux, a shared library in HP-UX – called Chrystoki. Applications wanting to use token services must connect with Chrystoki.

In addition, support is provided for Microsoft's cryptographic APIs (CAPI/CNG) and Oracle's Java Security API.

The extensions to each API enable optimum use of SafeNet hardware for commonly used calls and functions, where the unaugmented API would tend to use software, or to make generic, non-optimized use of available HSMs.

Table 1: SafeNet libraries by platform

Platform	Key name	Libraries
Windows	LibNT	X:\Program Files\SafeNet\LunaClient\cryptoki.dll
		X:\Program Files\SafeNet\LunaClient\cklog201.dll
		X:\Program Files\SafeNet\LunaClient\shim.dll
		X:\Program Files\SafeNet\LunaClient\LunaCSP\LunaCSP.dll
		C:\WINDOWS\system32\SafeNetKSP.dll
Solaris (32-bit)	LibUNIX	/opt/safenet/lunaclient/lib/libCryptoki2.so
		/opt/safenet/lunaclient/lib/libcklog2.so
		/opt/safenet/lunaclient/lib/libshim.so
Solaris (64-bit)	LibUNIX64	/opt/safenet/lunaclient/lib/libCryptoki2_64.so
		/opt/safenet/lunaclient/lib/libcklog2.so
		/opt/safenet/lunaclient/lib/libshim_64.so
Linux (64-bit)	LibUNIX	/usr/safenet/lunaclient/lib/libCryptoki2.so
		/usr/safenet/lunaclient/lib/libcklog2.so
		/usr/safenet/lunaclient/lib/libshim.so
Linux (64-bit)	LibUNIX64	/usr/safenet/lunaclient/lib/libCryptoki2_64.so
		/usr/safenet/lunaclient/lib/libcklog2.so
		/usr/safenet/lunaclient/lib/libshim_64.so
HP-UX (32-bit and 64-bit)	LibHPUX	/opt/safenet/lunaclient/lib/libCryptoki2.sl
		/opt/safenet/lunaclient/lib/libCryptoki2_64.sl
		/opt/safenet/lunaclient//lib/libcklog2.sl
		/opt/safenet/lunaclient/lib/libshim.sl
AIX (32-bit and 64-bit)	LibAIX	/usr/safenet/lunaclient/lib/libCryptoki2.so
		/usr/safenet/lunaclient/lib/libCryptoki2_64.so
		/usr/safenet/lunaclient/lib/libcklog2.so
		/usr/safenet/lunaclient/lib/libshim.so

Included with SafeNet Product Software Development Kit is a sample application – and the source code – to accelerate integration of SafeNet's cryptographic engine into your system.

Note: To reduce development or adaptation time, you may re-distribute the salogin program to customers who use SafeNet Network HSM, in accordance with the terms of the End User License Agreement. However, you may not re-distribute the SafeNet Software Development Kit itself.

Application Programming Interface (API) Overview

The major API provided with SafeNet Product Software Development Kit conforms to RSA Laboratories' Public-Key Cryptography Standards #11 (PKCS #11) v2.20, as described in "PKCS#11 Support" on page 26. A set of API services (called PKCS #11 Extensions) designed by SafeNet, augments the services provided by PKCS#11, as described in "Extensions to PKCS#11" on page 32. The extensions to each API enable optimum use of SafeNet SafeNet hardware for commonly used calls and functions, where the unaugmented API would tend to use software, or to make generic, non-optimized use of available HSMs.

In addition, support is provided for Microsoft's cryptographic APIs (CAPI/CNG) (see "Microsoft Interfaces" on page 471 and Oracle's Java Security API (see "Java Interfaces" on page 448).

The API is a library – a DLL in Windows, a shared object in Solaris, AIX and Linux, a shared library in HP-UX – called Chrystoki. Applications wanting to use token services must connect with Chrystoki.

Table 1: SafeNet libraries by platform

Platform	Key name	Libraries
Windows	LibNT	X:\Program Files\SafeNet\LunaClient\cryptoki.dll
		X:\Program Files\SafeNet\LunaClient\cklog201.dll
		X:\Program Files\SafeNet\LunaClient\shim.dll
		X:\Program Files\SafeNet\LunaClient\LunaCSP\LunaCSP.dll
		C:\WINDOWS\system32\SafeNetKSP.dll
Solaris (32-bit)	LibUNIX	/opt/safenet/lunaclient/lib/libCryptoki2.so
		/opt/safenet/lunaclient/lib/libcklog2.so
		/opt/safenet/lunaclient/lib/libshim.so
Solaris (64-bit)	LibUNIX64	/opt/safenet/lunaclient/lib/libCryptoki2_64.so
		/opt/safenet/lunaclient/lib/libcklog2.so
		/opt/safenet/lunaclient/lib/libshim_64.so
Linux (64-bit)	LibUNIX	/usr/safenet/lunaclient/lib/libCryptoki2.so
		/usr/safenet/lunaclient/lib/libcklog2.so
		/usr/safenet/lunaclient/lib/libshim.so

Platform	Key name	Libraries
Linux (64-bit)	LibUNIX64	/usr/safenet/lunaclient/lib/libCryptoki2_64.so
		/usr/safenet/lunaclient/lib/libcklog2.so
		/usr/safenet/lunaclient/lib/libshim_64.so
HP-UX (32-bit and 64-bit)	LibHPUX	/opt/safenet/lunaclient/lib/libCryptoki2.sl
		/opt/safenet/lunaclient/lib/libCryptoki2_64.sl
		/opt/safenet/lunaclient//lib/libcklog2.sl
		/opt/safenet/lunaclient/lib/libshim.sl
AIX (32-bit and 64-bit)	LibAIX	/usr/safenet/lunaclient/lib/libCryptoki2.so
		/usr/safenet/lunaclient/lib/libCryptoki2_64.so
		/usr/safenet/lunaclient/lib/libcklog2.so
		/usr/safenet/lunaclient/lib/libshim.so

Sample Application

Included with SafeNet Product Software Development Kit is a sample application – and the source code – to accelerate integration of SafeNet's cryptographic engine into your system.

Note: To reduce development or adaptation time, you may re-distribute the salogin program to customers who use SafeNet Network HSM, in accordance with the terms of the End User License Agreement. However, you may not re-distribute the SafeNet Software Development Kit itself.

A Note About RSA Key Attributes 'p' and 'q'

When RSA keys are generated, 'p' and 'q' components are generated which, theoretically, could be of considerably different sizes.

Unwrapping

The SafeNet Network HSM allows RSA private keys to be unwrapped onto the HSM where the lengths of the 'p' and 'q' components are unequal. Because the effective strength of an RSA key pair is determined by the length of the shorter component, choosing 'p' and 'q' to be of equal length provides the maximum strength from the generated key pair. If your application is designed to generate key pairs that will be unwrapped onto the HSM, care should be taken in choosing the lengths of the 'p' and 'q' components such that they differ by no more than 15%.

Generation

Where you are generating RSA private keys within the HSM, the HSM enforces that 'p' and 'q' be equal in size, to the byte level.

A Note About the Shim

The Client install includes a shim library to support PKCS#11 integration with various third-party products. You should have no need for this shim library in your development. If for some reason you determine that you need the shim, Chrystoki supports it.

What Does 'Supported' Mean?

With the exception of some generic items that (for example) might need to be set in Windows when installing CSP, KSP, or Java, we do not include a list of integrations in the main product documentation.

Instead, you can check with the www.safenet-inc.com website for third-party applications that have been integrated and tested with SafeNet HSMs by our Integrations group. That group is constantly testing and updating third-party integrations and publishing notes and instructions to help you integrate our HSMs with your applications.

As a general rule, if a specific version of an application and a specific version of a SafeNet HSM product are mentioned in an Integration document, then those items will definitely work together. A newer version of the SafeNet HSM or its attendant software is most likely to work with the indicated application without problem. We take care, for several generations of a given HSM product, to not break working relationships, though eventually it might happen that very old versions of third-party software and systems can no longer be supported. One thing that can sometimes happen is that we update HSM firmware to include newer algorithms, and to exclude older algorithms or key sizes that no longer meet industry-accepted standards (like NIST, Common Criteria, etc.).

A newer version of a third-party software might, or might not work with SafeNet HSMs that were tested to work with a specific earlier version of the same software. This is because some vendors make changes in their products that require new adaptation or at least new configuration instructions. If this happens to you, SafeNet Customer Support or Sales Engineering is usually happy to work with you to find a solution - both to support you as one of our customers and to have a revised/new integration that can be added to our portfolio.

Check the website or contact SafeNet Customer Support for the latest list of third-party applications that are tested and supported with SafeNet HSMs.

Why Is an Integration Not Listed Here Or On the Website?

In many cases, third-party application vendors see a need to integrate their application with SafeNet products. In those cases, the third-party company performs the integration and testing, and also provides the support for the integrated solution to their customers (including you). For integrations not listed by SafeNet, please contact the application vendor for current information.

Similarly some value-added resellers and custom/third-party integrators or consultants might have performed specific integrations of SafeNet HSMs for the benefit of their specific customers. If you have purchased services or product from such a supplier, you will need to contact them for support of such integrations.

Third-party-tested integrations are not listed here or on the SafeNet website library of integration documents because we have not verified them in our own labs. If you call SafeNet Support regarding use of our product with an application that we have not integrated, you will be asked to contact the third party that performed the integration.

Frequently Asked Questions

This section provides additional information by answering questions that are frequently asked by our customers.

How can we use a SafeNet HSM with a Key Manager?

A SafeNet HSM could be a Certificate Authority (CA) within your organization, and would operate in parallel with a Key Manager. It is normally the Key Manager that requests service from a CA, and not the other way around. For example, the Key Manager might generate an RSA key pair for an endpoint to use for authentication. The KM would then go to its associated CA and request a certificate for the public key.

The other typical use case for a KM looking to a CA for service is for confirming certificate validity, either through CRLs or OCSP.

In general, the HSM keeps keys safe within its confines, and exports only metadata about the contained objects. The metadata allows the KM or an integrated application to refer to the keys and objects within the HSM, when invoking cryptographic operations by the HSM, but not to touch the actual keys or objects themselves.

A CA's private key(s) are extremely valuable and often are used only by a CA application operating on a stand-alone server or one on a very minimally-connected subnet. Backup is normally done to a small form factor HSM that can then be locked away in a safe.

We need to encrypt PANs on MS SQL Server 2008 (Extensible Key Management). We have a problem with the encrypted PAN, as the length is greater than the original PAN (16 digits).

The issue is a common one and it arises because the CBC padding scheme requires an extra padding block (8 bytes), with all bytes having the hex value 8, to be appended if the length of the original plaintext is a multiple of the cipher’s block length. Another format issue often comes up as well since encrypted data does not generally represent well as decimal digits.

We suggest one of two options:

1. You can set up a shadow table to hold the encrypted PANs. The shadow table schema can then be set up for a sufficient number of hex numerals to hold the padded data or just make that field a binary blob. This takes some coding on your part, and the plaintext PANs would be retrieved into a dynamic view, rather than back into the “real” table, to protect their confidentiality. You should do this only if there is a hard requirement to use SafeNet HSM, such as certification.
2. Alternatively, you can switch to DataSecure. It has tokenization support and is, in general, designed for DB security.

"Makecert" fails when using SafeNet Network HSM with MS Authenticode, because the MD5 algorithm is not available when the HSM is in FIPS mode. Error: CryptHashPublicKeyInfo failed => 0x80090005 (-2146893819) Failed, and FINIDigest_Init ***CKR_MECHANISM_INVALID***(296ms) {}

The certificate always has an MD5 hash in it. Configure LunaCSP algorithm registration such that MD5 hashing is performed in software. For example:

register.exe /algorithms

We are developing our application(s) in C#, and we want to integrate with SafeNet HSMs

If you want to integrate your C# application with SafeNet HSM 6.x using PKCS#11 calls, rather than using Microsoft CAPI or CNG, then you might consider using "ncryptoki". At the time this note is being written, we have not created anything formal, but we have worked with some customers who are successfully using "ncryptoki" for that purpose.

Keep an eye on the Safenet C3 website, or ask your SafeNet technical representatives if anything new has been added. Or, you could engage SafeNet Professional Services for formal assistance with your project.

We intend to use PKCS#11 data objects - is this supported in the API for your HSMs?

Yes, it's a basic requirement.
If you have concerns, you might wish to verify if SafeNet HSMs' (and our API's) handling of data objects are conducive to the operation of your intended application(s). SafeNet API generally places no restrictions on whether data objects can be private or not. We understand that, in the past, some competitors' modules might have allowed only public data objects, if that was the basis of your question.

However, one concern that might arise is Java.
Java offers no support for data objects, and so we do not support them with the LunaProvider. Unexpected results can occur with SafeNet JCA if a data object is present in a partition. This might be the case if you attempt to use an application that uses the CSP, and then the JSP accesses the same partition. CSP inherently creates a data object for its own purposes.

Therefore, keep CSP and JSP clients tied to separate partitions. Generally do not allow JSP to connect to a partition that contains a data object, regardless of the source - Java (and therefore JSP) doesn't know what to do with it.

If your application scenario really does demand the use of both the Microsoft Cryptographic Provider and Java against a common partition, then consider upgrading/updating to Microsoft CNG and use our KSP, which does not inherently create a data object, and so would not cause conflict of that sort.

In our application, both for PKCS#11 and for the JCA/JCE SafeNet Provider, we need to use CKM_SHAxxx_RSA_PKCS mechanism for Signing. Does Hashing occur at the Client or in the HSM?

CKM_SHAxxx_RSA_PKCS is a PKCS#11 mechanism, not a Java method.

For PKCS#11 the digest operation is done within the HSM if that mechanism is called.
For Java, digests are done in software.

We were using another vendor's HSM - or are evaluating HSM products - to host an online sub- or issuing CA with MSCA. With the other vendor we must check "Allow administrator interaction when the private key is accessed by the CA" in the "Configure Cryptography" setup dialog. SafeNet HSMs seem to work regardless of whether that selection is checked or not.

So, for that other vendor's product, you need to enter the additional credentials every time you need to issue a certificate? That seems a bit restrictive.

"Allow administrator interaction..." actually means "Allow administrator interaction if the underlying KSP requires it".

The Windows operating system passes a Windows handle that the KSP can use to render any GUI designed by a vendor (SafeNet or some other vendor).

Somewhere in the process a KSP reports that it can (or cannot) interact with the GUI so the application will (or will not) request GUI interaction; that is, pass a window handle to the KSP.

So, the <competitor product> KSP expects a window handle - implying hands-on action by an administrator, each time - whereas SafeNetKsp ignores the handle (if one was provided).

SafeNet's KSP was designed to register partitions ahead of time. SafeNet HSMs can be Activated, which caches the administrative and enabling credentials, such that only the partition challenge (text string) is needed, which can be passed by your application without need for GUI interaction. Furthermore, SafeNet Network HSM can "AutoActivate" partitions, which allows cached ("Activated") partition credentials to be retained through power interruptions as long as 2 hours in duration.

For SafeNet HSMs, as long as the user is registered in the KSP utility, and the partition is activated, the "Allow administrator interaction..." check box (checked or not checked) does not impose any additional, ongoing, authentication requirements -- no additional prompts for credentials from the GUI. After initial setup and Activation, the SafeNet HSM knows what to do, and doesn't need to pester you.

For root CAs, on the other hand, you always have the option of not activating the partition, so PED interaction would always be required to ensure close supervision for each use of the private key.

2 PKCS#11 Support

This chapter describes the PKCS#11 support provided by the SafeNet SDK. It contains the following topics:

- " PKCS#11 Compliance" below
- "Using the PKCS#11 Sample" on page 30

PKCS#11 Compliance

This section shows the compliance of SafeNet Software Development Kit HSM products to the PKCS#11 standard, with reference to particular versions of the standard. The text of the standard is not reproduced here.

Supported PKCS#11 Services

The table below identifies which PKCS#11 services this version of SafeNet Software Development Kit supports. The table following lists other features of PKCS#11 and identifies the compliance of this version of the SafeNet Software Development Kit to these features.

Table 1: PKCS#11 function support

Category	Function	Supported SafeNet ver 2.20
General purpose functions	C_Initialize	Yes
	C_Finalize	Yes
	C_GetInfo	Yes
	C_GetFunctionList	Yes
	C_Terminate	Yes

Category	Function	Supported SafeNet ver 2.20
Slot and token management functions	C_GetSlotList	Yes
	C_GetSlotInfo	Yes
	C_GetTokenInfo	Yes
	C_WaitForSlotEvent	No
	C_GetMechanismList	Yes
	C_GetMechanismInfo	Yes
	C_InitToken	Yes
	C_InitPIN	Yes
	C_SetPIN	Yes
Session management functions	C_OpenSession	Yes
	C_CloseSession	Yes
	C_CloseAllSessions	Yes
	C_GetSessionInfo	Yes
	C_GetOperationState	Yes
	C_SetOperationState	Yes
	C_Login	Yes
	C_Logout	Yes
Object management functions	C_CreateObject	Yes
	C_CopyObject	Yes
	C_DestroyObject	Yes
	C_GetObjectSize	Yes
	C_GetAttributeValue	Yes
	C_SetAttributeValue	Yes
	C_FindObjectsInit	Yes
	C_FindObjects	Yes
	C_FindObjectsFinal	Yes

Category	Function	Supported SafeNet ver 2.20
Encryption functions	C_EncryptInit	Yes
	C_Encrypt	Yes
	C_EncryptUpdate	Yes
	C_EncryptFinal	Yes
Decryption functions	C_DecryptInit	Yes
	C_Decrypt	Yes
	C_DecryptUpdate	Yes
	C_DecryptFinal	Yes
Message digesting functions	C_DigestInit	Yes
	C_Digest	Yes
	C_DigestUpdate	Yes
	C_DigestKey	Yes
	C_DigestFinal	Yes
Signing and MACing functions	C_SignInit	Yes
	C_Sign	Yes
	C_SignUpdate	Yes
	C_SignFinal	Yes
	C_SignRecoverInit	No
	C_SignRecover	No
Functions for verifying signatures and MACs	C_VerifyInit	Yes
	C_Verify	Yes
	C_VerifyUpdate	Yes
	C_VerifyFinal	Yes
	C_VerifyRecoverInit	No
	C_VerifyRecover	No

Category	Function	Supported SafeNet ver 2.20
Dual-purpose cryptographic functions	C_DigestEncryptUpdate	No
	C_DecryptDigestUpdate	No
	C_SignEncryptUpdate	No
	C_DecryptVerifyUpdate	No
Key management functions	C_GenerateKey	Yes
	C_GenerateKeyPair	Yes
	C_WrapKey	Yes
	C_UnwrapKey*	Yes
	C_DeriveKey	Yes
Random number generation functions	C_SeedRandom	Yes
	C_GenerateRandom	Yes
Parallel function management functions	C_GetFunctionStatus	No
	C_CancelFunction	No
Callback function		No

*C_UnwrapKey has support for the CKA_Unwrap_Template object. All mechanisms that perform the unwrap function support an unwrap template. Nested templates are not supported.
The ability to affect key attributes is controlled by partition policy *11: Allow changing key attributes*.

Note: UNWRAP TEMPLATE attribute - Your Backup HSM must have firmware version 6.24.0 or newer, as well. If a key is cloned or backed-up to an HSM with older firmware, the newer attribute will not be recognized and will be dropped from the object. So when the object is restored, it will no longer have a CKA_UNWRAP_TEMPLATE attribute.

Table 2: PKCS#11 feature support

Feature	Supported?
Exclusive sessions	Yes
Parallel sessions	No

Additional Functions

Please note that certain additional functions have been implemented by SafeNet as extensions to the standard. These include aspects of object cloning, and are described in detail in "SafeNet Luna Extensions to PKCS#11" on page 32

Using the PKCS#11 Sample

The SafeNet SDK includes a simple "C" language cross platform source example, **p11Sample**, that demonstrates the following:

- how to dynamically load the SafeNet cryptoki library
- how to obtain the function pointers to the exported PKCS11 standard functions and the SafeNet extension functions.

The sample demonstrates how to invoke some, but not all of the API functions.

The SfntLibPath Environment Variable

The sample depends on an environment variable created and exported prior to execution. This variable specifies the location of **cryptoki.dll** (Windows) or **libCryptoki2.so** on Linux/UNIX. The variable is called **SfntLibPath**. You are free to provide your own means for locating the library.

What p11Sample Does

The p11Sample program performs the following actions:

1. The sample first attempts to load the dynamic library in the function called **LoadP11Functions**. This calls **LoadLibrary** (Windows) or **dlopen** (Linux/UNIX).
2. The function then attempts to get a function pointer to the PKCS11 API **C_GetFunctionList** using **GetProcAddress** (Windows) or **dlsym** (Linux/UNIX).
3. Once the function pointer is obtained, use the API to obtain a pointer called **P11Functions** that points to the static CK_FUNCTION_LIST structure in the library. This structure holds pointers to all the other PKCS11 API functions supported by the library.

   At this point, if successful, PKCS11 APIs may be invoked like the following:

   ```
   P11Functions->C_Initialize(...);
   P11Functions->C_GetSlotList(...);
   P11Functions->C_OpenSession(...);
   P11Functions->C_Login(...);
   P11Functions->C_GenerateKey(...);
   P11Functions->C_Encrypt(...);
   :
   :
   etc
   ```

4. The sample next attempts to get a function pointer to the SafeNet extension **API CA_GetFunctionList** using **GetProcAddress** (Windows) or **dlsym** (Linux/UNIX).
5. Once the function pointer is obtained, use the API to obtain a pointer called **SfntFunctions** that points to the static CK_SFNT_CA_FUNCTION_LIST structure in the library. This structure holds pointers to some but not all of the other SafeNet extension API functions supported by the library.
6. At this point, if successful, SafeNet extension APIs may be invoked like the following:

   ```
   SfntFunctions->CA_GetHAState(...);
   :
   :
   etc.
   ```

7. Three sample makefiles are provided:
   - one for 32-bit Windows,
   - one for 32-bit Linux, and
   - one for 64-bit AIX.

   You can easily port to another platform with minor changes.
8. To build:

Windows	nmake -f Makefile.win32
Linux	make -f Makefile.linux.32
Aix	make -f Makefile.aix.64

Note: Please note that this simple example loads the cryptoki library directly. If your application requires integration with cklog or ckshim, you will need to load the required library (see SDK General for naming on your platform) in lieu of cryptoki. cklog and ckshim will then use the Chrystoki configuration file to locate and load cryptoki. You also have the option of locating the cryptoki library by parsing the Chrystoki2 section of the Chrystoki config file. If you do this, then the initial library (cryptoki, cklog, or ckshim) can be changed by simply updating the configuration file.

3
Extensions to PKCS#11

This chapter describes the SafeNet extensions to the PKCS#11 standard. It contains the following topics:

SafeNet Luna Extensions to PKCS#11

The following table provides a list of the SafeNet Luna PKCS#11 C-API extensions.

Firmware Dependencies

Some functions are firmware-dependent, as indicated. Where there is a firmware dependency, the specified firmware version applies to all minor revisions of the firmware. For example, a function that applies to Firmware 4 works with firmware versions 4.xx.xx.

Other APIs

These commands and functions can also be used as extensions to other Application Programming Interfaces (for example, OpenSSL).

Cryptoki Version Supported

The current release of SafeNet SafeNet Toolkit provides the Chrystoki library supporting version 2.20 of the Cryptoki standard.

Extension	Description
CA_ActivateMofN	Activates a token that has the secret sharing feature enabled.

Extension	Description
CA_CapabilityUpdate	Apply configuration update file as Security Officer only.
CA_CheckOperationState	Checks if the specified cryptographic operation (encrypt, decrypt, sign, verify,digest) is in progress or not in the given session.
CA_CloneAsSource	Refer to the *SafeNet Luna Cloning Functions Technical Note*, available from Technical Support.
CA_CloneAsTarget	Refer to the *SafeNet Luna Cloning Functions Technical Note*, available from Technical Support.
CA_CloneAsTargetInit	Refer to the *SafeNet Luna Cloning Functions Technical Note*, available from Technical Support.
CA_CloneModifyMofN	Firmware 4. Cloning of M of N.
CA_CloneMofN	Firmware 4 cloning of M of N. Copy a cloneable secret-splitting vector from one token to another.
CA_CloneMofN_Common	Firmware 4 cloning of M of N.
CA_CloneObject	Refer to the *SafeNet Luna Cloning Functions Technical Note*, available from Technical Support.
CA_ClonePrivateKey	Permits the secure transfer a private key (RSA) between a source token and a target token.
CA_CloseApplicationID	Deactivate an application identifier.
CA_CloseApplicationIDForContainer	Deactivate an application identifier for a container.
CA_CloseSecureToken	Firmware 6. Close context for an SFF token.
CA_ConfigureRemotePED	Configure the given slot to use the provided remote PED information (appliance slot only).
CA_CreateContainer	Create a partition for non-PPSO users.
CA_CreateContainerLoginChallenge	Create a challenge for a role on a partition.
CA_CreateContainerWithPolicy	Firmware 6. Create a partition with per-partition template data.
CA_CreateLoginChallenge	Create a login challenge for the specified user.
CA_Deactivate	Deactivate a partition.
CA_DeactivateMofN	Firmware 4. Deactivate M of N.
CA_DeleteContainer	Delete a partition.

Extension	Description
CA_DeleteContainerWithHandle	Delete a partition.
CA_DeleteRemotePEDVector	Delete the Remote PED vector.
CA_DeriveKeyAndWrap	This is an optimization of C_DeriveKey with C_Wrap, merging the two functions into one (the in and out constraints are the same as for the individual functions). A further optimization is applied when mechanism CKM_ECDH1_DERIVE is used with CA_ DeriveKeyAndWrap.
CA_DestroyMultipleObjects	Delete multiple objects.
CA_DismantleRemotePED	Inverse of CA_ConfigureRemotePED(). Delete remote PED configuration information.
CA_DuplicateMofN	Create duplicates (copies) of all MofN secret splits.
CA_EncodeECChar2Params	Encode EC curve parameters for user defined curves.
CA_EncodeECParamsFromFile	Encode EC curve parameters for user defined curves.
CA_EncodeECPrimeParams	Encode EC curve parameters for user defined curves.
CA_Extract	Extract a SIM3 blob.
CA_FactoryReset	Factory Reset the HSM.
CA_FindAdminSlotForSlot	Get the Admin slot for the current slot.
CA_FirmwareRollback	Rollback firmware.
CA_FirmwareUpdate	Firmware 4. Firmware update for Firmware 4 (only used in Luna SA 4.x).
CA_GenerateCloneableMofN	Create a cloneable secret-splitting vector on a token.
CA_GenerateCloningKEV	Refer to the *SafeNet Luna Cloning Functions Technical Note*, available from Technical Support.
CA_GenerateMofN	Generate the secret information on a token.
CA_GenerateMofN_Common	Refer to the M of N document.
CA_Get	Get HSM parameters such as serial numbers, and certificates.
CA_GetConfigurationElementDescription	Get capability / policy description and properties.
CA_GetContainerCapabilitySet	Get all partition capability values.
CA_GetContainerCapabilitySetting	Get a single partition capability value.

Extension	Description
CA_GetContainerList	Get the list of all partitions on a slot.
CA_GetContainerName	Get the name of a specific partition.
CA_GetContainerPolicySet	Get all partition policy values.
CA_GetContainerPolicySetting	Get a single partition policy value.
CA_GetContainerStatus	Get partition status, which returns authentication status flags.
CA_GetContainerStorageInformation	Get partition storage information such as size, usage, and number of objects.
CA_GetDefaultHSMPolicyValue	Get the default value of a single HSM policy.
CA_GetDefaultPartitionPolicyValue	Get the default value of a single partition policy.
CA_GetFirmwareVersion	Get the vendor-specific firmware version of the HSM.
CA_GetHAState	Get HA status from the application perspective.
CA_GetHSMCapabilitySet	Get all HSM capability values.
CA_GetHSMCapabilitySetting	Get a single HSM capability value.
CA_GetHSMPolicySet	Get all HSM policy values.
CA_GetHSMPolicySetting	Get a single HSM policy value.
CA_GetHSMStats	Get HSM usage stats such as operational counters and how busy the HSM is.
CA_GetHSMStorageInformation	Get HSM storage information such as storage and usage.
CA_GetMofNStatus	Retrieve the MofN structure of the specified token.
CA_GetNumberOfAllowedContainers	Get the number of allowed partitions depending on the partition license count.
CA_GetObjectHandle	Get the object handle for a given OUID.
CA_GetObjectUID	Get the OUID for a given object handle.
CA_GetPartitionPolicyTemplate	Firmware 6. Gets default partition policy template data from HSM.
CA_GetPedId	Get the PED ID.
CA_GetRemotePEDVectorStatus	Get the status of the RPV, created or not.
CA_GetRollbackFirmwareVersion	Get the available rollback version.

Extension	Description
CA_GetSecureElementMeta	Get META data for objects on an SFF backup token.
CA_GetServerInstanceBySlotID	Get the instance # in the chrystoki.conf (crystoki.ini) file for the appliance/server the specified slot maps to.
CA_GetSessionInfo	Gets the session info that includes vendor specific information such as authentication state and container handle.
CA_GetSlotIdForContainer	Return a slot for a given container handle.
CA_GetSlotIdForPhysicalSlot	Return a slot for a given physical slot.
CA_GetSlotListFromServerInstance	Get the list of slots for the specified appliance/server instance #, as defined in the chrystoki.conf (crystoki.ini) file.
CA_GetTime	Get the HSM time.
CA_GetTokenCapabilities	Get the capabilities for the specified partition.
CA_GetTokenCertificateInfo	Get the cloning certificate.
CA_GetTokenCertificates	Get all HSM certifcates.
CA_GetTokenInsertionCount	Get the insertion or reset count of HSM in the given slot.
CA_GetTokenObjectHandle	Firmware 6.22.0 or higher. Same as CA_ GetObjectHandle for partitions with a partition security officer.
CA_GetTokenObjectUID	Firmware 6.22.0 or higher. Same as CA_ GetObjectOUID for partitions with a partition security officer.
CA_GetTokenPolicies	Get partition policies.
CA_GetTokenStatus	Get partition status.
CA_GetTokenStorageInformation	Get partition storage information.
CA_GetTunnelSlotNumber	Get the tunnel slot number for a given slot number.
CA_HAActivateMofN	See "High Availability Indirect Login Functions" on page 46.
CA_HAAnswerLoginChallenge	See "High Availability Indirect Login Functions" on page 46.
CA_HAAnswerMofNChallenge	See "High Availability Indirect Login Functions" on page 46.
CA_HAGetLoginChallenge	See "High Availability Indirect Login Functions" on page

Extension	Description
	46.
CA_HAGetMasterPublic	See "High Availability Indirect Login Functions" on page 46.
CA_HAInit	See "High Availability Indirect Login Functions" on page 46.
CA_HALogin	See "High Availability Indirect Login Functions" on page 46.
CA_InitAudit	Initialize the Auditor role.
CA_InitializeRemotePEDVector	Create the Remote PED Vector.
CA_InitRolePIN	Initialize a role on the current slot.
CA_InitSlotRolePIN	Initialize a role on a different slot.
CA_InitToken	Same as CA_Init_token with PPT support.
CA_Insert	Insert a SIM3 blob.
CA_IsMofNEnabled	Firmware 4. Queries M of N status.
CA_IsMofNRequired	Firmware 4. Queries M of N status.
CA_ListSecureTokenInit	Retrieve information from an SFF backup token.
CA_ListSecureTokenUpdate	Continue retrieving information from a backup SFF token.
CA_LogExportSecret	Export (backup) the audit log HMAC key.
CA_LogExternal	Log external message - pushes an application-provided message to the HSM and logs it via the audit log.
CA_LogGetConfig	Get the audit log configuration.
CA_LogGetStatus	Get the audit log status (audit role, logs needing export, HSM to PedClient communication status).
CA_LogImportSecret	Restore the audit log HMAC key.
CA_LogSetConfig	Modify the audit log configuration.
CA_LogVerify	Verify the audit log record(s).
CA_LogVerifyFile	Verify the audit log record file.
CA_ManualKCV	Set the key cloning vector (KCV) (sets the domain).
CA_ModifyMofN	Modify the secret-splitting vector on a token.

Extension	Description
CA_ModifyUsageCount	Modify key usage count (Crypto Officer).
CA_MTKGetState	Firmware 6. Get the master tamper key (MTK) state (tampered or not).
CA_MTKResplit	Generate new MTK split, new purple key value.
CA_MTKRestore	Return MTK, provide purple key to recover from tamper.
CA_MTKSetStorage	Create purple key, enables STM/SRK.
CA_MTKZeroize	Erase the MTK, user invoked tamper. Puts HSM in to transport mode.
CA_OpenApplicationID	Activate an application identifier, independent of any open sessions.
CA_OpenApplicationIDForContainer	Same as CA_OpenApplicationID, but partition specific.
CA_OpenSecureToken	Firmware 6. Open context for an SFF token.
CA_OpenSession	Same as C_OpenSession, but lets you specify partition.
CA_OpenSessionWithAppID	Same as CA_OpenSession, but lets you specify an application ID (AppID)
CA_PerformSelfTest	Invoke a self test on HSM (RNG statistics, Cryptographic Algorithms).
CA_QueryLicense	Get License/CUF information.
CA_ResetDevice	Reset the HSM .
CA_ResetPIN	SO reset of a CO role PIN (if "SO can reset PIN" policy is on).
CA_Restart	Clean up all sessions for a given slot.
CA_RestartForContainer	Clean up all sessions for a given partition.
CA_RetrieveLicenseList	Get a list of all Licenses/CUFs.
CA_RoleStateGet	Get the state of a role (initialized, activated, failed logins, challenge created, etc).
CA_SetApplicationID	Set the application's identifier.
CA_SetCloningDomain	Set the domain string used during token initialization.
CA_SetContainerPolicies	Set multiple partition policies.
CA_SetContainerPolicy	Set single partition policy.

Extension	Description
CA_SetContainerSize	Set container storage size.
CA_SetDestructiveHSMPolicies	Set multiple destructive HSM policies.
CA_SetDestructiveHSMPolicy	Set single destructive HSM policy.
CA_SetHSMPolicies	Set multiple HSM policies.
CA_SetHSMPolicy	Set single HSM policy.
CA_SetKCV	Set KCV (domain).
CA_SetLKCV	Set a legacy KCV (legacy domain).
CA_SetMofN	Set the security policy for the token to use the secret sharing feature.
CA_SetPedId	Set the PED ID for a specific slot.
CA_SetRDK	Set the RDK (role specific KCV) for the current role.
CA_SetTokenPolicies	Set partition policies for given slot (PPSO only)
CA_SetUserContainerName	Set the name the library should use for the user partition on non-PPSO partitions.
CA_SIMExtract	SIM2, SKS, firmware 4.x, firmware 6.x. Extract SIM2 blob.
CA_SIMInsert	SIM2, SKS, firmware 4.x, firmware 6.x. Insert SIM2 blob.
CA_SIMMultiSign	SIM2, SKS, firmware 4.x, firmware 6.x. Sign multiple data blobs with multiple keys provided as SIM2 blobs.
CA_SpRawRead	PED key migration - read PED key value from DataKey PED Key.
CA_SpRawWrite	PED key migration - store PED key value to iKey PED Key.
CA_STCClearCipherAlgorithm	Remove the specified Cipher Algorithm from use with STC for the specified slot.
CA_STCClearDigestAlgorithm	Remove the specified Digest Algorithm from use with STC for the specified slot.
CA_STCDeregister	Remove STC registration of a client from the specified slot.
CA_STCGetAdminPubKey	Get the public key for the Admin slot's STC identity RSA keypair.

Extension	Description
CA_STCGetChannelID	Get the Secure Trusted Channel ID for the current slot.
CA_STCGetCipherAlgorithm	Get all the valid cipher suites allowed for the specified slot.
CA_STCGetCipherID	Get the ID for the cipher currently in use on active STC to this slot.
CA_STCGetCipherIDs	Get all cipher IDs valid for use with STC to the specified slot.
CA_STCGetCipherNameByID	Get the readable name string for the specified Cipher ID.
CA_STCGetClientInfo	Get the STC registration details (name, public key, active access) about the specified client on the specified slot.
CA_STCGetClientsList	Get the list of all STC clients registered to the specified slot.
CA_STCGetCurrentKeyLife	Get the remaining lifetime (in operations) for the active negotiated STC session key.
CA_STCGetDigestAlgorithm	Get all the valid digest algorithms allowed for the specified slot.
CA_STCGetDigestID	Get the ID for the digest currently in use on active STC to this slot.
CA_STCGetDigestIDs	Get all digest IDs valid for use with STC to the specified slot.
CA_STCGetDigestNameByID	Get the readable name string for the specified Digest ID.
CA_STCGetKeyActivationTimeOut	Get the amount of time allowed between the initiation and completion of STC session negotiation.
CA_STCGetKeyLifeTime	Get the configured session key lifetime (in operations) for the specified slot.
CA_STCGetPartPubKey	Get the public key for the specified slot STC identity RSA keypair.
CA_STCGetPubKey	Get the specified slot's public key.
CA_STCGetSequenceWindowSize	Get the replay window size for the specified slot.
CA_STCGetState	Get the STC state of the specified slot.
CA_STCIsEnabled	Determine if STC is configured for the specified slot.
CA_STCRegister	Register a client for STC to the specified slot.

Extension	Description
CA_STCSetCipherAlgorithm	Set a cipher algorithm as valid for use with STC on the specified slot.
CA_STCSetDigestAlgorithm	Set a digest algorithm as valid for use with STC on the specified slot.
CA_STCSetKeyActivationTimeOut	Set the amount of time allowed between the initiation and completion of STC session negotiations for the specified slot.
CA_STCSetKeyLifeTime	Set how long a STC key can live before STC rekeying occurs.
CA_STCSetSequenceWindowSize	Set the replay window size for the specified slot.
CA_STMGetState	Firmware 7. Get STM state (enabled or disabled).
CA_STMToggle	Enter, or recover from, Secure Transport Mode.
CA_TamperClear	Firmware 7. Used by the SO to clear tamper status.
CA_TimeSync	Synchronize the HSM time with the host time.
CA_TokenDelete	SO can delete a partition (PPSO only).
CA_TokenZeroize	Zeroize a PPSO partition.
CA_ValidateContainerPolicySet	Firmware 7. Validate partition policy settings prior to calling SetPolicies.
CA_ValidateHSMPolicySet	Firmware 7. Validate HSM policy settings prior to calling SetPolicies.
CA_WaitForSlotEvent	For PCMCIA HSMs, extends C_WaitForSlotEvent and provides some history of events.
CA_Zeroize	Zeroize the HSM.

HSM Configuration Settings

SafeNet HSMs implement configuration settings that can be used to modify the behavior of the HSM, or can be read to determine how the HSM will behave. There are multiple settings that may be manipulated. Other than the "allow non-FIPS algorithms", most customers have no need to either query or change HSM settings. If you believe that your application needs more control over the HSM, please contact SafeNet for guidance.

SafeNet Network HSM-Specific Commands

SafeNet Network HSM, both the HSM Server and the client, use PKCS#11 and the SafeNet Extensions, with some exceptions that differ from other SafeNet products. This SDK document is meant to support all SafeNet products that use PKCS#11 and the other supported interfaces, in addition to SafeNet Network HSM.

Commands Not Available Through Libraries

Several commands, both standard PKCS#11 commands and our Extensions are not enabled in the Client, because their functions are addressed on SafeNet Network HSM via the lunash interface. These are:

- C_InitToken
- C_SetPin
- CA_ResetPin
- CA_SetCloningDomain
- all of the CCM commands
- CA_ClonePrivateKey
- C_GetOperationState
- C_SetOperationState

Configuration Settings

Other SafeNet tokens implement configuration settings that can be used to modify the behavior of the token, or can be read to determine how the token will behave.

In SafeNet Network HSM, this configuration and modification of HSM and behavior is controlled in lunash via HSM Policies, using the following commands:

- "hsm showpolicies" on page 1
- "hsm changepolicy" on page 1

Control of HSM Partition behavior is accomplished through the HSM Partition Policies, using the following lunash commands:

- "partition showpolicies" on page 1
- "partition changepolicy" on page 1

Secure PIN Port Authentication

Generally, an application collects an authentication code or PIN from a user and/or other source controlled by the host computer. With Gemalto's FIPS 140-2 level 3-validated products (such as SafeNet Network HSM), the PIN must come from a device connected to the secure port of the physical interface (or connected via a secure Remote PED protocol connection). The SafeNet PED (PIN Entry Device) is used for secure entry of PINs.

A bit setting in the device's capabilities settings determines whether the HSM requires that PINs be entered through the secure port. If the appropriate configuration bit is set, PINs must be entered through the secure port.

If the device`s configuration bit is off, the application must provide the PIN through the existing mechanism. Through setting the PIN parameters, the application tells the token where to look for PINs. A similar programming approach applies to define the key cloning domain identifier.

Applications wanting PINs to be collected via the secure port must pass a NULL pointer for the pPin parameter and a value of zero for the ulPinLen parameter in function calls with PIN parameters. This restriction applies everywhere PINs are used. The following functions are affected:

- C_InitToken
- C_InitIndirectToken

- C_InitPIN
- C_SetPIN
- CA_InitIndirectPIN
- C_Login
- CA_IndirectLogin

When domains are generated/collected through the secure port during a C_InitToken call, the application must pass a NULL pointer for the pbDomainString parameter and a value of zero for the ulDomainStringLen parameter in the CA_SetCloningDomain function.

Shared Login State and Application IDs

The PKCS#11 specification states that sessions within an application share a login state. An application is defined as a single address space and all threads that execute within it. Thus, if process A spawns multiple threads, and all of those threads open sessions on token #1, then all of those sessions share a login state. When one is logged in, they all are, and when one is logged out, they all are. However, if process B also has sessions open on token #1, they are independent from the sessions of process A. The login state of process B sessions is irrelevant to process A sessions (except where they conflict, such as process A logging in as USER when process B is already logged in as SO).

The Chrystoki library provides additional functionality that allows separate applications to share a login state. Within Chrystoki, each application has an application ID. An application ID is a 64-bit integer, normally specified in two 32-bit parts. A default application ID for the application is generated automatically by the Chrystoki library, when the application invokes **C_Initialize**. The default value is based upon the process ID of the application, so different applications will always have different application IDs.

Each session also has an application ID associated with it. This is the application ID of the application that created the session. Within Chrystoki and SafeNet tokens, login states are shared by sessions which have identical application IDs. Since there is usually a one-to-one mapping between applications and application IDs, this means that login states are normally shared between sessions within an application but not between applications. In order to allow separate Chrystoki applications to share session state, Chrystoki provides functionality that allows applications to alter their application IDs.

Why Share Session State Between Applications?

For many applications, the functionality described here serves no purpose. If an application consists of a single process that exists perpetually, unshared session states are sufficient. If the application supports multiple processes, but the application designer wants each process to validate (login) separately, unshared session states are sufficient.

However, if

- the application consists of multiple processes each with its own sessions and
- the application designer wants to require only one login action by the user and
- the system uses SafeNet CA3 tokens (where PINs cannot be cached and used multiple times by the application),

then, it is necessary to share login state between processes.

The SafeNet CA3 token provides FIPS 140-1 level 3 security through use of a separate port for password entry (with the SafeNet CA3 token, PINs take the form of special data keys). Use of these keys prevents an application from caching a password and using it to log in with multiple sessions. If you want to log in once only, and you use separate processes, you must somehow share login state between processes.

[UPDATE: Applies to newer SafeNet HSMs as well, in some integrations, for ease of use particularly against PED-authenticated HSMs.]

Login State Sharing Overview

The simplest form the extra Chrystoki functionality takes is the **CA_SetApplicationID** function. This function should be invoked after **C_Initialize** is invoked, but before any sessions are opened. Two separate applications can use this function to set their application IDs to the same value, and thus allow them to share login states between their sessions.

Alternately, the **AppIdMajor** and **AppIdMinor** fields in the **Misc** section of the Chrystoki configuration file can be set. This causes the default application ID of all applications to be set to the value given in the configuration file, rather than being generated from the application's process ID. This means that unless applications use the **CA_SetApplicationID** function, all applications on a host system will share login state between their sessions.

Example

A sample configuration file (**crystoki.ini** for Windows) using explicit application IDs is duplicated here:

```
[Chrystoki2]
LibNT=D:\Program Files\SafeNet\LunaClient\cryptoki.dl
[Luna]
DefaultTimeOut=500000
PEDTimeout1=100000
PEDTimeout2=200000
[CardReader]
RemoteCommand=1
[Misc]
AppIdMajor=2
AppIdMinor=4
```

One effect that can still cause problems is that when all sessions of a particular application ID are closed, that application ID reverts to a dormant state. When another session for that application ID is created, the application ID is recreated, but always in the logged-out state, regardless of the state it was in when it went dormant.

For example, consider an application where a parent process sets its application ID, opens a session, logs the session in, then closes the session and terminates. Several child pro-cesses then set their application IDs, open sessions and try to use them. However, since the application ID went dormant when the parent process closed its session, the child processes find their sessions logged out. The logged-in state of the parent process' session was lost when it closed its session.

The CA_OpenApplicationID function can be used to ensure that the login state of an application ID is maintained, even when no sessions exist which belong to that application ID. When CA_OpenApplicationID is invoked, the application ID is tagged so that it never goes dormant, even if no open ses-sions exist.

Login State Sharing Functions

Use the following functions to configure and manage login state sharing:

CA_SetApplicationID

```
CK_RV CK_ENTRY CA_SetApplicationID(
CK_ULONG ulHigh,
CK_ULONG ulLow
);
```

The **CA_SetApplicationID** function allows an application to set its own application ID, rather than letting the application ID be generated automatically from the application's process ID. **CA_SetApplicationID** should be invoked after **C_Initialize** but before any session manipulation functions are invoked. If **CA_SetApplicationID** is invoked after sessions have been opened, results will be unpredictable.

CA_SetApplicationID always returns CKR_OK.

CA_OpenApplicationID

```
CK_RV CK_ENTRY CA_OpenApplicationID(
CK_SLOT_ID slotID,
CK_ULONG ulHigh,
CK_ULONG ulLow
);
```

The **CA_OpenApplicationID** function forces a given application ID on a given token to remain active, even when all sessions belonging to the application ID have been closed. Normally an application ID on a token goes dormant when the last session that belongs to the application ID is closed. When an application ID goes dormant login state is lost, so when a new session is created within the application ID, it starts in the logged-out state. However, if **CA_OpenApplicationID** is used the application ID is prevented from going dormant, so login state is main-tained even when all sessions for an application ID are closed.

CA_OpenApplicationID can return CKR_SLOT_ID_INVALID or CKR_TOKEN_NOT_PRESENT.

CA_CloseApplicationID

```
CK_RV CK_ENTRY CA_CloseApplicationID(
CK_SLOT_ID slotID,
CK_ULONG ulHigh,
CK_ULONG ulLow
);
```

The **CA_CloseApplicationID** function removes the property of an application ID that prevents it from going dormant. **CA_CloseApplicationID** also closes any open sessions owned by the given application ID. Thus, when **CA_CloseApplicationID** returns, all open sessions owned by the given application ID have been closed and the application ID has gone dormant.

CA_CloseApplicationID can return CKR_SLOT_ID_INVALID or CKR_TOKEN_NOT_PRESENT.

Application ID Examples

The following code fragments show how two separate applications might share a single application ID:

```
app 1:          app 2:
C_Initialize()
CA_SetApplicationID(3,4)
C_OpenSession()
C_Login()
              C_Initialize()
              CA_SetApplicationID(3,4)
              C_OpenSession()
              C_GetSessionInfo()
              // Session info shows session
              // already logged in.
              <perform work, no login
              necessary>

C_Logout()
```

```
              C_GetSessionInfo()
              // Session info shows session
              // logged out.

C_CloseSession()
              C_CloseSession()
C_Finalize()
              C_Finalize()
```

The following code fragments show how one process might login for others:

Setup app:

```
C_Initialize()
CA_SetApplicationID(7,9)
CA_OpenApplicationID(slot,7,9)
C_OpenSession(slot)
C_Login()
C_CloseSession()
```

Spawn many child applications:

```
C_Finalize()
```

Terminate each child app:

```
              C_Initialize()
              CA_SetApplicationID(7,9)
              C_OpenSession(slot)
              <perform work, no login necessary>
```

Takedown app:

Terminate child applications:

```
              C_CloseSession()
              C_Finalize()
C_Initialize()
CA_CloseApplicationID(slot,7,9)
C_Finalize()
```

High Availability Indirect Login Functions

Note: In order to implement High Availability Recovery, the primary and secondary tokens must exist on separate systems.

The following enhancements securely extend the indirect login capability to SafeNet CA3 tokens. SafeNet CA3 tokens to store sensitive information (encrypted) in flash memory, and must therefore be protected against attack by a man-in-the-middle who physically attacks the target token to expose the contents of flash memory, and employs that information against intercepted (or spuriously-generated) message traffic.

The SafeNet CA3 to SafeNet CA3 indirect login protocol also supports old-style MofN authentication between tokens that share an MofN secret.

Initialization functions

Initialization of tokens in a high-availability environment involves three steps:

1. The generation of an RSA login key pair (the public key of the pair may be discarded),
2. Cloning of the private key member to the User (and optionally to the SO) spaces of all tokens within that environment and,
3. Calling the **CA_HAInit** function on all tokens within that environment, in the context of the session owned by the User or SO.

The first two steps are performed using ordinary key generate and cloning Cryptoki function calls. The **CA_HAInit** function is implemented as follows:

CA_HAInit()

```
CK_RV CK_ENTRY CA_HAInit(
CK_SESSION_HANDLE hSession, // Logged-in session of user
// who owns the Login key pair
CK_OBJECT_HANDLE hLoginPrivateKey // Handle to Login private key
);
```

Recovery Functions

The HA recovery mechanism requires the following commands and interface functions:

CA_HAGetMasterPublic()

Called on the primary token, CA_HAGetMasterPublic() retrieves the primary token's TWC (Token Wrapping Certificate) and returns it as a blob (octet string and length). The format of this function is as follows:

```
CK_RV CK_ENTRY CA_HAGetMasterPublic(
CK_SLOT_ID slotId, // Slot number of the primary
// token
CK_BYTE_PTR pCertificate, // pointer to buffer to hold
//TWC certificate
CK_ULONG_PTR pulCertificateLen // pointer to value to hold
//TWC certificate length
);
```

CA_HAGetLoginChallenge()

Called on the secondary token, **CA_HAGetLoginChallenge()** accepts the TWC blob and returns the secondary token's login challenge blob. The format of this command is as follows:

```
CK_RV CK_ENTRY CA_HAGetLoginChallenge(
CK_SESSION_HANDLE hSession, // Public session
CK_USER_TYPE userType, // User type - SO or USER
CK_BYTE_PTR pCertificate, // TWC certificate retrieved
// from primary
CK_ULONG ulCertificateLen, // TWC certificate length
CK_BYTE_PTR pChallengeBlob, // pointer to buffer to hold
// challenge blob
CK_ULONG_PTR pulChallengeBlobLen // pointer to value to hold
// challenge blob length
);
```

CA_HAAnswerLoginChallenge()

Called on the primary token, **CA_HAAnswerLoginChallenge()** accepts the login challenge blob and returns the encrypted SO or User PIN, as appropriate.

```
CK_RV CK_ENTRY CA_HAAnswerLoginChallenge(
CK_SESSION_HANDLE hSession, // Session of the Login Private
// key owner
CK_OBJECT_HANDLE hLoginPrivateKey, // object handle to login key
CK_BYTE_PTR pChallengeBlob, // pointer to buffer containing
// challenge blob
CK_ULONG ulChallengeBlobLen, // length of challenge blob
CK_BYTE_PTR pEncryptedPin, // pointer to buffer holding
// encrypted PIN
CK_ULONG_PTR pulEncryptedPinLen // pointer to value holding
// encrypted PIN length
);
```

CA_HALogin()

Called on the secondary token, **CA_HALogin()** accepts the encrypted PIN and logs the secondary token in. If the second-ary token requires MofN authentication, an MofN challenge blob is returned. If no MofN authentication is required, a zero-length blob is returned. The format of this function is as follows:

```
CK_RV CK_ENTRY CA_HALogin(
CK_SESSION_HANDLE hSession, // Same public session opened
// in CA_HAGetLoginChallenge,
//above
CK_BYTE_PTR pEncryptedPin, // pointer to buffer holding
// encrypted PIN
CK_ULONG ulEncryptedPinLen,  //  length of encrypted PIN
CK_BYTE_PTR pMofNBlob, // pointer to buffer to hold
// MofN blob
CK_ULONG_PTR pulMofNBlobLen // pointer to value to hold the
// length of MofN blob
);
```

If the call is successful, then the session now becomes a pri-vate session owned by the User or SO (as appropriate).

CA_HAAnswerMofNChallenge()

Called on the primary token, **CA_AnswerMofNChallenge()** accepts the MofN challenge blob and returns the primary token's masked MofN secret. The format of this function is as follows:

```
CK_RV CK_ENTRY CA_HAAnswerMofNChallenge(
CK_SESSION_HANDLE hSession, // Private session
CK_BYTE_PTR pMofNBlob, // passed in MofN blob
CK_ULONG ulMofNBlobLen, // length of MofN blob
CK_BYTE_PTR pMofNSecretBlob, // pointer to buffer to hold
// MofN secret blob
CK_ULONG_PTR pulMofNSecretBlobLen//pointer to value that holds
// the MofN secret blob len
);
```

CA_HAActivateMofN()

Called on the secondary token, **CA_HAActivateMofN()** accepts the masked MofN secret and performs MofN authentication. The resulting MofN secret is checked against the CRC stored in the MofN PARAM structure.

```
CK_RV CK_ENTRY CA_HAActivateMofN(
CK_SESSION_HANDLE hSession, // The now-private session from
// successful CA_HALogin call
CK_BYTE_PTR pMofNSecretBlob, // pointer to MofN secret
// blob that is passed in
CK_ULONG ulMofNSecretBlobLen // length of MofN secret blob
```



```
);
```

It is expected that the recovery functions will be executed in the proper sequence and as part of an atomic operation. Nonetheless, the recovery operation may be restarted at any time due to an error. Restarting the recovery operation resets the state condition of the secondary token, and any data that has been stored or generated on the token is discarded.

Login Key Attributes

The login keys must possess the following attributes to function properly in a HA recovery scenario:

```
// Object
CKA_CLASS = CKO_PRIVATE_KEY,
// StorageClass
CKA_TOKEN = True,
CKA_PRIVATE = True,
CKA_MODIFIABLE = False,
// Key
CKA_KEY_TYPE = CKK_RSA,
CKA_DERIVE = False,
CKA_LOCAL = True,
// Private
CKA_SENSITIVE = True,
CKA_DECRYPT = False,
CKA_SIGN = False,
CKA_SIGN_RECOVER = False,
CKA_UNWRAP = False,
CKA_EXTRACTABLE = False
```

Control of HA Functionality

Refer to for the mechanisms by which the SO can control availability of the HA functionality.

MofN Secret Sharing

In previous SafeNet HSM releases, this page described library and firmware aspects of MofN secret sharing.

Current implementation (since HSM firmware 5) no longer implements MofN via the HSM.

Instead, MofN is entirely mediated via SafeNet PED 2.4 and later. The HSM is unaware of secret sharing. Multi-person access control for any of the authentication secrets (SO, User, Cloning domains, Remote PED Vector, Secure Recovery Vector) is a PED function, and the HSM sees only the fully reconstituted MofN secrets as they are presented to it by the PED.

Green PED Keys are no longer used.

This implementation is both cleaner and more flexible than the legacy implementation.If you have used, or are still using legacy SafeNet HSMs, be aware that the legacy implementation of MofN split-secret, multi-person access control is not compatible with the modern implementation. For migration instructions, contact SafeNet Technical Support -- e-mail: support@safenet-inc.com or phone 800-545-6608 (+1 410-931-7520 International)

Key Export Features

The SafeNet Key Export HSM provides the feature(s) detailed in this section.

RSA Key Component Wrapping

The RSA Key Component Wrapping is a feature that allows an application to wrap any subset of attributes from an RSA private key with 3-DES. Access to the feature is through the PKCS #11 function C_WrapKey with the CKM_DES3_ECB mechanism. The wrapping key must be a CKK_DES2 or CKK_DES3 key with its CKA_WRAP attribute set to TRUE. The key to wrap must be an RSA private key with CKA_EXTRACTABLE set to TRUE and the FPV must have FPV_WRAPPING_TOKEN turned on.

The details of the wrapping format are specified with a format descriptor. The format descriptor is provided as the mechanism parameter to the CKM_DES3_ECB mechanism. This descriptor consists of a 32-bit format version, followed by a set of field element descriptors. Each field element descriptor consists of a 32-bit Field Type Identifier and optionally some additional data. The SafeNet firmware parses the set of field element descriptors and builds the custom layout of the RSA private key in an internal buffer. Once all field element descriptors are processed, the buffer is wrapped with 3-DES and passed out to the calling application. It is the responsibility of the calling application to ensure that the buffer is a multiple of 8 bytes.

The format descriptor version (the first 32-bit value in the format data) must always be set to zero.

The set of supported field element descriptor constants is as follows:

- #define KM_APPEND_STRING 0x00000000
- #define KM_APPEND_ATTRIBUTE 0x00000001
- #define KM_APPEND_REVERSED_ATTRIBUTE 0x00000002
- #define KM_APPEND_RFC1423_PADDING 0x00000010
- #define KM_APPEND_ZERO_PADDING 0x00000011
- #define KM_APPEND_ZERO_WORD_PADDING 0x00000012
- #define KM_APPEND_INV_XOR_CHECKSUM 0x00000020
- #define KM_DEFINE_IV_FOR_CBC 0x00000030

The meanings of the field element descriptors is as follows:

Field element descriptor	Description
KM_APPEND_STRING	Appends an arbitrary string of bytes to the custom layout buffer. The field type identifier is followed by a 32-bit length field defining the number of bytes to append. The length field is followed by the bytes to append. There is no restriction of the length of data that may be appended, as long as the total buffer length does not exceed 3072 bytes.
KM_APPEND_ATTRIBUTE	Appends an RSA private key component into the buffer in big endian representation. The field type identifier is followed by a 32-bit CK_ATTRIBUTE_TYPE value set to one of the following: CKA_PRIVATE_EXPONENT, CKA_PRIME_1, CKA_PRIME_2, CKA_EXPONENT_1, CKA_EXPONENT_2, or CKA_COEFFICIENT.. The key component is padded with leading zeros such that the length is equal to the modulus length in the case of the private exponent, or equal to half of the modulus length in the case of the other 5 components.
KM_APPEND_REVERSED_	Appends an RSA private key component into the buffer in little endian representation. The field type identifier is followed by a 32-bit CK_ATTRIBUTE_TYPE value set to one of the

Field element descriptor	Description
ATTRIBUTE	following: CKA_PRIVATE_EXPONENT, CKA_PRIME_1, CKA_PRIME_2, CKA_EXPONENT_1, CKA_EXPONENT_2, or CKA_COEFFICIENT. The key component is padded with trailing zeros such that the length is equal to the modulus length in the case of the private exponent, or equal to half of the modulus length in the case of the other 5 components.
KM_APPEND_RFC1423_PADDING	Applies RFC 1423 padding to the buffer (appends 1 to 8 bytes with values equal to the number of bytes, such that the total buffer length becomes a multiple of 8). This would typically be the last formatting element in a set, but this is not enforced.
KM_APPEND_ZERO_PADDING	Applies Zero padding to the buffer (appends 0 to 7 bytes with values equal to Zero, such that the total buffer length becomes a multiple of 8). This would typically be the last formatting element in a set, but this is not enforced.
KM_APPEND_ZERO_WORD_PADDING	Zero pads the buffer to the next 32-bit word boundary.
KM_APPEND_INV_XOR_CHECKSUM	Calculates and adds a checksum byte to the buffer. The checksum is calculated as the complement of the bytewise XOR of the buffer being built.
KM_DEFINE_IV_FOR_CBC	Allows definition of an IV so that 3DES_CBC wrapping can be performed even though the functionality is invoked with the CKM_3DES_ECB mechanism. The field type identifier is followed by a 32-bit length field, which must be set to 8. The length is followed by exactly 8 bytes of data which are used as the IV for the wrapping operation.

Examples

To wrap just the private exponent of an RSA key in big endian representation, the parameters would appear as follows:

Note: Ensure that the packing alignment for your structures uses one (1) byte boundaries.

```
struct
{
UInt32 version = 0;
UInt32 elementType = KM_APPEND_ATTRIBUTE;
CK_ATTRIBUTE_TYPE attribute = CKA_PRIVATE_EXPONENT;
}
```

To wrap the set of RSA key components Prime1, Prime2, Coefficient, Exponent1, Exponent2 in little endian representation with a leading byte of 0x05 and ending with a CRC byte and then zero padding, the parameters would appear in a packed structure as follows:

```
struct
{
UInt32 version = 0;
UInt32 elementType1 = KM_APPEND_STRING;
UInt32 length = 1;
```

```
UInt8 byteValue = 5;
UInt32 elementType2 = KM_APPEND_REVERSED_ATTRIBUTE;
CK_ATTRIBUTE_TYPE attribute1 = CKA_PRIME_1;
UInt32 elementType3 = KM_APPEND_REVERSED_ATTRIBUTE;
CK_ATTRIBUTE_TYPE attribute2 = CKA_PRIME_2;
UInt32 elementType4 = KM_APPEND_REVERSED_ATTRIBUTE;
CK_ATTRIBUTE_TYPE attribute3 = CKA_COEFFICIENT;
UInt32 elementType5 = KM_APPEND_REVERSED_ATTRIBUTE;
CK_ATTRIBUTE_TYPE attribute4 = CKA_EXPONENT_1;
UInt32 elementType6 = KM_APPEND_REVERSED_ATTRIBUTE;
CK_ATTRIBUTE_TYPE attribute5 = CKA_EXPONENT_2;
UInt32 elementType7 = KM_APPEND_INV_XOR_CHECKSUM;
UInt32 elementType8 = KM_APPEND_ZERO_PADDING;
}
```

Derivation of Symmetric Keys with 3DES_ECB

SafeNet supports derivation of symmetric keys by the encryption of "diversification data" with a base key. Access to the derivation functionality is through the PKCS #11 C_DeriveKey function with the CKM_DES3_ECB and CKM_DES_ECB mechanism. Diversification data is provided as the mechanism parameter. The derived key can be any type of symmetric key. The encrypted data forms the CKA_VALUE attribute of the derived key. A template provided as a parameter to the C_DeriveKey function defines all other attributes.

Rules for the derivation are as follows:

- The Base Key must be of type CKK_DES2 or CKK_DES3 when using CKM_DES3_ECB. It must be of type CKK_DES when using CKM_DES_ECB.
- The base key must have its CKA_DERIVE attribute set to TRUE.
- The template for the derived key must identify the key type (CKA_KEY_TYPE) and length (CKA_VALUE_LEN). The type and length must be compatible. The length can be omitted if the key type supports only one length. (E.g., If key type is CKK_DES2, the length must either be explicitly defined as 16, or be omitted to allow the value to default to 16). Other attributes in the template must be consistent with the security policy settings of the SafeNet HSM.
- The derivation mechanism must be set to CKM_DES3_ECB or CKM_DES_ECB, the mechanism parameter pointer must point to the diversification data, and the mechanism parameter length must be set to the diversification data length.
- The diversification data must be the same length as the key to be derived, with one exception. If the key to be derived is16 bytes, the base key is CKK_DES2 and the diversification data is only 8 bytes, then the data is encrypted twice - once with the base key and once with the base key with its halves reversed. Joining the two encrypted pieces forms the derived key.
- If the derived key is of type CKK_DES, CKK_DES2 or CKK_DES3, odd key parity is applied to the new key value immediately following the encryption of the diversification data. The encrypted data is taken as-is for the formation of all other types of symmetric keys.

PKCS # 11 Extension HA Status Call

A SafeNet extension to the PKCS#11 standard allows query of the HA group state.

Function Definition

```
CK_RV CK_ENTRY CA_GetHAState( CK_SLOT_ID slotId, CK_HA_STATE_PTR pState );
```

The structure definitions for a CK_HA_STATE_PTR and CK_HA_MEMBER are:

```
typedef struct CK_HA_MEMBER{
CK_ULONG memberSerial;
CK_RV memberStatus;
}CK_HA_MEMBER;

typedef struct CK_HA_STATUS{
CK_ULONG groupSerial;
CK_HA_MEMBER memberList[CK_HA_MAX_MEMBERS];
CK_USHORT listSize;
}CK_HA_STATUS;
```

See the JavaDocs included with the software for a description of the Java methods derived from this cryptoki function.

Pseudorandom Function KDF Mechanisms

The SafeNet HSMs support the following two vendor defined mechanisms. They can be used to perform Counter Mode KDF (key derivation functions) using various CMAC algorithms (DES3, AES, ARIA, SEED) as the PRF (pseudo-random function). See NIST SP 800-108. These mechanisms are available in firmware 6.2.1 and later.

```
#define CKM_NIST_PRF_KDF                        (CKM_VENDOR_DEFINED + 0xA02)
#define CKM_PRF_KDF                             (CKM_VENDOR_DEFINED + 0xA03)

/* Parameter and values used with CKM_PRF_KDF and * CKM_NIST_PRF_KDF. */

typedef CK_ULONG CK_KDF_PRF_TYPE;
typedef CK_ULONG CK_KDF_PRF_ENCODING_SCHEME;

/** PRF KDF types */
#define CK_NIST_PRF_KDF_DES3_CMAC      0x00000001
#define CK_NIST_PRF_KDF_AES_CMAC       0x00000002
#define CK_PRF_KDF_ARIA_CMAC           0x00000003
#define CK_PRF_KDF_SEED_CMAC           0x00000004

#define LUNA_PRF_KDF_ENCODING_SCHEME_1     0x00000000
#define LUNA_PRF_KDF_ENCODING_SCHEME_2     0x00000001

typedef struct CK_KDF_PRF_PARAMS {
   CK_KDF_PRF_TYPE            prfType;
   CK_BYTE_PTR                pLabel;
   CK_ULONG                   ulLabelLen;
   CK_BYTE_PTR                pContext;
   CK_ULONG                   ulContextLen;
   CK_ULONG                   ulCounter;
   CK_KDF_PRF_ENCODING_SCHEME ulEncodingScheme;
} CK_PRF_KDF_PARAMS;

typedef CK_PRF_KDF_PARAMS CK_PTR CK_KDF_PRF_PARAMS_PTR;
```

Derive Template

The CKA_DERIVE_TEMPLATE attribute is an optional extension to the C_DeriveKey function. This attribute points to an array template which provides additional security by restricting important attributes in the resulting derived key. This derive template, along with the user-supplied application template (called pTemplate in the PKCS#11 specification), determine the attributes of the derived key.

To invoke a derive template, the base key must have the CKA_DERIVE_TEMPLATE attribute set, pointing to a user-supplied derive template. When you specify this attribute on the base key and then attempt to derive a key, the derive operation adds the attributes of the application template to the attributes in the derive template. If there are any mismatches between attribute values specified in the two templates, the derive operation fails. Otherwise, the operation succeeds, producing a derived key with the combined attributes of the two templates.

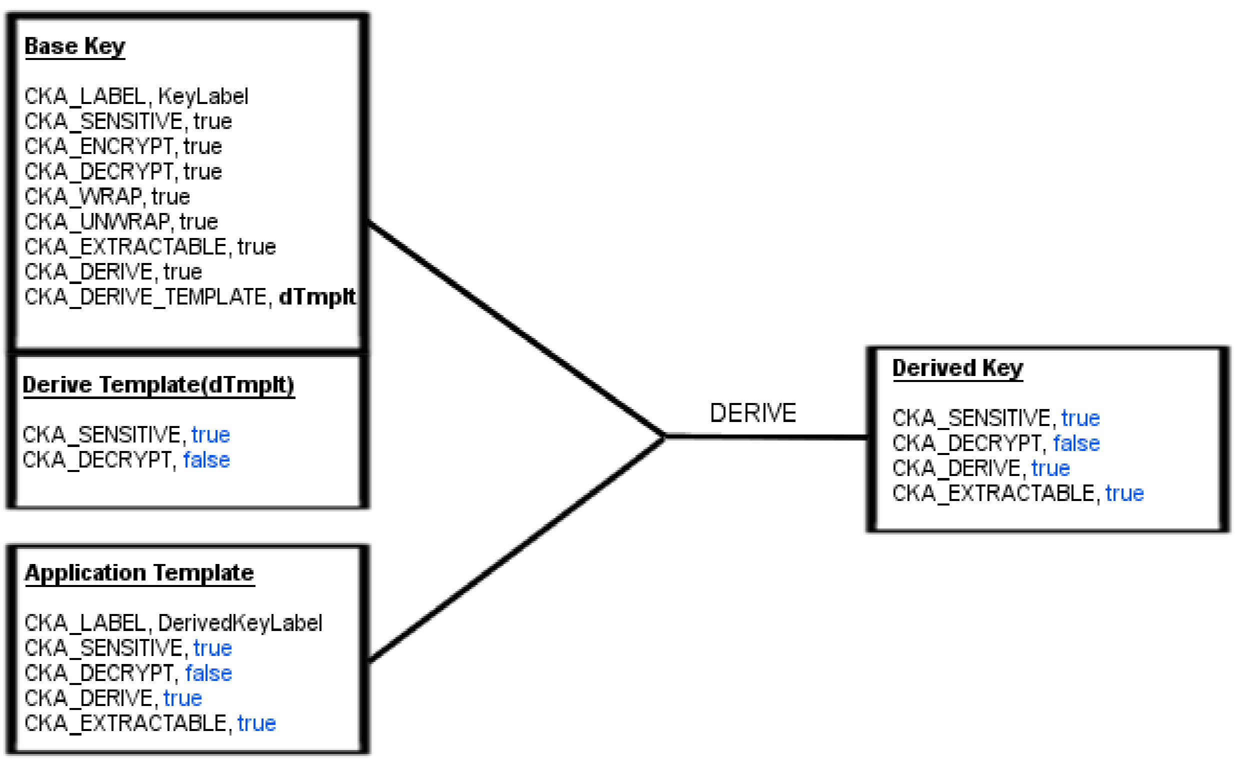
Any and all attributes which are valid for application template of a particular mechanism are also valid for the derive template. For security, the most effective attributes to restrict are those which might allow the derived key to be misused or expose secret information. Broadly these include but are not limited to encryption/decryption capabilities, extractability, the CKA_SENSITIVE attribute and the CKA_MODIFIABLE attribute. All mechanisms which support key derivation also support derive templates.

Examples

The following examples show a successful derivation with a derive template, and a failed derivation.

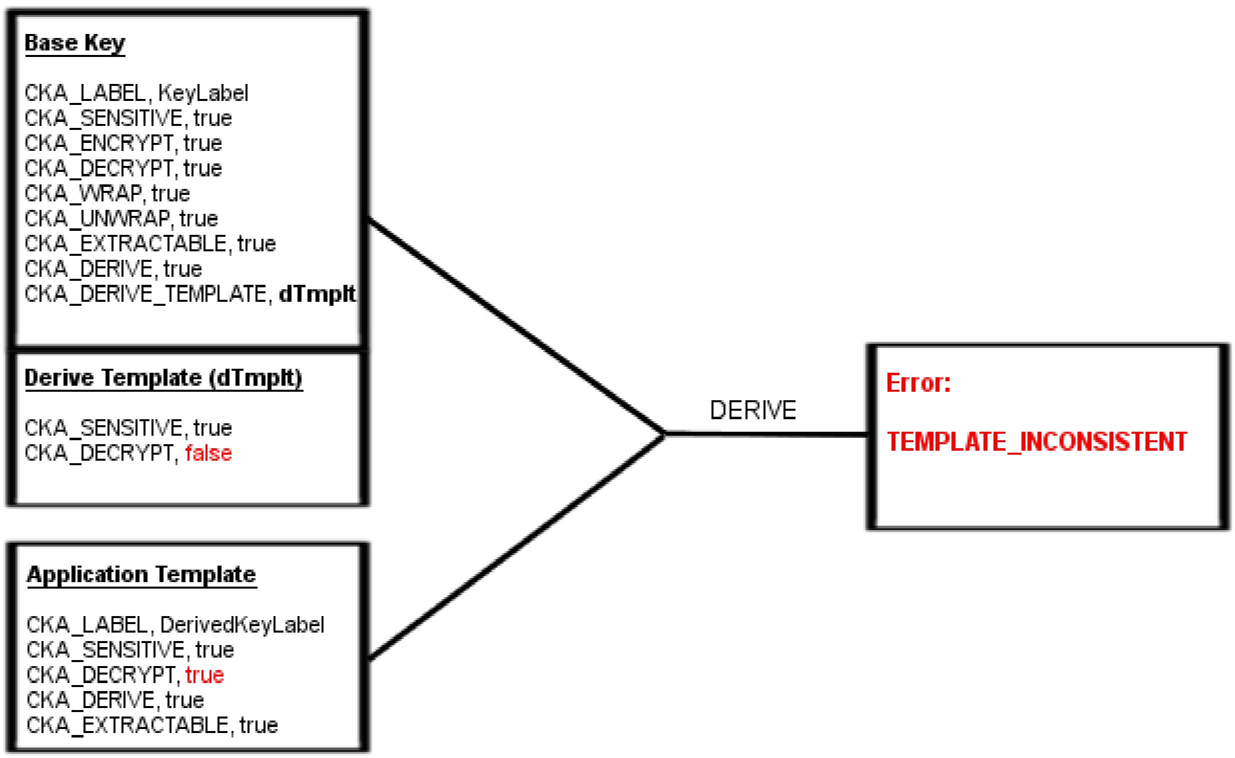
Successful Derivation

Here, the base key has the CKA_DERIVE_TEMPLATE attribute pointing to the derive template dTmplt. There are no conflicts between dTmplt and the application template. The application template's extra attributes are added to dTmplt's attributes, and the derivation operation produces a derived key containing the attributes in the two templates.



Failed Derivation

Here, the base key has the CKA_DERIVE_TEMPLATE attribute pointing to the derive template dTmplt. Notice that dTmplt has the CKA_DECRYPT attribute set to false, where the application template has the CKA_DECRYPT attribute set to true. This conflict causes the derivation operation to fail with the error TEMPLATE_INCONSISTENT.



Unwrap Template

The CKA_UNWRAP_TEMPLATE attribute is an optional extension to the C_UnwrapKey function. This attribute points to an array template which provides additional security by restricting important attributes in the resulting unwrapped key. This unwrap template, along with the user-supplied application template (called uTemplate in the PKCS#11 specification), determine the attributes of the unwrapped key.

To invoke an unwrap template, the base key must have the CKA_UNWRAP_TEMPLATE attribute set, pointing to a user-supplied unwrap template. When you specify this attribute on the base key and then attempt to unwrap a key, the unwrap operation adds the attributes of the application template to the attributes in the unwrap template. If there are any mismatches between attribute values specified in the two templates, the unwrap operation fails. Otherwise, the operation succeeds, producing an unwrapped key with the combined attributes of the two templates.

Any and all attributes which are valid for application template of a particular mechanism are also valid for the unwrap template. For security, the most effective attributes to restrict are those which might allow the unwrapped key to be misused or expose secret information. All mechanisms that support key unwrapping also support unwrap templates.

Use Case Example

Key wrapping of asymmetric keys using asymmetric keys. Assume a 2-level wrapping scheme

- Level 1: a private key stored on the HSM will have the suggested attributes; so far, so good
- Level 2: a wrapped symmetric key is used to wrap an asymmetric key - this is where CKA_UNWRAP_TEMPLATE would be used on the Level 1 key to enforce these attributes on the Level 2 key as well; without CKA_UNWRAP_TEMPLATE feature the application would have to rely on the software to ensure that attributes for the Level 2 key are set appropriately.

Like this:

Since asymmetric keys are too big to be directly wrapped using another asymmetric key (2k key in PKCS#8 would be probably require an 8K wrapping key...) use 2 layers of wrapping:

Wrapping:

- 2k RSA private key is wrapped using an random symmetric key (all keys and operations in software)

- random symmetric key is wrapped using 2K RSA public key (all keys and operations in software, matching private key for public key in HSM)

Unwrapping:

- unwrap symmetric key onto the HSM using private key on the HSM (here, want to use CKA_UNWRAP_TEMPLATE to ensure that the unwrapped symmetric key can be used to unwrap only)

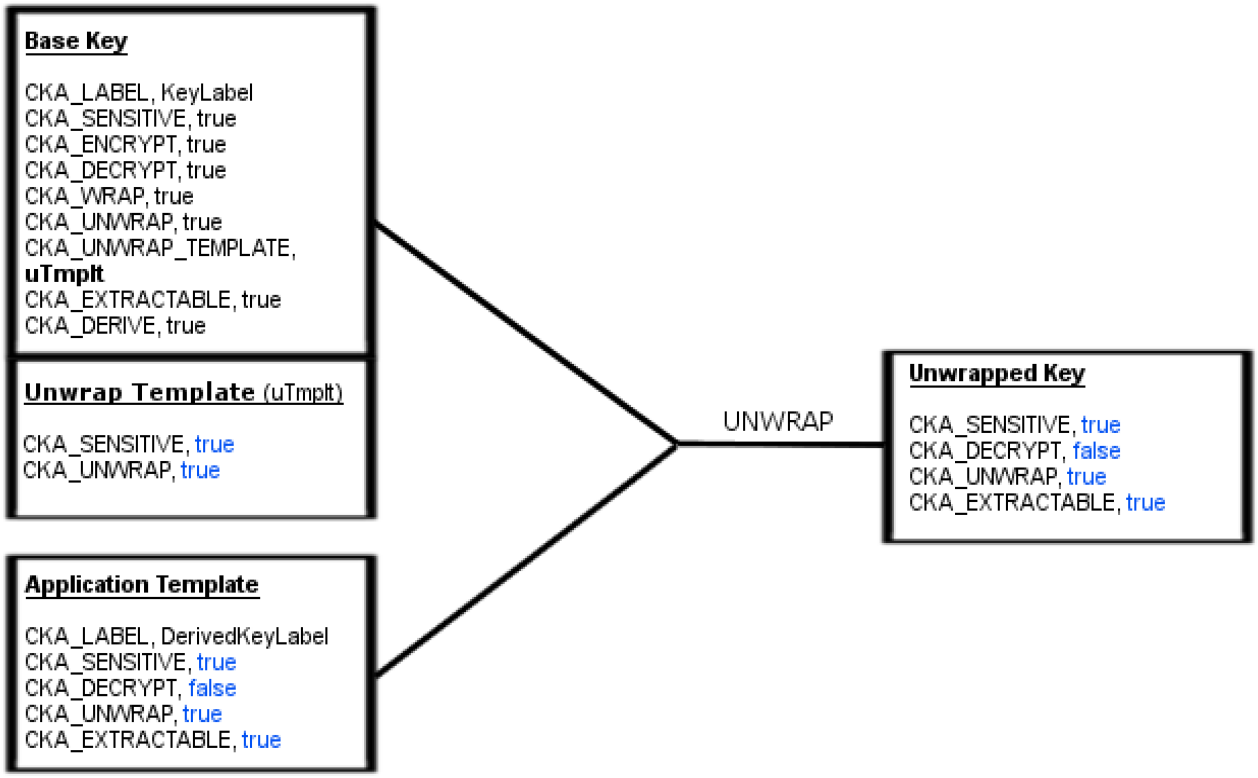
- unwrap 2K RSA private key onto HSM, use it and delete it.

Examples

The following examples show a successful unwrapping with an unwrap template, and a failed unwrap.

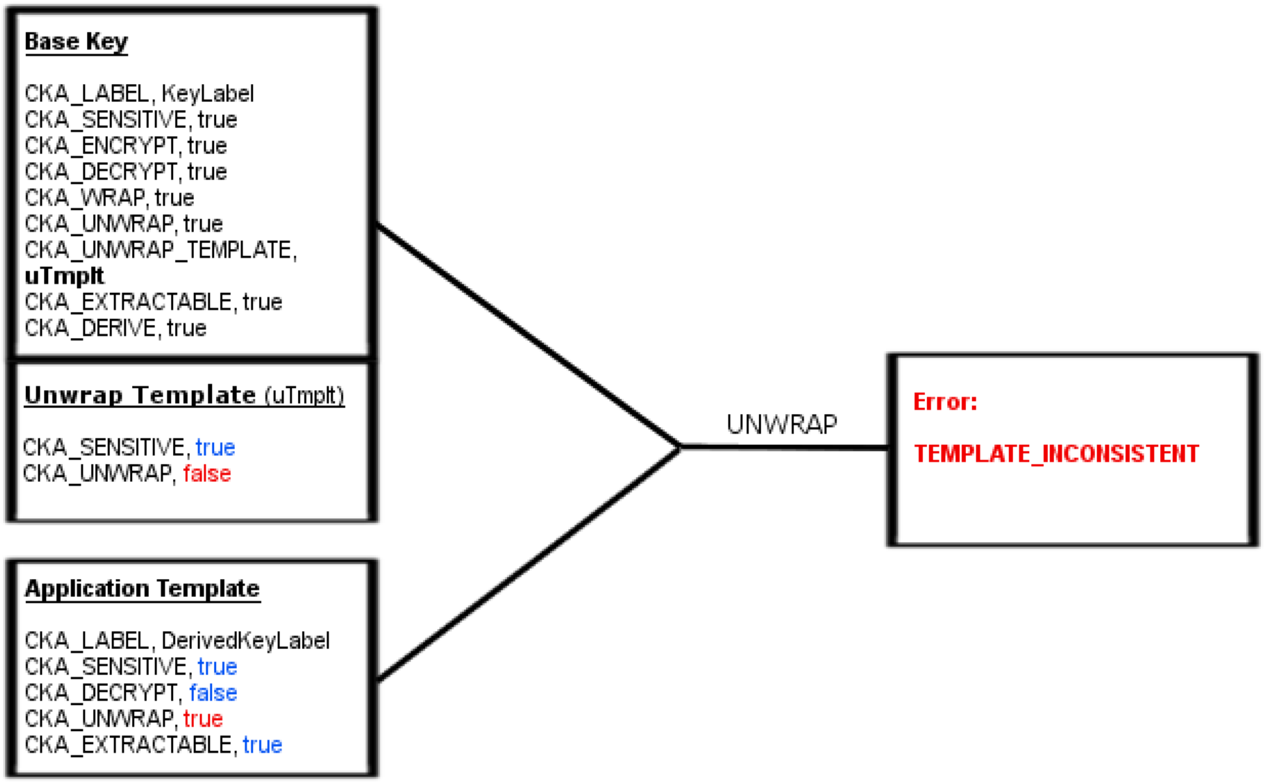
Successful Unwrap

Here, the base key has the CKA_UNWRAP_TEMPLATE attribute pointing to the unwrap template uTmplt. There are no conflicts between uTmplt and the application template. The application template's extra attributes are added to uTmplt's attributes, and the unwrap operation produces an unwrapped key containing the attributes in the two templates.



Failed Unwrap

Here, the base key has the CKA_UNWRAP_TEMPLATE attribute pointing to the unwrap template uTmplt. Notice that uTmplt has the CKA_UNWRAP attribute set to false, where the application template has the CKA_UNWRAP attribute set to true. This conflict causes the unwrap operation to fail with the error TEMPLATE_INCONSISTENT.


Base Key
CKA_LABEL, KeyLabel
CKA_SENSITIVE, true
CKA_ENCRYPT, true
CKA_DECRYPT, true
CKA_WRAP, true
CKA_UNWRAP, true
CKA_UNWRAP_TEMPLATE, uTmplt
CKA_EXTRACTABLE, true
CKA_DERIVE, true
Unwrap Template (uTmplt)
CKA_SENSITIVE, true
CKA_UNWRAP, false
Application Template
CKA_LABEL, DerivedKeyLabel
CKA_SENSITIVE, true
CKA_DECRYPT, false
CKA_UNWRAP, true
CKA_EXTRACTABLE, true
UNWRAP
Error:
TEMPLATE_INCONSISTENT

4
Supported Mechanisms

This chapter provides an alphabetical listing of the supported PKCS #11 standard mechanisms and SafeNet proprietary mechanisms.

Note: NIST analyzes and approves cipher algorithms for the purposes of their clients. The list is maintained at http://csrc.nist.gov/groups/STM/cavp/
Approvals and guidance can change. If you think the FIPS approval entry in any of the algorithms in this list is incorrect, check with the NIST site for the most current information.

Mechanism Remap for FIPS Compliance

Under FIPS 186-3/4, the only RSA methods permitted for generating keys are 186-3 with primes and 186-3 with aux primes. This means that RSA PKCS and X9.31 key generation is no longer approved for operation in a FIPS-compliant HSM. Firmware version 6.2.1 and older supported only PKCS and X9.31, and these were allowed in FIPS mode. Firmware versions 6.10 through 6.21 provide the newer mechanisms, and allow both older and newer mechanisms in FIPS mode. Firmware versions 6.22.0 and newer do not allow PKCS and X9.31 in FIPS mode.

Firmware Version	Supported Mechanisms	FIPS-mode Allowed Mechanisms
fw <= 6.2.1	PKCS, X9.31	PKCS, X9.31
6.10 <= fw <= 6.21	PKCS, X9.31, 186-3 with primes, 186-3 with aux primes	PKCS, X9.31, 186-3 with primes, 186-3 with aux primes
fw >= 6.22.0	PKCS, X9.31, 186-3 with primes, 186-3 with aux primes	186-3 with primes, 186-3 with aux primes

Mechanism Remap Configuration Settings

Two configuration settings are available in the Chrystoki.conf (Linux/UNIX) or Crystoki.ini (Windows) configuration file installed with SafeNet HSM Client, to deal with calls to newer-firmware HSMs for outdated mechanisms, or calls to older-firmware HSMs for newer mechanisms that they do not support. The configuration settings control redirecting or mapping of mechanism calls.

Redirect Old to New

Under the configuration file's [Misc] section, RSAKeyGenMechRemap can be set to 0 or 1.

- When RSAKeyGenMechRemap is set to 0 (the default) and firmware version is 6.10.x or greater, no re-mapping is performed.

- When RSAKeyGenMechRemap is set to 1 and firmware version is 6.10.x or greater, the following re-mapping occurs:
  - PKCS Key Gen --> 186-3 Prime key gen
  - X9.31 Key Gen --> 186-3 Aux Prime key gen

> **Note:** This setting is intended for older applications, allowing them to continue to call outdated mechanisms, but have the calls redirected to newer, equivalent, FIPS-acceptable mechanisms, while your software development or integration catches up.

The following table summarizes the possible combinations, for firmware versions that are supported in SafeNet HSM 6.0 and later.

Firmware version	State of RSAKeyGen MechRemap	Action in your application	Result
6.2.x	N/A	N/A	• RSAKeyGenMechRemap has no effect
6.10- through-6.21	0	Call PKCS Key Gen or X9.31 Key Gen	• PKCS Key Gen or X9.31 Key Gen is called and runs as requested • redirect is not set, and does not occur
	1		• call is redirected and 186-3 Prime key gen or 186-3 Aux Prime key gen is run
	0	Call 186-3 Prime key gen or 186-3 Aux Prime key gen	• either set of mechanisms is available • 186-3 Prime key gen or 186-3 Aux Prime key gen is run as requested
	1		• either set of mechanisms is available • 186-3 Prime key gen or 186-3 Aux Prime key gen is run as requested
6.22.0 or newer	0	Call PKCS Key Gen or X9.31 Key Gen	• Error message; old mechanism does not exist and no redirect is indicated [see Note 1]
	1		• old mechanisms do not exist in FIPS mode; new ones exist • call is redirected and 186-3 Prime key gen or 186-3 Aux Prime key gen is run
Note 1: Calling an unsupported mechanism, where no redirect is in place, yields error CKR_MECHANISM_ INVALID			
Note 2: If RSA-PKCS keys or X9.31 keys were previously created by an older firmware version, and firmware is updated to version 6.22.0, then : • keys of size 2048 or 3072 bits can still be used for sign and verify operations • keys of size 1024-up-to-4096 bits can be used to verify existing signatures, only. • when FIPS186-4 with SP800-131A is applied, it disallows RSA 4096-bit keys for signing			

In FIPS mode

When RSAKeyGenMechRemap is enabled,

1. CKM_RSA_PKCS_KEY_PAIR_GEN is inserted into the C_GetMechanismList output by the client library, as the HSM does not return it in FIPS mode.
2. C_GetMechanismInfo for CKM_RSA_PKCS_KEY_PAIR_GEN returns the default Mechanism information from the client library. In FIPS mode, the HSM does not return it.

When RSAKeyGenMechRemap is disabled

1. CKM_RSA_PKCS_KEY_PAIR_GEN is not returned by C_GetMachanismList.
2. C_GetMachanismInfo for CKM_RSA_PKCS_KEY_PAIR_GEN results in an Invalid Mechanism Attribute error.

Redirect New to Old

Under the configuration file's [Misc] section, RSAPre1863KeyGenMechRemap can be set to 0 or 1.

- When RSAPre1863KeyGenMechRemap is set to 0 (the default) and firmware is version 6.2.x, no re-mapping is performed.
- When RSAPre1863KeyGenMechRemap is set to 1 and firmware is version 6.2.x, the following re-mapping occurs:
  - 186-3 Prime key gen --> PKCS Key Gen
  - 186-3 Aux Prime key gen --> X9.31 Key Gen

CAUTION: This setting is intended for evaluation purposes, such as with existing integrations that require newer mechanisms, before you update to firmware that actually supports the more secure mechanisms. Be careful with this setting, which makes it appear you are getting a new, secure mechanism, when really you are getting an outdated, insecure mechanism.

The following table summarizes the possible combinations, for firmware versions that are supported in SafeNet HSM 6.0 and later.

Firmware version	State of RSAPre1863 KeyGen MechRemap	Action in your application	Result
6.2.x	0	Call PKCS Key Gen or X9.31 Key Gen	• PKCS Key Gen or X9.31 Key Gen is called and runs
	1		• PKCS Key Gen or X9.31 Key Gen is called and runs
	0	Call 186-3 Prime key gen or 186-3 Aux Prime key gen	• Call fails; new mechanism does not exist
	1		• PKCS Key Gen or X9.31 Key Gen is called and runs • new mechanism does not exist; redirect to old [see Note 1]

Firmware version	State of RSAPre1863 KeyGen MechRemap	Action in your application	Result
6.10- through-6.22	N/A	N/A	• RSAPre1863KeyGenMechRemap has no effect

Note 1: The inclusion of redirection to the outdated mechanisms, where the firmware does not support the newer mechanisms, allows you to [re-]write your implementation to call the newer, FIPS-approved mechanisms, yet allows you to use that application with older-firmware HSMs - perhaps in a mixed or transitioning environment.

CKM_2DES_DERIVE

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	192
Block size	0
Digest size	0
Key types	Symmetric
Algorithms	None
Modes	None
Flags	Not Listed

CKM_AES_CBC

Summary

FIPS approved?	Yes
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	0
Key types	AES
Algorithms	AES
Modes	CBC
Flags	Extractable

CKM_AES_CBC_ENCRYPT_DATA

Summary

FIPS approved?	Yes
Supported functions	Derive
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	0
Digest size	0
Key types	AES
Algorithms	None
Modes	None
Flags	None

CKM_AES_CBC_PAD

Summary

FIPS approved?	Yes
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	0
Key types	AES
Algorithms	AES
Modes	CBC_PAD
Flags	Extractable

CKM_AES_CBC_PAD_EXTRACT

Summary

FIPS approved?	No
Supported functions	None
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	0
Digest size	0
Key types	AES
Algorithms	None
Modes	None
Flags	Not Listed

CKM_AES_CBC_PAD_EXTRACT_DOMAIN_CTRL

Summary

FIPS approved?	No
Supported functions	None
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	0
Digest size	0
Key types	AES
Algorithms	None
Modes	None
Flags	Not Listed

CKM_AES_CBC_PAD_EXTRACT_FLATTENED

Summary

FIPS approved?	No
Supported functions	None
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	0
Digest size	0
Key types	AES
Algorithms	None
Modes	None
Flags	Not Listed

CKM_AES_CBC_PAD_EXTRACT_PUBLIC

Summary

FIPS approved?	No
Supported functions	None
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	0
Digest size	0
Key types	AES
Algorithms	None
Modes	None
Flags	Not Listed

CKM_AES_CBC_PAD_EXTRACT_PUBLIC_FLATTENED

Summary

FIPS approved?	No
Supported functions	None
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	0
Digest size	0
Key types	AES
Algorithms	None
Modes	None
Flags	Not Listed

CKM_AES_CBC_PAD_INSERT

Summary

FIPS approved?	No
Supported functions	None
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	0
Digest size	0
Key types	AES
Algorithms	None
Modes	None
Flags	Not Listed

CKM_AES_CBC_PAD_INSERT_DOMAIN_CTRL

Summary

FIPS approved?	No
Supported functions	None
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	0
Digest size	0
Key types	AES
Algorithms	None
Modes	None
Flags	Not Listed

CKM_AES_CBC_PAD_INSERT_FLATTENED

Summary

FIPS approved?	No
Supported functions	None
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	0
Digest size	0
Key types	AES
Algorithms	None
Modes	None
Flags	Not Listed

CKM_AES_CBC_PAD_INSERT_PUBLIC

Summary

FIPS approved?	No
Supported functions	None
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	0
Digest size	0
Key types	AES
Algorithms	None
Modes	None
Flags	Not Listed

CKM_AES_CBC_PAD_INSERT_PUBLIC_FLATTENED

Summary

FIPS approved?	No
Supported functions	None
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	0
Digest size	0
Key types	AES
Algorithms	None
Modes	None
Flags	Not Listed

CKM_AES_CBC_PAD_IPSEC

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	0
Key types	AES
Algorithms	AES
Modes	CBC_PAD_IPSEC
Flags	Extractable

CKM_AES_CFB8

Summary

FIPS approved?	Yes
Supported functions	Encrypt | Decrypt
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	1
Key types	AES
Algorithms	AES
Modes	CFB
Flags	Extractable

CKM_AES_CFB128

Summary

FIPS approved?	Yes
Supported functions	Encrypt | Decrypt
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	16
Key types	AES
Algorithms	AES
Modes	CFB
Flags	Extractable

CKM_AES_CMAC

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	0
Key types	AES
Algorithms	AES
Modes	MAC
Flags	Extractable | CMAC

CKM_AES_CTR

Summary

FIPS approved?	Yes
Supported functions	Encrypt | Decrypt
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	0
Key types	AES
Algorithms	AES
Modes	CTR
Flags	Extractable

CKM_AES_ECB

Summary

FIPS approved?	Yes
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	0
Key types	AES
Algorithms	AES
Modes	ECB
Flags	Extractable

CKM_AES_ECB_ENCRYPT_DATA

Summary

FIPS approved?	Yes
Supported functions	Derive
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	0
Digest size	0
Key types	AES
Algorithms	None
Modes	None
Flags	None

CKM_AES_GCM

GCM is the Galois/Counter Mode of operation of the AES algorithm for symmetric key encryption.

Usage Notes

Data size

The maximum allowed data size for this mechanism is 16KB.

Initialization Vector (IV)

Random initialization vector (IV) is supported and recommended for GCM and for GMAC. In FIPS mode, the HSM firmware does not accept the IV parameter, and instead returns a generated IV.

The internal IV is a randomly generated 16-byte IV.

If you are using CKDEMO to try CKM_AES_GCM, be aware that CKDEMO generally defaults to an external IV, so for an HSM in FIPS mode, be sure to set CKDEMO menu item 98 Options, item 11 - GCM IV Source to "internal" instead of "external", otherwise CKM_AES_GCM would return CKR_MECHANISM_PARAM_INVALID)

JCPROV

AES-GMAC and AES-GCM are supported in JCPROV. Use CK_AES_CMAC_PARAMS.java to define the GMAC operation. Implementation is the same as for PKCS#11.

Performance

If GCM input is confined to data that will not be encrypted, then you can use GMAC (see "CKM_AES_GMAC" on page 86) instead for much better performance in authentication-only mode on the input data.

Accumulating data

Our GMAC and GCM are single part operations, so even if they are called using multi-part API, we accumulate the data (up to a maximum) and return data only on the “final” operation. That is the meaning of "Accumulating" in the table, below.

Summary

FIPS approved?	Yes
Supported functions	Encrypt | Decrypt
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	0

Key types	AES
Algorithms	AES
Modes	GCM
Flags	Extractable | Accumulating

CKM_AES_GMAC

GCM is the Galois/Counter Mode of operation of the AES algorithm for symmetric key encryption.

GMAC is a variant of GCM for sign/verify operation. If GCM input is confined to data that will not be encrypted, then GMAC is purely an authentication mode on the input data. The SafeNet HSM GMAC implementation, formerly invoked only via PKCS#11 interface, can now be accessed via JCPROV and via our Java Provider (see Notes, below).

The GMAC implementation follows NIST SP-800-38D. It supports AES symmetric key sizes of 128, 192, and 256 bits.

Usage Notes

Initialization Vector (IV)

If the HSM is in FIPS mode (see HSM policy 12 at "HSM Capabilities and Policies" on page 1), the initialization vector (IV) is generated in the HSM and returned to the PKCS#11 function call. The buffer must be large enough to store the GMAC tag plus the generated IV (which has a length of 16 bytes).

If the HSM is **not** in FIPS mode, then the developer is responsible to specify an IV. Random IV is supported and recommended for GCM and GMAC. If you are not using random IV, then the most efficient IV value length is 12 bytes; any other size reduces performance and requires more work (per NIST SP-800-38D).

The internal IV is a randomly generated 16-byte IV.

Performance

For PKCS#11, to achieve highest performance, use the Gemalto-SafeNet defined CK_AES_GMAC_PARAMS to define the GMAC operation parameters (additional authenticated data, tag size, IV and the IV size). To initialize the sign operation, use the CKM_AES_GMAC mechanism.

For authentication, it is possible to use CKM_AES_GCM mechanism, when passing no data to encrypt (for strict compliance with NIST specification), and performance in that mode is better than in previous SafeNet releases.

The correlation is not exact but, as a general rule for a given mechanism, invocation by PKCS#11 API always provides the best performance, JSP performance is close but lower due to Java architecture, and JCPROV performance is somewhat lower still than PKCS#11 and JSP performance levels.

JCPROV

AES-GMAC and AES-GCM are supported in JCPROV. Use CK_AES_CMAC_PARAMS.java to define the GMAC operation. Implementation is the same as for PKCS#11.

Java Provider (JSP)

Both GMC and GMAC are supported. "GmacAesDemo.java" provides a sample for using GMAC with Java. Java Parameter Specification class LunaGmacParameterSpec.java defines default values recommended by the NIST specification.

Accumulating Data

Our GMAC and GCM are single part operations, so even if they are called using multi-part API, we accumulate the data (up to a maximum) and return data only on the “final” operation. That is the meaning of "Accumulating" in the table, below.

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	0
Key types	AES
Algorithms	AES
Modes	GCM
Flags	Extractable | Accumulating

CKM_AES_KEY_GEN

Summary

FIPS approved?	Yes
Supported functions	Generate Key
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	0
Digest size	0
Key types	AES
Algorithms	None
Modes	None
Flags	None

CKM_AES_KW

NIST Special Publication 800-38F describes cryptographic methods that are approved for "key wrapping," that is, the protection of the confidentiality and integrity of cryptographic keys. In addition to describing existing methods, that publication specifies two new, deterministic authenticated-encryption modes of operation of the Advanced Encryption Standard (AES) algorithm: the AES Key Wrap (KW) mode and the AES Key Wrap With Padding (KWP) mode. Gemalto's SafeNet HSMs implement the AES Key Wrap (KW) mode at this time, which SP800-38F recommends as more secure than CKM_AES_CBC. Your HSM must have firmware 6.24 installed, in order to make use of the new mechanism.

Note: NIST Special Publication 800-38F recommends this method as more secure than CKM_AES_CBC.

Summary

FIPS approved?	Yes
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	8
Digest size	0
Key types	AES
Algorithms	AES
Modes	KW
Flags	Extractable | Accumulating

CKM_AES_MAC

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	0
Key types	AES
Algorithms	AES
Modes	MAC
Flags	Extractable

CKM_AES_OFB

Summary

FIPS approved?	Yes
Supported functions	Encrypt | Decrypt
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	0
Key types	AES
Algorithms	AES
Modes	OFB
Flags	Extractable

CKM_ARIA_CBC

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	0
Key types	ARIA
Algorithms	ARIA
Modes	CBC
Flags	Extractable

CKM_ARIA_CBC_ENCRYPT_DATA

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	0
Digest size	0
Key types	ARIA
Algorithms	None
Modes	None
Flags	None

CKM_ARIA_CBC_PAD

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	0
Key types	ARIA
Algorithms	ARIA
Modes	CBC_PAD
Flags	Extractable

CKM_ARIA_CFB8

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	1
Key types	ARIA
Algorithms	ARIA
Modes	CFB
Flags	Extractable

CKM_ARIA_CFB128

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	16
Key types	ARIA
Algorithms	ARIA
Modes	CFB
Flags	Extractable

CKM_ARIA_CMAC

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	0
Key types	ARIA
Algorithms	ARIA
Modes	MAC
Flags	Extractable | CMAC

CKM_ARIA_CTR

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	0
Key types	ARIA
Algorithms	ARIA
Modes	CTR
Flags	Extractable

CKM_ARIA_ECB

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	0
Key types	ARIA
Algorithms	ARIA
Modes	ECB
Flags	Extractable

CKM_ARIA_ECB_ENCRYPT_DATA

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	0
Digest size	0
Key types	ARIA
Algorithms	None
Modes	None
Flags	None

CKM_ARIA_GCM

Note: Our GCM is a single part operation, so even if it is called using multi-part API, we accumulate the data (up to a maximum) and return data only on the “final” operation. That is the meaning of "Accumulating" in the table, below.

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	0
Key types	ARIA
Algorithms	ARIA
Modes	GCM
Flags	Extractable | Accumulating

CKM_ARIA_KEY_GEN

Summary

FIPS approved?	No
Supported functions	Generate Key
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	0
Digest size	0
Key types	ARIA
Algorithms	None
Modes	None
Flags	None

CKM_ARIA_L_CBC

Summary

FIPS approved?	No
Supported functions	Decrypt | Unwrap
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	0
Key types	ARIA
Algorithms	ARIA
Modes	CBC
Flags	Extractable

CKM_ARIA_L_CBC_PAD

Summary

FIPS approved?	No
Supported functions	Decrypt | Unwrap
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	0
Key types	ARIA
Algorithms	ARIA
Modes	CBC_PAD
Flags	Extractable

CKM_ARIA_L_ECB

Summary

FIPS approved?	No
Supported functions	Decrypt | Unwrap
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	0
Key types	ARIA
Algorithms	ARIA
Modes	ECB
Flags	Extractable

CKM_ARIA_L_MAC

Summary

FIPS approved?	No
Supported functions	Verify
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	0
Key types	ARIA
Algorithms	ARIA
Modes	MAC
Flags	Extractable

CKM_ARIA_MAC

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	0
Key types	ARIA
Algorithms	ARIA
Modes	MAC
Flags	Extractable

CKM_ARIA_OFB

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	16
Digest size	0
Key types	ARIA
Algorithms	ARIA
Modes	OFB
Flags	Extractable

CKM_CAST3_CBC

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	64
Block size	8
Digest size	0
Key types	CAST3
Algorithms	CAST3
Modes	CBC
Flags	Extractable

CKM_CAST3_CBC_PAD

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	64
Block size	8
Digest size	0
Key types	CAST3
Algorithms	CAST3
Modes	CBC_PAD
Flags	Extractable

CKM_CAST3_ECB

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	64
Block size	8
Digest size	0
Key types	CAST3
Algorithms	CAST3
Modes	ECB
Flags	Extractable

CKM_CAST3_KEY_GEN

Summary

FIPS approved?	No
Supported functions	Generate Key
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	64
Block size	0
Digest size	0
Key types	CAST3
Algorithms	None
Modes	None
Flags	None

CKM_CAST3_MAC

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	64
Block size	8
Digest size	0
Key types	CAST3
Algorithms	CAST3
Modes	MAC
Flags	Extractable

CKM_CAST5_CBC

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	128
Block size	8
Digest size	0
Key types	CAST5
Algorithms	CAST5
Modes	CBC
Flags	Extractable

CKM_CAST5_CBC_PAD

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	128
Block size	8
Digest size	0
Key types	CAST5
Algorithms	CAST5
Modes	CBC_PAD
Flags	Extractable

CKM_CAST5_ECB

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	128
Block size	8
Digest size	0
Key types	CAST5
Algorithms	CAST5
Modes	ECB
Flags	Extractable

CKM_CAST5_KEY_GEN

Summary

FIPS approved?	No
Supported functions	Generate Key
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	128
Block size	0
Digest size	0
Key types	CAST5
Algorithms	None
Modes	None
Flags	None

CKM_CAST5_MAC

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	128
Block size	8
Digest size	0
Key types	CAST5
Algorithms	CAST5
Modes	MAC
Flags	Extractable

CKM_CONCATENATE_BASE_AND_DATA

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	112
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	0
Digest size	0
Key types	Symmetric
Algorithms	None
Modes	None
Flags	Internal

CKM_CONCATENATE_BASE_AND_KEY

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	112
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	0
Digest size	0
Key types	Symmetric
Algorithms	None
Modes	None
Flags	Internal

CKM_CONCATENATE_DATA_AND_BASE

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	112
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	0
Digest size	0
Key types	Symmetric
Algorithms	None
Modes	None
Flags	Internal

CKM_CONCATENATE_KEY_AND_BASE

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	112
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	0
Digest size	0
Key types	Symmetric
Algorithms	None
Modes	None
Flags	Internal

CKM_DES_CBC

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	64
Block size	8
Digest size	0
Key types	DES
Algorithms	DES
Modes	CBC
Flags	Extractable

CKM_DES_CBC_ENCRYPT_DATA

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	64
Block size	0
Digest size	0
Key types	Symmetric
Algorithms	None
Modes	None
Flags	None

CKM_DES_CBC_PAD

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	64
Block size	8
Digest size	0
Key types	DES
Algorithms	DES
Modes	CBC_PAD
Flags	Extractable

CKM_DES_ECB

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	64
Block size	8
Digest size	0
Key types	DES
Algorithms	DES
Modes	ECB
Flags	Extractable

CKM_DES_ECB_ENCRYPT_DATA

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	64
Block size	0
Digest size	0
Key types	Symmetric
Algorithms	None
Modes	None
Flags	None

CKM_DES_KEY_GEN

Summary

FIPS approved?	No
Supported functions	Generate Key
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	64
Block size	0
Digest size	0
Key types	DES
Algorithms	None
Modes	None
Flags	None

CKM_DES_MAC

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	64
Block size	8
Digest size	0
Key types	DES
Algorithms	DES
Modes	MAC
Flags	Extractable

CKM_DES2_DUKPT_DATA

The CKM_DES2_DUKPT family of key derive mechanisms create keys used to protect EFTPOS terminal sessions. The mechanisms implement the algorithm for server side DUKPT derivation as defined by ANSI X9.24 part 1.

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	192
Block size	0
Digest size	0
Key types	Symmetric
Algorithms	None
Modes	None
Flags	None

Usage

This mechanism has the following attributes:

- Only CKK_DES2 keys can be derived. The mechanism will force the CKA_KEY_TYPE attribute of the derived object to equal CKK_DES2. If the template does specify a CKA_KEY_TYPE attribute then it must be CKK_DES2.
- The mechanism takes a CK_KEY_DERIVATION_STRING_DATA structure as a parameter.
- The pData field of the parameter must point to a 10 byte array which holds the 80 bit Key Sequence Number (KSN).
- This mechanism contributes the CKA_CLASS and CKA_KEY_TYPE and CKA_VALUE to the resulting object.

The DUKPT MAC and DATA versions will default to the appropriate usage mechanism as described in the following table:

Mechanism	CKA_SIGN	CKA_VERIFY	CKA_DECRYPT	CKA_ENCRYPT
CKM_DES2_DUKPT_MAC	True	True		
CKM_DES2_DUKPT_MAC_RESP	True			
CKM_DES2_DUKPT_DATA			True	True
CKM_DES2_DUKPT_DATA_RESP				True

Example

```
#define CKM_DES2_DUKPT_PIN              (CKM_VENDOR_DEFINED + 0x611)
#define CKM_DES2_DUKPT_MAC              (CKM_VENDOR_DEFINED + 0x612)
#define CKM_DES2_DUKPT_MAC_RESP         (CKM_VENDOR_DEFINED + 0x613)
#define CKM_DES2_DUKPT_DATA             (CKM_VENDOR_DEFINED + 0x614)
#define CKM_DES2_DUKPT_DATA_RESP        (CKM_VENDOR_DEFINED + 0x615)

CK_OBJECT_HANDLE hBDKey; // handle of CKK_DES2 or CKK_DES2 Base Derive Key
CK_OBJECT_HANDLE hMKey;   // handle of CKK_DES2 MAC session Key
CK_MECHANISM svMech = { CKM_DES3_X919_MAC , NULL, 0};

CK_KEY_DERIVATION_STRING_DATA param;
CK_MECHANISM kdMech = { CKM_DES2_DUKPT_MAC , NULL, 0};
CK_CHAR ksn[10];
CK_CHAR inp[any length];
CK_CHAR mac[4];
CK_SIZE len;

// Derive MAC verify session key
param.pData=ksn;
param.ulLen = 10;

kdMech.mechanism = CKM_DES2_DUKPT_MAC;
kdMech.pParameter = &param;
kdMech.ulParameterLen = sizeof parram;

C_DeriveKey(hSes, &kdMech, hBDKey , NULL, 0, &hMKey);

// Single part verify operation

C_VerifyInit(hSes, &svMech, hMKey);
len = sizeof mac;
C_Verify(hSes, inp, sizeof inp, mac, len);

// clean up

C_DestroyObject(hSes, hMKey);

// Test vectors
```

CKM_DES2_DUKPT_DATA_RESP

The CKM_DES2_DUKPT family of key derive mechanisms create keys used to protect EFTPOS terminal sessions. The mechanisms implement the algorithm for server side DUKPT derivation as defined by ANSI X9.24 part 1.

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	192
Block size	0
Digest size	0
Key types	Symmetric
Algorithms	None
Modes	None
Flags	None

Usage

This mechanism has the following attributes:

- Only CKK_DES2 keys can be derived. The mechanism will force the CKA_KEY_TYPE attribute of the derived object to equal CKK_DES2. If the template does specify a CKA_KEY_TYPE attribute then it must be CKK_DES2.
- The mechanism takes a CK_KEY_DERIVATION_STRING_DATA structure as a parameter.
- The pData field of the parameter must point to a 10 byte array which holds the 80 bit Key Sequence Number (KSN).
- This mechanism contributes the CKA_CLASS and CKA_KEY_TYPE and CKA_VALUE to the resulting object.

The DUKPT MAC and DATA versions will default to the appropriate usage mechanism as described in the following table:

Mechanism	CKA_SIGN	CKA_VERIFY	CKA_DECRYPT	CKA_ENCRYPT
CKM_DES2_DUKPT_MAC	True	True		
CKM_DES2_DUKPT_MAC_RESP	True			
CKM_DES2_DUKPT_DATA			True	True
CKM_DES2_DUKPT_DATA_RESP				True

Example

```
#define CKM_DES2_DUKPT_PIN              (CKM_VENDOR_DEFINED + 0x611)
#define CKM_DES2_DUKPT_MAC              (CKM_VENDOR_DEFINED + 0x612)
#define CKM_DES2_DUKPT_MAC_RESP         (CKM_VENDOR_DEFINED + 0x613)
#define CKM_DES2_DUKPT_DATA             (CKM_VENDOR_DEFINED + 0x614)
#define CKM_DES2_DUKPT_DATA_RESP        (CKM_VENDOR_DEFINED + 0x615)

CK_OBJECT_HANDLE hBDKey; // handle of CKK_DES2 or CKK_DES2 Base Derive Key
CK_OBJECT_HANDLE hMKey;   // handle of CKK_DES2 MAC session Key
CK_MECHANISM svMech = { CKM_DES3_X919_MAC , NULL, 0};

CK_KEY_DERIVATION_STRING_DATA param;
CK_MECHANISM kdMech = { CKM_DES2_DUKPT_MAC , NULL, 0};
CK_CHAR ksn[10];
CK_CHAR inp[any length];
CK_CHAR mac[4];
CK_SIZE len;

// Derive MAC verify session key
param.pData=ksn;
param.ulLen = 10;

kdMech.mechanism = CKM_DES2_DUKPT_MAC;
kdMech.pParameter = &param;
kdMech.ulParameterLen = sizeof parram;

C_DeriveKey(hSes, &kdMech, hBDKey , NULL, 0, &hMKey);

// Single part verify operation

C_VerifyInit(hSes, &svMech, hMKey);
len = sizeof mac;
C_Verify(hSes, inp, sizeof inp, mac, len);

// clean up

C_DestroyObject(hSes, hMKey);

// Test vectors
```

CKM_DES2_DUKPT_MAC

The CKM_DES2_DUKPT family of key derive mechanisms create keys used to protect EFTPOS terminal sessions. The mechanisms implement the algorithm for server side DUKPT derivation as defined by ANSI X9.24 part 1.

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	192
Block size	0
Digest size	0
Key types	Symmetric
Algorithms	None
Modes	None
Flags	None

Usage

This mechanism has the following attributes:

- Only CKK_DES2 keys can be derived. The mechanism will force the CKA_KEY_TYPE attribute of the derived object to equal CKK_DES2. If the template does specify a CKA_KEY_TYPE attribute then it must be CKK_DES2.
- The mechanism takes a CK_KEY_DERIVATION_STRING_DATA structure as a parameter.
- The pData field of the parameter must point to a 10 byte array which holds the 80 bit Key Sequence Number (KSN).
- This mechanism contributes the CKA_CLASS and CKA_KEY_TYPE and CKA_VALUE to the resulting object.

The DUKPT MAC and DATA versions will default to the appropriate usage mechanism as described in the following table:

Mechanism	CKA_SIGN	CKA_VERIFY	CKA_DECRYPT	CKA_ENCRYPT
CKM_DES2_DUKPT_MAC	True	True		
CKM_DES2_DUKPT_MAC_RESP	True			
CKM_DES2_DUKPT_DATA			True	True
CKM_DES2_DUKPT_DATA_RESP				True

Example

```
#define CKM_DES2_DUKPT_PIN              (CKM_VENDOR_DEFINED + 0x611)
#define CKM_DES2_DUKPT_MAC              (CKM_VENDOR_DEFINED + 0x612)
#define CKM_DES2_DUKPT_MAC_RESP         (CKM_VENDOR_DEFINED + 0x613)
#define CKM_DES2_DUKPT_DATA             (CKM_VENDOR_DEFINED + 0x614)
#define CKM_DES2_DUKPT_DATA_RESP        (CKM_VENDOR_DEFINED + 0x615)

CK_OBJECT_HANDLE hBDKey; // handle of CKK_DES2 or CKK_DES2 Base Derive Key
CK_OBJECT_HANDLE hMKey;   // handle of CKK_DES2 MAC session Key
CK_MECHANISM svMech = { CKM_DES3_X919_MAC , NULL, 0};

CK_KEY_DERIVATION_STRING_DATA param;
CK_MECHANISM kdMech = { CKM_DES2_DUKPT_MAC , NULL, 0};
CK_CHAR ksn[10];
CK_CHAR inp[any length];
CK_CHAR mac[4];
CK_SIZE len;

// Derive MAC verify session key
param.pData=ksn;
param.ulLen = 10;

kdMech.mechanism = CKM_DES2_DUKPT_MAC;
kdMech.pParameter = &param;
kdMech.ulParameterLen = sizeof parram;

C_DeriveKey(hSes, &kdMech, hBDKey , NULL, 0, &hMKey);

// Single part verify operation

C_VerifyInit(hSes, &svMech, hMKey);
len = sizeof mac;
C_Verify(hSes, inp, sizeof inp, mac, len);

// clean up

C_DestroyObject(hSes, hMKey);

// Test vectors
```


CKM_DES2_DUKPT_MAC_RESP

The CKM_DES2_DUKPT family of key derive mechanisms create keys used to protect EFTPOS terminal sessions. The mechanisms implement the algorithm for server side DUKPT derivation as defined by ANSI X9.24 part 1.

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	192
Block size	0
Digest size	0
Key types	Symmetric
Algorithms	None
Modes	None
Flags	None

Usage

This mechanism has the following attributes:

- Only CKK_DES2 keys can be derived. The mechanism will force the CKA_KEY_TYPE attribute of the derived object to equal CKK_DES2. If the template does specify a CKA_KEY_TYPE attribute then it must be CKK_DES2.
- The mechanism takes a CK_KEY_DERIVATION_STRING_DATA structure as a parameter.
- The pData field of the parameter must point to a 10 byte array which holds the 80 bit Key Sequence Number (KSN).
- This mechanism contributes the CKA_CLASS and CKA_KEY_TYPE and CKA_VALUE to the resulting object.

The DUKPT MAC and DATA versions will default to the appropriate usage mechanism as described in the following table:

Mechanism	CKA_SIGN	CKA_VERIFY	CKA_DECRYPT	CKA_ENCRYPT
CKM_DES2_DUKPT_MAC	True	True		
CKM_DES2_DUKPT_MAC_RESP	True			
CKM_DES2_DUKPT_DATA			True	True
CKM_DES2_DUKPT_DATA_RESP				True

Example

```
#define CKM_DES2_DUKPT_PIN              (CKM_VENDOR_DEFINED + 0x611)
#define CKM_DES2_DUKPT_MAC              (CKM_VENDOR_DEFINED + 0x612)
#define CKM_DES2_DUKPT_MAC_RESP         (CKM_VENDOR_DEFINED + 0x613)
#define CKM_DES2_DUKPT_DATA             (CKM_VENDOR_DEFINED + 0x614)
#define CKM_DES2_DUKPT_DATA_RESP        (CKM_VENDOR_DEFINED + 0x615)

CK_OBJECT_HANDLE hBDKey; // handle of CKK_DES2 or CKK_DES2 Base Derive Key
CK_OBJECT_HANDLE hMKey;   // handle of CKK_DES2 MAC session Key
CK_MECHANISM svMech = { CKM_DES3_X919_MAC , NULL, 0};

CK_KEY_DERIVATION_STRING_DATA param;
CK_MECHANISM kdMech = { CKM_DES2_DUKPT_MAC , NULL, 0};
CK_CHAR ksn[10];
CK_CHAR inp[any length];
CK_CHAR mac[4];
CK_SIZE len;

// Derive MAC verify session key
param.pData=ksn;
param.ulLen = 10;

kdMech.mechanism = CKM_DES2_DUKPT_MAC;
kdMech.pParameter = &param;
kdMech.ulParameterLen = sizeof parram;

C_DeriveKey(hSes, &kdMech, hBDKey , NULL, 0, &hMKey);

// Single part verify operation

C_VerifyInit(hSes, &svMech, hMKey);
len = sizeof mac;
C_Verify(hSes, inp, sizeof inp, mac, len);

// clean up

C_DestroyObject(hSes, hMKey);

// Test vectors
```

CKM_DES2_DUKPT_PIN

The CKM_DES2_DUKPT family of key derive mechanisms create keys used to protect EFTPOS terminal sessions. The mechanisms implement the algorithm for server side DUKPT derivation as defined by ANSI X9.24 part 1.

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	192
Block size	0
Digest size	0
Key types	Symmetric
Algorithms	None
Modes	None
Flags	None

Usage

This mechanism has the following attributes:

- Only CKK_DES2 keys can be derived. The mechanism will force the CKA_KEY_TYPE attribute of the derived object to equal CKK_DES2. If the template does specify a CKA_KEY_TYPE attribute then it must be CKK_DES2.
- The mechanism takes a CK_KEY_DERIVATION_STRING_DATA structure as a parameter.
- The pData field of the parameter must point to a 10 byte array which holds the 80 bit Key Sequence Number (KSN).
- This mechanism contributes the CKA_CLASS and CKA_KEY_TYPE and CKA_VALUE to the resulting object.

The DUKPT MAC and DATA versions will default to the appropriate usage mechanism as described in the following table:

Mechanism	CKA_SIGN	CKA_VERIFY	CKA_DECRYPT	CKA_ENCRYPT
CKM_DES2_DUKPT_MAC	True	True		
CKM_DES2_DUKPT_MAC_RESP	True			
CKM_DES2_DUKPT_DATA			True	True
CKM_DES2_DUKPT_DATA_RESP				True

Example

```
#define CKM_DES2_DUKPT_PIN              (CKM_VENDOR_DEFINED + 0x611)
#define CKM_DES2_DUKPT_MAC              (CKM_VENDOR_DEFINED + 0x612)
#define CKM_DES2_DUKPT_MAC_RESP         (CKM_VENDOR_DEFINED + 0x613)
#define CKM_DES2_DUKPT_DATA             (CKM_VENDOR_DEFINED + 0x614)
#define CKM_DES2_DUKPT_DATA_RESP        (CKM_VENDOR_DEFINED + 0x615)

CK_OBJECT_HANDLE hBDKey; // handle of CKK_DES2 or CKK_DES2 Base Derive Key
CK_OBJECT_HANDLE hMKey;   // handle of CKK_DES2 MAC session Key
CK_MECHANISM svMech = { CKM_DES3_X919_MAC , NULL, 0};

CK_KEY_DERIVATION_STRING_DATA param;
CK_MECHANISM kdMech = { CKM_DES2_DUKPT_MAC , NULL, 0};
CK_CHAR ksn[10];
CK_CHAR inp[any length];
CK_CHAR mac[4];
CK_SIZE len;

// Derive MAC verify session key
param.pData=ksn;
param.ulLen = 10;

kdMech.mechanism = CKM_DES2_DUKPT_MAC;
kdMech.pParameter = &param;
kdMech.ulParameterLen = sizeof parram;

C_DeriveKey(hSes, &kdMech, hBDKey , NULL, 0, &hMKey);

// Single part verify operation

C_VerifyInit(hSes, &svMech, hMKey);
len = sizeof mac;
C_Verify(hSes, inp, sizeof inp, mac, len);

// clean up

C_DestroyObject(hSes, hMKey);

// Test vectors
```

CKM_DES2_KEY_GEN

Summary

FIPS approved?	Yes
Supported functions	Generate Key
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	128
Block size	0
Digest size	0
Key types	DES2
Algorithms	None
Modes	None
Flags	None

CKM_DES3_CBC

Summary

FIPS approved?	Yes
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	192
Minimum legacy key length for FIPS use (bits)	128
Maximum key length (bits)	192
Block size	8
Digest size	0
Key types	DES3
Algorithms	DES3
Modes	CBC
Flags	Extractable

CKM_DES3_CBC_ENCRYPT_DATA

Summary

FIPS approved?	Yes
Supported functions	Derive
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	192
Minimum legacy key length for FIPS use (bits)	128
Maximum key length (bits)	192
Block size	0
Digest size	0
Key types	Symmetric
Algorithms	None
Modes	None
Flags	None

CKM_DES3_CBC_PAD

Summary

FIPS approved?	Yes
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	192
Minimum legacy key length for FIPS use (bits)	128
Maximum key length (bits)	192
Block size	8
Digest size	0
Key types	DES3
Algorithms	DES3
Modes	CBC_PAD
Flags	Extractable

CKM_DES3_CBC_PAD_IPSEC

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	192
Block size	8
Digest size	0
Key types	DES3
Algorithms	DES3
Modes	CBC_PAD_IPSEC
Flags	Extractable

CKM_DES3_CFB8

Summary

FIPS approved?	Yes
Supported functions	Encrypt | Decrypt
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	192
Minimum legacy key length for FIPS use (bits)	128
Maximum key length (bits)	192
Block size	8
Digest size	1
Key types	DES3
Algorithms	DES3
Modes	CFB
Flags	Extractable

CKM_DES3_CFB64

Summary

FIPS approved?	Yes
Supported functions	Encrypt | Decrypt
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	192
Minimum legacy key length for FIPS use (bits)	128
Maximum key length (bits)	192
Block size	8
Digest size	8
Key types	DES3
Algorithms	DES3
Modes	CFB
Flags	Extractable

CKM_DES3_CMAC

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	192
Minimum legacy key length for FIPS use (bits)	128
Maximum key length (bits)	192
Block size	8
Digest size	0
Key types	DES3
Algorithms	DES3
Modes	MAC
Flags	Extractable | CMAC

CKM_DES3_CTR

Summary

FIPS approved?	Yes
Supported functions	Encrypt | Decrypt
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	192
Minimum legacy key length for FIPS use (bits)	128
Maximum key length (bits)	192
Block size	8
Digest size	0
Key types	DES3
Algorithms	DES3
Modes	CTR
Flags	Extractable

CKM_DES3_ECB

Summary

FIPS approved?	Yes
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	192
Minimum legacy key length for FIPS use (bits)	128
Maximum key length (bits)	192
Block size	8
Digest size	0
Key types	DES3
Algorithms	DES3
Modes	ECB
Flags	Extractable

CKM_DES3_ECB_ENCRYPT_DATA

Summary

FIPS approved?	Yes
Supported functions	Derive
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	192
Minimum legacy key length for FIPS use (bits)	128
Maximum key length (bits)	192
Block size	0
Digest size	0
Key types	Symmetric
Algorithms	None
Modes	None
Flags	None

CKM_DES3_GCM

Note: Our GCM is a single part operation, so even if it is called using multi-part API, we accumulate the data (up to a maximum) and return data only on the “final” operation. That is the meaning of "Accumulating" in the table, below.

Summary

FIPS approved?	Yes
Supported functions	Encrypt | Decrypt
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	192
Minimum legacy key length for FIPS use (bits)	128
Maximum key length (bits)	192
Block size	8
Digest size	0
Key types	DES3
Algorithms	DES3
Modes	GCM
Flags	Extractable | Accumulating

CKM_DES3_KEY_GEN

Summary

FIPS approved?	Yes
Supported functions	Generate Key
Minimum key length (bits)	192
Minimum key length for FIPS use (bits)	192
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	192
Block size	0
Digest size	0
Key types	DES3
Algorithms	None
Modes	None
Flags	None

CKM_DES3_MAC

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	192
Minimum legacy key length for FIPS use (bits)	128
Maximum key length (bits)	192
Block size	8
Digest size	0
Key types	DES3
Algorithms	DES3
Modes	MAC
Flags	Extractable

CKM_DES3_OFB

Summary

FIPS approved?	Yes
Supported functions	Encrypt | Decrypt
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	192
Minimum legacy key length for FIPS use (bits)	128
Maximum key length (bits)	192
Block size	8
Digest size	0
Key types	DES3
Algorithms	DES3
Modes	OFB
Flags	Extractable

CKM_DES3_X919_MAC

The CKM_DES3_X919_MAC is a signature generation and verification mechanism, as defined ANSI X9.19-1996 Financial Institution Retail Message Authentication annex 1 Cipher Block Chaining Procedure.

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	192
Block size	8
Digest size	0
Key types	DES3
Algorithms	DES3
Modes	MAC
Flags	Extractable

Usage

The CKM_DES3_X919_MAC mechanism is used with the **C_VerifyInit** and **C_SignInit** functions. It has the following attriobutes:

- Only CKK_DES2 and CKK_DES3 keys are supported.
- The mechanism takes no parameter.
- Multi-part operation is supported.
- The total input data length must be at least one byte.
- The length of result is half the size of the DES block (i.e. 4 bytes).

Example

```
#define CKM_DES3_X919_MAC (CKM_VENDOR_DEFINED + 0x150)

CK_OBJECT_HANDLE hKey; // handle of CKK_DES2 or CKK_DES3 key
CK_MECHANISM mech = { CKM_DES3_X919_MAC , NULL, 0};
CK_CHAR inp[any length];
CK_CHAR mac[4];
CK_SIZE len;

// Single-part operation
```

```
C_SignInit(hSes, &mech, hKey);
len = sizeof mac;
C_Sign(hSes, inp, sizeof inp, mac, &len);

// Multi-part operation

C_SignInit(hSes, &mech, hKey);
C_SignUpdate(hSes, inp, sizeof inp/2);
C_SignUpdate(hSes, inp+ (sizeof inp)/2, sizeof inp/2);
len = sizeof mac;
C_SignFinal(hSes, mac, &len);

// Test vectors

static const UInt8 retailKey[16] =
{
   0x58, 0x91, 0x25, 0x86, 0x3D, 0x46, 0x10, 0x7F,
   0x46, 0x3E, 0x52, 0x3B, 0xF7, 0x46, 0x9D, 0x52
};

static const UInt8 retailInputAscii[19] =
{
   't','h','e',' ','q','u','i','c','k',' ','b','r','o','w','n',' ','f','o','x'
};

static const UInt8 retailMACAscii[4] =
{
   0x55, 0xA7, 0xBF, 0xBA
};

static const UInt8 retailInputEBCDIC[19] =
{
   // "the quick brown fox" in EBCDIC
   0xA3, 0x88, 0x85, 0x40, 0x98, 0xA4, 0x89, 0x83,
   0x92, 0x40, 0x82, 0x99, 0x96, 0xA6, 0x95, 0x40,
   0x86, 0x96, 0xA7
};

static const UInt8 retailMACEBCDIC[4] =
{
   0x60, 0xAE, 0x2C, 0xD7
};
```

CKM_DH_PKCS_DERIVE

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	512
Minimum key length for FIPS use (bits)	512
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	2048
Block size	0
Digest size	0
Key types	DH
Algorithms	None
Modes	None
Flags	None

CKM_DH_PKCS_KEY_PAIR_GEN

Summary

FIPS approved?	No
Supported functions	Generate Key Pair
Minimum key length (bits)	512
Minimum key length for FIPS use (bits)	512
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	2048
Block size	0
Digest size	0
Key types	DH
Algorithms	None
Modes	None
Flags	None

CKM_DH_PKCS_PARAMETER_GEN

Summary

FIPS approved?	No
Supported functions	Generate Key
Minimum key length (bits)	512
Minimum key length for FIPS use (bits)	0
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	2048
Block size	0
Digest size	0
Key types	DH
Algorithms	None
Modes	None
Flags	None

CKM_DSA

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	3072
Block size	0
Digest size	0
Key types	DSA
Algorithms	DSA
Modes	None
Flags	None

CKM_DSA_KEY_PAIR_GEN

Summary

FIPS approved?	Yes
Supported functions	Generate Key Pair
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	3072
Block size	0
Digest size	0
Key types	DSA
Algorithms	None
Modes	None
Flags	None

CKM_DSA_PARAMETER_GEN

Summary

FIPS approved?	Yes
Supported functions	Generate Key
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	3072
Block size	0
Digest size	0
Key types	DSA
Algorithms	None
Modes	None
Flags	None

CKM_EC_KEY_PAIR_GEN

Summary

FIPS approved?	Yes
Supported functions	Generate Key Pair
Minimum key length (bits)	105
Minimum key length for FIPS use (bits)	224
Minimum legacy key length for FIPS use (bits)	160
Maximum key length (bits)	571
Block size	0
Digest size	0
Key types	ECDSA
Algorithms	None
Modes	None
Flags	None

CKM_EC_KEY_PAIR_GEN_W_EXTRA_BITS

Summary

FIPS approved?	Yes
Supported functions	Generate Key Pair
Minimum key length (bits)	105
Minimum key length for FIPS use (bits)	224
Minimum legacy key length for FIPS use (bits)	160
Maximum key length (bits)	571
Block size	0
Digest size	0
Key types	ECDSA
Algorithms	None
Modes	None
Flags	ECC_EXTRA_BITS

CKM_ECDH1_COFACTOR_DERIVE

Summary

FIPS approved?	Yes
Supported functions	Derive
Minimum key length (bits)	105
Minimum key length for FIPS use (bits)	224
Minimum legacy key length for FIPS use (bits)	160
Maximum key length (bits)	571
Block size	0
Digest size	0
Key types	ECDSA
Algorithms	None
Modes	None
Flags	None

CKM_ECDH1_DERIVE

Elliptic Curve Diffie-Hellman is an anonymous key-agreement protocol. CKM_ECDH1_DERIVE is the derive function for that protocol.

Note: To enhance performance, we have created a proprietary call CA_DeriveKeyAndWrap, which is an optimization of C_DeriveKey with C_Wrap, merging the two functions into one (the in and out constraints are the same as for the individual functions). A further optimization is applied when mechanism CKM_ECDH1_DERIVE is used with CA_DeriveKeyAndWrap.

If CA_DeriveKeyAndWrap is called with other mechanisms, those would not be optimized.

Summary

FIPS approved?	Yes
Supported functions	Derive
Minimum key length (bits)	105
Minimum key length for FIPS use (bits)	224
Minimum legacy key length for FIPS use (bits)	160
Maximum key length (bits)	571
Block size	0
Digest size	0
Key types	ECDSA
Algorithms	None
Modes	None
Flags	None

CKM_ECDSA

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	105
Minimum key length for FIPS use (bits)	224
Minimum legacy key length for FIPS use (bits)	160
Maximum key length (bits)	571
Block size	0
Digest size	0
Key types	ECDSA
Algorithms	ECDSA
Modes	None
Flags	None

CKM_ECIES

Note: This is a single part operation, so even if it is called using multi-part API, we accumulate the data (up to a maximum) and return data only on the “final” operation. That is the meaning of "Accumulating" in the table, below.

Summary

FIPS approved?	Yes
Supported functions	Encrypt | Decrypt
Minimum key length (bits)	105
Minimum key length for FIPS use (bits)	224
Minimum legacy key length for FIPS use (bits)	160
Maximum key length (bits)	571
Block size	0
Digest size	0
Key types	ECDSA
Algorithms	None
Modes	None
Flags	Accumulating

CKM_ECMQV_DERIVE

Summary

FIPS approved?	Yes
Supported functions	Derive
Minimum key length (bits)	105
Minimum key length for FIPS use (bits)	224
Minimum legacy key length for FIPS use (bits)	160
Maximum key length (bits)	571
Block size	0
Digest size	0
Key types	ECDSA
Algorithms	None
Modes	None
Flags	None

CKM_EXTRACT_KEY_FROM_KEY

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	112
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	0
Digest size	0
Key types	Symmetric
Algorithms	None
Modes	None
Flags	Internal

CKM_GENERIC_SECRET_KEY_GEN

Summary

FIPS approved?	Yes
Supported functions	Generate Key
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	112
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	0
Digest size	0
Key types	None
Algorithms	None
Modes	None
Flags	None

CKM_HAS160

Summary

FIPS approved?	No
Supported functions	Digest
Minimum key length (bits)	0
Minimum key length for FIPS use (bits)	0
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	0
Block size	64
Digest size	20
Key types	None
Algorithms	HAS160
Modes	None
Flags	Extractable | Korean

CKM_HAS160_KCDSA

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	1024
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	2048
Block size	64
Digest size	20
Key types	KCDSA
Algorithms	HAS160
Modes	None
Flags	Korean

CKM_HAS160_KCDSA_NO_PAD

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	1024
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	2048
Block size	64
Digest size	20
Key types	KCDSA
Algorithms	HAS160
Modes	None
Flags	Korean

CKM_HMAC_HAS160

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	112
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	64
Digest size	20
Key types	Symmetric
Algorithms	HAS160
Modes	HMAC
Flags	Extractable | Korean | Internal

CKM_HMAC_MD5

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	112
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	64
Digest size	16
Key types	Symmetric
Algorithms	MD5
Modes	HMAC
Flags	Extractable

CKM_HMAC_MD5_80

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	112
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	64
Digest size	16
Key types	Symmetric
Algorithms	MD5
Modes	HMAC
Flags	Extractable | Internal

CKM_HMAC_RIPEMD160

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	112
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	64
Digest size	20
Key types	Symmetric
Algorithms	RIPEMD160
Modes	HMAC
Flags	Extractable | Internal

CKM_HMAC_SHA1

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	112
Minimum legacy key length for FIPS use (bits)	80
Maximum key length (bits)	4096
Block size	64
Digest size	20
Key types	Symmetric
Algorithms	SHA
Modes	HMAC
Flags	Extractable

CKM_HMAC_SHA1_80

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	112
Minimum legacy key length for FIPS use (bits)	80
Maximum key length (bits)	4096
Block size	64
Digest size	20
Key types	Symmetric
Algorithms	SHA
Modes	HMAC
Flags	Extractable

CKM_HMAC_SHA224

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	112
Minimum legacy key length for FIPS use (bits)	80
Maximum key length (bits)	4096
Block size	64
Digest size	28
Key types	Symmetric
Algorithms	SHA224
Modes	HMAC
Flags	Extractable

CKM_HMAC_SHA256

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	112
Minimum legacy key length for FIPS use (bits)	80
Maximum key length (bits)	4096
Block size	64
Digest size	32
Key types	Symmetric
Algorithms	SHA256
Modes	HMAC
Flags	Extractable

CKM_HMAC_SHA384

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	112
Minimum legacy key length for FIPS use (bits)	80
Maximum key length (bits)	4096
Block size	128
Digest size	48
Key types	Symmetric
Algorithms	SHA384
Modes	HMAC
Flags	Extractable

CKM_HMAC_SHA512

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	112
Minimum legacy key length for FIPS use (bits)	80
Maximum key length (bits)	4096
Block size	128
Digest size	64
Key types	Symmetric
Algorithms	SHA512
Modes	HMAC
Flags	Extractable

CKM_HMAC_SM3

SM3 is a hash function published by the Chinese Commercial Cryptography Administration Office for the use of electronic authentication service system. The design of SM3 builds upon the design of the SHA-2 hash function, but introduces additional strengthening features. For SafeNet HSMs, the available mechanisms are CKM_SM3, the hash function, and CKM_SM3_KEY_DERIVATION, and CKM_HMAC_SM3.

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	8
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	64
Digest size	32
Key types	Symmetric
Algorithms	SM3
Modes	HMAC
Flags	None

CKM_KCDSA_KEY_PAIR_GEN

Summary

FIPS approved?	No
Supported functions	Generate Key Pair
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	1024
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	2048
Block size	0
Digest size	0
Key types	KCDSA
Algorithms	None
Modes	None
Flags	Korean

CKM_KCDSA_PARAMETER_GEN

Summary

FIPS approved?	No
Supported functions	Generate Key
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	1024
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	2048
Block size	0
Digest size	0
Key types	KCDSA
Algorithms	None
Modes	None
Flags	Korean

CKM_KEY_WRAP_SET_OAEP

Summary

FIPS approved?	No
Supported functions	Wrap | Unwrap
Minimum key length (bits)	256
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	8192
Block size	0
Digest size	0
Key types	RSA
Algorithms	None
Modes	None
Flags	None

CKM_LOOP_BACK

Summary

FIPS approved?	No
Supported functions	None
Minimum key length (bits)	0
Minimum key length for FIPS use (bits)	0
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	0
Block size	0
Digest size	0
Key types	None
Algorithms	None
Modes	None
Flags	Not Listed

CKM_LZS

Summary

FIPS approved?	No
Supported functions	None
Minimum key length (bits)	0
Minimum key length for FIPS use (bits)	0
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	0
Block size	0
Digest size	0
Key types	None
Algorithms	None
Modes	None
Flags	Not Listed

CKM_MD2

Summary

FIPS approved?	No
Supported functions	Digest
Minimum key length (bits)	0
Minimum key length for FIPS use (bits)	0
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	0
Block size	16
Digest size	16
Key types	None
Algorithms	MD2
Modes	None
Flags	Extractable

CKM_MD2_DES_CBC

Summary

FIPS approved?	No
Supported functions	Generate Key
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	64
Block size	16
Digest size	16
Key types	None
Algorithms	None
Modes	None
Flags	None

CKM_MD2_KEY_DERIVATION

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	112
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	16
Digest size	16
Key types	Symmetric
Algorithms	None
Modes	None
Flags	None

CKM_MD5

Summary

FIPS approved?	No
Supported functions	Digest
Minimum key length (bits)	0
Minimum key length for FIPS use (bits)	0
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	0
Block size	64
Digest size	16
Key types	None
Algorithms	MD5
Modes	None
Flags	Extractable | Internal

CKM_MD5_CAST_CBC

Summary

FIPS approved?	No
Supported functions	Generate Key
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	64
Block size	64
Digest size	16
Key types	None
Algorithms	None
Modes	None
Flags	None

CKM_MD5_CAST3_CBC

Summary

FIPS approved?	No
Supported functions	Generate Key
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	64
Block size	64
Digest size	16
Key types	None
Algorithms	None
Modes	None
Flags	None

CKM_MD5_DES_CBC

Summary

FIPS approved?	No
Supported functions	Generate Key
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	64
Block size	64
Digest size	16
Key types	None
Algorithms	None
Modes	None
Flags	None

CKM_MD5_KEY_DERIVATION

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	112
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	64
Digest size	16
Key types	Symmetric
Algorithms	None
Modes	None
Flags	None

CKM_MD5_RSA_PKCS

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	256
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	8192
Block size	64
Digest size	16
Key types	RSA
Algorithms	MD5
Modes	None
Flags	Extractable | Internal

CKM_NIST_PRF_KDF

Summary

FIPS approved?	Yes
Supported functions	Derive
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	112
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	0
Digest size	0
Key types	Symmetric
Algorithms	None
Modes	None
Flags	None

Usage

The CKM_NIST_PRF_KDF mechanism only supports counter mode. CKM_NIST_PRF_KDF is always allowed. It does not matter if the “allow non-FIPS approved algorithms” HSM policy is on or off. This mechanism can only be used with DES3_CMAC or AES_CMAC as the PRF.

The SP 800-108 allows for some variation on what/how the information is encoded and describes some fields as optional. To accommodate that, there are two encoding schemes you can specify:

- LUNA_PRF_KDF_ENCODING_SCHEME_2: the separator byte and the length of the derived key are not encoded in the input data for the PRF.
- LUNA_PRF_KDF_ENCODING_SCHEME_1: both fields are included.

Example

```
/* Parameter and values used with CKM_PRF_KDF and CKM_NIST_PRF_KDF. */
typedef CK_ULONG CK_KDF_PRF_TYPE;
typedef CK_ULONG CK_KDF_PRF_ENCODING_SCHEME;
/** PRF KDF schemes */
#define CK_NIST_PRF_KDF_DES3_CMAC      0x00000001
#define CK_NIST_PRF_KDF_AES_CMAC       0x00000002
#define CK_PRF_KDF_ARIA_CMAC           0x00000003
#define CK_PRF_KDF_SEED_CMAC           0x00000004
#define LUNA_PRF_KDF_ENCODING_SCHEME_1     0x00000000
#define LUNA_PRF_KDF_ENCODING_SCHEME_2     0x00000001
typedef struct CK_KDF_PRF_PARAMS {
CK_KDF_PRF_TYPE            prfType;
```



```
CK_BYTE_PTR                 pLabel;
CK_ULONG                    ulLabelLen;
CK_BYTE_PTR                 pContext;
CK_ULONG                    ulContextLen;
CK_ULONG                    ulCounter;
CK_KDF_PRF_ENCODING_SCHEME ulEncodingScheme;
} CK_PRF_KDF_PARAMS;
typedef CK_PRF_KDF_PARAMS CK_PTR CK_KDF_PRF_PARAMS_PTR;
```


CKM_PKCS5_PBKD2

Summary

FIPS approved?	No
Supported functions	Generate Key
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	8
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	8
Block size	0
Digest size	0
Key types	None
Algorithms	None
Modes	None
Flags	None

CKM_PRF_KDF

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	112
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	0
Digest size	0
Key types	Symmetric
Algorithms	None
Modes	None
Flags	None

Usage

The CKM_NIST_PRF mechanism only supports counter mode. CKM_PRF_KDF is only allowed when the "allow non-FIPS approved algorithms" HSM policy is on. This mechanism can be used with DES3_CMAC, AES_CMAC, ARIA_CMAC or SEED_CMAC as the PRF.

The SP 800-108 allows for some variation on what/how the information is encoded and describes some fields as optional. To accommodate that, there are two encoding schemes you can specify:

- LUNA_PRF_KDF_ENCODING_SCHEME_2: the separator byte and the length of the derived key are not encoded in the input data for the PRF.
- LUNA_PRF_KDF_ENCODING_SCHEME_1: both fields are included.

Example

```
/* Parameter and values used with CKM_PRF_KDF and CKM_NIST_PRF_KDF. */
typedef CK_ULONG CK_KDF_PRF_TYPE;
typedef CK_ULONG CK_KDF_PRF_ENCODING_SCHEME;
/** PRF KDF schemes */
#define CK_NIST_PRF_KDF_DES3_CMAC      0x00000001
#define CK_NIST_PRF_KDF_AES_CMAC       0x00000002
#define CK_PRF_KDF_ARIA_CMAC           0x00000003
#define CK_PRF_KDF_SEED_CMAC           0x00000004
#define LUNA_PRF_KDF_ENCODING_SCHEME_1     0x00000000
#define LUNA_PRF_KDF_ENCODING_SCHEME_2     0x00000001
typedef struct CK_KDF_PRF_PARAMS {
CK_KDF_PRF_TYPE            prfType;
```



```
CK_BYTE_PTR                pLabel;
CK_ULONG                   ulLabelLen;
CK_BYTE_PTR                pContext;
CK_ULONG                   ulContextLen;
CK_ULONG                   ulCounter;
CK_KDF_PRF_ENCODING_SCHEME ulEncodingScheme;
} CK_PRF_KDF_PARAMS;
typedef CK_PRF_KDF_PARAMS CK_PTR CK_KDF_PRF_PARAMS_PTR;
```


CKM_RC2_CBC

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	1024
Block size	8
Digest size	0
Key types	RC2
Algorithms	RC2
Modes	CBC
Flags	Extractable

CKM_RC2_CBC_PAD

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	1024
Block size	8
Digest size	0
Key types	RC2
Algorithms	RC2
Modes	CBC_PAD
Flags	Extractable

CKM_RC2_ECB

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	1024
Block size	8
Digest size	0
Key types	RC2
Algorithms	RC2
Modes	ECB
Flags	Extractable

CKM_RC2_KEY_GEN

Summary

FIPS approved?	No
Supported functions	Generate Key
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	1024
Block size	0
Digest size	0
Key types	RC2
Algorithms	None
Modes	None
Flags	None

CKM_RC2_MAC

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	1024
Block size	8
Digest size	0
Key types	RC2
Algorithms	RC2
Modes	MAC
Flags	Extractable

CKM_RC4

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	2048
Block size	0
Digest size	0
Key types	RC4
Algorithms	RC4
Modes	STREAM
Flags	Extractable

CKM_RC4_KEY_GEN

Summary

FIPS approved?	No
Supported functions	Generate Key
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	2048
Block size	0
Digest size	0
Key types	RC4
Algorithms	None
Modes	None
Flags	None

CKM_RC5_CBC

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	2040
Block size	8
Digest size	0
Key types	RC5
Algorithms	RC5
Modes	CBC
Flags	Extractable

CKM_RC5_CBC_PAD

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	2040
Block size	8
Digest size	0
Key types	RC5
Algorithms	RC5
Modes	CBC_PAD
Flags	Extractable

CKM_RC5_ECB

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	2040
Block size	8
Digest size	0
Key types	RC5
Algorithms	RC5
Modes	ECB
Flags	Extractable

CKM_RC5_KEY_GEN

Summary

FIPS approved?	No
Supported functions	Generate Key
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	2040
Block size	0
Digest size	0
Key types	RC5
Algorithms	None
Modes	None
Flags	None

CKM_RC5_MAC

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	2040
Block size	8
Digest size	0
Key types	RC5
Algorithms	RC5
Modes	MAC
Flags	Extractable

CKM_RIPEMD160

Summary

FIPS approved?	No
Supported functions	Digest
Minimum key length (bits)	0
Minimum key length for FIPS use (bits)	0
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	0
Block size	64
Digest size	20
Key types	None
Algorithms	RIPEMD160
Modes	None
Flags	Extractable | Internal

CKM_RSA_FIPS_186_3_AUX_PRIME_KEY_PAIR_GEN

Summary

FIPS approved?	Yes
Supported functions	Generate Key Pair
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	4096
Block size	0
Digest size	0
Key types	RSA
Algorithms	None
Modes	None
Flags	None

CKM_RSA_FIPS_186_3_PRIME_KEY_PAIR_GEN

Summary

FIPS approved?	Yes
Supported functions	Generate Key Pair
Minimum key length (bits)	2048
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	0
Digest size	0
Key types	RSA
Algorithms	None
Modes	None
Flags	None

CKM_RSA_PKCS

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify | Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	256
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	8192
Block size	0
Digest size	0
Key types	RSA
Algorithms	None
Modes	None
Flags	None

CKM_RSA_PKCS_KEY_PAIR_GEN

Summary

FIPS approved?	No
Supported functions	Generate Key Pair
Minimum key length (bits)	256
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	8192
Block size	0
Digest size	0
Key types	RSA
Algorithms	None
Modes	None
Flags	None

CKM_RSA_PKCS_OAEP

The RSA PKCS OAEP mechanism can now use a supplied hashing mechanism. Previously RSA OAEP would always use SHA1 and returned an error if another was attempted.

With current firmware, PKCS#11 API and ckdemo now accept a new mechanism.

Allowed mechanisms are:

CKM_SHA1

CKM_SHA224

CKM_SHA256

CKM_SHA384

CKM_SHA512

0 (use the firmware's default engine, which is currently SHA1)

In ckdemo menu option 98 has a new value 17 - OAEP Hash Params, which can be set to use either default (CKM_SHA1) or selectable. When it is set to selectable the user is prompted for a hash mechanism when using the OAEP mechanism.

Summary

FIPS approved?	Yes
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	256
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	8192
Block size	0
Digest size	0
Key types	RSA
Algorithms	None
Modes	None
Flags	None

CKM_RSA_PKCS_PSS

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	256
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	8192
Block size	0
Digest size	0
Key types	RSA
Algorithms	None
Modes	None
Flags	None | PSS

CKM_RSA_X_509

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt
Minimum key length (bits)	256
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	8192
Block size	0
Digest size	0
Key types	RSA
Algorithms	None
Modes	None
Flags	None

The algorithm allows considerable freedom to form any value of input to the Private Key transformation operation, which could potentially be exploited.

CKM_RSA_X9_31

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	8192
Block size	0
Digest size	0
Key types	RSA
Algorithms	None
Modes	None
Flags	Extractable | X9.31

CKM_RSA_X9_31_KEY_PAIR_GEN

Summary

FIPS approved?	No
Supported functions	Generate Key Pair
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	8192
Block size	0
Digest size	0
Key types	RSA
Algorithms	None
Modes	None
Flags	X9.31

CKM_RSA_X9_31_NON_FIPS

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	8192
Block size	0
Digest size	0
Key types	RSA
Algorithms	None
Modes	None
Flags	Extractable | X9.31 | Non-FIPS X9.31

CKM_SEED_CBC

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	128
Block size	16
Digest size	0
Key types	SEED
Algorithms	SEED
Modes	CBC
Flags	Extractable | Korean

CKM_SEED_CBC_PAD

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	128
Block size	16
Digest size	0
Key types	SEED
Algorithms	SEED
Modes	CBC_PAD
Flags	Extractable | Korean

CKM_SEED_CMAC

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	128
Block size	16
Digest size	0
Key types	SEED
Algorithms	SEED
Modes	MAC
Flags	Extractable | Korean | CMAC

CKM_SEED_CTR

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	128
Block size	16
Digest size	0
Key types	SEED
Algorithms	SEED
Modes	CTR
Flags	Extractable | Korean

CKM_SEED_ECB

Summary

FIPS approved?	No
Supported functions	Encrypt | Decrypt | Wrap | Unwrap
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	128
Block size	16
Digest size	0
Key types	SEED
Algorithms	SEED
Modes	ECB
Flags	Extractable | Korean

CKM_SEED_KEY_GEN

Summary

FIPS approved?	No
Supported functions	Generate Key
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	128
Block size	0
Digest size	0
Key types	SEED
Algorithms	None
Modes	None
Flags	Korean

CKM_SEED_MAC

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	128
Block size	16
Digest size	0
Key types	SEED
Algorithms	SEED
Modes	MAC
Flags	Extractable | Korean

CKM_SHA_1

Summary

FIPS approved?	Yes
Supported functions	Digest
Minimum key length (bits)	0
Minimum key length for FIPS use (bits)	0
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	0
Block size	64
Digest size	20
Key types	None
Algorithms	SHA
Modes	None
Flags	Extractable

CKM_SHA1_CAST5_CBC

Summary

FIPS approved?	No
Supported functions	Generate Key
Minimum key length (bits)	64
Minimum key length for FIPS use (bits)	64
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	128
Block size	64
Digest size	20
Key types	None
Algorithms	None
Modes	None
Flags	None

CKM_SHA1_DES2_CBC

Summary

FIPS approved?	No
Supported functions	Generate Key
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	128
Block size	64
Digest size	20
Key types	None
Algorithms	None
Modes	None
Flags	None

CKM_SHA1_DES2_CBC_OLD

Summary

FIPS approved?	No
Supported functions	Generate Key
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	128
Block size	64
Digest size	20
Key types	None
Algorithms	None
Modes	None
Flags	None

CKM_SHA1_DES3_CBC

Summary

FIPS approved?	No
Supported functions	Generate Key
Minimum key length (bits)	192
Minimum key length for FIPS use (bits)	192
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	192
Block size	64
Digest size	20
Key types	None
Algorithms	None
Modes	None
Flags	None

CKM_SHA1_DES3_CBC_OLD

Summary

FIPS approved?	No
Supported functions	Generate Key
Minimum key length (bits)	192
Minimum key length for FIPS use (bits)	192
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	192
Block size	64
Digest size	20
Key types	None
Algorithms	None
Modes	None
Flags	None

CKM_SHA1_DSA

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	3072
Block size	64
Digest size	20
Key types	DSA
Algorithms	SHA
Modes	None
Flags	Extractable

CKM_SHA1_ECDSA

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	105
Minimum key length for FIPS use (bits)	224
Minimum legacy key length for FIPS use (bits)	160
Maximum key length (bits)	571
Block size	64
Digest size	20
Key types	ECDSA
Algorithms	SHA
Modes	None
Flags	Extractable

CKM_SHA1_KCDSA

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	1024
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	2048
Block size	64
Digest size	20
Key types	KCDSA
Algorithms	SHA
Modes	None
Flags	Korean

CKM_SHA1_KCDSA_NO_PAD

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	1024
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	2048
Block size	64
Digest size	20
Key types	KCDSA
Algorithms	SHA
Modes	None
Flags	Korean

CKM_SHA1_KEY_DERIVATION

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	112
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	64
Digest size	20
Key types	Symmetric
Algorithms	None
Modes	None
Flags	None

CKM_SHA1_RC2_40_CBC

Summary

FIPS approved?	No
Supported functions	Generate Key
Minimum key length (bits)	40
Minimum key length for FIPS use (bits)	40
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	40
Block size	64
Digest size	20
Key types	None
Algorithms	None
Modes	None
Flags	None

CKM_SHA1_RC2_128_CBC

Summary

FIPS approved?	No
Supported functions	Generate Key
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	128
Block size	64
Digest size	20
Key types	None
Algorithms	None
Modes	None
Flags	None

CKM_SHA1_RC4_40

Summary

FIPS approved?	No
Supported functions	Generate Key
Minimum key length (bits)	40
Minimum key length for FIPS use (bits)	40
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	40
Block size	64
Digest size	20
Key types	None
Algorithms	None
Modes	None
Flags	None

CKM_SHA1_RC4_128

Summary

FIPS approved?	No
Supported functions	Generate Key
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	128
Block size	64
Digest size	20
Key types	None
Algorithms	None
Modes	None
Flags	None

CKM_SHA1_RSA_PKCS

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	256
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	8192
Block size	64
Digest size	20
Key types	RSA
Algorithms	SHA
Modes	None
Flags	Extractable

CKM_SHA1_RSA_PKCS_PSS

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	256
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	8192
Block size	64
Digest size	20
Key types	RSA
Algorithms	SHA
Modes	None
Flags	Extractable | PSS

CKM_SHA1_RSA_X9_31

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	8192
Block size	64
Digest size	20
Key types	RSA
Algorithms	SHA
Modes	None
Flags	Extractable | X9.31

CKM_SHA1_RSA_X9_31_NON_FIPS

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	8192
Block size	64
Digest size	20
Key types	RSA
Algorithms	SHA
Modes	None
Flags	Extractable | X9.31 | Non-FIPS X9.31

CKM_SHA224

Summary

FIPS approved?	Yes
Supported functions	Digest
Minimum key length (bits)	0
Minimum key length for FIPS use (bits)	0
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	0
Block size	64
Digest size	28
Key types	None
Algorithms	SHA224
Modes	None
Flags	Extractable

CKM_SHA224_DSA

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	3072
Block size	64
Digest size	28
Key types	DSA
Algorithms	SHA224
Modes	None
Flags	Extractable

CKM_SHA224_ECDSA

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	105
Minimum key length for FIPS use (bits)	224
Minimum legacy key length for FIPS use (bits)	160
Maximum key length (bits)	571
Block size	64
Digest size	28
Key types	ECDSA
Algorithms	SHA224
Modes	None
Flags	Extractable

CKM_SHA224_KCDSA

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	1024
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	2048
Block size	64
Digest size	28
Key types	KCDSA
Algorithms	SHA224
Modes	None
Flags	Korean

CKM_SHA224_KCDSA_NO_PAD

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	1024
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	2048
Block size	64
Digest size	28
Key types	KCDSA
Algorithms	SHA224
Modes	None
Flags	Korean

CKM_SHA224_KEY_DERIVATION

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	112
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	64
Digest size	28
Key types	Symmetric
Algorithms	None
Modes	None
Flags	None

CKM_SHA224_RSA_PKCS

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	256
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	8192
Block size	64
Digest size	28
Key types	RSA
Algorithms	SHA224
Modes	None
Flags	Extractable

CKM_SHA224_RSA_PKCS_PSS

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	512
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	8192
Block size	64
Digest size	28
Key types	RSA
Algorithms	SHA224
Modes	None
Flags	Extractable | PSS

CKM_SHA224_RSA_X9_31

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	8192
Block size	64
Digest size	28
Key types	RSA
Algorithms	SHA224
Modes	None
Flags	Extractable | X9.31

CKM_SHA224_RSA_X9_31_NON_FIPS

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	8192
Block size	64
Digest size	28
Key types	RSA
Algorithms	SHA224
Modes	None
Flags	Extractable | X9.31 | Non-FIPS X9.31

CKM_SHA256

Summary

FIPS approved?	Yes
Supported functions	Digest
Minimum key length (bits)	0
Minimum key length for FIPS use (bits)	0
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	0
Block size	64
Digest size	32
Key types	None
Algorithms	SHA256
Modes	None
Flags	Extractable

CKM_SHA256_DSA

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	3072
Block size	64
Digest size	32
Key types	DSA
Algorithms	SHA256
Modes	None
Flags	Extractable

CKM_SHA256_ECDSA

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	105
Minimum key length for FIPS use (bits)	224
Minimum legacy key length for FIPS use (bits)	160
Maximum key length (bits)	571
Block size	64
Digest size	32
Key types	ECDSA
Algorithms	SHA256
Modes	None
Flags	Extractable

CKM_SHA256_ECDSA_GBCS

GBCS is the Great Britain Companion Specification, a component of the Smart Metering Equipment Technical Specification, in support of the Smart Metering Programme. SHA256withECDSAGBCS is a proprietary ECDSA signature algorithm defined by the GBCS standard. It does not appear to be congruent with any of the other Deterministic ECDSA algorithms available in the various published RFCs (at time of writing this comment). As well (at time of writing) this algorithm is currently not FIPS compliant. SHA256withECDSAGBCS was implemented specifically for GBCS integration. If you need to be compliant with GBCS then you must use SHA256withECDSAGBCS.

Otherwise, SHA256withECDSA is the standard ECDSA algorithm defined by most other standards (for example FIPS, X9).

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	256
Minimum key length for FIPS use (bits)	256
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	64
Digest size	32
Key types	ECDSA
Algorithms	SHA256
Modes	None
Flags	Extractable

CKM_SHA256_ECDSA_GBCS

GBCS is the Great Britain Companion Specification, a component of the Smart Metering Equipment Technical Specification, in support of the Smart Metering Programme. SHA256withECDSAGBCS is a proprietary ECDSA signature algorithm defined by the GBCS standard. It does not appear to be congruent with any of the other Deterministic ECDSA algorithms available in the various published RFCs (at time of writing this comment). As well (at time of writing) this algorithm is currently not FIPS compliant. SHA256withECDSAGBCS was implemented specifically for GBCS integration. If you need to be compliant with GBCS then you must use SHA256withECDSAGBCS.

Otherwise, SHA256withECDSA is the standard ECDSA algorithm defined by most other standards (for example FIPS, X9).

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	256
Minimum key length for FIPS use (bits)	256
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	256
Block size	64
Digest size	32
Key types	ECDSA
Algorithms	SHA256
Modes	None
Flags	Extractable

CKM_SHA256_KCDSA

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	1024
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	2048
Block size	64
Digest size	32
Key types	KCDSA
Algorithms	SHA256
Modes	None
Flags	Korean

CKM_SHA256_KCDSA_NO_PAD

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	1024
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	2048
Block size	64
Digest size	32
Key types	KCDSA
Algorithms	SHA256
Modes	None
Flags	Korean

CKM_SHA256_KEY_DERIVATION

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	112
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	64
Digest size	32
Key types	Symmetric
Algorithms	None
Modes	None
Flags	None

CKM_SHA256_RSA_PKCS

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	256
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	8192
Block size	64
Digest size	32
Key types	RSA
Algorithms	SHA256
Modes	None
Flags	Extractable

CKM_SHA256_RSA_PKCS_PSS

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	512
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	8192
Block size	64
Digest size	32
Key types	RSA
Algorithms	SHA256
Modes	None
Flags	Extractable | PSS

CKM_SHA256_RSA_X9_31

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	8192
Block size	64
Digest size	32
Key types	RSA
Algorithms	SHA256
Modes	None
Flags	Extractable | X9.31

CKM_SHA256_RSA_X9_31_NON_FIPS

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	8192
Block size	64
Digest size	32
Key types	RSA
Algorithms	SHA256
Modes	None
Flags	Extractable | X9.31 | Non-FIPS X9.31

CKM_SHA384

Summary

FIPS approved?	Yes
Supported functions	Digest
Minimum key length (bits)	0
Minimum key length for FIPS use (bits)	0
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	0
Block size	128
Digest size	48
Key types	None
Algorithms	SHA384
Modes	None
Flags	Extractable

CKM_SHA384_ECDSA

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	105
Minimum key length for FIPS use (bits)	224
Minimum legacy key length for FIPS use (bits)	160
Maximum key length (bits)	571
Block size	128
Digest size	48
Key types	ECDSA
Algorithms	SHA384
Modes	None
Flags	Extractable

CKM_SHA384_KCDSA

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	1024
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	2048
Block size	128
Digest size	48
Key types	KCDSA
Algorithms	SHA384
Modes	None
Flags	Korean

CKM_SHA384_KCDSA_NO_PAD

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	1024
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	2048
Block size	128
Digest size	48
Key types	KCDSA
Algorithms	SHA384
Modes	None
Flags	Korean

CKM_SHA384_KEY_DERIVATION

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	112
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	128
Digest size	48
Key types	Symmetric
Algorithms	None
Modes	None
Flags	None

CKM_SHA384_RSA_PKCS

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	256
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	8192
Block size	128
Digest size	48
Key types	RSA
Algorithms	SHA384
Modes	None
Flags	Extractable

CKM_SHA384_RSA_PKCS_PSS

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	512
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	8192
Block size	128
Digest size	48
Key types	RSA
Algorithms	SHA384
Modes	None
Flags	Extractable | PSS

CKM_SHA384_RSA_X9_31

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	8192
Block size	128
Digest size	48
Key types	RSA
Algorithms	SHA384
Modes	None
Flags	Extractable | X9.31

CKM_SHA384_RSA_X9_31_NON_FIPS

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	8192
Block size	128
Digest size	48
Key types	RSA
Algorithms	SHA384
Modes	None
Flags	Extractable | X9.31 | Non-FIPS X9.31

CKM_SHA512

Summary

FIPS approved?	Yes
Supported functions	Digest
Minimum key length (bits)	0
Minimum key length for FIPS use (bits)	0
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	0
Block size	128
Digest size	64
Key types	None
Algorithms	SHA512
Modes	None
Flags	Extractable

CKM_SHA512_ECDSA

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	105
Minimum key length for FIPS use (bits)	224
Minimum legacy key length for FIPS use (bits)	160
Maximum key length (bits)	571
Block size	128
Digest size	64
Key types	ECDSA
Algorithms	SHA512
Modes	None
Flags	Extractable

CKM_SHA512_KCDSA

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	1024
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	2048
Block size	128
Digest size	64
Key types	KCDSA
Algorithms	SHA512
Modes	None
Flags	Korean

CKM_SHA512_KCDSA_NO_PAD

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	1024
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	2048
Block size	128
Digest size	64
Key types	KCDSA
Algorithms	SHA512
Modes	None
Flags	Korean

CKM_SHA512_KEY_DERIVATION

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	112
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	128
Digest size	64
Key types	Symmetric
Algorithms	None
Modes	None
Flags	None

CKM_SHA512_RSA_PKCS

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	256
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	8192
Block size	128
Digest size	64
Key types	RSA
Algorithms	SHA512
Modes	None
Flags	Extractable

CKM_SHA512_RSA_PKCS_PSS

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	8192
Block size	128
Digest size	64
Key types	RSA
Algorithms	SHA512
Modes	None
Flags	Extractable | PSS

CKM_SHA512_RSA_X9_31

Summary

FIPS approved?	Yes
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	1024
Maximum key length (bits)	8192
Block size	128
Digest size	64
Key types	RSA
Algorithms	SHA512
Modes	None
Flags	Extractable | X9.31

CKM_SHA512_RSA_X9_31_NON_FIPS

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	8192
Block size	128
Digest size	64
Key types	RSA
Algorithms	SHA512
Modes	None
Flags	Extractable | X9.31 | Non-FIPS X9.31

CKM_SM3

SM3 is a hash function published by the Chinese Commercial Cryptography Administration Office for the use of electronic authentication service system. The design of SM3 builds upon the design of the SHA-2 hash function, but introduces additional strengthening features. For SafeNet HSMs, the available mechanisms are CKM_SM3, the hash function, and CKM_SM3_KEY_DERIVATION, and CKM_HMAC_SM3.

Summary

FIPS approved?	No
Supported functions	Digest
Minimum key length (bits)	0
Minimum key length for FIPS use (bits)	0
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	0
Block size	64
Digest size	32
Key types	None
Algorithms	SM3
Modes	None
Flags	None

CKM_SM3_KEY_DERIVATION

SM3 is a hash function published by the Chinese Commercial Cryptography Administration Office for the use of electronic authentication service system. The design of SM3 builds upon the design of the SHA-2 hash function, but introduces additional strengthening features. For SafeNet HSMs, the available mechanisms are CKM_SM3, the hash function, and CKM_SM3_KEY_DERIVATION, and CKM_HMAC_SM3.

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	8
Minimum key length for FIPS use (bits)	8
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	64
Digest size	32
Key types	Symmetric
Algorithms	None
Modes	None
Flags	None

CKM_SSL3_KEY_AND_MAC_DERIVE

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	384
Minimum key length for FIPS use (bits)	384
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	384
Block size	0
Digest size	0
Key types	Symmetric
Algorithms	None
Modes	None
Flags	None

CKM_SSL3_MASTER_KEY_DERIVE

Summary

FIPS approved?	No
Supported functions	Derive
Minimum key length (bits)	384
Minimum key length for FIPS use (bits)	384
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	384
Block size	0
Digest size	0
Key types	Symmetric
Algorithms	None
Modes	None
Flags	None

CKM_SSL3_MD5_MAC

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	128
Minimum key length for FIPS use (bits)	128
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	128
Block size	64
Digest size	16
Key types	Symmetric
Algorithms	MD5
Modes	HMAC
Flags	Extractable

CKM_SSL3_PRE_MASTER_KEY_GEN

Summary

FIPS approved?	No
Supported functions	Generate Key
Minimum key length (bits)	384
Minimum key length for FIPS use (bits)	384
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	384
Block size	0
Digest size	0
Key types	None
Algorithms	None
Modes	None
Flags	None

CKM_SSL3_SHA1_MAC

Summary

FIPS approved?	No
Supported functions	Sign | Verify
Minimum key length (bits)	160
Minimum key length for FIPS use (bits)	160
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	160
Block size	64
Digest size	20
Key types	Symmetric
Algorithms	SHA
Modes	HMAC
Flags	Extractable

CKM_UNKNOWN

Summary

FIPS approved?	No
Supported functions	None
Minimum key length (bits)	0
Minimum key length for FIPS use (bits)	0
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	0
Block size	0
Digest size	0
Key types	None
Algorithms	None
Modes	None
Flags	Not Listed

CKM_X9_42_DH_DERIVE

Summary

FIPS approved?	Yes
Supported functions	Derive
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	0
Digest size	0
Key types	X9_42_DH
Algorithms	None
Modes	None
Flags	None

CKM_X9_42_DH_HYBRID_DERIVE

Summary

FIPS approved?	Yes
Supported functions	Derive
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	0
Digest size	0
Key types	X9_42_DH
Algorithms	None
Modes	None
Flags	None

CKM_X9_42_DH_KEY_PAIR_GEN

Summary

FIPS approved?	Yes
Supported functions	Generate Key Pair
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	0
Digest size	0
Key types	X9_42_DH
Algorithms	None
Modes	None
Flags	None

CKM_X9_42_DH_PARAMETER_GEN

Summary

FIPS approved?	Yes
Supported functions	Generate Key
Minimum key length (bits)	1024
Minimum key length for FIPS use (bits)	2048
Minimum legacy key length for FIPS use (bits)	N/A
Maximum key length (bits)	4096
Block size	0
Digest size	0
Key types	X9_42_DH
Algorithms	None
Modes	None
Flags	None

5 Using the SafeNet SDK

This chapter describes how to use the SDK to develop applications that exercise the HSM. It contains the following topics:

- "Libraries and Applications" on page 316
- "Application IDs" below
- "Named Curves and User-Defined Parameters" on page 401
- "Curve Names By Organization" on page 314
- "Capability and Policy Configuration Control Using the SafeNet API" on page 310
- "Connection Timeout" on page 313

Application IDs

Within Chrystoki, each application has an application ID, a 64-bit integer, normally specified in two 32-bit parts. When an application invokes **C_Initialize**, the Chrystoki library automatically generates a default application ID. The default value is based on the application's process ID, so different applications will always have different application IDs. The application ID is also associated with each session created by the application.

Shared Login State and Application IDs

PKCS#11 specifies that sessions within an application (a single address space and all threads that execute within it) share a login state, meaning that if one session is logged in, all are logged in. If one logs out, all are logged out. Thus, if process A spawns multiple threads, and all of those threads open sessions on Token #1, then all of those sessions share a login state. If process B also has sessions open on Token #1, they are independent from the sessions of process A. The login state of process B sessions does not affect process A sessions, unless they conflict with one another (e.g. process A logs in as USER when process B is already logged in as SO).

Within Chrystoki and SafeNet tokens, login states are shared by sessions with the same application ID. This means that sessions within an application share a login state, but sessions across separate applications do not. However, Chrystoki does provides functionality allowing applications to alter their application IDs, so that separate applications can share a login state.

CAUTION: The ability to share login states through the use of application IDs is a legacy feature. It can eliminate the need for repeated PED authentication across multiple applications, but this is not ideal for security reasons. To avoid these risks, it is recommended to use auto-activation in conjunction with a PED challenge password instead (see "About Activation and Auto-Activation " on page 1 in the *Administration Guide*).

To change application IDs manually using the LunaCM **appid** command, see "appid" on page 1 in the *LunaCM Reference Guide*.

Why Share Login State Between Applications?

For most applications, this is unnecessary. If an application consists of a single perpetual process, unshared session states are sufficient. If the application supports multiple, separately-validated processes, unshared session states are also sufficient. Generally, applications that validate (login) separately are more secure.

It is only necessary to share login state between processes if *all* of the following conditions are true:

- the application designer wants to require only one login action by the user
- the application consists of multiple processes, each with their own sessions
- the system uses SafeNet CA3 tokens

The SafeNet CA3 token provides FIPS 140-1 level 3 security by using a separate port for password entry (where PINs take the form of special data keys). Use of these keys prevents an application from caching a password and using it to log in with multiple sessions. To log in to separate processes simultaneously, login state between those processes must be shared.

Login State Sharing Overview

The simplest form of the Chrystoki state-sharing functionality is the **CA_SetApplicationID** function. This function should be invoked after **C_Initialize**, but before any sessions are opened. Two separate applications can use this function to set their application IDs to the same value, and thus allow them to share login states between their sessions.

Alternatively, set the **AppIdMajor** and **AppIdMinor** fields in the Misc section of the Chrystoki configuration file. This causes default application IDs for all applications to be generated from these fields, rather than from each application's process ID. When these fields are set, all applications on a host system will share login state between their sessions, unless individual applications use the **CA_SetApplicationID** function.

Example

A sample configuration file (**crystoki.ini** for Windows) using explicit application IDs is duplicated here:

```
[Chrystoki2]
LibNT=D:\Program Files\SafeNet\LunaClient\cryptoki.dl
[Luna]
DefaultTimeOut=500000
PEDTimeout1=100000
PEDTimeout2=200000
[CardReader]
RemoteCommand=1
[Misc]
AppIdMajor=2
AppIdMinor=4
```

Problems may still arise. When all sessions of a particular application ID are closed, that application ID reverts to a dormant state. When another session for that application ID is created, the application ID is recreated, but always in the logged-out state, regardless of the state it was in when it went dormant.

For example, consider an application where a parent process sets its application ID, opens a session, logs the session in, then closes the session and terminates. Several child processes then set their application IDs, open sessions and try to use them. However, since the application ID went dormant when the parent process closed its session, the child processes find their sessions logged out. The logged-in state of the parent process's session was lost when it closed its session.

The **CA_OpenApplicationID** function can ensure that the login state of an application ID is maintained, even when no sessions belonging to that application ID exist. When **CA_OpenApplicationID** is invoked, the application ID is tagged so that it never goes dormant, even if no open sessions exist.

Note: Running **CA_OpenApplication_ID** does not set the application ID for the current process. You must first explicitly run **CA_SetApplicationID** to do this.

Login State Sharing Functions

Use the following functions to configure and manage login state sharing:

CA_SetApplicationID

```
CK_RV CK_ENTRY CA_SetApplicationID(
        CK_ULONG ulHigh,
        CK_ULONG ulLow
);
```

The **CA_SetApplicationID** function allows an application to set its own application ID, rather than letting the application ID be generated automatically from the application's process ID. **CA_SetApplicationID** should be invoked after **C_Initialize**, but before any session manipulation functions are invoked. If **CA_SetApplicationID** is invoked after sessions have been opened, results will be unpredictable.

CA_SetApplicationID always returns CKR_OK.

CA_OpenApplicationID

```
CK_RV CK_ENTRY CA_OpenApplicationID(
        CK_SLOT_ID slotID,
        CK_ULONG ulHigh,
        CK_ULONG ulLow
);
```

The **CA_OpenApplicationID** function forces a given application ID on a given token to remain active, even when all sessions belonging to the application ID have been closed. Normally, an application ID on a token goes dormant when the last session that belongs to the application ID is closed. When an application ID goes dormant, login state is lost, so when a new session is created within the application ID, it starts in the logged-out state. However, if **CA_OpenApplicationID** is used, the application ID is prevented from going dormant, so login state is maintained even when all sessions for an application ID are closed.

Note: Running **CA_OpenApplication_ID** does not set the application ID for the current process. You must first explicitly run **CA_SetApplicationID** to do this.

CA_OpenApplicationID can return CKR_SLOT_ID_INVALID or CKR_TOKEN_NOT_PRESENT.

CA_CloseApplicationID

```
CK_RV CK_ENTRY CA_CloseApplicationID(
        CK_SLOT_ID slotID,
        CK_ULONG ulHigh,
        CK_ULONG ulLow
);
```

The **CA_CloseApplicationID** function removes the property of an application ID that prevents it from going dormant. **CA_CloseApplicationID** also closes any open sessions owned by the given application ID. Thus, when **CA_**

CloseApplicationID returns, all open sessions owned by the given application ID have been closed and the application ID has gone dormant.

CA_CloseApplicationID can return CKR_SLOT_ID_INVALID or CKR_TOKEN_NOT_PRESENT.

Application ID Examples

The following code fragments show how two separate applications might share a single application ID:

```
app 1:          app 2:
C_Initialize()
CA_SetApplicationID(3,4)
C_OpenSession()
C_Login()
                C_Initialize()
                CA_SetApplicationID(3,4)
                C_OpenSession()
                C_GetSessionInfo()
                // Session info shows session
                // already logged in.
                <perform work, no login
                necessary>

C_Logout()
                C_GetSessionInfo()
                // Session info shows session
                // logged out.

C_CloseSession()
                C_CloseSession()
C_Finalize()
                C_Finalize()
```

The following code fragments show how one process might login for others:

Setup app:

```
C_Initialize()
CA_SetApplicationID(7,9)
CA_OpenApplicationID(slot,7,9)
C_OpenSession(slot)
C_Login()
C_CloseSession()
```

Spawn many child applications:

```
C_Finalize()
```

Terminate each child app:

```
                C_Initialize()
                CA_SetApplicationID(7,9)
                C_OpenSession(slot)
                <perform work, no login necessary>
```

Takedown app:

Terminate child applications:

```
                C_CloseSession()
                C_Finalize()
C_Initialize()
CA_CloseApplicationID(slot,7,9)
```

```
C_Finalize()
```

Capability and Policy Configuration Control Using the SafeNet API

The configuration and control of the SafeNet HSM is provided by a set of capabilities and policies which you can query and set using the SafeNet API. See for more information.

HSM Capabilities and Policies

Each HSM has a set of capabilities. An HSM's capability set defines and controls the behaviour of the HSM.

HSM behaviour can be further modified through changing policies. The HSM Admin can refine the behaviour of an HSM by changing the policy settings.

HSM Partition Capabilities and Policies

Each HSM can support one-or-more virtual HSMs called HSM Partitions (may also be called “containers” in some areas of the API), which are used by properly authenticated remote clients to perform cryptographic operations.

Each HSM Partition has a set of capabilities. An HSM Partition's capability set defines and controls the behaviour of the HSM partition.

HSM Partition behaviour can be further modified through changing policies. The HSM Admin can refine the behaviour of an HSM Partition by changing the policy settings. Different Partitions can have different values for the configuration elements which apply to specific HSM Partitions – in other words, if a Policy is set to a given value for one HSM Partition, the Policy can be set to a different value for another HSM Partitition on the same HSM.

In some cases, a Partition policy change is destructive.

Policy Refinement

For every policy set element, there is a corresponding capability set element (the reverse is not true – there can be some capability set elements that do not have corresponding policy set elements). The value of a policy set element can be modified by the HSM Admin, but only within the limitations imposed by the corresponding capability set element.

For example, there is a policy set element which determines how many failed login attempts may be made before a Partition is deleted or locked out. There is also a corresponding capability set element for the same purpose. The policy element may be modified by the HSM Admin, but may only be set to a value less than or equal to that of the capability set element. So if the capability set element has a value of 10, the HSM Admin can set the policy to a value less than or equal to 10.

In general, the HSM Admin may modify policy set elements to make the HSM or Partition policy more restrictive than that imposed by the capability set elements. The HSM Admin can not make the HSM or HSM Partition policy less restrictive or enable functionality that is disabled through capability settings.

Policy Types

There are three types of policy elements, as follows:

Normal policy elements	May be set at any time by the HSM Admin. The values which may be set are limited only by the corresponding capability element as described in the previous section (i.e. the policy element can be set only to a value less than or equal to the capability set element).
Destructive policy elements	May be set at any time, but setting them results in the erasure of any Partitions and their contents. Policy elements are destructive if changing them significantly affects the security policy of the HSM.
Write-restricted policy elements	Cannot be modified directly, but instead are affected by other actions that can be taken.

Querying and Modifying HSM Configuration

The following are the relevant functions (found in **sfnt_extensions.h**):

- CK_RV CK_ENTRY CA_GetConfigurationElementDescription(
- CK_SLOT_ID slotID,
- CK_ULONG ulIsContainerElement,
- CK_ULONG ulIsCapabilityElement,
- CK_ULONG ulElementId,
- CK_ULONG_PTR pulElementBitLength,
- CK_ULONG_PTR pulElementDestructive,
- CK_ULONG_PTR pulElementWriteRestricted,
- CK_CHAR_PTR pDescription);
- CK_RV CK_ENTRY CA_GetHSMCapabilitySet(
- CK_SLOT_ID uPhysicalSlot,
- CK_ULONG_PTR pulCapIdArray,
- CK_ULONG_PTR pulCapIdSize,
- CK_ULONG_PTR pulCapValArray,
- CK_ULONG_PTR pulCapValSize);
- CK_RV CK_ENTRY CA_GetHSMCapabilitySetting (
- CK_SLOT_ID slotID,
- CK_ULONG ulPolicyId,
- CK_ULONG_PTR pulPolicyValue);
- CK_RV CK_ENTRY CA_GetHSMPolicySet(
- CK_SLOT_ID uPhysicalSlot,
- CK_ULONG_PTR pulPolicyIdArray,
- CK_ULONG_PTR pulPolicyIdSize,
- CK_ULONG_PTR pulPolicyValArray,

- CK_ULONG_PTR pulPolicyValSize);
- CK_RV CK_ENTRY CA_GetHSMPolicySetting (
- CK_SLOT_ID slotID,
- CK_ULONG ulPolicyId,
- CK_ULONG_PTR pulPolicyValue);
- CK_RV CK_ENTRY CA_GetContainerCapabilitySet(
- CK_SLOT_ID uPhysicalSlot,
- CK_ULONG ulContainerNumber,
- CK_ULONG_PTR pulCapIdArray,
- CK_ULONG_PTR pulCapIdSize,
- CK_ULONG_PTR pulCapValArray,
- CK_ULONG_PTR pulCapValSize);
- CK_RV CK_ENTRY CA_GetContainerCapabilitySetting (
- CK_SLOT_ID slotID,
- CK_ULONG ulContainerNumber,
- CK_ULONG ulPolicyId,
- CK_ULONG_PTR pulPolicyValue);
- CK_RV CK_ENTRY CA_GetContainerPolicySet(
- CK_SLOT_ID uPhysicalSlot,
- CK_ULONG ulContainerNumber,
- CK_ULONG_PTR pulPolicyIdArray,
- CK_ULONG_PTR pulPolicyIdSize,
- CK_ULONG_PTR pulPolicyValArray,
- CK_ULONG_PTR pulPolicyValSize);
- CK_RV CK_ENTRY CA_GetContainerPolicySetting(
- CK_SLOT_ID uPhysicalSlot,
- CK_ULONG ulContainerNumber,
- CK_ULONG ulPolicyId,
- CK_ULONG_PTR pulPolicyValue);
- CK_RV CK_ENTRY CA_SetHSMPolicy (
- CK_SESSION_HANDLE hSession,
- CK_ULONG ulPolicyId,
- CK_ULONG ulPolicyValue);
- CK_RV CK_ENTRY CA_SetDestructiveHSMPolicy (
- CK_SESSION_HANDLE hSession,
- CK_ULONG ulPolicyId,

- CK_ULONG ulPolicyValue);
- CK_RV CK_ENTRY CA_SetContainerPolicy (
- CK_SESSION_HANDLE hSession,
- CK_ULONG ulContainer,
- CK_ULONG ulPolicyId,
- CK_ULONG ulPolicyValue);

The CA_GetConfigurationElementDescription() Function

The **CA_GetConfigurationElementDescription()** function requires that you pass in a zero or one value to indicate whether the element you are querying is an HSM Partition (container) element or an HSM element, and another zero/one value to define whether it is a capability or policy that you are interested in. You also pass in the id of the element and a character buffer of at least 60 characters. The function then returns the size of the element value (in bits), an indication of whether the element is destructive, an indication of whether the policy (if it is a policy) is write-restricted, and it also writes the description string into the buffer that you provided.

The CA_Get{HSM|Container}{Capability|Policy}Set() Functions

The various **CA_Get{HSM|Container}{Capability|Policy}Set()** functions all return (in the word arrays provided) a complete list of element id/value pairs for the set specified. For example, **CA_GetHSMCapabilitySet()** returns a list of all HSM capability elements and their values. The parameters for these functions include a list pointer and length pointer for each of the element ids and element values. On calling the function, you should provide a buffer or a null pointer for each of the lists, and the length value should be initialized to the size of the buffer. On return, the buffer (if given) is populated, and the length is updated to the real length of the list. If the buffer is given but is not large enough, an error results.

Typically you would invoke the function twice: call the function the first time with null buffer pointers so that the real length necessary is returned, then allocate the necessary buffers and call the function a second time, giving the real buffers.

The various **CA_Get{HSM|Container}{Capability|Policy}Setting()** functions allow you to query a specific element value. Provide the element id and the function returns the value.

The CA_Set...() Functions

The various **CA_Set...()** functions allow you to set individual HSM and HSM Partition policies. There are two varieties for setting HSM policies, because changing the value of a destructive HSM policy results in the HSM being cleared of any Partitions and their contents. To make it clear when this is going to happen, the appropriate set function must be called based on whether the HSM policy is destructive or not (which you can determine with the **CA_GetConfigurationElementDescription()** function).

Connection Timeout

The connection timeout is not configurable.

Linux and Unix Connection Timeout

On Unix platforms, the client performs a "connect" on the socket. If the socket is busy or unavailable, the client performs a "select" on the socket with the timeout set to 10 seconds (hardcoded). If the "select" call returns before the timeout, then the client is able to connect. If not then it fails. This prevents the situation where some Unix operating systems can block for several minutes when SafeNet Network HSM is unavailable.

Windows Connection Timeout

On Windows platforms, "connect" is called without "select", relying upon the default Windows timeout of approximately 20 seconds.

Curve Names By Organization

Elliptic curves are widely used, despite being defined and described differently by different groups in the cryptographic world. The following table attempts to reconcile curve names across three different standards organizations, the SEC Group, ANSI, and NIST.

Table 1: Equivalent curves defined by standards organizations

SECG	ANSI X9.62	NIST
sect163k1		NIST K-163
sect163r1		
sect163r2		NIST B-163
sect193r1		
sect193r2		
sect233k1		NIST K-233
sect233r1		NIST B-233
sect239k1		
sect283k1		NIST K-283
sect283r1		NIST B-283
sect409k1		NIST K-409
sect409r1		NIST B-409
sect571k1		NIST K-571
sect571r1		NIST B-571
secp160k1		
secp160r1		
secp160r2		
secp192k1		
secp192r1	prime192v1	NIST P-192

SECG	ANSI X9.62	NIST
secp224k1		
secp224r1		NIST P-224
secp256k1		
secp256r1	prime256v1	NIST P-256
secp256r1		NIST P-384
secp521r1		NIST P-521

For additional information about the Elliptic Curve specification, see this article:

http://www.ietf.org/rfc/rfc4492.txt

Integrating SafeNet Network HSM with Your Applications

SafeNet staff continue to perform integrations of the SafeNet HSM products with popular or important third-party applications and APIs. The resulting instructional documents are available from your SafeNet representative for the latest list of integration documents.

This page briefly introduces a utility that you might need when using an HSM or appliance with your application.

Cryptographic applications that are not specifically adapted to use an HSM Server can nevertheless be run using SafeNet Enterprise HSMs, with the aid of the `salogin` utility. This section provides the settings required for some widely-used applications.

An example of a situation where you might use `salogin` is where you wish to use a SafeNet HSM appliance with openssl, which can be used with HSMs, but which has no inherent ability to provide credentials to the HSM.

SALogin (Optional)

The “`salogin`” client-side utility is provided to assist clients that do not include the requisite HSM login and logout capability within the client application. Run the utility from a shell or command prompt, or include it in scripts.

The `salogin` utility has a single command, with several arguments, as follows:

```
>salogin -h
Luna Login Utility 1.0 Arguments:
o            open application access
c            close application access
i    hi:lo   application id; high and low component
s    slot    token slot id number (default = 1)
u            specifies that login  should be performed as the
             Crypto-User if no user type is supplied, the
             Crypto-Officer will be used
p    pswd    challenge password -  if not included, login
             will not be performed
v            verbose
h            this help
```

Examples

```
salogin -o -s 1 -i 1:1
# open a persistent application connection
# on slot 1 with app id 1:1

salogin -o -s 1 -i 1:1 -p HT7bHTHPRp/4/Cdb
# open a persistent application connection
# and login with Luna HSM challenge

salogin -c -s 1 -i 1:1
# close persistent application connection 1:1
# on slot 1
```

Note: The applications in the integrations documents have been explicitly integrated by SafeNet, to work with your SafeNet HSM product. Contact your SafeNet representative.

If you are a developer, you might prefer to create or modify your own application to include support for the HSM or appliance. Refer to the Software Development Kit and the Extensions sections of this document set.

Other options

For java applications you could consider the KeyStore interface. It is internally consistent with the service provider interface defined by SUN/Oracle and does not require any proprietary code or applications.

If you are using an integration that does not refer to a KeyStore then the `salogin` method might be required. You are then limited to working with 1 partition. The type of HSM doesn't matter, as long as it is SafeNet and visible by the client at the time that the library is initialized.

Libraries and Applications

This section explains how to make the Chrystoki library available to the other components of the SafeNet Software Development Kit.

An application has no knowledge of which library is to be loaded nor does the application know the library's location. For these reasons, a special scheme must be employed to tell the application, while it is running, where to find the library. The next paragraphs describe how applications connect to Chrystoki.

SafeNet SDK Applications General Information

All applications provided in SafeNet Network HSM Software Development Kit have been compiled with a component called CkBridge, which uses a configuration file to find the library it is intended to load. Ckbridge first uses the environment variable "ChrystokiConfigurationPath" to locate the corresponding configuration file. If this environment variable is not set, it attempts to locate the configuration file in a default location depending on the product platform (/etc on Unix, and c:\Program Files\SafeNet\LunaClient on Windows).

Configuration files differ from one platform to the next - refer to the appropriate sub-section for the operating system and syntax applicable to your development platform.

Windows

In Windows, an initialization file called **crystoki.ini** specifies which library is to be loaded. The syntax of this file is standard to Windows.

The following example shows proper configuration files for Windows:

```
[Chrystoki2]
LibNT=C:\Program Files\SafeNet\LunaClient\cryptoki.dll
[LunaSA Client]
SSLConfigFile=C:\Program Files\SafeNet\LunaClient\openssl.cnf
ReceiveTimeout=20000
NetClient=1
ServerCAFile=C:\Program Files\SafeNet\LunaClient\cert\server\CAFile.pem
ClientCertFile=C:\Program Files\SafeNet\LunaClient\cert\client\ClientNameCert.pem
ClientPrivKeyFile=C:\Program Files\SafeNet\LunaClient\cert\client\ClientNameKey.pem
[Luna]
DefaultTimeOut=500000
PEDTimeout1=100000
PEDTimeout2=200000
PEDTimeout3=10000
[CardReader]
RemoteCommand=1
```

CAUTION: NEVER insert TAB characters into the crystoki.ini (Windows) or chrystoki.conf (UNIX) file.

UNIX

In UNIX, a configuration file called "Chrystoki.conf" is used to guide CkBridge in finding the appropriate library.

The configuration file is a regular text file with a special format. It is made up of a number of sections, each section containing one or multiple entries. The following example shows a typical UNIX configuration file:

```
Chrystoki2 = {
LibUNIX=/usr/lib/libCryptoki2.so;
}
Luna = {
DefaultTimeOut=500000;
PEDTimeout1=100000;
PEDTimeout2=200000;
PEDTimeout3=10000;
KeypairGenTimeOut=2700000;
CloningCommandTimeOut=300000;
}
CardReader = {
RemoteCommand=1;
}
LunaSA Client = {
NetClient = 1;
ServerCAFile = /usr/safenet/lunaclient/cert/server/CAFile.pem;
ClientCertFile = /usr/safenet/lunaclient/cert/client/ClientNameCert.pem;
ClientPrivKeyFile = /usr/safenet/lunaclient/cert/client/ClientNameKey.pem;
SSLConfigFile = /usr/safenet/lunaclient/bin/openssl.cnf;
ReceiveTimeout = 20000;
}
```

The shared object "libcrystoki2.so" is a library supporting version 2.2.0 of the PKCS#11 standard.

CAUTION: NEVER insert TAB characters into the chrystoki.ini (Windows) or crystoki.conf (UNIX) file.

Compiler Tools

Tools used for SafeNet development are platform specific tools/development environments, where applicable (e.g., Visual C++ on Windows 2008 and Windows 2012, or Workshop on Solaris, or aCC on HP-UX). Current version information is provided in the Customer Release Notes.

Note: Contact SafeNet for information about the availability of newer versions of compilers.

The Applications

See the "About the Utilities Reference Guide" on page 1 for information about individual tools and utilities, provided for use with SafeNet HSMs.

Mechanisms

Characteristics of all supported mechanisms are summarized in the tables that follow. Both PKCS #11 standard mechanisms and SafeNet proprietary mechanisms are included.

Table 1 lists the operations supported by each mechanism.

Table 2 lists the key size range and any parameters defined for each mechanism.

NOTE: Functions in bold in the tables are SafeNet proprietary.

After the tables are notes corresponding to the superscript numbers and, in alphabetical order, a detailed description of each mechanism.

Table 1: Mechanisms - Operations Supported

Mechanism	Encrypt & Decrypt	Sign & Verify	SR & VR1	Digest	Gen. Key / Key-Pair	Wrap & Un-wrap	Derive	FIPSAlg
CKM_AES_CBC	y					y		y
CKM_AES_CBC_PAD	y					y		y
CKM_AES_ECB	y					y		y

Mechanism	Encrypt & Decrypt	Sign & Verify	SR & VR1	Digest	Gen. Key / Key-Pair	Wrap & Un-wrap	Derive	FIPSAlg
CKM_AES_KEY_GEN					y			y
CKM_AES_MAC		y						
CKM_AES_MAC_ GENERAL		y						
CKM_CAST128_CBC (CKM_CAST5_CBC)	y					y		
CKM_CAST128_CBC_ PAD (CKM_CAST5_ CBC_PAD)	y					y		
CKM_CAST128_ECB (CKM_CAST5_ECB)	y					y		
CKM_CAST128_ECB_ PAD	y					y		
CKM_CAST128_KEY_ GEN (CKM_CAST5_ KEY_GEN)					y			
CKM_CAST128_MAC (CKM_CAST5_MAC)		y						
CKM_CAST128_MAC_ GENERAL (CKM_ CAST5_MAC_ GENERAL)		y						
CKM_ CONCATENATE_ BASE_AND_DATA							y	y
CKM_ CONCATENATE_							y	y

Mechanism	Encrypt & Decrypt	Sign & Verify	SR & VR1	Digest	Gen. Key / Key-Pair	Wrap & Un-wrap	Derive	FIPSAlg
BASE_AND_KEY								
CKM_ CONCATENATE_ DATA_AND_BASE								y
CKM_DECODE_ PKCS_7							y	y
CKM_DECODE_X_ 509							y	y
CKM_DES_BCF 4, 15	y					y		
CKM_DES_CBC						y		
CKM_DES_CBC_PAD	y					y		
CKM_DES_DERIVE_ CBC							y	
CKM_DES_DERIVE_ ECB							y	
CKM_DES_ECB	y					y		
CKM_DES_ECB_PAD	y					y		
CKM_DES_KEY_GEN					y			
CKM_DES_MAC		y						
CKM_DES_MAC_ GENERAL		y						
CKM_DES_MDC_2_ PAD1				y				

Mechanism	Encrypt & Decrypt	Sign & Verify	SR & VR1	Digest	Gen. Key / Key-Pair	Wrap & Un-wrap	Derive	FIPSAlg
CKM_DES_OFB64	y							
CKM_DES2_KEY_GEN					y			y
CKM_DES3_CBC	y					y		y
CKM_DES3_CBC_PAD	y					y		y
CKM_DES3_DDD_CBC	y					y		
CKM_DES3_DERIVE_CBC							y	y
CKM_DES3_DERIVE_ECB							y	y
CKM_DES3_ECB	y					y		y
CKM_DES3_ECB_PAD	y					y		y
CKM_DES3_KEY_GEN					y			y
CKM_DES3_MAC		y						y
CKM_DES3_MAC_GENERAL		y						y
CKM_DES3_OFB64	y							y
CKM_DES3_RETAIL_CFB_MAC		y						y

Mechanism	Encrypt & Decrypt	Sign & Verify	SR & VR1	Digest	Gen. Key / Key-Pair	Wrap & Un-wrap	Derive	FIPSAlg
CKM_DES3_X919_MAC_GENERAL		y						y
CKM_DES3_X919_MAC		y						y
CKM_DH_PKCS_DERIVE							y	y
CKM_DH_PKCS_KEY_PAIR_GEN					y			y
CKM_DH_PKCS_PARAMETER_GEN					y			y
CKM_DSA		y						y
CKM_DSA_KEY_PAIR_GEN					y			y
CKM_DSA_PARAMETER_GEN					y			
CKM_DSA_SHA1		y						y
CKM_DSA_SHA1_PKCS		y						y
CKM_EC_KEY_PAIR_GEN								y
CKM_ECDH1_DERIVE							y	Y
CKM_ECDSA		y						y
CKM_ECDSA_SHA1		y						y

Mechanism	Encrypt & Decrypt	Sign & Verify	SR & VR1	Digest	Gen. Key / Key-Pair	Wrap & Un-wrap	Derive	FIPSAlg
CKM_ECIES	y							y
CKM_ENCODE_ ATTRIBUTES						y		y
CKM_ENCODE_ PKCS_10							y	y
CKM_ENCODE_ PUBLIC_KEY						y		y
CKM_ENCODE_X_ 509_LOCAL_CERT							y	y
CKM_ENCODE_X_509							y	y
CKM_EXTRACT_ KEY_FROM_KEY							y	y
CKM_FM_ DOWNLOAD		y						y
CKM_GENERIC_ SECRET_KEY_GEN					y			y
CKM_IDEA_CBC	y					y		
CKM_IDEA_CBC_PAD	y					y		
CKM_IDEA_ECB	y					y		
CKM_IDEA_ECB	y					y		
CKM_IDEA_KEY_GEN					y			

Mechanism	Encrypt & Decrypt	Sign & Verify	SR & VR1	Digest	Gen. Key / Key-Pair	Wrap & Un-wrap	Derive	FIPSAlg
CKM_IDEA_MAC		y						
CKM_IDEA_MAC_GENERAL		y						
CKM_KEY_TRANSLATION						y		y
CKM_KEY_WRAP_SET_OAEP						y		y
CKM_MD2				y				
CKM_MD2_HMAC		y						
CKM_MD2_HMAC_GENERAL		y						
CKM_MD2_KEY_DERIVATION							y	
CKM_MD2_RSA_PKCS		y						
CKM_MD5				y				
CKM_MD5_HMAC		y						
CKM_MD5_HMAC_GENERAL		y						
CKM_MD5_KEY_DERIVATION							y	
CKM_MD5_RSA_PKCS		y						

Mechanism	Encrypt & Decrypt	Sign & Verify	SR & VR1	Digest	Gen. Key / Key-Pair	Wrap & Un-wrap	Derive	FIPSAlg
CKM_OS_UPGRADE		y						y
CKM_PBA_SHA1_ WITH_SHA1_HMAC								y
CKM_PBE_MD2_ DES_CBC					y			
CKM_PBE_MD5_ CAST128_CBC (CKM_ PBE_MD5_CAST5_ CBC)					y			
CKM_PBE_MD5_ DES_CBC					y			
CKM_PBE_SHA1_ CAST128_CBC (CKM_ PBE_SHA1_CAST5_ CBC)					y			
CKM_PBE_SHA1_ DES2_EDE_CBC					y			y
CKM_PBE_SHA1_ DES3_EDE_CBC					y			y
CKM_PBE_SHA1_ RC2_128_CBC								
CKM_PBE_SHA1_ RC2_40_CBC								
CKM_PBE_SHA1_ RC4_128								
CKM_PBE_SHA1_ RC4_40								

Mechanism	Encrypt & Decrypt	Sign & Verify	SR & VR1	Digest	Gen. Key / Key-Pair	Wrap & Un-wrap	Derive	FIPSAlg
CKM_PKCS12_PBE_EXPORT								
CKM_PKCS12_PBE_IMPORT								
CKM_PP_LOAD_SECRET					y			y
CKM_RC2_CBC	y					y		
CKM_RC2_CBC_PAD	y					y		
CKM_RC2_ECB	y					y		
CKM_RC2_ECB_PAD	y					y		
CKM_RC2_KEY_GEN					y			
CKM_RC2_MAC		y						
CKM_RC2_MAC_GENERAL		y						
CKM_RC4	y							
CKM_RC4_KEY_GEN					y			
CKM_REPLICATE_TOKEN_RSA_AES						y		y
CKM_RIPEMD128				y				
CKM_RIPEMD128_HMAC		y						

Mechanism	Encrypt & Decrypt	Sign & Verify	SR & VR1	Digest	Gen. Key / Key-Pair	Wrap & Un-wrap	Derive	FIPSAlg
CKM_RIPEMD128_ HMAC_GENERAL		y						
CKM_RIPEMD128_ RSA_PKCS		y						
CKM_RIPEMD160				y				
CKM_RIPEMD160_ HMAC		y						
CKM_RIPEMD160_ HMAC_GENERAL		y						
CKM_RIPEMD160_ RSA_PKCS		y						
CKM_RSA_9796		y	y					
CKM_RSA_PKCS	y	y	y			y		y
CKM_RSA_PKCS_ KEY_PAIR_GEN					y			y
CKM_RSA_PKCS_ OAEP	y					y		y
CKM_RSA_X_509	y	y	y			y		y
CKM_RSA_X9_31_ KEY_PAIR_GEN					y			y
							y	
							y	

Mechanism	Encrypt & Decrypt	Sign & Verify	SR & VR1	Digest	Gen. Key / Key-Pair	Wrap & Un-wrap	Derive	FIPSAlg
CKM_SEED_CBC	y					y		
CKM_SEED_CBC_PAD						y		
CKM_SEED_ECB	y					y		
CKM_SEED_ECB_PAD	y					y		
CKM_SEED_KEY_GEN					y			
CKM_SEED_MAC		y						
CKM_SEED_MAC_GENERAL		y						
CKM_SHA_1				y				y
CKM_SHA_1_HMAC		y						y
CKM_SHA_1_HMAC_GENERAL		y						y
CKM_SHA1_KEY_DERIVATION							y	y
CKM_SHA1_RSA_PKCS		y						y
CKM_SHA1_RSA_PKCS_TIMESTAMP		y						y
CKM_SHA224				y				y

Mechanism	Encrypt & Decrypt	Sign & Verify	SR & VR1	Digest	Gen. Key / Key-Pair	Wrap & Un-wrap	Derive	FIPSAlg
CKM_SHA224_HMAC		y						y
CKM_SHA224_HMAC_GENERAL		y						y
CKM_SHA224_KEY_DERIVATION							y	y
CKM_SHA224_RSA_PKCS		y						y
CKM_SHA256				y				y
CKM_SHA256_HMAC		y						y
CKM_SHA256_HMAC_GENERAL		y						y
CKM_SHA256_KEY_DERIVATION							y	y
CKM_SHA256_RSA_PKCS		y						y
CKM_SHA384				y				y
CKM_SHA384_HMAC		y						y
CKM_SHA384_HMAC_GENERAL		y						y
CKM_SHA384_KEY_DERIVATION							y	y
CKM_SHA384_RSA_PKCS		y						y

Mechanism	Encrypt & Decrypt	Sign & Verify	SR & VR1	Digest	Gen. Key / Key-Pair	Wrap & Un-wrap	Derive	FIPSAlg
CKM_SHA512				y				y
CKM_SHA512_HMAC		y						y
CKM_SHA512_HMAC_ GENERAL		y						y
CKM_SHA512_KEY_ DERIVATION							y	y
CKM_SHA512_RSA_ PKCS		y						y
CKM_SSL3_KEY_ AND_MAC_DERIVE							y	y
CKM_SSL3_MASTER_ KEY_DERIVE							y	y
CKM_SSL3_MD5_ MAC		y						
CKM_SSL3_PRE_ MASTER_KEY_GEN					y			y
CKM_SSL3_SHA1_ MAC		y						y
CKM_VISA_CVV		y						
CKM_WRAPKEY_ DES3_CBC						y		y
CKM_WRAPKEY_ DES3_ECB						y		y
CKM_XOR_BASE_							y	y

Mechanism	Encrypt & Decrypt	Sign & Verify	SR & VR1	Digest	Gen. Key / Key-Pair	Wrap & Un-wrap	Derive	FIPSAlg
AND_DATA								
CKM_XOR_BASE_ AND_KEY							y	Y
CKM_ZKA_MDC_2_ KEY_DERIVATION							y	

Table 2 – Mechanisms - Key Size Range and Parameters

Table 2: Table 2: Mechanisms - Key Size Range and Parameters

Mechanism	Min	Max	Parameter
CKM_AES_CBC	16	32	byte[16]
CKM_AES_CBC_PAD	16	32	byte[16]
CKM_AES_ECB	16	32	Null
CKM_AES_KEY_GEN	16	32	Null
CKM_AES_MAC	16	32	Null
CKM_AES_MAC_GENERAL	16	32	CK_MAC_GENERAL_PARAMS
CKM_CAST128_CBC (CKM_CAST5_CBC)	1	16	byte[blockSize]
CKM_CAST128_CBC_PAD (CKM_CAST5_ CBC_PAD)	1	16	byte[blockSize]
CKM_CAST128_ECB (CKM_CAST5_ECB)	1	16	Null

Mechanism	Min	Max	Parameter
CKM_CAST128_ECB_PAD	1	16	Null
CKM_CAST128_KEY_GEN (CKM_CAST5_KEY_GEN)	1	16	Null
CKM_CAST128_MAC (CKM_CAST5_MAC)	1	16	Null
CKM_CAST128_MAC_GENERAL (CKM_CAST5_MAC_GENERAL)	1	16	CK_MAC_GENERAL_PARAMS
CKM_CONCATENATE_BASE_AND_DATA	0	-1	CK_KEY_DERIVATION_STRING_DATA
CKM_CONCATENATE_BASE_AND_KEY	0	-1	CK_OBJECT_HANDLE
CKM_CONCATENATE_DATA_AND_BASE	0	-1	CK_KEY_DERIVATION_STRING_DATA
CKM_DECODE_PKCS_7	0	0	Null
CKM_DECODE_X_509	0	0	Null
CKM_DES_CBC	8	8	byte[blockSize]
CKM_DES_CBC_PAD	8	8	byte[blockSize]
CKM_DES_DERIVE_CBC	8	8	CK_DES_CBC_PARAMS
CKM_DES_DERIVE_ECB	8	8	byte[n*BlockLen]
CKM_DES_ECB	8	8	Null
CKM_DES_ECB_PAD	8	8	Null
CKM_DES_KEY_GEN	8	8	Null

Mechanism	Min	Max	Parameter
CKM_DES_MAC	8	8	CK_MAC_GENERAL_PARAMS
CKM_DES_MAC_GENERAL	8	8	CK_MAC_GENERAL_PARAMS
CKM_DES_MDC_2_PAD1	0	0	Null
CKM_DES_OFB64	8	8	byte[blockSize]
CKM_DES2_KEY_GEN	16	16	Null
CKM_DES3_CBC	16	24	byte[blockSize]
CKM_DES3_CBC_PAD	16	24	byte[blockSize]
CKM_DES3_DDD_CBC	16	24	byte[blockSize]
CKM_DES3_DERIVE_CBC	16	24	CK_DES2_CBC_PARAMS CK_ DES3_CBC_PARAMS
CKM_DES3_DERIVE_ECB	0	0	byte[n*BlockLen]
CKM_DES3_ECB	16	24	Null
CKM_DES3_ECB_PAD	16	24	Null
CKM_DES3_KEY_GEN	24	24	Null
CKM_DES3_MAC	16	24	Null
CKM_DES3_MAC_GENERAL	16	24	CK_MAC_GENERAL_PARAMS
CKM_DES3_OFB64	16	24	byte[blockSize]
CKM_DES3_RETAIL_CFB_MAC	16	24	byte[8] (IV)

Mechanism	Min	Max	Parameter
CKM_DES3_X919_MAC_GENERAL	16	24	byte[blockSize]
CKM_DES3_X919_MAC	16	24	CK_MAC_GENERAL_PARAMS
CKM_DH_PKCS_DERIVE	512	4096	byte[] (Big Integer)
CKM_DH_PKCS_KEY_PAIR_GEN	512	4096	Null
CKM_DH_PKCS_PARAMETER_GEN	512	4096	Null
CKM_DSA	512	1024	Null
CKM_DSA_KEY_PAIR_GEN	512	1024	Null
CKM_DSA_PARAMETER_GEN	512	1024	Null
CKM_DSA_SHA1	512	1024	Null
CKM_DSA_SHA1_PKCS	512	1024	Null
CKM_EC_KEY_PAIR_GEN	160	571	Null
CKM_ECDH1_DERIVE	160	571	CK_ECDH1_DERIVE_PARAMS
CKM_ECDSA	160	571	Null
CKM_ECDSA_SHA1	160	571	Null
CKM_ECIES	160	571	CK_ECIES_PARAMS
CKM_ENCODE_ATTRIBUTES	0	0	Null
CKM_ENCODE_PKCS_10	0	0	Null

Mechanism	Min	Max	Parameter
CKM_ENCODE_PUBLIC_KEY	0	0	Null
CKM_ENCODE_X_509_LOCAL_CERT	0	0	Null
CKM_ENCODE_X_509	0	0	CK_MECH_TYPE_AND_OBJECT
CKM_EXTRACT_KEY_FROM_KEY	0	0	CK_EXTRACT_PARAMS
CKM_FM_DOWNLOAD	512	4096	Null
CKM_GENERIC_SECRET_KEY_GEN	0	-1	Null
CKM_IDEA_CBC	16	16	byte[blockSize]
CKM_IDEA_CBC_PAD	16	16	byte[blockSize]
CKM_IDEA_ECB	16	16	Null
CKM_IDEA_ECB_PAD	16	16	Null
CKM_IDEA_KEY_GEN	16	16	Null
CKM_IDEA_MAC	16	16	Null
CKM_IDEA_MAC_GENERAL	16	16	CK_MAC_GENERAL_PARAMS
CKM_KEY_TRANSLATION	512	4096	Null
CKM_KEY_WRAP_SET_OAEP	512	4096	CK_KEY_WRAP_SET_OAEP_ PARAMS
CKM_MD2	0	0	Null

Mechanism	Min	Max	Parameter
CKM_MD2_HMAC	0	0	Null
CKM_MD2_HMAC_GENERAL	0	0	CK_MAC_GENERAL_PARAMS
CKM_MD2_KEY_DERIVATION	0	0	Null
CKM_MD2_RSA_PKCS	512	4096	Null
CKM_MD5	0	0	Null
CKM_MD5_HMAC	0	0	Null
CKM_MD5_HMAC_GENERAL	0	0	CK_MAC_GENERAL_PARAMS
CKM_MD5_KEY_DERIVATION	0	0	Null
CKM_MD5_RSA_PKCS	512	4096	Null
CKM_OS_UPGRADE	2048	4096	Null
CKM_PBA_SHA1_WITH_SHA1_HMAC	20	20	CK_PBE_PARAMS
CKM_PBE_MD2_DES_CBC	8	8	CK_PBE_PARAMS
CKM_PBE_MD5_CAST128_CBC (CKM_ PBE_MD5_CAST5_CBC)	16	16	CK_PBE_PARAMS
CKM_PBE_MD5_DES_CBC	8	8	CK_PBE_PARAMS
CKM_PBE_SHA1_CAST128_CBC (CKM_ PBE_SHA1_CAST5_CBC)	16	16	CK_PBE_PARAMS
CKM_PBE_SHA1_DES2_EDE_CBC	16	16	CK_PBE_PARAMS

Mechanism	Min	Max	Parameter
CKM_PBE_SHA1_DES3_EDE_CBC	24	24	CK_PBE_PARAMS
CKM_PBE_SHA1_RC2_128_CBC	16	16	CK_PBE_PARAMS
CKM_PBE_SHA1_RC2_40_CBC	5	5	CK_PBE_PARAMS
CKM_PBE_SHA1_RC4_128	16	16	CK_PBE_PARAMS
CKM_PBE_SHA1_RC4_40	5	5	CK_PBE_PARAMS
CKM_PKCS12_PBE_EXPORT	1	-1	CKM_PKCS12_PBE_EXPORT_PARAMS
CKM_PKCS12_PBE_IMPORT	1	-1	CKM_PKCS12_PBE_IMPORT_PARAMS
CKM_PP_LOAD_SECRET	1	-1	CK_PP_LOAD_SECRET_PARAMS
CKM_RC2_CBC	1	128	CK_RC2_CBC_PARAMS
CKM_RC2_CBC_PAD	1	128	CK_RC2_CBC_PARAMS
CKM_RC2_ECB	1	128	CK_RC2_PARAMS
CKM_RC2_ECB_PAD	1	128	CK_RC2_PARAMS
CKM_RC2_KEY_GEN	1	128	Null
CKM_RC2_MAC	1	128	CK_RC2_PARAMS
CKM_RC2_MAC_GENERAL	1	128	CK_RC2_MAC_GENERAL_PARAMS
CKM_RC4	0	256	Null

Mechanism	Min	Max	Parameter
CKM_RC4_KEY_GEN	0	256	Null
CKM_REPLICATE_TOKEN_RSA_AES	2048	2048	CK_REPLICATE_TOKEN_ PARAMS
CKM_RIPEMD128	0	0	Null
CKM_RIPEMD128_HMAC	0	0	Null
CKM_RIPEMD128_HMAC_GENERAL	0	0	CK_MAC_GENERAL_PARAMS
CKM_RIPEMD128_RSA_PKCS	512	4096	Null
CKM_RIPEMD160	0	0	Null
CKM_RIPEMD160_HMAC	0	0	Null
CKM_RIPEMD160_HMAC_GENERAL	0	0	CK_MAC_GENARAL_PARAMS
CKM_RIPEMD160_RSA_PKCS	512	4096	Null
CKM_RSA_9796	512	4096	Null
CKM_RSA_PKCS	512	4096	Null
CKM_RSA_PKCS_KEY_PAIR_GEN	512	4096	Null
CKM_RSA_PKCS_OAEP	512	4096	CK_RSA_PKCS_OAEP_PARAMS
CKM_RSA_X_509	512	4096	Null
CKM_RSA_X9_31_KEY_PAIR_GEN	1024	4096	Null

Mechanism	Min	Max	Parameter
CKM_SECRET_RECOVER_WITH_ ATTRIBUTES	0	-1	CK_SECRET_SHARE_PARAMS
CKM_SECRET_SHARE_WITH_ ATTRIBUTES	0	-1	Null
CKM_SEED_CBC	16	16	byte[16]
CKM_SEED_CBC_PAD	16	16	byte[16]
CKM_SEED_ECB	16	16	Null
CKM_SEED_ECB_PAD	16	16	Null
CKM_SEED_KEY_GEN	16	16	Null
CKM_SEED_MAC	16	16	Null
CKM_SEED_MAC_GENERAL	16	16	CK_MAC_GENERAL_PARAMS
CKM_SHA_1	0	0	Null
CKM_SHA_1_HMAC	0	-1	Null
CKM_SHA_1_HMAC_GENERAL	0	-1	CK_MAC_GENERAL_PARAMS
CKM_SHA1_KEY_DERIVATION	0	0	Null
CKM_SHA1_RSA_PKCS	512	4096	Null
CKM_SHA1_RSA_PKCS_TIMESTAMP	512	4096	CK_TIMESTAMP_PARAMS

Mechanism	Min	Max	Parameter
CKM_SHA2246	0	0	Null
CKM_SHA225_HMAC	0	-1	Null
CKM_SHA224_HMAC_GENERAL	0	-1	CK_MAC_GENERAL_PARAMS
CKM_SHA224_KEY_DERIVATION	0	0	Null
CKM_SHA224_RSA_PKCS	512	4096	Null
CKM_SHA256	0	0	Null
CKM_SHA256_HMAC	0	-1	Null
CKM_SHA256_HMAC_GENERAL	0	-1	CK_MAC_GENERAL_PARAMS
CKM_SHA256_KEY_DERIVATION	0	0	Null
CKM_SHA256_RSA_PKCS	512	4096	Null
CKM_SHA384	0	0	Null
CKM_SHA384_HMAC	0	-1	Null
CKM_SHA384_HMAC_GENERAL	0	-1	CK_MAC_GENERAL_PARAMS
CKM_SHA384_KEY_DERIVATION	0	0	Null
CKM_SHA384_RSA_PKCS	512	4096	Null
CKM_SHA512	0	0	Null

Mechanism	Min	Max	Parameter
CKM_SHA512_HMAC	0	-1	Null
CKM_SHA512_HMAC_GENERAL	0	-1	CK_MAC_GENERAL_PARAMS
CKM_SHA512_KEY_DERIVATION	0	0	Null
CKM_SHA512_RSA_PKCS	512	4096	Null
CKM_SSL3_KEY_AND_MAC_DERIVE	48	48	CK_SSL3_KEY_MAT_PARAMS
CKM_SSL3_MASTER_KEY_DERIVE	48	48	CK_SSL3_MASTER_KEY_ DERIVE_PARAMS
CKM_SSL3_MD5_MAC	0	-1	CK_MAC_GENERAL_PARAMS
CKM_SSL3_PRE_MASTER_KEY_GEN	48	48	CK_VERSION
CKM_SSL3_SHA1_MAC	0	-1	CK_MAC_GENERAL_PARAMS
CKM_VISA_CVV	16	16	Null
CKM_WRAPKEY_DES3_CBC	0	0	Null
CKM_WRAPKEY_DES3_ECB	0	0	Null
CKM_XOR_BASE_AND_DATA	0	-1	CK_KEY_DERIVATION_STRING_ DATA
CKM_XOR_BASE_AND_KEY	0	-1	CK_OBJECT_HANDLE
CKM_ZKA_MDC_2_KEY_DERIVATION	0	0	byte[arbitrary]

3Mechanism can be used only for wrapping, not unwrapping
4Mechanism SafeNet proprietary
7
8
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14
15

CKM_AES_CBC

AES-CBC, denoted CKM_AES_CBC, is a mechanism for single and multiple-part encryption and decryption; key wrapping; and key unwrapping, based on NIST's Advanced Encryption Standard and cipher-block chaining mode. It has a parameter, a 16-byte initialization vector.

This mechanism can wrap and unwrap any secret key. Of course, a particular token may not be able to wrap/unwrap every secret key that it supports. For wrapping, the mechanism encrypts the value of the CKA_VALUE attribute of the key that is wrapped; padded on the trailing end with up to block size, minus one, null bytes so that the resulting length is a multiple of the block size. The output data is the same length as the padded input data. It does not wrap the key type, key length, or any other information about the key. The application must convey these separately.

For unwrapping, the mechanism decrypts the wrapped key and truncates the result according to the CKA_KEY_ TYPEattribute of the template and, if it has one and the key type supports it, the CKA_VALUE_LENattribute of the template. The mechanism contributes the result as the CKA_VALUE attribute of the new key. Other attributes required by the key type must be specified in the template.

Constraints on key types and the length of data are summarized in the following table:

Table 3 – AES-CBC: Key and Data Length

Function	Key type	Input length	Output length	Comments
	AES	Multiple of block size	same as input length	no final part
	AES	Multiple of block size	same as input length	no final part
	AES	Any	input length rounded up to multiple of the block size	
	AES	Multiple of block size	determined by type of key being unwrapped or CKA_VALUE_LEN	

For this mechanism, the ulMinKeySize and ulMaxKeySize fields of the CK_MECHANISM_INFOstructure specify the supported range of AES key sizes, in bytes.

CKM_AES_CBC_PAD

AES-CBC with PKCS padding, denoted CKM_AES_CBC_PAD, is a mechanism for single and multiple-part encryption and decryption; key wrapping; and key unwrapping, based on NIST's Advanced Encryption Standard; cipher-block chaining mode; and the block cipher padding method detailed in PKCS #7. It has a parameter, a 16-byte initialization vector.

The PKCS padding in this mechanism allows the length of the plaintext value to be recovered from the cipher text value. No value should be specified for the CKA_VALUE_LEN attribute when unwrapping keys with this mechanism.

In addition to being able to wrap and unwrap secret keys, this mechanism can wrap and unwrap RSA, Diffie-Hellman, X9.42 Diffie-Hellman, and DSA private keys. The entries in Table 40 for data length constraints when wrapping and unwrapping keys do not apply to wrapping and unwrapping private keys.

Constraints on key types and the length of data are summarized in the following table: For this mechanism, the ulMinKeySize and ulMaxKeySize fields of the CK_MECHANISM_INFOstructure specify the supported range of AES key sizes, in bytes.

Table 4 – AES-CBC with PKCS Padding: Key and Data Length

Function	Key type	Input length	Output length
	AES	Any	Input length rounded up to multiple of the block size
	AES	Multiple of block size	Between 1 and block size bytes shorter than input length

Function	Key type	Input length	Output length
	AES	Any	Input length rounded up to multiple of the block size
	AES	Multiple of block size	Between 1 and block length bytes shorter than input length

CKM_AES_ECB

AES-ECB, denoted CKM_AES_ECB, is a mechanism for single- and multiple-part encryption and decryption; key wrapping; and key unwrapping, based on NIST Advanced Encryption Standard and electronic codebook mode. It does not have a parameter.

This mechanism can wrap and unwrap any secret key. Of course, a particular token may not be able to wrap/unwrap every secret key that it supports. For wrapping, the mechanism encrypts the value of the CKA_VALUE attribute of the key that is wrapped; padded on the trailing end with up to block size, minus one, null bytes so that the resulting length is a multiple of the block size. The output data is the same length as the padded input data. It does not wrap the key type, key length, or any other information about the key. The application must convey these separately.

For unwrapping, the mechanism decrypts the wrapped key and truncates the result according to the CKA_KEY_ TYPEattribute of the template and, if it has one and the key type supports it, the CKA_VALUE_LENattribute of the template. The mechanism contributes the result as the CKA_VALUEattribute of the new key. Other attributes required by the key type must be specified in the template.

Constraints on key types and the length of data are summarized in the following table:

Table 5 – AES-ECB: Key and Data Length

Function	Key type	Input length	Output length	Comments
	AES	Multiple of block size	Same as input length	No final part
	AES	Multiple of block size	Same as input length	No final part
	AES	Any	Input length rounded up to multiple of block size	
	AES	Multiple of block size	Determined by type of key being unwrapped or CKA_VALUE_LEN	

For this mechanism, the ulMinKeySize and ulMaxKeySize fields of the CK_MECHANISM_INFOstructure specify the supported range of AES key sizes, in bytes.

CKM_AES_KEY_GEN

The AES key generation mechanism, denoted CKM_AES_KEY_GEN, is a key generation mechanism for NIST's Advanced Encryption Standard. It does not have a parameter.

The mechanism generates AES keys with a particular length in bytes, as specified in the CKA_VALUE_LENattribute of the template for the key.

The mechanism contributes the CKA_CLASS, CKA_KEY_TYPE and CKA_VALUE attributes to the new key. Other attributes supported by the AES key type (specifically, the flags indicating which functions the key supports) may be specified in the template for the key or else are assigned default initial values.

For this mechanism, the ulMinKeySize and ulMaxKeySize fields of the CK_MECHANISM_INFOstructure specify the supported range of AES key sizes, in bytes. Key sizes from 8 to 256 bytes are supported. The algorithm block size is 16 bytes.

CKM_AES_MAC

AES-MAC, denoted by CKM_AES_MAC, is a special case of the general-length AES-MAC mechanism (see section above). AES-MAC always produces and verifies MACs that are half the block size in length. It does not have a parameter.

Constraints on key types and the length of data are summarized in the following table:

Table 6 – AES-MAC: Key and Data Length

Function	Key type	Data length	Signature length
	AES	Any	½ block size (8 bytes)
	AES	Any	½ block size (8 bytes)

For this mechanism, the ulMinKeySize and ulMaxKeySize fields of the CK_MECHANISM_INFOstructure specify the supported range of AES key sizes, in bytes.

CKM_AES_MAC_GENERAL

General-length AES-MAC, denoted CKM_AES_MAC_GENERAL, is a mechanism for single- and multiple-part signatures and verification, based on NIST Advanced Encryption Standard.

It has a parameter, a CK_MAC_GENERAL_PARAMS structure, which specifies the output length desired from the mechanism.

The output bytes from this mechanism are taken from the start of the final AES cipher block produced in the MACing process.

Constraints on key types and the length of data are summarized in the following table:

Table 7 – General-length AES-MAC: Key and Data Length

Function	Key type	Data length	Signature length
	AES	Any	0-block size, as specified in parameters
	AES	Any	0-block size, as specified in parameters

For this mechanism, the ulMinKeySize and ulMaxKeySize fields of the CK_MECHANISM_INFOstructure specify the supported range of AES key sizes, in bytes.

CKM_CAST128_ECB_PAD

This is a padding mechanism. Other padding mechanisms implemented are: CKM_RC2_ECB_PAD, CKM_DES_ECB_PAD, CKM_DES3_ECB_PAD and CKM_IDEA_ECB_PAD.

These block cipher mechanisms are all based on the corresponding Electronic Code Book (ECB) algorithms, implied by their name, but with the addition of the block-cipher padding method detailed in PKCS#7.

These mechanisms are supplied for compatibility only and their use in new applications is not recommended.

PKCS#11 Version 2.1 specifies mechanisms for Chain Block Cipher algorithms with and without padding and ECB algorithms without padding, but not ECB with padding. These mechanisms fill this gap. The mechanisms may be used for general data encryption and decryption and also for key wrapping and unwrapping (provided all the access conditions of the relevant keys are satisfied).

CKM_DECODE_PKCS_7

This mechanism is used with the C_DeriveKeyfunction to derive a set of X.509 Certificate objects and X.509 CRL objects from a PKCS#7 object. The base key object handle is a CKO_DATA object (the PKCS#7 encoding) which has a CKA_OBJECT_ID attribute indicating the type of the object as being a PKCS#7 encoding. This mechanism does not take any parameters.

One of the functions of PKCS7 is a mechanism for distributing certificates and CRLs in a single encoded package. In this case the PKCS7 message content is usually empty. This mechanism is provided to split certificates and CRLs from such a PKCS7 encoding so that those certificates and CRLs may be further processed.

This mechanism will decode a PKCS7 encoding and create PKCS#11 objects for all certificates (object class CKO_CERTIFICATE) and CRLs (object class CKO_CRL) that it finds in the encoding. The signature on the PKCS7 content is not verified. The parameter containing the newly derived key is the last Certificate or CRL that is extracted from the PKCS7 encoding. The attribute template is applied to all objects extracted from the encoding.

CKM_DECODE_X_509

This mechanism is used with the C_DeriveKeyfunction to derive a public key object from an X.509 certificate or a PKCS#10 certification request. This mechanism does not perform a certificate validation.

The base key object handle should refer to the X.509 certificate or PKCS#10 certificate request. This mechanism has no parameter.

CKM_DES_DERIVE_CBC

The CKM_DES_DERIVE_CBC and CKM_DES3_DERIVE_CBC mechanisms are used with the C_DeriveKeyfunction to derive a secret key by performing a CBC (no padding) encryption. They create a new secret key whose value is generated by encrypting the provided data with the provided Single, Double or Triple length DES key.

Three new mechanism Parameter structures are created, CK_DES_CBC_PARAMS, CK_DES2_CBC_PARAMS and CK_DES3_CBC_PARAMS, for use by these mechanisms. These structures consists of 2-byte arrays, the first array contains the IV (must be 8 bytes) and the second array contains the data to be encrypted, being 8, 16 or 24 bytes in length, for each PARAMS structure respectively.

These mechanisms require the pParameter in the CK_MECHANISM structure to be a pointer to one of the above new Parameter structures and the parameterLen to be the size of the provided Parameter structure.

If the length of data to be encrypted by the CBC mechanism does not fit into one of the above PARAMS structures, the developer must produce their own byte array with the following layout. The first 8 bytes must be the IV, then the data to be encrypted. To use this array, the pParameter in the CK_MECHANISM structure must be a pointer to this array and the parameterLen is the length of the IV (must be 8 bytes) plus the length of the provided data, which must be a multiple of 8 bytes.

The following rules apply to the provided attribute template:

- If no length or key type is provided in the template, then the key produced by these mechanisms is a generic secret key. Its length is equal to the length of the provided data.
- If no key type is provided in the template, but a length is, then the key produced by these mechanisms is a generic secret key of the specified length, extracted from the left bytes of the cipher text.
- If no length is provided in the template, but a key type is, then that key type must have a well-defined length. If it does, then the key produced by these mechanisms is of the type specified in the template. If it doesn't, an error is returned.
- If both a key type and a length are provided in the template, the length must be compatible with that key type. The key produced by these mechanisms is of the specified type and length, extracted from the left bytes of the cipher text.

If a DES key is derived with these mechanisms, the parity bits of the key are set properly. If the requested type of key requires more bytes than the length of the provided data, an error is generated.

These mechanisms have the following rules about key sensitivity and extractability:

- If the base key has its CKA_SENSITIVE attribute set to TRUE, so does the derived key. If not, then the derived key's CKA_SENSITIVE attribute is set either from the supplied template or else it defaults to TRUE.
- Similarly, if the base key has its CKA_EXTRACTABLE attribute set to FALSE, so does the derived key. If not, then the derived key's CKA_EXTRACTABLE attribute is set either from the supplied template or else it defaults to TRUE.
- The derived key's CKA_ALWAYS_SENSITIVE attribute is set to TRUE if and only if the base key has its CKA_ALWAYS_SENSITIVE attribute set to TRUE.
- Similarly, the derived key's CKA_NEVER_EXTRACTABLE attribute is set to TRUE if and only if the base key has its CKA_NEVER_EXTRACTABLE attribute set to TRUE.

CKM_DES_DERIVE_ECB

The CKM_DES_DERIVE_ECB and CKM_DES3_DERIVE_ECB mechanisms are used with the *C_DeriveKey* function to derive a secret key by performing an ECB (no padding) encryption. They create a new secret key whose value is generated by encrypting the provided data with the provided single, double or triple length DES key.

The CKM_DES_DERIVE_ECB and CKM_DES3_DERIVE_ECB mechanisms require the pParameter in the CK_MECHANISM structure to be the pointer to the data that is to be encrypted. The parameterLen is the length of the provided data, which must be a multiple of 8 bytes.

The following rules apply to the provided attribute template:

If no length or key type is provided in the template, then the key produced by these mechanisms is a generic secret key. Its length is equal to the length of the provided data.

If no key type is provided in the template, but a length is, then the key produced by these mechanisms is a generic secret key of the specified length, extracted from the left bytes of the cipher text.

If no length is provided in the template, but a key type is, then that key type must have a well-defined length. If it does, then the key produced by these mechanisms is of the type specified in the template. If it doesn't, an error is returned.

If both a key type and a length are provided in the template, the length must be compatible with that key type. The key produced by these mechanisms is of the specified type and length, extracted from the left bytes of the cipher text.

If a DES key is derived with these mechanisms, the parity bits of the key are set properly. If the requested type of key requires more bytes than the length of the provided data, an error is generated.

The mechanisms have the following rules about key sensitivity and extractability:

If the base key has its CKA_SENSITIVE attribute set to TRUE, so does the derived key. If not, then the derived key's CKA_SENSITIVE attribute is set either from the supplied template or else it defaults to TRUE.

Similarly, if the base key has its CKA_EXTRACTABLE attribute set to FALSE, so does the derived key. If not, then the derived key's CKA_EXTRACTABLE attribute is set either from the supplied template or else it defaults to TRUE.

The derived key's CKA_ALWAYS_SENSITIVE attribute is set to TRUE if and only if the base key has its CKA_ALWAYS_SENSITIVE attribute set to TRUE.

Similarly, the derived key's CKA_NEVER_EXTRACTABLE attribute is set to TRUE if and only if the base key has its CKA_NEVER_EXTRACTABLE attribute set to TRUE.

CKM_DES_ECB_PAD

See the entry for CKM_CAST128_ECB_PAD

CKM_DES_MDC_2_PAD1

This mechanism is a hash function as defined in ISO/IEC DIS 10118-2 using DES as block algorithm.
This mechanism implements padding in accordance with ISO 10118-1 Method 1. Basically, zeros are used to pad the input data to a multiple of eight if required. If the input data is already a multiple of eight, then no padding is added.

CKM_DES_OFB64

Single DES-OFB64 denoted CKM_DES_OFB64 is a mechanism for single and multiple part encryption and decryption; based on DES Output Feedback Mode.

It has a parameter, an 8-byte initialization vector.

This mechanism does not require either clear text or cipher text to be presented in multiple block lengths. There is no padding required. The mechanism will always return a reply equal in length to the request.

CKM_DES3_DDD_CBC

CKM_DES3_DDD_CBC is a mechanism for single- and multiple-part encryption and decryption, key wrapping and key unwrapping, based on the DES block cipher and cipher-block chaining mode as defined in FIPS PUB 81.

The DES3-DDD cipher encrypts an 8 byte block by D(KL, D(KR, D(KL, data)))and decrypts with E(KL, E(KR, E(KL, cipher))); where Key = KL || KR, and E(KL, data) is a single DES encryption using key KL and D(KL, cipher)is a single DES decryption.

It has a parameter, an initialization vector for cipher block chaining mode. The initialization vector has the same length as the block size, which is 8 bytes.

Constraints on key types and the length of data are summarized in the following table:

Table 8 – DES3-DDD Block Cipher CBC: Key and Data Length

Function	Key type	Input length	Output length	Comments
	CKK_ DES2	Any	input length rounded up to multiple of block size	no final part
	CKK_ DES2	Multiple of block size	same as input length	no final part
	CKK_ DES2	Any	input length rounded up to multiple of block size	
	CKK_ DES2	Any	Determined by type of key being unwrapped or CKA_VALUE_LEN	

For the encrypt and wrap operations, the mechanism performs zero-padding when the input data or wrapped key's length is not a multiple of 8. That is, the value 0x00is appended to the last block until its length is 8 (for example, plaintext 0x01 would be padded to become 0x010x000x000x000x000x000x000x00).

With the exception of the algorithm specified in this section, the use of this mechanism is identical to the use of other secret key mechanisms. Therefore, for further details on aspects not covered here (for example, access control, or error codes) refer to the PKCS#11 standard.

CKM_DES3_DERIVE_CBC

See the entry for CKM_DES_DERIVE_CBC

CKM_DES3_DERIVE_ECB

See the entry for CKM_DES_DERIVE_ECB

CKM_DES3_ECB_PAD

See the entry for CKM_CAST128_ECB_PAD.

CKM_DES3_OFB64

Triple DES-OFB64 denoted CKM_DES3_OFB64is a mechanism for single and multiple part encryption and decryption; based on DES Output Feedback Mode.

It has a parameter, an 8-byte initialization vector.

This mechanism does not require either clear text or cipher text to be presented in multiple block lengths. There is no padding required. The mechanism will always return a reply equal in length to the request.

CKM_DES3_RETAIL_CFB_MAC

This is a signature generation and verification mechanism. The produced MAC is 8 bytes in length. It is an extension of the single length key MAC mechanisms. It takes an 8 byte IV as a parameter, which is encrypted (ECB mode) with the left most key value before the first data block is MAC'ed.

The data, which must be a multiple of 8 bytes, is MAC’ed with the left most key value in the normal manner, but the final cipher block is then decrypted (ECB mode) with the middle key value and encrypted (ECB mode) with the Right most key part.

For double length DES keys, the Right key component is the same as the Left key component.

CKM_DES3_X919_MAC

See the entry for CKM_DES3_X919_MAC_GENERAL

CKM_DES3_X919_MAC_GENERAL

CKM_DES3_X919_MAC and CKM_DES3_X919_MAC_GENERAL are signature generation and verification mechanisms, as defined by ANSI X9.19. They are an extension of the single length key MAC mechanisms. The data is MAC’ed with the left most key value in the normal manner, but the final cipher block is then decrypted (ECB mode) with the middle key value and encrypted (ECB mode) with the Right most key part.

For double length keys, the Right key component is the same as the Left key component.

CKM_DH_PKCS_PARAMETER_GEN

The PKCS #3 Diffie-Hellman key parameter generation mechanism, denoted CKM_DH_PKCS_PARAMETER_GEN, is a key parameter generation mechanism based on Diffie-Hellman key agreement, as defined in PKCS #3. It does not have a parameter.

The mechanism generates Diffie-Hellman key parameters with a particular prime length in bits, as specified in the CKA_PRIME_BITSattribute of the template for the key parameters. The mechanism contributes the CKA_CLASS, CKA_KEY_TYPE, CKA_PRIME, CKA_BASE, and CKA_PRIME_BITS attributes to the new object. Other attributes supported by the Diffie-Hellman key parameter types may also be specified in the template for the key parameters, or else are assigned default initial values.

For this mechanism, the ulMinKeySizeand ulMaxKeySize fields of the CK_MECHANISM_INFOstructure specify the supported range of Diffie-Hellman prime sizes, in bits.

CKM_DSA_PARAMETER_GEN

The DSA key parameter generation mechanism, denoted CKM_DSA_PARAMETER_GEN, is a key parameter generation mechanism based on the Digital Signature Algorithm defined in FIPS PUB 186. This mechanism does not have a parameter.

The mechanism generates DSA key parameters with a particular prime length in bits, as specified in the CKA_PRIME_BITSattribute of the template for the key parameters. The mechanism contributes the CKA_CLASS, CKA_KEY_TYPE, CKA_PRIME, CKA_BASE, CKA_SUBPRIME, and CKA_PRIME_BITS attributes to the new object. Other attributes supported by the DSA key parameter types may also be specified in the template for the key parameters, or else are assigned default initial values.

For this mechanism, the ulMinKeySize and ulMaxKeySize fields of the CK_MECHANISM_INFOstructure specify the supported range of DSA prime sizes, in bits.

CKM_DSA_SHA1_PKCS

The PKCS #1 DSA signature with SHA-1 mechanism, denoted CKM_DSA_SHA1_PKCS, performs single and multiple-part digital signature and verification operations without message recovery. The operations performed are as described in PKCS #1 with the object identifier sha1WithDSAEncryption.

It is similar to the PKCS#11 mechanism CKM_RSA_SHA1_PKCSexcept DSA is used instead of RSA. This mechanism has no parameter.

CKM_EC_KEY_PAIR_GEN

The elliptic curve key pair generation mechanism, denoted CKM_EC_KEY_PAIR_GEN, is a key pair generation mechanism for EC Operation.

This mechanism operates as specified in PKCS#11, with the following adjustments.

The CKA_EC_PARAMS or CKA_ECDSA_PARAMS attribute value must be supplied in the Public Key Template. This attribute is known as the “EC domain parameters” and is defined in ANSI X9.62 as a choice of three parameter representation methods with the following syntax:

```
Parameters ::= CHOICE {
        ecParameters ECParameters,
        namedCurve CURVES.&id({CurveNames}),
        implicitlyCA NULL
}
```

If the CKA_EC_PARAMS attribute contains a namedCurve then it must be the of DER OID-encoding of one of the following supported curves:

```
{ iso(1) member-body(2) US(840) x9-62(10045) curves(3) characteristicTwo(0)
c2tnb191v1(5) }
```

{ iso(1) member-body(2) US(840) x9-62(10045) curves(3) prime(1) prime192v1(1) }

{ iso(1) identified-organization(3) Certicom(132) certicom_ellipticCurve(0) secp224r1(33) }

{ iso(1) member-body(2) US(840) x9-62(10045) curves(3) prime(1) prime256v1(7) }

{ iso(1) identified-organization(3) Certicom(132) certicom_ellipticCurve(0) secp384r1(34) }

{ iso(1) identified-organization(3) Certicom(132) certicom_ellipticCurve(0) secp521r1(35) }

Plus the custom curve with unofficial OID -
{ iso(1) member-body(2) US(840) x9-62(10045) curves(3) characteristicTwo(0) c2tnb191v1e (15) }

Refer to the CT_DerEncodeNamedCurve function in the CTUTIL library for a convenient way to obtain the encodings of supported namedCurve OIDs.

If the CKA_EC_PARAMS attribute is in the form of the ECParameters sequence then the domain parameters may be described explicitly. In this way the developer is able to specify the curve parameters for curves that the firmware has no prior knowledge of.

Support for ECParameters sequence is disabled unless the Security Configuration “User Specified ECC Domain Parameters Allowed”is enabled (see ctconf –fE).

Refer to the CT_GetECCDomainParameters function in the CTUTILS library and the KM_EncodeECParamsP and KM_EncodeECParams2M functions from the KMLIB library for convenient methods to obtain ECParameters encodings.

CKM_ECDH1_DERIVE

The elliptic curve Diffie-Hellman (ECDH) key derivation mechanism, denoted CKM_ECDH1_DERIVE, is a mechanism for key derivation based on the Diffie-Hellman version of the elliptic curve key agreement scheme, as defined in ANSI X9.63, where each party contributes one key pair all using the same EC domain parameters.

This mechanism has a parameter, a CK_ECDH1_DERIVE_PARAMS structure.

```
typedef struct CK_ECDH1_DERIVE_PARAMS {
CK_EC_KDF_TYPE kdf; /* key derivation function */
CK_ULONG ulSharedDataLen; /* optional extra shared data */
CK_BYTE_PTR pSharedData;
CK_ULONG ulPublicDataLen; /* other party public key value */
CK_BYTE_PTR pPublicData;
} CK_ECDH1_DERIVE_PARAMS;
typedef struct CK_ECDH1_DERIVE_PARAMS * CK_ECDH1_DERIVE_PARAMS_PTR;
```

The fields of the structure have the following meanings:

kdf This is the Key Derive Function (see below for the a description of the possible values of this field).

ulSharedDataLen The length of the optional shared data used by some of the key derive functions. This may be zero if there is no shared data.

pSharedData The address of the optional shared data or NULL if there is no shared data.

ulPublicDataLen Length of the other party public key.

pPublicData Pointer to the other party public key. Only uncompressed format is accepted.

The mechanism calculates an agreed value using the EC Private key referenced by the base object handle and the EC Public key passed to the mechanism through the pPublicData field of the mechanism parameter.
The length of the agreed value is equal to the ‘q’ value of the underlying EC curve.
The agreed value is then processed by the Key Derive Function (kdf) to produce the CKA_VALUE of the new Secret Key object.
Four main types of KDFs are supported.

The NULL KDF performs no additional processing and can be used to obtain the raw agreed value.
Basically: Key = Z

The CKF_<hash>_KDF algorithms are based on the algorithm described in section 5.6.3 of ANSI X9.63 2001.
Basically: Key = H(Z || *counter* || *OtherInfo*).

The CKF_<hash>_SES_KDF algorithms are based on the variant of the x9.63 algorithm specified in *Technical Guideline TR-03111 - Elliptic Curve Cryptography (ECC) based on ISO 15946 Version 1.0,* Bundesamt Fur Sicherheit in der Informationstechnik (BSI)
Basically: Key = H(Z || *counter*) where *counter*is a user specified parameter.

The CKF_<hash>_NIST_KDF algorithms are based on the algorithm described in NIST 800-56A Concatenisation Algorithm
Basically: Key = H(*counter* || Z || *OtherInfo*).

The CKF_SES_<hash>_KDF algorithms require the value of the counter to be specified. This is done by arithmetically adding the counter value to the CKF value.

The following Counter values are defined in TR-03111

Counter Name	*Value*	*Description*
CKD_SES_ENC_CTR	*0x00000001*	*Default encryption Key*
CKD_SES_AUTH_CTR	*0x00000002*	*Default authentication Key*
CKD_SES_ALT_ENC_CTR	*0x00000003*	*Alternate encryption Key*
CKD_SES_ALT_AUTH_CTR	*0x00000004*	*alternate Authentication Key*
CKD_SES_MAX_CTR	*0x0000FFFF*	*Maximum counter value*

For example –

To derive a session key to be used as an Alternate key for Encryption the counter must equal 0x00000003. If the SHA-1 hash algorithm is required then the kdf value would be set like this –

CK_ECDH1_DERIVE_PARAMS Params;

Params.kdf = CKD_SHA1_SES_KDF + CKD_SES_ALT_ENC_CTR;

The table below describes the supported KDFs.

KDF Type	***Description***
CKD_NULL	*The null transformation. The derived key value is produced by taking bytes from the left of the agreed value. The new key size is limited to the size of the agreed value.* *The Shared Data is not used by this KDF and* pSharedData*should be NULL.*
CKD_SHA1_ KDF	*This KDF generates secret keys of virtually any length using the algorithm described in X9.63 with the SHA-1 hash algorithm.* *Shared data may be provided.*
CKD_ SHA224_ KDF	*This KDF generates secret keys of virtually any length using the algorithm described in X9.63 with the SHA-224 hash algorithm.* *Shared data may be provided.*
CKD_ SHA256_ KDF	*This KDF generates secret keys of virtually any length using the algorithm described in X9.63 with the SHA-256 hash algorithm.* *Shared data may be provided.*
CKD_ SHA384_ KDF	*This KDF generates secret keys of virtually any length using the algorithm described in X9.63 with the SHA-384 hash algorithm.* *Shared data may be provided.*
CKD_ SHA512_ KDF	*This KDF generates secret keys of virtually any length using the algorithm described in X9.63 with the SHA-512 hash algorithm.* *Shared data may be provided.*
CKD_ RIPEMD160_ KDF	*This KDF generates secret keys of virtually any length using the algorithm described in X9.63 with the RIPE MD 160 hash algorithm.* *Shared data may be provided.* *This KDF is not available if the HSM is configured for "Only allow Fips Approved Algorithms".*
CKD_SHA1_ SES_KDF	*This KDF generates session keys. It uses the algorithm described in TR-03111with the SHA-1 hash algorithm.* *Shared data may be provided but typically it is not used.*

KDF Type	Description
	The counter value that is a parameter to this KDF must be added to this constant.
CKD_ SHA224_ SES_KDF	*This KDF generates single, double and triple length DES keys that are intended for Encryption operations. It uses the algorithm described in TR-03111with the SHA-224 hash algorithm.* *Shared data may be provided but typically it is not used.* *The counter value that is a parameter to this KDF must be added to this constant.*
CKD_ SHA256_ SES_KDF	*This KDF generates single, double and triple length DES keys that are intended for Encryption operations. It uses the algorithm described in TR-03111with the SHA-256 hash algorithm.* *Shared data may be provided but typically it is not used.* *The counter value that is a parameter to this KDF must be added to this constant.*
CKD_ SHA384_ SES_KDF	*This KDF generates single, double and triple length DES keys that are intended for Encryption operations. It uses the algorithm described in TR-03111with the SHA-384 hash algorithm.* *Shared data may be provided but typically it is not used.* *The counter value that is a parameter to this KDF must be added to this constant.*
CKD_ SHA512_ SES_KDF	*This KDF generates single, double and triple length DES keys that are intended for Encryption operations. It uses the algorithm described in TR-03111with the SHA-512 hash algorithm.* *Shared data may be provided but typically it is not used.* *The counter value that is a parameter to this KDF must be added to this constant.*
CKD_ RIPEMD160_ SES_KDF	*This KDF generates single, double and triple length DES keys that are intended for Encryption operations. It uses the algorithm described in TR-03111with the Ripe MD 160 hash algorithm.* *Shared data may be provided but typically it is not used.* *The counter value that is a parameter to this KDF must be added to this constant.* *This KDF is not available if the HSM is configured for "Only allow Fips Approved Algorithms".*
CKD_SHA1_ NIST_KDF	*This KDF generates secret keys of virtually any length using the algorithm described in NIST 800-56A with the SHA-1 hash algorithm.* *Shared data should be formatted according to the standard.*
CKD_ SHA224_ NIST_KDF	*This KDF generates secret keys of virtually any length using the algorithm described in NIST 800-56A with the SHA-224 hash algorithm.* *Shared data should be formatted according to the standard.*

KDF Type	Description
CKD_ SHA256_ NIST_KDF	*This KDF generates secret keys of virtually any length using the algorithm described in NIST 800-56A with the SHA-256 hash algorithm.* *Shared data should be formatted according to the standard.*
CKD_ SHA384_ NIST_KDF	*This KDF generates secret keys of virtually any length using the algorithm described in NIST 800-56A with the SHA-384 hash algorithm.* *Shared data should be formatted according to the standard.*
CKD_ SHA512_ NIST_KDF	*This KDF generates secret keys of virtually any length using the algorithm described in NIST 800-56A with the SHA-512 hash algorithm.* *Shared data should be formatted according to the standard.*
CKD_ RIPEMD160_ NIST_KDF	*This KDF generates secret keys of virtually any length using the algorithm described in NIST 800-56A with the RIPE MD 160 hash algorithm.* *Shared data should be formatted according to the standard.* *This KDF is not available if the HSM is configured for "Only allow Fips Approved Algorithms".*

This mechanism derives a secret value, and truncates the result according to the CKA_KEY_TYPE attribute of the template and, if it has one and the key type supports it, the CKA_VALUE_LEN attribute of the template. (The truncation removes bytes from the leading end of the secret value.) The mechanism contributes the result as the CKA_VALUE attribute of the new key; other attributes required by the key type must be specified in the template.

The following rules apply to the provided attribute template:

A key type must be provided in the template or else a Template Error is returned.

If no length is provided in the template then that key type must have a well-defined length. If it doesn't, an error is returned.

If both a key type and a length are provided in the template, the length must be compatible with that key type.

If a DES key is derived with these mechanisms, the parity bits of the key are set properly.

If the requested type of key requires more bytes than the Key Derive Function can provide, an error is generated.

The mechanisms have the following rules about key sensitivity and extractability:

The CKA_SENSITIVE, CKA_EXTRACTABLE and CKA_EXPORTABLE attributes in the template for the new key can both be specified to be either CK_TRUE or CK_FALSE. If omitted, these attributes all take on the default value TRUE.

If the base key has its CKA_ALWAYS_SENSITIVE attribute set to CK_FALSE, then the derived key will as well. If the base key has its CKA_ALWAYS_SENSITIVE attribute set to CK_TRUE, then the derived key has its CKA_ ALWAYS_SENSITIVE attribute set to the same value as its CKA_SENSITIVE attribute.

Similarly, if the base key has its CKA_NEVER_EXTRACTABLE attribute set to CK_FALSE, then the derived key will, too. If the base key has its CKA_NEVER_EXTRACTABLE attribute set to CK_TRUE, then the derived key has its CKA_NEVER_EXTRACTABLE attribute set to the opposite value from its CKA_EXTRACTABLE attribute.

CKM_ECIES

The Elliptic Curve Integrated Encryption Scheme (ECIES) mechanism, denoted CKM_ECIES, performs single-part encryption and decryption operations. The operations performed are as described in ANSI X9.63-2001.

This mechanism has a parameter, a CK_ECIES_PARAMS structure. This structure is defined as follows:

```
typedef struct CK_ECIES_PARAMS
{
CK_EC_DH_PRIMITIVE dhPrimitive;
CK_EC_KDF_TYPE kdf;
CK_ULONG ulSharedDataLen1;
CK_BYTE_PTR pSharedData1;
CK_EC_ENC_SCHEME encScheme;
CK_ULONG ulEncKeyLenInBits;
CK_EC_MAC_SCHEME macScheme;
CK_ULONG ulMacKeyLenInBits;
CK_ULONG ulMacLenInBits;
CK_ULONG ulSharedDataLen2;
CK_BYTE_PTR pSharedData2;
} CK_ECIES_PARAMS;
```

The fields of this structure have the following meanings:

dhPrimitive	Diffie-Hellman primitive used to derive the shared secret value. Valid value: CKDHP_STANDARD
kdf	key derivation function used on the shared secret value. Valid value: CKD_SHA1_KDF

ulSharedDataLen1	the length in bytes of the key derivation shared data
pSharedData1	the key derivation padding data shared between the two parties
encScheme	the encryption scheme used to transform the input data. Valid value: CKES_XOR
ulEncKeyLenInBits	the bit length of the key to use for the encryption scheme
macScheme	the MAC scheme used for MAC generation or validation Valid values: CKMS_HMAC_SHA1 CKMS_SHA1 NB: The MAC scheme CKMS_SHA1, should onlybe used for compatability with RSA BSAFE® Crypto-C, which uses a NON-STANDARD MAC scheme, that was defined in the 10/97 X9.63 Draft, but was removed from the released ANSI X9.63-2001 specification.
ulMacKeyLenInBits	the bit length of the key to use for the MAC scheme
ulMacLenInBits	the bit length of the MAC scheme output
ulSharedDataLen2	the length in bytes of the MAC shared data
pSharedData2	the MAC padding data shared between the two parties

The *pSharedData1* and *pSharedData2* parameters are optional, and if not supplied then they must be NULL and the *ulSharedDataLen1* and *ulSharedDataLen2* parameters must be zero. With the MAC scheme CKMS_SHA1, any supplied shared data is ignored.

With the encryption scheme CKES_XOR, the *ulEncKeyLenInBits*parameter MUST be zero. With any other encryption scheme, the *ulEncKeyLenInBits* parameter must be set to the applicable key length in bits.

With the MAC scheme CKMS_SHA1, the *ulMacKeyLenInBits*parameter must be 0. With any other MAC scheme, the *ulMacKeyLenInBit*s parameter must be a minimum of 80 bits, and a multiple of 8 bits.

The *ulMacLenInBits* parameter must be a minimum of 80 bits, a multiple of 8 bits, and not greater than the maximum output length for the specified Hash.

Constraints on key types and the length of the data are summarized in the following table.

Table 9 – ECIES: Key and Data Length

Function	Key type	Input length	Output length
C_Encrypt	EC public key	any	1 + 2modLen + any + macLen
C_Decrypt	EC private key	1 + 2modLen + any + macLen	any

Where:

modLen is the curve modulus length

macLen is the length of the produced MAC

The encrypted data is in the format QE||EncData||MAC, where:

QE is the uncompressed bit string of the ephemeral EC public key

EncData is the encrypted data

MAC is the generated MAC

CKM_ENCODE_ATTRIBUTES

This wrapping mechanism takes the attributes of an object and encodes them. The encoding is not encrypted therefore the wrapping key object handle parameter is ignored.

If the object is sensitive then only non-sensitive attributes of the object are encoded. The encoding format is a simple proprietary encoding with the attribute type, length, a value presence indicator (Boolean) and the attribute value. This simple encoding format is used wherever BER or DER is not required.

CKM_ENCODE_PKCS_10

This mechanism is used with the C_DeriveKeyfunction to create a PKCS#10 certification request from a public key. Either an RSA or DSA public key may be used with this function. The PKCS#10 certificate request could then be sent to a Certificate authority for signing.

From PKCS#10:

A certification request consists of a distinguished name, a public key and optionally a set of attributes that are collectively signed by the entity requesting certification. Certification requests are sent to a certification authority, which will transform the request to an X.509 public-key certificate.

Usage:

Use CKM_RSA_PKCS_KEY_PAIR_GEN to generate a key.

Add a CKA_SUBJECT attribute to the public key, containing the subject's distinguished name.

Initialize the signature mechanism to sign the request. Note that a digest/sign mechanism must be chosen. For example, CKM_SHA1_RSA_PKCS

Call C_DeriveKey with the CKM_ENCODE_PKCS_10 mechanism to perform the generation.

On success, an object handle for the certificate request is returned.

The object's CKA_VALUE attribute contains the PKCS#10 request.

CKM_ENCODE_PUBLIC_KEY

This wrapping mechanism performs a DER encoding of a Public Key object. The encoding is not encrypted therefore the wrapping key object handle parameter is ignored.

Public keys of type CKK_RSA, CKK_DSA and CKK_DHmay be encoded with this mechanism. The encoding format is defined in PKCS#1. This mechanism has no parameter.

CKM_ENCODE_X_509

This mechanism is used with the C_DeriveKeyfunction to derive an X.509 certificate from a public key or a PKCS#10 certification request. This mechanism creates a new X.509 certificate based on the provided public key or certification request signed with a CA key. This mechanism takes no parameter.

The new certificate validity period is based on the CKA_START_DATE and CKA_END_DATE attributes on the base object. If the start date is missing the current time is used. If the end date is missing the certificate is valid for one year. These dates may be specified as relative values by adding the + character at the start of the date value. The start date is relative to 'now' and the end date is relative to the start date if relative times are specified. Negative relative times are not allowed. If the start or end date is invalid then the error CKR_TEMPLATE_INCONSISTENT is returned.

The certificate’s serial number is taken from the template’s CKA_SERIAL_NUMBER, CKA_SERIAL_NUMBER_INT or the signing key’s CKA_USAGE_COUNTin that order. If none of these values is available CKR_WRAPPING_KEY_HANDLE_INVALID error is returned.

To determine the Subject distinguished name for the new certificate if the base object is a public key the algorithm will use the CKA_SUBJECT_STR, CKA_SUBJECTfrom the template or the base key (in that order). If none of these values is available CKR_KEY_HANDLE_INVALID is returned.

It is also possible to include arbitrary X.509 extensions in the certificate. These are not verified for validity nor parsed for correctness. Rather they are included verbatim in the newly generated certificate. In order to specify an extension use the CKA_PKI_ATTRIBUTE_BER_ENCODEDattribute with the value specified as a BER encoding of the attribute. If the base object is a Certification request or a self-signed certificate the subject is taken from the objects encoded subject name.

Currently this mechanism supports generation of RSA or DSA certificates. On success, a handle to a new CKO_CERTIFICATE object is returned. The certificate will include the CKA_ISSUER, CKA_SERIAL_NUMBER and CKA_SUBJECT attributes as well as a CKA_VALUE attribute which will contain the DER encoded certificate.

To create a X.509 certificate that uses EC keys, either provide a PKCS#10 certificate request that was created with EC keys, or provide an EC public key for the hBaseKey parameter to the function. To sign the certificate as a CA using EC keys, use the CKM_ECDSA_SHA1 mechanism to initialise the sign operation before calling C_DeriveKey().

Usage:

Create a key-pair using the CKM_RSA_PKCSmechanism (this is the key-pair for the new certificate), or

Create a CKO_CERTIFICATE_REQUEST object (with the object's CKA_VALUE attribute set to the PKCS#10 data)

This object is the "base-key" used in the C_DeriveKey function

Initialize the signature mechanism to sign the request using C_SignInit. Note that a digest / sign mechanism must be chosen. For example, CKM_SHA1_RSA_PKCS

Call C_DeriveKey with CKM_ENCODE_X_509 to perform the generation

The new certificate's template may contain:

CKA_ISSUER_STR CKA_ISSUER	The distinguished name of the issuer of the new certificate. If this attribute is not included the issuer is taken from the signing key's CKA_SUBJECT attribute. CKA_ISSUER is the encoded version of this attribute.
CKA_SERIAL_NUMBER_INT CKA_SERIAL_NUMBER	The serial number of the new certificate. If this attribute is not included the serial number is set to the value of the CKA_USAGE_COUNT attribute of the signing key. CKA_SERIAL_NUMBER is the encoded version of this attribute.
CKA_SUBJECT_STR CKA_SUBJECT	If the base key (i.e. the input object) is a public key then either the template must contain this attribute or the public key must have a CKA_SUBJECT attribute. This attribute contains the distinguished name of the subject. When the base key is a PKCS#10 certification request the CKA_SUBJECT information is taken from there. CKA_SUBJECT is the encoded version of this attribute.
CKA_START_DATE CKA_END_DATE	These attributes are used to determine the new certificate’s validity period. If the start date is missing the current date is used. If the end date is missing the date is set to one year from the start date. Relative values may be specified (see above).
CKA_PKI_ATTRIBUTE_BER _ENCODED	These attributes are used to determine the new certificate’s extended attributes.

CKM_ENCODE_X_509_LOCAL_CERT

This mechanism is similar to the CKM_ENCODE_X_509mechanism in that it is used to create an X 509 public key certificate. The basic difference is that this mechanism has additional usage controls.

This mechanism will only create certificates for public keys locally generated on the adapter. That is, the base key must have a CKA_CLASS attribute of CKO_PUBLIC_KEYand have the CKA_LOCAL attribute set to TRUE.

In addition, the signing key specified in the mechanism parameter (see below) must have the CKA_SIGN_LOCAL_CERT attribute set to TRUE. It is used with the C_KeyDerive function only, (that is, it is a derive mechanism). It takes a parameter that is a pointer to a CK_MECH_TYPE_AND_OBJECT structure.

```
typedef struct CK_MECH_TYPE_AND_OBJECT {
CK_MECHANISM_TYPE mechanism;
CK_OBJECT_HANDLE obj;
} CK_MECH_TYPE_AND_OBJECT;
```

The above mechanism field specifies the actual signature mechanism to use in generation of the certificate signature. This must be one of the multipart digest RSA or DSA algorithms. The objfield above specifies the signature generation key. That is, it should specify a RSA or DSA private key as appropriate for the chosen signature mechanism.

To create a X.509 local certificate that uses EC keys, either provide a PKCS#10 certificate request that was created with EC keys, or provide an EC public key for the hBaseKeyparameter to the function. To sign the certificate as a CA using EC keys, use the CKM_ECDSA_SHA1mechanism to initialize the sign operation before calling C_DeriveKey(). The CKM_ECDSA_SHA1 mechanism and EC key must also be specified in the mechanism parameter.

CKM_IDEA_ECB_PAD

See the entry for CKM_CAST128_ECB_PAD

CKM_KEY_TRANSLATION

This is a key wrapping mechanisms as used by Entrust compliant applications. This mechanism is only visible when the CKF_ENTRUST_READY flag is set in the SecurityMode attribute of the Adapter Configuration object in the Admin Token of the adapter.

CKM_PBA_SHA1_WITH_HMAC_SHA1

This is a mechanism used for generating a 160-bit generic secret key from a password and a salt value by using the SHA-1 digest algorithm and an iteration count.

It has a parameter, a CK_PBE_PARAMS structure. The parameter specifies the input information for the key generation process. The parameter also has a field to hold the location of an application-supplied buffer which will receive an IV; for this mechanism, the contents of this field are ignored, since authentication with SHA-1-HMAC does not require an IV.

The key generated by this mechanism will typically be used for computing a SHA-1 HMAC to perform password-based authentication (not *password-based encryption*). At the time of this writing, this is primarily done to ensure the integrity of a PKCS #12 PDU.

CKM_PBE_SHA1_RC2_128_CBC

This is a mechanism used for generating a 128-bit RC2 secret key and IV from a password and a salt value by using the SHA-1 digest algorithm and an iteration count.

It has a parameter, a CK_PBE_PARAMS structure. The parameter specifies the input information for the key generation process and the location of the application-supplied buffer that will receive the 8-byte IV generated by the mechanism.

When the key and IV generated by this mechanism are used to encrypt or decrypt, the effective number of bits in the RC2 search space should be set to 128. This ensures compatibility with the ASN.1 Object Identifier pbeWithSHA1And128BitRC2-CBC.

The key and IV produced by this mechanism will typically be used for performing password-based encryption.

CKM_PBE_SHA1_RC2_40_CBC

This is a mechanism used for generating a 40-bit RC2 secret key and IV from a password and a salt value by using the SHA-1 digest algorithm and an iteration count.

It has a parameter, a CK_PBE_PARAMS structure. The parameter specifies the input information for the key generation process and the location of the application-supplied buffer that will receive the 8-byte IV generated by the mechanism.

When the key and IV generated by this mechanism are used to encrypt or decrypt, the effective number of bits in the RC2 search space should be set to 40. This ensures compatibility with the ASN.1 Object Identifier pbeWithSHA1And40BitRC2-CBC.

The key and IV produced by this mechanism will typically be used for performing password-based encryption.

CKM_PBE_SHA1_RC4_128

This is a mechanism used for generating a 128-bit RC4 secret key from a password and a salt value by using the SHA-1 digest algorithm and an iteration count.

It has a parameter, a CK_PBE_PARAMS structure. The parameter specifies the input information for the key generation process. The parameter also has a field to hold the location of an application-supplied buffer that will receive an IV; for this mechanism, the contents of this field are ignored, since RC4 does not require an IV. The key produced by this mechanism will typically be used for performing password-based encryption.

CKM_PBE_SHA1_RC4_40

This is a mechanism used for generating a 40-bit RC4 secret key from a password and a salt value by using the SHA-1 digest algorithm and an iteration count.

It has a parameter, a CK_PBE_PARAMS structure. The parameter specifies the input information for the key generation process. The parameter also has a field to hold the location of an application-supplied buffer which will receive an IV; for this mechanism, the contents of this field are ignored, since RC4 does not require an IV.

The key produced by this mechanism will typically be used for performing password-based encryption.

CKM_PKCS12_PBE_EXPORT

The PKCS#12 export mechanism, denoted CKM_PKCS12_PBE_EXPORTis a mechanism for wrapping a private key and a certificate. The outcome of the wrapping operation is a PKCS#12 byte buffer.

This mechanism has a parameter, a CK_PKCS12_PBE_EXPORT_PARAMSstructure.

This mechanism will enforce a password length based on the token. If the PIN is too short, then CKR_PIN_LEN_RANGE is returned.

This mechanism does not require a wrapping key and it only support RSA, ECDSA and DSA private keys and certificates.

During the wrapping operation, this mechanism performs a sign and verify test on the supplied key/certificate pair. Should this test fail, the wrapping operation will abort.

If the exported key is marked CKA_EXPORTABLE=TRUE and CKA_EXTRACTABLE=FALSE this mechanism forces the export to be performed under the Security Officer session. In this case, the user must ensure that the private key is either visible to the Security Ofiicer or made available to the Security Officer by performing a copy.

Note that the user performing the private key export is asked to supply two (2) passwords. These passwords must be identical if MS Windows is to be used to later extract the created PKCS#12 file. For other 3rd party tools such as OpenSSL these two passwords do not have to be the same.

CK_PKCS12_PBE_EXPORT_PARAMS is a structure that provides parameter to the CKM_PKCS12_PBE_EXPORT mechanism. This structure is defined as follows:

```
typedef struct CK_PKCS12_PBE_EXPORT_PARAMS

{
CK_OBJECT_HANDLE keyCert;
CK_CHAR_PTR passwordAuthSafe;
CK_SIZE passwordAuthSafeLen;
CK_CHAR_PTR passwordHMAC;
CK_SIZE passwordHMACLen;
CK_MECHANISM_TYPE safeBagKgMech;
CK_MECHANISM_TYPE safeContentKgMech;
CK_MECHANISM_TYPE hmacKgMech;


}
```

The fields of the structure have the following meanings:

keyCert Certificate handle for the associated private key

passwordAuthSafe Password for the PBE keys.

passwordAuthSafeLen Length of the password

passwordHMAC Password for the PBA keys.

passwordHMACLen Length of the password

safeBagKgMech Key generation mechanism for SafeBag encryption. Only applicable to pkcs8ShroudedKeyBag. Valid options are:
CKM_PBE_SHA1_RC4_128 CKM_PBE_SHA1_RC4_40 CKM_PBE_SHA1_DES3_EDE_CBC CKM_PBE_SHA1_DES2_EDE_CBC CKM_PBE_SHA1_RC2_128_CBC CKM_PBE_SHA1_RC2_40_CBC

safeContentKgMech Key generation mechanism for SafeContent encryption. Only applicable to EncryptedData. Valid options are:

CKM_PBE_SHA1_RC4_128 CKM_PBE_SHA1_RC4_40 CKM_PBE_SHA1_DES3_EDE_CBC CKM_PBE_SHA1_DES2_EDE_CBC CKM_PBE_SHA1_RC2_128_CBC CKM_PBE_SHA1_RC2_40_CBC

hmacKgMech Key generation mechanism for generating PFX MAC.

Valid option is:

CKM_PBA_SHA1_WITH_SHA1_HMAC

CKM_PKCS12_PBE_IMPORT

The PKCS#12 import mechanism, denoted CKM_PKCS12_PBE_IMPORT is a mechanism for unwrapping a private key and certificate(s). This mechanism shall return the user a handle to a private key and handle(s) to certificate(s).

Note that multiple certificate handles could be returned depending on the contents of the PKCS#12 file.

NOTE: This mechanism does not import optional PKCS#12 bag attributes and PKCS#8 private-key attributes. These components are discarded during import.

The mechanism has a parameter, a CK_PKCS12_PBE_IMPORT_PARAMS structure. This mechanism does not require an unwrapping key and supports RSA, DH, DSA and EC Private Keys and certificates.

CK_PKCS12_PBE_IMPORT_PARAMS is a structure that provides parameters to the CKM_PKCS12_PBE_IMPORT mechanism. This structure is defined as follows:

typedef struct CK_PKCS12_PBE_IMPORT_PARAMS

{
/** AuthenticatedSafe password */
CK_CHAR_PTR passwordAuthSafe;

/** Size of AuthenticatedSafe password */

CK_SIZE passwordAuthSafeLen;

/** HMAC password */

CK_CHAR_PTR passwordHMAC;

/** Size of HMAC password */

CK_SIZE passwordHMACLen;

/** Certificate attributes */

CK_ATTRIBUTE_PTR certAttr;

/** Number of certificate attributes */

CK_COUNT certAttrCount;

/** Handle to returned certificate(s) */

CK_OBJECT_HANDLE_PTR hCert;

/** Number of returned certificate handle(s) */

CK_COUNT_PTR hCertCount;

}CK_PKCS12_PBE_IMPORT_PARAMS;

The fields of the structure have the following meanings:

	Password to authenticated safe container
	Length of password
	Password to HMAC

	Attributes asigned to certificate
	Number of entries in certAttr
	Returned certificate handles(s)
	Number of handles allocated for hCert or number of certificates found in PKCS#12 file. See below.

Length Prediction

The PKCS#12 file may contain more than one certificate, as such, the user would need to allocate sufficient buffer to hold the returned handles. The user needs to specify NULL as a parameter to the returned certificate handle (hCert), the import mechanism shall then return a count (hCertCount) of the certificate found the in the PKCS#12 file. Using the value of hCertCount, the user then allocates the required buffer to hold the returned certificate handles for the next C_UnwrapKeyfunction call.

Returning Multiple Ceritificates

Assuming the user has allocated sufficient buffer to hold the certificate handles and there is multiple certificate in the PKCS#12 files, the import mechanism shall populate buffer hCert with the allocated certificate handles. The returned hCertCount shall match the specified value.

Reporting Remaining Certificates

In the event of the user not reserving sufficient buffer in hCert and there are more certificates to be unwrapped, the import mechanism shall unwrap up to a maximum of cerficate handles allocated by the user and return the total count of the certificates found in the PKCS#12 file. For example, if the user initially allocated one handle (hCertCount=1) and the PKCS#12 contains 2 certificates, the import mechanism shall extract the first certificate it encounters and return hCertCount=2. In this case, the returned hCertCountshall always be larger than the specified value.

PKCS#12 Import Return Code

The following vendor specific return code may be returned in the event of errors:

CKR_PKCS12_DECODE This error code is returned when there is an error decoding the PKCS#12 file.

CKR_PKCS12_UNSUPPORTED_SAFEBAG_TYPE This error code is returned when unsupported SafeBag is found. The import mechanism for this release only support keyBag, pkcs8ShroudedKeyBag and certBag

CKR_PKCS12_UNSUPPORTED_PRIVACY_MODE This error code is returned when a PKCS#12 file with unsupported privacy mode is encountered. The import mechanism for this release only supports password privacy mode.

CKR_PKCS12_UNSUPPORTED_INTEGRITY_MODE This error code is returned when a PKCS#12 file with unsupported integrity mode is encountered. The import mechanism for this release only supports password integrity mode.

CKM_PP_LOAD_SECRET

This is a key generate mechanism to provide the capability to load a clear key component from a directly attached pin pad device.

It has a parameter, a CK_PP_LOAD_SECRET_PARAMS, which holds the operational details for the mechanism.

```
struct CK_PP_LOAD_SECRET_PARAMS
{
/** Entered characters should be masked with '*' or similar to hide the

* value being entered. An error is returned if this is TRUE
* and the device does not support this feature. */
 CK_BBOOL bMaskInput;


/** Entered characters should be converted from the ASCII representation
* to binary before being stored, according to the conversion type
* supplied. If the device does not support the specified type of input
* (e.g. hex input on a decimal keyboard), an error is returned.
* The octal and decimal representations will expect 3 digits per byte,
* whereas the hexadecimal representations will expect 2 digits per byte.
* An error is returned if the data contains invalid encoding (such
* as 351 for decimal conversion).

*/
CK_PP_CONVERT_TYPE cConvert;

/** The time to wait for operator response - in seconds. An error is
* returned if the operation does not complete in the specified time.
* This field may be ignored if the device does not support a configurable
* timeout. */
 CK_CHAR cTimeout;


/** Reserved for future extensions. Must be set to zero. */
CK_CHAR reserved;
/** The prompt to be displayed on the device. If the prompt cannot fit on
* the device display, the output is clipped. If the device does not
* have any display, the operation will continue without any prompt, or
* error.
*

* The following special characters are recognized on the display:
* - Newline (0x0a): Continue the display on the next line.
*/


CK_CHAR_PTR prompt;
};
```

The template supplied with the call to the C_GenerateKeyfunction determines the type of object generated by the operation. CKA_CLASSmay be CKO_SECRETKEYonly, and the only key type supported is CKK_GENERIC_SECRET. (This restriction applies because only key components are to be entered by this mechanism).

The normal rules for template consistencies apply. In particular the CKA_ALWAYS_SENSITIVEmust be set FALSEand the CKA_NEVER_EXTRACTABLEmust be FALSE.

The expected size of the object value created by this operation is supplied in the CKA_VALUE_LENparameter in the template.

CKM_RC2_ECB_PAD

See the entry for CKM_CAST128_ECB_PAD

CKM_REPLICATE_TOKEN_RSA_AES

This mechanism is a SafeNet vendor defined mechanism for wrapping and unwrapping tokens.

Wrapping Tokens

The mechanism wraps the token associated with the *hSession*parameter to C_WrapKey() into a protected format.
When the mechanism is used to wrap a token it has a required parameter, a CK_REPLICATE_TOKEN_PARAMS_PTR.

The CK_REPLICATE_TOKEN_PARAMS structure is defined as follows:

```
typedef struct CK_REPLICATE_TOKEN_PARAMS {
CK_CHAR peerId[CK_SERIAL_NUMBER_SIZE];
} CK_REPLICATE_TOKEN_PARAMS;
```

The *peerId* field identifies the peer public key on the administrative token. The public key is used to wrap the token encryption key and therefore must identify the public key of the destination HSM.

CK_REPLICATE_TOKEN_PARAMS_PTR is a pointer to a CK_REPLICATE_TOKEN_PARAMS.

The following conditions must be satisfied:

- The token being wrapped which is associated with the *hSession*parameter to the C_WrapKey() must be a regular user token (i.e. NOT the administrative token or a smart-card token).
- The session state for *hSession* must be one of CKS_RO_USER_FUNCTIONS or CKS_RW_USER_FUNCTIONS.
- The *hWrappingKey* parameter to *C_WrapKey()* must specify CK_INVALID_HANDLE.
- The *hKey* parameter to *C_WrapKey()* must specify CK_INVALID_HANDLE.

Unwrapping Tokens

This mechanism unwraps the protected token information, replacing the entire token contents of the token associated with the *hSession*parameter to C_UnwrapKey().When the mechanism is used for unwrapping a token, a mechanism parameter must not be specified.

The following conditions must be satisfied:

The token being unwrapped which is associated with the *hSession*parameter to *C_UnwrapKey()* must be a regular user token. That is, NOT the administrative token or a smart card token.

The session state for *hSession* must be CKS_RW_USER_FUNCTIONS.

The *hUnwrappingKey* parameter to *C_UnwrapKey()* must specify CK_INVALID_HANDLE.

The *pTemplate* parameter to *C_UnwrapKey()* must specify NULL.

The *ulAttributeCount* parameter to *C_UnwrapKey()* must specify zero.

The *phKey* parameter to *C_UnwrapKey()* must specify NULL.

Any new sessions must be deferred until the operation has finished.

The current session must be the only session in existence for the token.

The application should call C_Finalize() upon completion.

CKM_SECRET_RECOVER_WITH_ATTRIBUTES

The Secret Recovery Mechanism denoted CKM_SECRET_RECOVER_WITH_ATTRIBUTESis a derive mechanism to create a new key object by combining two or more shares.

The mechanism has no parameter.

The *C_DeriveKey* parameter *hBaseKey* is the handle of one of the share objects. The mechanism will obtain the CKA_LABEL value from *hBaseKey* and then treat all data objects with the same label as shares.

A template is not required as all the attributes of the object are also recovered from the secret.

Usage Note:

To avoid shares getting mixed up between different uses of this mechanism the developer should ensure that data objects with the same label are all from the same secret share batch.

For further information about secure key backup and restoration see the *ProtectToolkit C Administration Manual*.

CKM_SECRET_SHARE_WITH_ATTRIBUTES

The Secret Share Mechanism denoted CKM_SECRET_SHARE_WITH_ATTRIBUTESis a derive mechanism to create M shares of a key such that N shares are required to recover the secret, where N is less than or equal to M.

The mechanism creates a secret value by combining all the attributes of the base key and then shares that secret into M shares.

The algorithm used is according to *A. Shamir - How to Share a Secret, Communications of the ACM vol. 22, no. 11, November 1979, pp. 612-613*

It has a parameter, a CK_SECRET_SHARE_PARAMS, which specifies the number of shares M and the recovery threshold N. See below for the definition.

The mechanism will create M data objects and return the object handle of one of them. It is expected that the data objects would be copied to a smart card token for storage.

The template supplied is used to specify the CKA_LABELattribute of each new data object. If the CKA_LABELattribute is not provided in the template then a CKR_TEMPLATE_INCOMPLETEerror is returned.

The mechanism contributes the CKA_VALUEattribute of each data object. Any attempt to specify a CKA_ VALUEattribute in the template will cause the mechanism to return the error: CKR_TEMPLATE_INCONSISTENT.

The default value of the CKA_TOKEN, CKA_PRIVATE attribute of the new objects is false. The new data objects will have a CKA_SENSITIVEattribute. If the CKA_SENSITIVEattribute of the base key is true then the data objects is sensitive. If the base key is not sensitive then the data objects take the value of CKA_SENSITIVE from the template or it is defaulted to false.

Usage Note:

To avoid shares getting mixed up between different uses of this mechanism the developer should ensure that there are no data objects with the same label already on the token before attempting to use this mechanism. If objects are found then these objects should be deleted or a different label chosen.

Security Note:

The key to be exported with this mechanism requires the CKA_DERIVE attribute to be true. This has the effect of enabling other key derive mechanisms to be performed with the key. If this is not desired then the CKA_MECHANISM_ LISTattribute may be used with the key to restrict its derive operations to this mechanism.

For further information about secure key backup and restoration see the *ProtectToolkit C Administration Manual*.

Secret Share Mechanism Parameter

CK_SECRET_SHARE_PARAMSis used to specify the number of shares M and the recovery threshold N for secret sharing mechanisms. It is defined as follows:

typedef struct CK_SECRET_SHARE_PARAMS {

CK_ULONG n;

CK_ULONG m;} CK_SECRET_SHARE_PARAMS;

The fields of the structure have the following meanings:
n Number of shares required to recover the secret. Must be at least two and not greater than the number of shares *m* Total number of shares. Must be at least two and not greater than sixty four.

CK_SECRET_SHARE_PARAMS_PTR is a pointer to a CK_SECRET_SHARE_PARAMS.

CKM_SEED_CBC

SEED-CBC, denoted CKM_SEED_CBC, is a mechanism for single and multiple part encryption and decryption, key wrapping and key unwrapping, based on the KISA (Korean Information Security Agency) SEED specification and cipher-block chaining mode.

It has a single parameter; a 16-byte initialization vector.

This mechanism can wrap and unwrap any secret key. Of course, a particular token may not be able to wrap/unwrap every secret key that it supports. For wrapping, the mechanism encrypts the value of the CKA_VALUE attribute of the key that is wrapped, padded on the trailing end with up to block size minus one null bytes so that the resulting length is a multiple of the block size. The output data is the same length as the padded input data. It does not wrap the key type, key length, or any other information about the key; the application must convey these separately.

For unwrapping, the mechanism decrypts the wrapped key, and truncates the result according to the CKA_KEY_TYPEattribute of the template and, if it has one and the key type supports it, the CKA_VALUE_LENattribute of the template. The mechanism contributes the result as the CKA_VALUE attribute of the new key. Other attributes required by the key type must be specified in the template.

Constraints on key types and the length of data are summarized in the following table.

Table 10 – SEED-CBC: Key and Data Length

Function	Key type	Input length	Output length	Comments
	CKK_SEED	Multiple of block size	Same as input length	No final part
	CKK_SEED	Multiple of block size	Same as input length	No final part
	CKK_SEED	Any	Input length rounded up to multiple of the block size	
	CKK_SEED	Multiple of block size	Determined by type of key being unwrapped or CKA_VALUE_LEN	

CKM_SEED_CBC_PAD

SEED-CBC with PKCS padding, denoted CKM_SEED_CBC_PAD, is a mechanism for single and multiple part encryption and decryption; key wrapping; and key unwrapping, based on the KISA (Korean Information Security Agency) SEED specification, cipher-block chaining mode and the block cipher padding method detailed in PKCS #7.

It has a single parameter; a 16-byte initialization vector.

The PKCS padding in this mechanism allows the length of the plaintext value to be recovered from the ciphertext value. Therefore, when unwrapping keys with this mechanism, no value should be specified for the CKA_VALUE_LENattribute.

In addition to being able to wrap and unwrap secret keys, this mechanism can wrap and unwrap RSA, Diffie-Hellman, X9.42 Diffie-Hellman, and DSA private keys.

Constraints on key types and the length of data are summarized in the following table. The data length constraints do not apply to the wrapping and unwrapping of private keys.

Table 11 – SEED-CBC with PKCS Padding: Key and Data Length

Function	Key type	Input length	Output length
	CKK_ SEED	Any	Input length plus one, rounded up to multiple of the block size
	CKK_ SEED	Multiple of block size	Between 1 and block size bytes shorter than input length
	CKK_ SEED	Any	Input length plus one, rounded up to multiple of the block size
	CKK_ SEED	Multiple of block size	Between 1 and block length bytes shorter than input length

CKM_SEED_ECB

SEED-ECB, denoted CKM_SEED_ECB, is a mechanism for single- and multiple-part encryption and decryption; key wrapping; and key unwrapping, based on the KISA (Korean Information Security Agency) SEED specification and electronic codebook mode. It does not have a parameter

This mechanism can wrap and unwrap any secret key. Of course, a particular token may not be able to wrap/unwrap every secret key that it supports. For wrapping, the mechanism encrypts the value of the CKA_VALUE attribute of the key that is wrapped, padded on the trailing end with up to block size minus one null bytes so that the resulting length is a multiple of the block size. The output data is the same length as the padded input data. It does not wrap the key type, key length, or any other information about the key; the application must convey these separately.

For unwrapping, the mechanism decrypts the wrapped key, and truncates the result according to the CKA_KEY_ TYPEattribute of the template and, if it has one and the key type supports it, the CKA_VALUE_LENattribute of the template. The mechanism contributes the result as the CKA_VALUEattribute of the new key. Other attributes required by the key type must be specified in the template.

Constraints on key types and the length of data are summarized in the following table.

Table 12 – SEED-ECB: Key and Data Length

Function	Key type	Input length	Output length	Comments
	CKK_ SEED	Multiple of block size	Same as input length	No final part
	CKK_ SEED	Multiple of block size	Same as input length	No final part

	CKK_ SEED	Any	Input length rounded up to multiple of block size	
	CKK_ SEED	Multiple of block size	Determined by type of key being unwrapped or CKA_VALUE_LEN	

CKM_SEED_ECB_PAD

SEED-ECB with PKCS padding, denoted CKM_SEED_ECB_PAD, is a mechanism for single- and multiple-part encryption and decryption, key wrapping and key unwrapping, based on the KISA (Korean Information Security Agency) SEED specification, electronic code book mode and the block cipher padding method detailed in PKCS #7. It does not have a parameter.

The PKCS padding in this mechanism allows the length of the plaintext value to be recovered from the ciphertext value. Therefore, when unwrapping keys with this mechanism, no value should be specified for the CKA_VALUE_ LENattribute.

In addition to being able to wrap and unwrap secret keys, this mechanism can wrap and unwrap RSA, Diffie-Hellman, X9.42 Diffie-Hellman, and DSA private keys. The entries in Table 13 – SEED-ECB with PKCS Padding: Key and Data Length for data length constraints when wrapping and unwrapping keys do not apply to wrapping and unwrapping private keys. Constraints on key types and the length of data are summarized in the following table.

Table 13 – SEED-ECB with PKCS Padding: Key and Data Length

Function	Key type	Input length	Output length
	CKK_ SEED	Any	Input length plus one, rounded up to multiple of the block size
	CKK_ SEED	Multiple of block size	Between 1 and block size bytes shorter than input length
	CKK_ SEED	Any	Input length plus one, rounded up to multiple of the block size
	CKK_ SEED	Multiple of block size	Between 1 and block length bytes shorter than input length

CKM_SEED_KEY_GEN

The SEED key generation mechanism, denoted CKM_SEED_KEY_GEN, is a key generation mechanism for the Korean Information Security Agency's SEED algorithm.

The mechanism does not have a parameter, and it generates SEED keys 16 bytes in length.

The mechanism contributes the CKA_CLASS, CKA_KEY_TYPE, CKA_VALUE_LEN, and CKA_VALUE attributes to the new key. Other attributes supported by the SEED key type (specifically, the flags indicating which functions the key supports) may be specified in the template for the key, or they may be assigned default initial values.

For this mechanism, the ulMinKeySizeand ulMaxKeySizefields of the CK_MECHANISM_INFOstructure specify the supported range of SEED key sizes, in bytes, which is 16.

The algorithm block size is 16 bytes.

CKM_SEED_MAC

SEED-MAC, denoted by CKM_SEED_MAC, is a special case of the general-length SEED-MAC mechanism. SEED-MAC always produces and verifies MACs that are eight bytes in length. It does not have a parameter.

Constraints on key types and the length of data are summarized in the following table.

Table 14 – SEED-MAC: Key and Data Length

Function	Key type	Data length	Signature length
	CKK_SEED	any	½ block size (8 bytes)
	CKK_SEED	any	½ block size (8 bytes)

CKM_SEED_MAC_GENERAL

General-length SEED-MAC, denoted CKM_SEED_MAC_GENERAL, is a mechanism for single and multiple part signatures and verification, based on the KISA (Korean Information Security Agency) SEED specification.

It has a single parameter, a CK_MAC_GENERAL_PARAMS structure, which specifies the output length desired from the mechanism.

The output bytes from this mechanism are taken from the start of the final SEED cipher block produced in the MACing process.

Constraints on key types and the length of data are summarized in the following table.

Table 15 – General-length SEED-MAC: Key and Data Length

Function	Key type	Data length	Signature length
	CKK_SEED	Any	0-block size, as specified in parameters
	CKK_SEED	Any	0-block size, as specified in parameters

CKM_SHA1_RSA PKCS_TIMESTAMP

The PKCS#11 mechanism CKM_SHA1_RSA_PKCS_TIMESTAMP provides time stamping functionality. The supported signing functions are C_Sign_Init and C_Sign. This mechanism supports single and multiple-part digital signatures and verification with message recovery. The mechanism uses the SHA1 hash function to generate the message digest. The mechanism only supports one second granularity in the timestamp although the timestamp format will provide for future sub-second granularity.

A monotonic counter object is used to generate the unique serial number that forms part of the timestamp. The monotonic counter object is automatically created when a token is initialized and exists by default in the Admin Token.

The following structure is used to provide the optional mechanism parameters in the CK_MECHANISM structure. The CK_MECHANISM structure is defined in the *PKCS #11 v2.10: Cryptographic Token Interface Standard, RSA Laboratories December 1999.*

typedef struct CK_TIMESTAMP_PARAMS {

CK_BBOOL useMilliseconds;

CK_TIMESTAMP_FORMAT timestampFormat;

} CK_TIMESTAMP_PARAMS;

The "useMilleseconds" parameter specifies whether the timestamp should include millisecond granularity. The default value for this parameter is FALSE. If the mechanism parameters are specified then the useMilliseconds parameter must be set to FALSE as only one-second granularity is provided in the first release of the mechanism’s implementation.

The "timeStampFormat" parameter specifies the input/output format of the data to be timestamped. This provides the ability to introduce future support for timestamping protocols such as those defined in RFC3161. The default value for this parameter is CK_TIMESTAMP_FORMAT_ERACOM. If the mechanism parameters are specified then the timeStampType parameter must be set to CK_TIMESTAMP_FORMAT_ERACOM as only this format is supported in the first release.

For CK_TIMESTAMP_FORMAT_ERACOM the mechanism expects the input data to be a stream of bytes for which a message digest must be computed and a timestamp generated according to the format defined below. If mechanism parameters are passed and the two parameters are not set as defined above, the C_SignInit function returns CKR_ MECHANISM_PARAM_INVALID.

C_Sign is defined in the PKCS #11 standard as:

CK_DEFINE_FUNCTION(CK_RV, C_Sign)(

CK_SESSION_HANDLE hSession,

CK_BYTE_PTR pData,

CK_ULONG ulDataLen,

CK_BYTE_PTR pSignature,

CK_ULONG_PTR pulSignatureLen);

The parameter formats are defined in the following tables.

Table 16 – Input format (=pData in C_Sign)

C-Definition	Description

	Transaction data (variable length), maximum of 3k.

Table 17 – Output format (=pSignature in C_Sign)

C-Definition	Contents on output
Unsigned char serialnumber [20]	A unique number for each timestamp, padded with zeroes in a Big Endian 20 byte array. The number is read from the CKH_MONOTONIC_COUNTER hardware feature object on the same token as the signing key. By this read action the value contained by the object is automatically increased by 1.
Unsigned char timestamp [15]	Timestamp in the format of GeneralizedTime specified in RFC3161. The syntax is: YYYYMMDDhhmmss[.s...]Z The sub-second component is optional and not supported in the intial release but still defined to ensure backward compatibility in the future.
Unsigned char sign [128]	RSA Signature

NOTE1:Please see the *PKCS #11 v2.10: Cryptographic Token Interface Standard*, RSA Laboratories December 1999 for a definition of types.

NOTE2: It is highly recommended that the RFC3161 format timestamp provided by the HSM be stored on the host to allow future independent third party timestamp verification.

The mechanism will perform the following:

Input data that is provided by the calling host.

Obtain the time from within the ProtectHost Orange/Gold.

Calculate a signature across the merged input data and time data using PKCS#1 type 01 padding as follows:
Signature = Sign(SHA1(Data || serialnumber || timestamp)

Output part of the input data, the time data and the signature.

Verification of the signature can be performed using the CKM_SHA1_RSA_PKCS_TIMESTAMP mechanism with C_ Verify or C_VerifyRecover. The difference between the two functions is that C_Verify calculates the hash but does not return it to the caller where as C_VerifyRecover() returns the hash. The following is passed as input data: <data><serialnumber><timestamp>

CKM_VISA_CVV

This is a signature generation and verification method. The Card Verification Value signature is generated as specified by VISA.
The mechanism does not have a parameter.
Constraints on key types and the length of data are summarized in the following table:

Table 18 – VISA CVV: Key and Data Length

Function	Key type	Input length	Output length
C_Sign		16	2
C_Verify		16, 2	N/A

2 Data length, signature length.

CKM_WRAPKEY_DES3_CBC

The CKM_WRAPKEY_DES3_CBC and CKM_WRAPKEY_DES3_ECB mechanisms are used to wrap a key value plus all of its attributes so that the entire key can be reconstructed without a template at the destination. The key value is encrypted using triple DES and all key attributes are MACed in the encoding. The wrapping key is supplied as normal to the C_Wrapand C_Unwrap Cryptoki functions.

The C_Unwrap operation will fail with CKR_SIGNATURE_INVALIDif any of the key's attributes have been tampered with while the key was in transit.

Encoding format.

The encoding is a proprietary encoding where fields are identified by their position in the entire encoding and are preceded by an encoding of the length of the content. The length may be zero indicating an empty field but must always be present. Where the length is zero the content is not present (zero bytes). Where the length is non zero the content has the number of bytes equal to the value of the encoded length. The length is encoded as a 32-bit big-endian binary value and can thus take values from 0 to (232-1) i.e. around 4 gigabytes.

Definitions:

wK Wrapping key. This is the wrapping key under which the subject key is to be wrapped. This key must be valid for the operation Ex.

mK A randomly generated MAC key using CKM_DES2_KEY_GEN. This key is used with Mx.

cK Clear encoding of the subject key. For single part symmetric keys this is just the key value. For compound (e.g. RSA) keys it is a BER encoding as per PKCS#1.

a The encoded non-sensitive subject key attributes. The attributes are encoded with an attribute header, which is the number of attributes (4 byte), followed by a list of sub encodings which contain the attribute type (4 byte), content length (4 byte), a content presence indicator (1 byte), and the content bytes. The presence indicator allows the content length value to be non-zero, but, where presence indicator = 0, no content bytes are included. If the presence indicator is 1 then the content length must be the number of bytes indicated by the content length field. All numeric values are encoded as big-endian. Note that the sensitive attributes are contained in cK.

E x Encryption using CKM_DES3_(ECB/CBC)_PAD with key 'x'.

M x MAC generation using CKM_DES3_MAC_GENERAL (8 byte MAC result) with key 'x'.

A wrapped key using CKM_WRAPKEY_DES3_ECB or CKM_WRAPKEY_DES3_CBC is made up of the following fields:

ecK the encrypted key value, ecK = EwK(cK).

a the encoded non-sensitive subject key attributes.

m a MAC of the key value and attributes, m = MmK(cK + a).

emK the encrypted MAC key value, emK = EwK(mK).

These fields are then encoded as described above.

E.g. Using CKM_WRAPKEY_DES3_CBC on a Single length DES key, with a Triple DES Wrapping key, produces the encoding:

|length | ecK – encrypted key value

00000010 2B847CF929FA2148A0A59BB6D44BBD74

|length | a – encoded non-sensitive attributes

00000120

```
0000001900000001000000010101000000020000000101000000000003000000
0501746573740000000106000000010100800001280000000101000000000107
0000000101010000016200000001010180000129000000010101000000017000
0000010101000000104000000001010100000010500000000101010000001080000
00010101000001 0A000000010101000000103000000001010000000163000000
01010100000000000000000401000000040000010000000000401000000130000
016100000000401000000088000010200000001001323030313131303131 3234
35303330300000010C00000001010000000102000000000000000110000000
000000000111000000000000000016500000000101000000001640000000010100
000000000000000000
```

|length | m – MAC of key value and attributes

00000008 6256751248BFA515

|length | emK – encrypted MAC key value

00000018 2B847CF929FA214837ACF80D3AA9D1470082249D71E053DA

CKM_WRAPKEY_DES3_ECB

See the entry for CKM_WRAPKEY_DES3_CBC

CKM_XOR_BASE_AND_KEY

XORing key derivation, denoted CKM_XOR_BASE_AND_KEY, is a mechanism which provides the capability of deriving a secret key by performing a bit XORing of two existing secret keys. The two keys are specified by handles; the values of the keys specified are XORed together in a buffer to create the value of the new key.

This mechanism takes a parameter, a CK_OBJECT_HANDLE. This handle produces the key value information that is XORed with the base key's value information (the base key is the key whose handle is supplied as an argument to C_DeriveKey).

For example, if the value of the base key is 0x01234567,and the value of the other key is 0x89ABCDEF, then the value of the derived key is taken from a buffer containing the string 0x88888888.

> If no length or key type is provided in the template, then the key produced by this mechanism is a generic secret key. Its length is equal to the minimum of the lengths of the data and the value of the original key.
>
> If no key type is provided in the template, but a length is, then the key produced by this mechanism is a generic secret key of the specified length.
>
> If no length is provided in the template, but a key type is, then that key type must have a well-defined length. If it does, then the key produced by this mechanism is of the type specified in the template. If it doesn't, an error is returned.
>
> If both a key type and a length are provided in the template, the length must be compatible with that key type. The key produced by this mechanism is of the specified type and length.
>
> If a key type is provided in the template the behavior depends on whether the type is identical to the type of the base key. If the base key is of type CKK_GENERIC_SECRET then you can change the type of the new key. Otherwise you can change the type only if the "Pure PKCS11" configuration flag has been set.

If a DES, DES2, DES3, or CDMF key is derived with this mechanism, the parity bits of the key are set properly.

If the requested type of key requires more bytes than are available by taking the shorter of the two key's value, an error is generated.

This mechanism has the following rules about key sensitivity and extractability:

> If the base key has its CKA_SENSITIVE attribute set to TRUE, so does the derived key. If not, then the derived key's CKA_SENSITIVE attribute is set either from the supplied template or from a default value.
>
> Similarly, if the base key has its CKA_EXTRACTABLE attribute set to FALSE, so does the derived key. If not, then the derived key's CKA_EXTRACTABLE attribute is set either from the supplied template or from a default value.
>
> The derived key's CKA_ALWAYS_SENSITIVE attribute is set to TRUE if and only if the base key has its CKA_ALWAYS_SENSITIVE attribute set to TRUE.
>
> Similarly, the derived key's CKA_NEVER_EXTRACTABLE attribute is set to TRUE if and only if the base key has its CKA_NEVER_EXTRACTABLE attribute set to TRUE.

CKM_ZKA_MDC_2_KEY_DERIVATION

This is the ZKA MDC-2 and DES based key derivation mechanism. The algorithm implemented by this mechanism is defined in the ZKA technical appendix, "Technischer Anhang zum Vertrag über die Zulassung als Netzbetreiber im electronic-cash-System der deutschen Kreditwirtschaft" V5.2, section 1.9.2.3, "Generierung kartenindividueller Schlüssel".

It has a parameter, the *derivation data*, which is an arbitrary-length byte array.

This mechanism only operates with the C_DeriveKey( )function.

The *derivation data* is digested using the CKM_DES_MDC_2_PAD1 mechanism, and the result is ECB decrypted with the base key. The result is used to make the value of a derived secret key. Only keys of type CKK_DES, CKK_DES2 and CKK_DES3 can be used as the base key for this mechanism. The derived key can have any *key type* with *key length* less than or equal to 16 bytes.

If no *key type* and no *length*is provided in the template, then the key produced by this mechanism is a generic secret key. Its length is 16 bytes (the output size of MDC2).

If no *key type* is provided in the template, but a *length* is provided, then the key produced by this mechanism is a generic secret key of the specified length – created by discarding one or more bytes from the right hand side of the decryption result.

If a *key type* is provided in the template, but no *length* is provided, then that key type must have a well-defined length. If it does, then the key produced by this mechanism is of the type specified in the template. If it doesn't, an error is returned.

If both a *key type* and a *length*are provided in the template, the length must be compatible with that key type. The key produced by this mechanism is of the specified type and length. If the length isn't compatible with the key type, an error is returned.

If the *derived key type* is CKK_DES, or CKK_DES2, the parity bits of the key are set properly.

If the *derived key value length* requested is more than 16 bytes, an error is returned.

The following *key sensitivity* and *extractability*rules apply for this mechanism:

The CKA_SENSITIVE, CKA_EXTRACTABLE and CKA_EXPORTABLE attributes in the template for the new key can be specified to be either TRUE or FALSE. If omitted, these attributes each take on the value of the corresponding attribute of the base key. The default value for the CKA_EXTRACTABLE and CKA_EXPORTABLE attributes is TRUE. The default value of the CKA_SENSITIVE attribute depends on the security flags. If the *No clear Pins* security flag is set, the default value is TRUE; otherwise, it is false.

If the base key has its CKA_ALWAYS_SENSITIVE attribute set to FALSE, then the derived key will as well. If the base key has its CKA_ALWAYS_SENSITIVE attribute set to TRUE, then the derived key has its CKA_ALWAYS_SENSITIVE attribute set to the same value as its CKA_SENSITIVE attribute.

If the base key has its CKA_NEVER_EXTRACTABLE attribute set to FALSE, then the derived key will too. If the base key has its CKA_NEVER_EXTRACTABLE attribute set to TRUE, then the derived key has its CKA_NEVER_EXTRACTABLE attribute set to TRUE only if both CKA_EXTRACTABLE and CKA_EXPORTABLE attributes are FALSE. Otherwise, it is set to FALSE.

Supported Cryptographic Mechanism Summary

Mechanism	FIPS Approved?	Supported Functions	Minimum Key Length (bits)	Minimum Key Length for FIPS	Maximum Key Length (bits)	Block Size	Digest Size	Key Types	Algorithms	Modes	Flags

				Use (bits)							
CKM_RSA_PKCS_KEY_PAIR_GEN	yes	Generate Key Pair	256	1024	8192	0	0	RSA	none	none	none
CKM_RSA_PKCS	yes	Sign | Verify | Encrypt | Decrypt | Wrap | Unwrap	256	1024	8192	0	0	RSA	none	none	none
CKM_RSA_X_509	no	Encrypt | Decrypt	256	1024	8192	0	0	RSA	none	none	none
CKM_MD5_RSA_PKCS	no	Sign | Verify	256	1024	8192	64	16	RSA	MD5	none	Extractable | Internal
CKM_SHA1_RSA_PKCS	yes	Sign | Verify	256	1024	8192	64	20	RSA	SHA	none	Extractable
CKM_RSA_PKCS_OAEP	yes	Encrypt | Decrypt | Wrap | Unwrap	256	1024	8192	0	0	RSA	none	none	none
CKM_RSA_X9_31_KEY_PAIR_GEN	yes	Generate Key Pair	1024	1024	8192	0	0	RSA	none	none	X9.31
CKM_RSA_FIPS_186_3_AUX_PRIME_KEY_PAIR_GEN	yes	Generate Key Pair	1024	1024	3072	0	0	RSA	none	none	none

CKM_RSA_FIPS_186_3_PRIME_KEY_PAIR_GEN	yes	Generate Key Pair	2048	2048	3072	0	0	RSA	none	none	none
CKM_RSA_X9_31	yes	Sign | Verify	1024	1024	8192	0	0	RSA	none	none	Extractable | X9.31
CKM_SHA1_RSA_X9_31	yes	Sign | Verify	1024	1024	8192	64	20	RSA	SHA	none	Extractable | X9.31
CKM_SHA224_RSA_X9_31	yes	Sign | Verify	1024	1024	8192	64	28	RSA	SHA224	none	Extractable | X9.31
CKM_SHA256_RSA_X9_31	yes	Sign | Verify	1024	1024	8192	64	32	RSA	SHA256	none	Extractable | X9.31
CKM_SHA384_RSA_X9_31	yes	Sign | Verify	1024	1024	8192	128	48	RSA	SHA384	none	Extractable | X9.31
CKM_SHA512_RSA_X9_31	yes	Sign | Verify	1024	1024	8192	128	64	RSA	SHA512	none	Extractable | X9.31
CKM_RSA_X9_31_NON_FIPS	no	Sign | Verify	1024	1024	8192	0	0	RSA	none	none	Extractable | X9.31 | Non-FIPS X9.31
CKM_SHA1_RSA_X9_31_NON_FIPS	no	Sign | Verify	1024	1024	8192	64	20	RSA	SHA	none	Extractable | X9.31 | Non-FIPS X9.31
CKM_SHA224_RSA_X9_31_NON_FIPS	no	Sign | Verify	1024	1024	8192	64	28	RSA	SHA224	none	Extractable | X9.31 | Non-FIPS X9.31

CKM_SHA256_RSA_X9_31_NON_FIPS	no	Sign | Verify	1024	1024	8192	64	32	RSA	SHA256	none	Extractable | X9.31 | Non-FIPS X9.31
CKM_SHA384_RSA_X9_31_NON_FIPS	no	Sign | Verify	1024	1024	8192	128	48	RSA	SHA384	none	Extractable | X9.31 | Non-FIPS X9.31
CKM_SHA512_RSA_X9_31_NON_FIPS	no	Sign | Verify	1024	1024	8192	128	64	RSA	SHA512	none	Extractable | X9.31 | Non-FIPS X9.31
CKM_RSA_PKCS_PSS	yes	Sign | Verify	256	1024	8192	0	0	RSA	none	none	none | PSS
CKM_SHA1_RSA_PKCS_PSS	yes	Sign | Verify	256	1024	8192	64	20	RSA	SHA	none	Extractable | PSS
CKM_DSA_KEY_PAIR_GEN	yes	Generate Key Pair	1024	2048	3072	0	0	DSA	none	none	none
CKM_DSA	yes	Sign | Verify	1024	2048	3072	0	0	DSA	DSA	none	none
CKM_SHA1_DSA	no	Sign | Verify	1024	2048	3072	64	20	DSA	SHA	none	Extractable
CKM_DH_PKCS_KEY_PAIR_GEN	no	Generate Key Pair	512	512	2048	0	0	DH	none	none	none
CKM_DH_PKCS_PARAMETER_GEN	no	Generate Key	512	0	2048	0	0	DH	none	none	none
CKM_DH_PKCS_DERIVE	no	Derive	512	512	2048	0	0	DH	none	none	none

CKM_SHA224_RSA_PKCS	yes	Sign | Verify	256	1024	8192	64	28	RSA	SHA224	none	Extractable
CKM_SHA224_RSA_PKCS_PSS	yes	Sign | Verify	512	1024	8192	64	28	RSA	SHA224	none	Extractable | PSS
CKM_SHA256_RSA_PKCS	yes	Sign | Verify	256	1024	8192	64	32	RSA	SHA256	none	Extractable
CKM_SHA256_RSA_PKCS_PSS	yes	Sign | Verify	512	1024	8192	64	32	RSA	SHA256	none	Extractable | PSS
CKM_SHA384_RSA_PKCS	yes	Sign | Verify	256	1024	8192	128	48	RSA	SHA384	none	Extractable
CKM_SHA384_RSA_PKCS_PSS	yes	Sign | Verify	512	1024	8192	128	48	RSA	SHA384	none	Extractable | PSS
CKM_SHA512_RSA_PKCS	yes	Sign | Verify	256	1024	8192	128	64	RSA	SHA512	none	Extractable
CKM_SHA512_RSA_PKCS_PSS	yes	Sign | Verify	1024	1024	8192	128	64	RSA	SHA512	none	Extractable | PSS
CKM_RC2_KEY_GEN	no	Generate Key	1	1	1024	0	0	RC2	none	none	none
CKM_RC2_ECB	no	Encrypt | Decrypt | Wrap | Unwrap	1	1	1024	8	0	RC2	RC2	ECB	Extractable
CKM_RC2_CBC	no	Encrypt | Decrypt | Wrap	1	1	1024	8	0	RC2	RC2	CBC	Extractable

		| Unwrap									
CKM_RC2_MAC	no	Sign | Verify	1	1	1024	8	0	RC2	RC2	MAC	Extractable
CKM_RC2_CBC_PAD	no	Encrypt | Decrypt | Wrap | Unwrap	1	1	1024	8	0	RC2	RC2	CBC_PAD	Extractable
CKM_RC4_KEY_GEN	no	Generate Key	8	8	2048	0	0	RC4	none	none	none
CKM_RC4	no	Encrypt | Decrypt	8	8	2048	0	0	RC4	RC4	STREAM	Extractable
CKM_DES_KEY_GEN	no	Generate Key	40	40	64	0	0	DES	none	none	none
CKM_DES_ECB	no	Encrypt | Decrypt | Wrap | Unwrap	40	40	64	8	0	DES	DES	ECB	Extractable
CKM_DES_CBC	no	Encrypt | Decrypt | Wrap | Unwrap	40	40	64	8	0	DES	DES	CBC	Extractable
CKM_DES_MAC	no	Sign | Verify	40	40	64	8	0	DES	DES	MAC	Extractable
CKM_DES_CBC_PAD	no	Encrypt | Decrypt | Wrap | Unwra	40	40	64	8	0	DES	DES	CBC_PAD	Extractable

		p									
CKM_DES2_KEY_GEN	yes	Generate Key	128	128	128	0	0	DES2	none	none	none
CKM_DES3_KEY_GEN	yes	Generate Key	192	192	192	0	0	DES3	none	none	none
CKM_DES3_ECB	yes	Encrypt | Decrypt | Wrap | Unwrap	128	128	192	8	0	DES3	DES3	ECB	Extractable
CKM_DES3_CBC	yes	Encrypt | Decrypt | Wrap | Unwrap	128	128	192	8	0	DES3	DES3	CBC	Extractable
CKM_DES3_MAC	yes	Sign | Verify	128	128	192	8	0	DES3	DES3	MAC	Extractable
CKM_DES3_CMAC	yes	Sign | Verify	128	128	192	8	0	DES3	DES3	MAC	Extractable | CMAC
CKM_DES3_CBC_PAD	yes	Encrypt | Decrypt | Wrap | Unwrap	128	128	192	8	0	DES3	DES3	CBC_PAD	Extractable
CKM_DES3_CBC_PAD_IPSEC	no	Encrypt | Decrypt | Wrap | Unwrap	128	128	192	8	0	DES3	DES3	CBC_PAD_IPSEC	Extractable
CKM_DES3_CFB8	yes	Encrypt |	128	128	192	8	1	DES3	DES3	CFB	Extractable

		Decrypt									
CKM_ DES3_ CFB64	yes	Encrypt | Decrypt	128	128	192	8	8	DES3	DES3	CFB	Extractable
CKM_ DES3_OFB	yes	Encrypt | Decrypt	128	128	192	8	0	DES3	DES3	OFB	Extractable
CKM_ DES3_CTR	yes	Encrypt | Decrypt	128	128	192	8	0	DES3	DES3	CTR	Extractable
CKM_ DES3_GCM	yes	Encrypt | Decrypt	128	128	192	8	0	DES3	DES3	GCM	Extractable | Accumulating
CKM_AES_ KEY_GEN	yes	Generate Key	128	128	256	0	0	AES	none	none	none
CKM_AES_ ECB	yes	Encrypt | Decrypt | Wrap | Unwrap	128	128	256	16	0	AES	AES	ECB	Extractable
CKM_AES_ CBC	yes	Encrypt | Decrypt | Wrap | Unwrap	128	128	256	16	0	AES	AES	CBC	Extractable
CKM_AES_ MAC	yes	Sign | Verify	128	128	256	16	0	AES	AES	MAC	Extractable
CKM_AES_ CMAC	yes	Sign | Verify	128	128	256	16	0	AES	AES	MAC	Extractable | CMAC
CKM_AES_ CBC_PAD	yes	Encrypt |	128	128	256	16	0	AES	AES	CBC_ PAD	Extractable

		Decrypt | Wrap | Unwrap									
CKM_AES_CBC_PAD_IPSEC	no	Encrypt | Decrypt | Wrap | Unwrap	128	128	256	16	0	AES	AES	CBC_PAD_IPSEC	Extractable
CKM_AES_CFB8	yes	Encrypt | Decrypt	128	128	256	16	1	AES	AES	CFB	Extractable
CKM_AES_CFB128	yes	Encrypt | Decrypt	128	128	256	16	16	AES	AES	CFB	Extractable
CKM_AES_OFB	yes	Encrypt | Decrypt	128	128	256	16	0	AES	AES	OFB	Extractable
CKM_AES_CTR	no	Encrypt | Decrypt	128	128	256	16	0	AES	AES	CTR	Extractable
CKM_AES_GCM	yes	Encrypt | Decrypt	128	128	256	16	0	AES	AES	GCM	Extractable | Accumulating
CKM_AES_GMAC	yes	Sign | Verify	128	128	256	16	0	AES	AES	GCM	Extractable | Accumulating
CKM_ARIA_KEY_GEN	no	Generate Key	128	128	256	0	0	ARIA	none	none	none
CKM_ARIA_ECB	no	Encrypt | Decrypt | Wrap	128	128	256	16	0	ARIA	ARIA	ECB	Extractable

		| Unwrap									
CKM_ARIA_CBC	no	Encrypt | Decrypt | Wrap | Unwrap	128	128	256	16	0	ARIA	ARIA	CBC	Extractable
CKM_ARIA_CBC_PAD	no	Encrypt | Decrypt | Wrap | Unwrap	128	128	256	16	0	ARIA	ARIA	CBC_PAD	Extractable
CKM_ARIA_MAC	no	Sign | Verify	128	128	256	16	0	ARIA	ARIA	MAC	Extractable
CKM_ARIA_CMAC	no	Sign | Verify	128	128	256	16	0	ARIA	ARIA	MAC	Extractable | CMAC
CKM_ARIA_CFB8	no	Encrypt | Decrypt	128	128	256	16	1	ARIA	ARIA	CFB	Extractable
CKM_ARIA_CFB128	no	Encrypt | Decrypt	128	128	256	16	16	ARIA	ARIA	CFB	Extractable
CKM_ARIA_OFB	no	Encrypt | Decrypt	128	128	256	16	0	ARIA	ARIA	OFB	Extractable
CKM_ARIA_CTR	no	Encrypt | Decrypt	128	128	256	16	0	ARIA	ARIA	CTR	Extractable
CKM_ARIA_GCM	no	Encrypt | Decrypt	128	128	256	16	0	ARIA	ARIA	GCM	Extractable | Accumulating

CKM_ARIA_L_ECB	no	Decrypt | Unwrap	128	128	256	16	0	ARIA	ARIA	ECB	Extractable
CKM_ARIA_L_CBC	no	Decrypt | Unwrap	128	128	256	16	0	ARIA	ARIA	CBC	Extractable
CKM_ARIA_L_CBC_PAD	no	Decrypt | Unwrap	128	128	256	16	0	ARIA	ARIA	CBC_PAD	Extractable
CKM_ARIA_L_MAC	no	Verify	128	128	256	16	0	ARIA	ARIA	MAC	Extractable
CKM_CAST3_KEY_GEN	no	Generate Key	40	40	64	0	0	CAST3	none	none	none
CKM_CAST3_ECB	no	Encrypt | Decrypt | Wrap | Unwrap	40	40	64	8	0	CAST3	CAST3	ECB	Extractable
CKM_CAST3_CBC	no	Encrypt | Decrypt | Wrap | Unwrap	40	40	64	8	0	CAST3	CAST3	CBC	Extractable
CKM_CAST3_MAC	no	Sign | Verify	40	40	64	8	0	CAST3	CAST3	MAC	Extractable
CKM_CAST3_CBC_PAD	no	Encrypt | Decrypt | Wrap | Unwrap	40	40	64	8	0	CAST3	CAST3	CBC_PAD	Extractable
CKM_	no	Genera	40	40	128	0	0	CAST	none	none	none

CAST5_ KEY_GEN		te Key						5			
CKM_ CAST5_ ECB	no	Encrypt | Decrypt | Wrap | Unwrap	40	40	128	8	0	CAST5	CAST5	ECB	Extractable
CKM_ CAST5_ CBC	no	Encrypt | Decrypt | Wrap | Unwrap	40	40	128	8	0	CAST5	CAST5	CBC	Extractable
CKM_ CAST5_ MAC	no	Sign | Verify	40	40	128	8	0	CAST5	CAST5	MAC	Extractable
CKM_ CAST5_ CBC_PAD	no	Encrypt | Decrypt | Wrap | Unwrap	40	40	128	8	0	CAST5	CAST5	CBC_ PAD	Extractable
CKM_RC5_ KEY_GEN	no	Generate Key	0	0	2040	0	0	RC5	none	none	none
CKM_RC5_ ECB	no	Encrypt | Decrypt	0	0	2040	8	0	RC5	RC5	ECB	Extractable
CKM_RC5_ CBC	no	Encrypt | Decrypt	0	0	2040	8	0	RC5	RC5	CBC	Extractable
CKM_RC5_ MAC	no	Sign | Verify	0	0	2040	8	0	RC5	RC5	MAC	Extractable
CKM_RC5_ CBC_PAD	no	Encrypt | Decrypt	0	0	2040	8	0	RC5	RC5	CBC_ PAD	Extractable

CKM_ SEED_ KEY_GEN	no	Generate Key	128	128	128	0	0	SEED	none	none	Korean
CKM_ SEED_ECB	no	Encrypt | Decrypt | Wrap | Unwrap	128	128	128	16	0	SEED	SEED	ECB	Extractable | Korean
CKM_ SEED_CBC	no	Encrypt | Decrypt | Wrap | Unwrap	128	128	128	16	0	SEED	SEED	CBC	Extractable | Korean
CKM_ SEED_CTR	no	Encrypt | Decrypt	128	128	128	16	0	SEED	SEED	CTR	Extractable | Korean
CKM_ SEED_MAC	no	Sign | Verify	128	128	128	16	0	SEED	SEED	MAC	Extractable | Korean
CKM_ SEED_ CMAC	no	Sign | Verify	128	128	128	16	0	SEED	SEED	MAC	Extractable | Korean | CMAC
CKM_ SEED_ CBC_PAD	no	Encrypt | Decrypt | Wrap | Unwrap	128	128	128	16	0	SEED	SEED	CBC_ PAD	Extractable | Korean
CKM_MD2	no	Digest	0	0	0	16	16	none	MD2	none	Extractable
CKM_MD5	no	Digest	0	0	0	64	16	none	MD5	none	Extractable | Internal
CKM_SHA_ 1	yes	Digest	0	0	0	64	20	none	SHA	none	Extractable

CKM_ SHA224	yes	Digest	0	0	0	64	28	none	SHA224	none	Extractable
CKM_ HMAC_ SHA224	yes	Sign | Verify	8	8	4096	64	28	symmetric	SHA224	HMAC	Extractable
CKM_ SHA256	yes	Digest	0	0	0	64	32	none	SHA256	none	Extractable
CKM_ HMAC_ SHA256	yes	Sign | Verify	8	8	4096	64	32	symmetric	SHA256	HMAC	Extractable
CKM_ SHA384	yes	Digest	0	0	0	128	48	none	SHA384	none	Extractable
CKM_ HMAC_ SHA384	yes	Sign | Verify	8	8	4096	128	48	symmetric	SHA384	HMAC	Extractable
CKM_ SHA512	yes	Digest	0	0	0	128	64	none	SHA512	none	Extractable
CKM_ HMAC_ SHA512	yes	Sign | Verify	8	8	4096	128	64	symmetric	SHA512	HMAC	Extractable
CKM_ SHA224_ KEY_ DERIVATION	no	Derive	8	8	160	64	28	none	none	none	none
CKM_ SHA256_ KEY_ DERIVATION	no	Derive	8	8	160	64	32	none	none	none	none
CKM_ SHA384_ KEY_ DERIVATION	no	Derive	8	8	160	128	48	none	none	none	none
CKM_ SHA512_ KEY_ DERIVATION	no	Derive	8	8	160	128	64	none	none	none	none

CKM_PKCS5_PBKD2	no	Generate Key	8	8	8	0	0	none	none	none	none
CKM_KEY_WRAP_SET_OAEP	no	Wrap | Unwrap	256	1024	8192	0	0	RSA	none	none	none
CKM_EC_KEY_PAIR_GEN	yes	Generate Key Pair	112	112	571	0	0	ECDSA	none	none	none
CKM_ECDSA	yes	Sign | Verify	112	112	571	0	0	ECDSA	ECDSA	none	none
CKM_SHA1_ECDSA	yes	Sign | Verify	112	112	571	64	20	ECDSA	SHA	none	Extractable
CKM_SHA224_ECDSA	yes	Sign | Verify	112	112	571	64	28	ECDSA	SHA224	none	Extractable
CKM_SHA256_ECDSA	yes	Sign | Verify	112	112	571	64	32	ECDSA	SHA256	none	Extractable
CKM_SHA384_ECDSA	yes	Sign | Verify	112	112	571	128	48	ECDSA	SHA384	none	Extractable
CKM_SHA512_ECDSA	yes	Sign | Verify	112	112	571	128	64	ECDSA	SHA512	none	Extractable
CKM_ECDH1_DERIVE	yes	Derive	112	112	571	0	0	ECDSA	none	none	none
CKM_ECDH1_COFACTOR_DERIVE	yes	Derive	112	112	571	0	0	ECDSA	none	none	none
CKM_ECIES	yes	Encrypt | Decrypt	112	112	571	0	0	ECDSA	none	none	Accumulating
CKM_ECMQV_DERIVE	yes	Derive	112	112	571	0	0	ECDSA	none	none	none

CKM_DES_ ECB_ ENCRYPT_ DATA	no	Derive	40	40	64	0	0	none	none	none	none
CKM_DES_ CBC_ ENCRYPT_ DATA	no	Derive	40	40	64	0	0	none	none	none	none
CKM_ DES3_ECB_ ENCRYPT_ DATA	yes	Derive	128	128	192	0	0	none	none	none	none
CKM_ DES3_ CBC_ ENCRYPT_ DATA	yes	Derive	128	128	192	0	0	none	none	none	none
CKM_AES_ ECB_ ENCRYPT_ DATA	yes	Derive	128	128	256	0	0	none	none	none	none
CKM_AES_ CBC_ ENCRYPT_ DATA	yes	Derive	128	128	256	0	0	none	none	none	none
CKM_ARIA_ ECB_ ENCRYPT_ DATA	no	Derive	128	128	256	0	0	none	none	none	none
CKM_ARIA_ CBC_ ENCRYPT_ DATA	no	Derive	128	128	256	0	0	none	none	none	none
CKM_DSA_ PARAMETE R_GEN	yes	Genera te Key	1024	2048	3072	0	0	DSA	none	none	none
CKM_X9_ 42_DH_ PARAMETE R_GEN	no	none	?	?	?	0	0	none	none	none	none
CKM_MD2_ DES_CBC	no	Genera te Key	64	64	64	16	16	none	none	none	none

CKM_MD5_DES_CBC	no	Generate Key	64	64	64	64	16	none	none	none	none
CKM_SHA1_DES3_CBC	no	Generate Key	192	192	192	64	20	none	none	none	none
CKM_MD5_CAST_CBC	no	Generate Key	64	64	64	64	16	none	none	none	none
CKM_MD5_CAST3_CBC	no	Generate Key	64	64	64	64	16	none	none	none	none
CKM_SHA1_CAST5_CBC	no	Generate Key	40	40	128	64	20	none	none	none	none
CKM_SHA1_DES2_CBC	no	Generate Key	128	128	128	64	20	none	none	none	none
CKM_SHA1_RC4_128	no	Generate Key	128	128	128	64	20	none	none	none	none
CKM_SHA1_RC4_40	no	Generate Key	40	40	40	64	20	none	none	none	none
CKM_SHA1_RC2_128_CBC	no	Generate Key	128	128	128	64	20	none	none	none	none
CKM_SHA1_RC2_40_CBC	no	Generate Key	40	40	40	64	20	none	none	none	none
CKM_SHA1_DES2_CBC_OLD	no	Generate Key	128	128	128	64	20	none	none	none	none
CKM_SHA1_DES3_CBC_OLD	no	Generate Key	192	192	192	64	20	none	none	none	none
CKM_CONCATENATE_BASE_	no	Derive	8	8	4096	0	0	none	none	none	none

AND_KEY											
CKM_ CONCATEN ATE_KEY_ AND_BASE	no	none	8	8	4096	0	0	none	none	none	none
CKM_ CONCATEN ATE_BASE_ AND_DATA	no	Derive	8	8	4096	0	0	none	none	none	none
CKM_ CONCATEN ATE_DATA_ AND_BASE	no	Derive	8	8	4096	0	0	none	none	none	none
CKM_XOR_ BASE_ AND_DATA	no	Derive	8	8	4096	0	0	none	none	none	none
CKM_XOR_ BASE_ AND_ DATA_W_ KDF	no	Encryp t | Decryp t	8	8	4096	0	0	symm etric	none	OFB	none
CKM_XOR_ BASE_ AND_KEY	no	Derive	8	8	4096	0	0	none	none	none	none
CKM_ EXTRACT_ KEY_ FROM_KEY	no	Derive	8	8	4096	0	0	none	none	none	none
CKM_MD2_ KEY_ DERIVATIO N	no	Derive	8	8	128	16	16	none	none	none	none
CKM_MD5_ KEY_ DERIVATIO N	no	Derive	8	8	128	64	16	none	none	none	none
CKM_ SHA1_KEY_ DERIVATIO N	no	Derive	8	8	160	64	20	none	none	none	none
CKM_	yes	Genera	8	8	4096	0	0	none	none	none	none

GENERIC_ SECRET_ KEY_GEN		te Key									
CKM_SSL3_ MASTER_ KEY_ DERIVE	no	Derive	384	384	384	0	0	none	none	none	none
CKM_SSL3_ KEY_AND_ MAC_ DERIVE	no	Derive	384	384	384	0	0	none	none	none	none
CKM_SSL3_ MD5_MAC	no	Sign | Verify	128	128	128	64	16	symm etric	MD5	HMA C	Extracta ble
CKM_SSL3_ SHA1_MAC	no	Sign | Verify	160	160	160	64	20	symm etric	SHA	HMA C	Extracta ble
CKM_ HMAC_ SHA1	yes	Sign | Verify	8	8	4096	64	20	symm etric	SHA	HMA C	Extracta ble
CKM_ HMAC_ SHA1_80	yes	Sign | Verify	8	8	4096	64	20	symm etric	SHA	HMA C	Extracta ble
CKM_ HMAC_MD5	no	Sign | Verify	8	8	4096	64	16	symm etric	MD5	HMA C	Extracta ble
CKM_ HMAC_ MD5_80	no	Sign | Verify	8	8	4096	64	16	symm etric	MD5	HMA C	Extracta ble | Internal
CKM_SSL3_ PRE_ MASTER_ KEY_GEN	no	Genera te Key	384	384	384	0	0	none	none	none	none
CKM_ HAS160	no	Digest	0	0	0	64	20	none	HAS160	none	Extracta ble | Korean
CKM_ HMAC_ HAS160	no	Sign | Verify	8	8	4096	64	20	symm etric	HAS160	HMA C	Extracta ble | Korean | Internal
CKM_ RIPEMD160	no	Digest	0	0	0	64	20	none	RIPEM D160	none	Extracta ble | Internal

CKM_ HMAC_ RIPEMD160	no	Sign | Verify	8	8	4096	64	20	symmetric	RIPEMD160	HMAC	Extractable | Internal
CKM_ KCDSA_ KEY_PAIR_ GEN	no	Generate Key Pair	1024	1024	2048	0	0	KCDSA	none	none	Korean
CKM_ HAS160_ KCDSA	no	Sign | Verify	1024	1024	2048	64	20	KCDSA	HAS160	none	Korean
CKM_ SHA1_ KCDSA	no	Sign | Verify	1024	1024	2048	64	20	KCDSA	SHA	none	Korean
CKM_ SHA224_ KCDSA	no	Sign | Verify	1024	1024	2048	64	28	KCDSA	SHA224	none	Korean
CKM_ SHA256_ KCDSA	no	Sign | Verify	1024	1024	2048	64	32	KCDSA	SHA256	none	Korean
CKM_ SHA384_ KCDSA	no	Sign | Verify	1024	1024	2048	128	48	KCDSA	SHA384	none	Korean
CKM_ SHA512_ KCDSA	no	Sign | Verify	1024	1024	2048	128	64	KCDSA	SHA512	none	Korean
CKM_ KCDSA_ PARAMETER_GEN	no	Generate Key	1024	1024	2048	0	0	KCDSA	none	none	Korean
CKM_ 2DES_ DERIVE	no	Derive	128	128	192	0	0	none	none	none	Not Listed
CKM_LZS	no	none	0	0	0	0	0	none	none	none	Not Listed
CKM_ LOOP_ BACK	no	none	0	0	0	0	0	none	none	none	Not Listed
CKM_ UNKNOWN	no	none	0	0	0	0	0	none	none	none	Not Listed

CKM_AES_CBC_PAD_EXTRACT	no	none	128	128	256	0	0	none	none	none	Not Listed
CKM_AES_CBC_PAD_INSERT	no	none	128	128	256	0	0	none	none	none	Not Listed
CKM_AES_CBC_PAD_EXTRACT_FLATTENED	no	none	128	128	256	0	0	none	none	none	Not Listed
CKM_AES_CBC_PAD_INSERT_FLATTENED	no	none	128	128	256	0	0	none	none	none	Not Listed
CKM_AES_CBC_PAD_EXTRACT_PUBLIC	no	none	128	128	256	0	0	none	none	none	Not Listed
CKM_AES_CBC_PAD_INSERT_PUBLIC	no	none	128	128	256	0	0	none	none	none	Not Listed
CKM_AES_CBC_PAD_EXTRACT_PUBLIC_FLATTENED	no	none	128	128	256	0	0	none	none	none	Not Listed
CKM_AES_CBC_PAD_INSERT_PUBLIC_FLATTENED	no	none	128	128	256	0	0	none	none	none	Not Listed
CKM_SHA224_DSA	yes	Sign | Verify	1024	2048	3072	64	28	DSA	SHA224	none	Extractable
CKM_SHA256_DSA	yes	Sign | Verify	1024	2048	3072	64	32	DSA	SHA256	none	Extractable

CKM_NIST_ PRF_KDF	yes	Derive	8	8	4096	0	0	symm etric	none	none	none
CKM_PRF_ KDF	no	Derive	8	8	4096	0	0	symm etric	none	none	none

Named Curves and User-Defined Parameters

The SafeNet HSM is a PKCS#11 oriented device. Prior to firmware 4.6.7, the HSM firmware statically defined the NIST named curve OIDs and curve parameters. To expand on that capability and add flexibility, firmware 4.6.7 (SafeNet Network HSM 4.3) and later added support for Brainpool curve OIDs and curve parameters. Additional support was added to decode the ecParameters structure and use that data in the generation of keys as well as in signing and verification.

Curve Validation Limitations

The HSM can validate the curve parameters, however domain parameter validation guarantees only the consistency/sanity of the parameters and the most basic, well-known security properties. The HSM has no way of judging the quality of a user-specified curve.

It is therefore important that you perform Known Answer Tests to verify the operation of the HSM for any new Domain Parameter.set. To maintain NIST-FIPS compatibility the feature is selectively enabled with the feature being disabled by default. Therefore the Administrator must ‘opt-in’ by actively choosing to enable the appropriate HSM policy. Among other effects, this causes the HSM to display a shell/console message to the effect that the HSM is not operating in FIPS mode.

Storing Domain Parameters

Under PKCS#11 v2.20, Domain Parameters are stored in object attribute CKA_EC_PARAMS. The value of this parameter is the DER encoding of an ANSI X9.62 Parameters value.

```
Parameters ::= CHOICE {
ecParameters ECParameters,
namedCurve CURVES.&id({CurveNames}),
implicitlyCA NULL
}
```

Because PKCS#11 states that the implicitlyCA is not supported by cryptoki, therefore the CKA_EC_PARAMS attribute must contain the encoding of an ecParameters or a namedCurve. Cryptoki holds ECC key pairs in separate Private and Public key objects. Each object has its own CKA_EC_PARAMS attribute which must be provided when the object is created and cannot be subsequently changed.

Cryptoki also supports CKO_DOMAIN_PARAMETERS objects. These store Domain Parameters but perform no cryptographic operations. A Domain Parameters object is really only for storage. To generate a key pair, you must extract the attributes from the Domain Parameters object and insert them in the CKA_EC_PARAMS attribute of the

Public key template. Cryptoki can create new ECC Public and Private key objects and Domain Parameters objects in the following ways:

- Objects can be directly stored using the C_CreateObject command
- Public and private key objects can be generated internally with the C_GenerateKeyPair command and the CKM_ EC_KEY_PAIR_GEN mechanism.
- Objects can be imported in encrypted form using C_UnwrapKey command.

Using Domain Parameters

ECC keys may be used for Signature Generation and Verification with the CKM_ECDSA and CKM_ECDSA_SHA1 mechanism and Encryption and Decryption with the CKM_ECIES mechanism. These three mechanism are enhanced so that they fetch the Domain Parameters from the CKA_EC_PARAMS attribute for both ecParameters and namedCurve choice and not just namedCurve choice.

User Friendly Encoder

Using ECC with Cryptoki to create or generate ECC keys requires that the CKA_EC_PARAMS attribute be specified. This is a DER encoded binary array. Usually in public documents describing ECC curves the Domain Parameters are specified as a series of printable strings so the programmer faces the problem of converting these to the correct format for Cryptoki use.

The cryptoki library is extended to support functions called CA_EncodeECPrimeParams and CA_ EncodeECChar2Params which allow an application to specify the parameter details of a new curve. These functions implement DER encoders to build the CKA_EC_PARAMS attribute from large integer presentations of the Domain Parameter values.

Refer to "Sample Domain Parameter Files " on page 405 for some sample Domain Parameter files.

Application Interfaces

CA_EncodeECPrimeParams

#include “cryptoki.h”

CK_RV CA_ EncodeECPrimeParams (

CK_BYTE_PTR DerECParams, CK_ULONG_PTR DerECParams Len

CK_BYTE_PTR prime, CK_USHORT primelen,

CK_BYTE_PTR a, CK_USHORT alen,

CK_BYTE_PTR b, CK_USHORT blen,

CK_BYTE_PTR seed, CK_USHORT seedlen,

CK_BYTE_PTR x, CK_USHORT xlen,

CK_BYTE_PTR y, CK_USHORT ylen,

CK_BYTE_PTR order, CK_USHORT orderlen,

CK_BYTE_PTR cofactor, CK_USHORT cofactorlen,

);

Do DER enc of ECC Domain Parameters Prime

Parameters

DerECParams	Resultant Encoding (length prediction supported if NULL).
DerECParamsLen	Buffer len/Length of resultant encoding
prime	Prime modulus
primelen	Prime modulus len
a	Elliptic Curve coefficient a
alen	Elliptic Curve coefficient a length
b	Elliptic Curve coefficient b
blen	Elliptic Curve coefficient b length
seed	Seed (optional may be NULL)
seedlen	Seed length
x	Elliptic Curve point X coord
xlen	Elliptic Curve point X coord length
y	Elliptic Curve point Y coord
ylen	Elliptic Curve point Y coord length
order	Order n of the Base Point
orderlen	Order n of the Base Point length
cofactor	The integer h = #E(Fq)/n (optional)
cofactorlen	h length
Return	Status of operation. CKR_OK if ok.

CA_EncodeECChar2Params

```
#include "cryptoki.h"
CK_RV CA_EncodeECChar2Params(
    CK_BYTE_PTR DerECParams, CK_ULONG_PTR DerECParams Len
    CK_USHORT m,
     CK_USHORT k1,
     CK_USHORT k2,
    CK_USHORT k3,
    CK_BYTE_PTR a, CK_USHORT alen,
     CK_BYTE_PTR b, CK_USHORT blen,
    CK_BYTE_PTR seed, CK_USHORT seedlen,
```



```
 CK_BYTE_PTR x, CK_USHORT xlen,
CK_BYTE_PTR y, CK_USHORT ylen,
CK_BYTE_PTR order, CK_USHORT orderlen,
CK_BYTE_PTR cofactor, CK_USHORT cofactorlen,
);
```

Do DER enc of ECC Domain Parameters 2^M

Parameters

DerECParams	Resultant Encoding (length prediction supported if NULL).
DerECParamsLen	Buffer len/Length of resultant encoding
M	Degree of field
k1	parameter in trinomial or pentanomial basis polynomial
k2	parameter in pentanomial basis polynomial
k3	parameter in pentanomial basis polynomial
a	Elliptic Curve coefficient a
alen	Elliptic Curve coefficient a length
b	Elliptic Curve coefficient b
blen	Elliptic Curve coefficient b length
seed	Seed (optional may be NULL)
seedlen	Seed length
x	Elliptic Curve point X coord
xlen	Elliptic Curve point X coord length
y	Elliptic Curve point Y coord
ylen	Elliptic Curve point Y coord length
order	Order n of the Base Point
orderlen	Order n of the Base Point length
cofactor	The integer h = #E(Fq)/n (optional)
cofactorlen	h length
Return	Status of operation. CKR_OK if ok.

Sample Domain Parameter Files

The following examples show some sample domain parameter files.

prime192v1

```
#
#This file describes the domain parameters of an EC curve
#
#File contains lines of text. All lines not of the form key=value are ignored.
#All values must be Hexidecimal numbers except m, k, k1, k2 and k3 which are decimal.
#Lines starting with '#' are comments.
#
#Keys recognised for fieldID values are -
#p           - only if the Curve is based on a prime field
#m           - only if the curve is based on a 2^M field
#k1, k2, k3 - these three only if 2^M field
#
#You should have these combinations of fieldID values -
#p           - if Curve is based on a prime field
#m,k1,k2,k3 - if curve is based on 2^M
#
#These are the values common to prime fields and polynomial fields.
#a           - field element A
#b           - field element B
#s           - this one is optional
#x           - field element Xg of the point G
#y           - field element Yg of the point G
#q           - order n of the point G
#h           - (optional) cofactor h
#
#
# Curve name prime192v1
p     = FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFEFFFFFFFFFFFFFFFF
a     = FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFEFFFFFFFFFFFFFFFC
b     = 64210519E59C80E70FA7E9AB72243049FEB8DEECC146B9B1
s     = 3045AE6FC8422F64ED579528D38120EAE12196D5
x     = 188DA80EB03090F67CBF20EB43A18800F4FF0AFD82FF1012
y     = 07192B95FFC8DA78631011ED6B24CDD573F977A11E794811
q     = FFFFFFFFFFFFFFFFFFFFFFFF99DEF836146BC9B1B4D22831
h     = 1
```

C2tnB191v1

```
#
#This file describes the domain parameters of an EC curve
#
#File contains lines of text. All lines not of the form key=value are ignored.
#All values must be Hexidecimal numbers except m, k, k1, k2 and k3 which are decimal.
#Lines starting with '#' are comments.
#
#Keys recognised for fieldID values are -
#p           - only if the Curve is based on a prime field
#m           - only if the curve is based on a 2^M field
#k1, k2, k3 - these three only if 2^M field
#
```

```
#You should have these combinations of fieldID values -
#p          - if Curve is based on a prime field
#m,k1,k2,k3 - if curve is based on 2^M
#
#
#These are the values common to prime fields and polynomial fields.
#a          - field element A
#b          - field element B
#s          - this one is optional
#x          - field element Xg of the point G
#y          - field element Yg of the point G
#q          - order n of the point G
#h          - (optional) cofactor h
#
#
# Curve name C2tnB191v1
m     = 191
k1    = 9
k2    = 0
k3    = 0
a     = 2866537B676752636A68F56554E12640276B649EF7526267
b     = 2E45EF571F00786F67B0081B9495A3D95462F5DE0AA185EC
x     = 36B3DAF8A23206F9C4F299D7B21A9C369137F2C84AE1AA0D
y     = 765BE73433B3F95E332932E70EA245CA2418EA0EF98018FB
q     = 40000000000000000000000004A20E90C39067C893BBB9A5
```

brainpoolP160r1

```
#
#This file describes the domain parameters of an EC curve
#
#File contains lines of text. All lines not of the form key=value are ignored.
#All values must be Hexidecimal numbers except m, k, k1, k2 and k3 which are decimal.
#Lines starting with '#' are comments.
#
#Keys recognised for fieldID values are -
#p          - only if the Curve is based on a prime field
#m          - only if the curve is based on a 2^M field
#k1, k2, k3 - these three only if 2^M field
#
#You should have these combinations of fieldID values -
#p          - if Curve is based on a prime field
#m,k1,k2,k3 - if curve is based on 2^M
#
#These are the values common to prime fields and polynomial fields.
#a          - field element A
#b          - field element B
#s          - this one is optional
#x          - field element Xg of the point G
#y          - field element Yg of the point G
#q          - order n of the point G
#h          - (optional) cofactor h
#
#
```

```
# Curve name brainpoolP160r1

p       = E95E4A5F737059DC60DFC7AD95B3D8139515620F
a       = 340E7BE2A280EB74E2BE61BADA745D97E8F7C300
b       = 1E589A8595423412134FAA2DBDEC95C8D8675E58
x       = BED5AF16EA3F6A4F62938C4631EB5AF7BDBCDBC3
y       = 1667CB477A1A8EC338F94741669C976316DA6321
q       = E95E4A5F737059DC60DF5991D45029409E60FC09
h       = 1
```

brainpoolP512r1

```
#
#This file describes the domain parameters of an EC curve
#
#File contains lines of text. All lines not of the form key=value are ignored.
#All values must be Hexidecimal numbers except m, k, k1, k2 and k3 which are decimal.
#Lines starting with '#' are comments.
#
#Keys recognised for fieldID values are -
#p           - only if the Curve is based on a prime field
#m           - only if the curve is based on a 2^M field
#k1, k2, k3 - these three only if 2^M field
#
#You should have these combinations of fieldID values -
#p           - if Curve is based on a prime field
#m,k1,k2,k3 - if curve is based on 2^M
#
#These are the values common to prime fields and polynomial fields.
#a           - field element A
#b           - field element B
#s           - this one is optional
#x           - field element Xg of the point G
#y           - field element Yg of the point G
#q           - order n of the point G
#h           - (optional) cofactor h
#
#
 # Curve name brainpoolP512r1

 p=AADD9DB8DBE9C48B3FD4E6AE33C9FC07CB308DB3B3C9D20ED6639CCA703308717D4D9B009BC66842AECDA12AE6A380E62881
 a=7830A3318B603B89E2327145AC234CC594CBDD8D3DF91610A83441CAEA9863BC2DED5D5AA8253AA10A2EF1C98B9AC8B57F111
 b=3DF91610A83441CAEA9863BC2DED5D5AA8253AA10A2EF1C98B9AC8B57F1117A72BF2C7B9E7C1AC4D77FC94CADC083E6798405
 x=81AEE4BDD82ED9645A21322E9C4C6A9385ED9F70B5D916C1B43B62EEF4D0098EFF3B1F78E2D0D48D50D1687B93B97D5F7C6D5
 y=7DDE385D566332ECC0EABFA9CF7822FDF209F70024A57B1AA000C55B881F8111B2DCDE494A5F485E5BCA4BD88A2763AED1CA2
 q=AADD9DB8DBE9C48B3FD4E6AE33C9FC07CB308DB3B3C9D20ED6639CCA70330870553E5C414CA92619418661197FAC10471DB1D
 h       = 1
```

Bad Parameter File

```
#
#This file describes the domain parameters of an EC curve
#
#File contains lines of text. All lines not of the form key=value are ignored.
#All values must be Hexidecimal numbers except m, k, k1, k2 and k3 which are decimal.
#Lines starting with '#' are comments.
#
#Keys recognised for fieldID values are -
```

```
#p          - only if the Curve is based on a prime field
#m          - only if the curve is based on a 2^M field
#k1, k2, k3 - these three only if 2^M field
#
#You should have these combinations of fieldID values -
#p          - if Curve is based on a prime field
#m,k1,k2,k3 - if curve is based on 2^M
#
#These are the values common to prime fields and polynomial fields.
#a          - field element A
#b          - field element B
#s          - this one is optional
#x          - field element Xg of the point G
#y          - field element Yg of the point G
#q          - order n of the point G
#h          - (optional) cofactor h
#
# Curve name prime192vx

p    = FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFEFFFFFFFFFFFFFFFF
a    = FFFFFFFFFFFFFFFFFFFFFFFFFFFFFFFEFFFFFFFFFFFFFFFC
b    = 64210519E59C80E70FA7E9AB72243049FEB8DEECC146B9B13
s    = 3454556768574352345 7
x    = 188DA80EB03090F67CBF20EB43A18800F4FF0AFD82FF1012
y    = 07192B95FFC8DA78631011ED6B24CDD573F977A11E794811
q    = FFFFFFFFFFFFFFFFFFFFFFFF99DEF836146BC9B1B4D22831
h    = 12323435765786
```

6
Design Considerations

This chapter provides guidance for creating applications that use specific SafeNet HSM configurations or features. It contains the following topics:

About Scalable Key Storage

For customer applications involving large numbers of keys, that might exceed the internal flash-memory capacity of the SafeNet Network HSM K6 engine, support is provided for secure external storage of keys.

For the most part, Scalable Key Storage functionality must be supported by custom programming. Our Software Development Kit (available separately) includes documentation and samples for Cryptoki and Java APIs.

The following characteristics apply to the Scalable Key Storage capability:

- Scalable Key Storage is a purchased capability that must be enabled when your SafeNet Network HSM is manufactured. Scalable Key Storage cannot be implemented with a SafeNet Network HSM that was not explicitly enabled for Scalable Key Storage.
- The database-management aspects of large numbers of externally stored keys are beyond the scope of SafeNet Network HSM. SafeNet Network HSM ensures the security of those keys, without reference to their management and retrieval. Such management is the responsibility of the customer's application.
- All keys that are externally stored with this feature are strongly encrypted, using symmetric keys that are never exposed outside the HSM server. Additional encryption and security measures are employed within the HSM server to afford multiple levels of security.
- All manipulations of the keys take place within protected, volatile memory inside the SafeNet Network HSM K6 engine.

Note: Each SafeNet Network HSM leaving the factory has a unique masking key, which is used for Secure Identity Management. To give several SafeNet Enterprise HSMs the same masking key, choose one and perform hsm -backup. Then, using that Backup HSM, perform hsm -restore onto each SafeNet Network HSM that must share that masking key.

Note: When the HSM is initialized, a new masking secret is created. The new masking secret will be backed up onto a backup token if "hsm backup" is performed, but the **old** masking secret will continue to be used for all masking operations until the HSM is powered off.

A SafeNet Network HSM with Scalable Key Storage enabled can support only a single HSM Partition.

WARNING! If the masking key is lost, then all extracted key material (all the keys in your database) is effectively lost as well. Therefore, perform an HSM Backup, to backup the Scalable Key Storage Masking Key.

Audit Logging

By default, the HSM logs select events to the file hsm.log.

For more robust and verifiable logging, SafeNet HSM (after version 5.2) includes the Audit Logging feature, to log select HSM events to files that can be securely verified for audit purposes.

The HSM creates a log secret unique to the HSM, computed during the first initialization after manufacture. The log secret resides in flash memory (permanent, non-volatile memory), and is used to create log records that are sent to a log file. Later, the log secret is used to prove that a log record originated from a legitimate HSM and has not been tampered with.

Audit Log Records

A log record consists of two fields – the log message and the HMAC for the previous record. When the HSM creates a log record, it uses the log secret to compute the SHA256-HMAC of all data contained in that log message, plus the HMAC of the previous log entry. The HMAC is stored in HSM flash memory. The log message is then transmitted, along with the HMAC of the previous record, to the host. The host has a logging daemon to receive and store the log data on the host hard drive.

For the first log message ever returned from the HSM to the host there is no previous record and, therefore, no HMAC in flash. In this case, the previous HMAC is set to zero and the first HMAC is computed over the first log message concatenated with 32 zero-bytes. The first record in the log file then consists of the first log message plus 32 zero-bytes. The second record consists of the second message plus HMAC1 = HMAC (message1 || 0x0000). This results in the organization shown below.

MSG 1	HMAC 0
	. . .
MSG n-1	HMAC n-2
MSG n	HMAC n-1
. . .	
MSG n+m	HMAC n+m-1
MSG n+m+1	HMAC n+m

. . .	
MSG end	HMAC n+m-1

Recent HMAC in NVRAM	HMAC end

To verify a sequence of *m* log records which is a subset of the complete log, starting at index *n*, the host must submit the data illustrated above. The HSM calculates the HMAC for each record the same way as it did when the record was originally generated, and compares this HMAC to the value it received. If all of the calculated HMACs match the received HMACs, then the entire sequence verifies. If an HMAC doesn't match, then the associated record and all following records can be considered suspect. Because the HMAC of each message depends on the HMAC of the previous one, inserting or altering messages would cause the calculated HMAC to be invalid.

The HSM always stores the HMAC of the most-recently generated log message in flash memory. When checking truncation, the host would send the newest record in its log to the HSM; and, the HSM would compute the HMAC and compare it to the one in flash. If it does not match, then truncation has occurred.

Audit Log Message Format

Each message is a fixed-length, comma delimited, and newline-terminated string. The table below shows the width and meaning of the fields in a message.

Offset	Length (Chars)	Description
0	10	Sequence number
10	1	Comma
11	17	Timestamp
28	1	Comma
29	256	Message text, interpreted from raw data
285	1	Comma
286	64	HMAC of previous record as ASCII-HEX
350	1	Comma
351	96	Data for this record as ASCII-HEX (raw data)
447	1	Newline '\n'

The raw data for the message is stored in ASCII-HEX form, along with a human-readable version. Although this format makes the messages larger, it simplifies the verification process, as the HSM expects to receive raw data records.

Example

The following example shows a sample log record. It is separated into multiple lines for readability even though it is a single record. Some white spaces are also omitted.

```
38,12/08/13 15:30:50,session 1 Access 2147483651:22621 operation LUNA_CREATE_CONTAINER
returned LUNA_RET_SM_UNKNOWN_TOSM_STATE(0x00300014) (using PIN (entry=LUNA_ENTRY_DATA_AREA)),
29C51014B6F131EC67CF48734101BBE301335C25F43EDF8828745C40755ABE25,
2600001003600B00EA552950140030005D580000030000800100000000000000000000000000000000000
```

The sequence number is “38”. The time is “12/08/13 15:30:50”.

The log message is “session 1 Access 2147483651:22621 operation LUNA_CREATE_CONTAINER returned LUNA_RET_SM_UNKNOWN_TOSM_STATE(0x00300014) (using PIN (entry=LUNA_ENTRY_DATA_AREA))”. In the message text, the “who” is the session identified by “session 1 Access 2147483651:22621” (the application is identified by the access ID major = 2147483651, minor = 22621). The “what” is “LUNA_CREATE_CONTAINER”. The operation status is “LUNA_RET_SM_UNKNOWN_TOSM_STATE(0x00300014)”.

The HMAC of previous record is
“29C51014B6F131EC67CF48734101BBE301335C25F43EDF8828745C40755ABE25”.

The remainder is the raw data for this record as ASCII-HEX.

Log External

An important element of the security audit logging feature is the ‘Log External’ function. This SafeNet extension to PKCS #11 allows a user application to insert text of the user’s choice into the log record stream. The function call is **CA_LogExternal ( )**. It can be used, for example, to insert an application name or the name of the user who is logged into the application and have the inserted text string protected as part of the audit log in the same way as records that have been generated by the HSM itself. It is recommended that applications use the **CA_LogExternal ( )** function when the application starts to insert the application name and also to insert the user name each time an individual user logs into or out of the application. The function is called as:

CA_LogExternal(CK_SLOT_ID slotID, CK_SESSION_HANDLE hSession, CK_CHAR_PTR pData, CK_ULONG puldataLen);

where:

- **slotID** is PKCS #11 slot containing the HSM or partition being addressed,
- **hSession** is the handle of the session with which the record is to be associated,
- **pData** is the pointer to the character array containing the external message and
- **puldataLen** is the length of the character array.

Note that the input character array is limited to a maximum of 100 characters and it will be truncated at 100 characters if **puldataLen** > 100.

For applications that cannot add this function call, it is possible to use the lunacm command-line function audit log external within a startup script to insert a text record at the time the application is started.

When a user logs in to the SafeNet Network HSM lunash:> session, the CA_LogExternal ( ) function is automatically called to register the user name and access ID. Subsequent HSM operations can be tracked by the access ID.

You must configure the “log external” event category in order for the HSM to log the CA_LogExternal() messages.

High Availability (HA) Implementations

If you use the SafeNet Network HSM HA feature then the calls to the SafeNet Enterprise HSMs are load-balanced. The session handle that the application receives when it opens a session is a virtual one and is managed by the HA code in the library. The actual sessions with the HSM are established by the HA code in the library and hidden from the application and will come and go as necessary to fulfill application level requests.

Before the introduction of HA AutoInsert[1] , bringing a failed or lost group member back into the group (recovery) was a manual procedure.

The Administration & Maintenance section contains a general description of the how the HA AutoInsert function works, in practice.

For every PKCS11 call, the HA recover logic will check to see if we need to perform automatic recovery to a disconnected appliance. If there is a disconnected appliance then it will try to reconnect to that appliance before it proceeds with the current PKCS11 call.

The HA recovery logic is designed in such a way that it will try to reconnect to an appliance only every X secs and N number of times where X is pre-set to one minute, and N is configurable via the "VTL" utility.

For HA recovery attempts:

- The default retry interval is 60 seconds.
- The default number of retries is effectively infinite.
- The HA configuration section in the Chrystoki.conf/crystoki.ini file is created and populated when either the interval or the number of retries is specified in the lunacm hagroup retry commands.

The following is the pseudo code of the HA logic

```
if (disconnected_member > 0  and recover_attempt_count < N and time_now - last_recover_attempt >
X) then
   performance auto recovery
   set last_recover_attempt  equal to time_now
   if  (recovery failed)  then
      increment recover_attempt_count  by 1
   else
      decrement disconnected_member by 1
      reset recover_attempt_count to 0
   end if
end if
```

The HA automatic recovery design runs within a PKCS#11 call. The responsiveness of recovering a disconnected member is greatly influenced by the frequency of PKCS11 calls from the user application. Although the logic shows that it will attempt to recover a disconnected client in X secs, in reality, it will not run until the user application makes the next PKCS11 call.

Detecting the Failure of an HA Member

When an HA Group member first fails, the HA status for the group shows "device error" for the failed member. All subsequent calls return "token not present", until the member (HSM Partition or PKI token) is returned to service.

Here is an example of two such calls using CKDemo:

```
Enter your choice : 52
Slots available:
   slot#1 - LunaNet Slot
   slot#2 - LunaNet Slot
   slot#3 - HA Virtual Card Slot

Select a slot: 3
```

[1]also known as "autorecovery", the re-introduction of a failed or lost member to an HA group.

```
HA group 1599447001 status:
   HSM 599447001      - CKR_DEVICE_ERROR
   HSM 78665001       - CKR_OK
Status: Doing great, no errors (CKR_OK)

TOKEN FUNCTIONS
( 1) Open Session  ( 2) Close Session  ( 3) Login
( 4) Logout        ( 5) Change PIN     ( 6) Init Token
( 7) Init Pin      ( 8) Mechanism List ( 9) Mechanism Info
(10) Get Info      (11) Slot Info      (12) Token Info
(13) Session Info  (14) Get Slot List  (15) Wait for Slot Event
(16) InitToken(ind)(17) InitPin (ind)  (18) Login (ind)
(19) CloneMofN

OBJECT MANAGEMENT FUNCTIONS
(20) Create object (21) Copy object    (22) Destroy object
(23) Object size   (24) Get attribute  (25) Set attribute
(26) Find object   (27) Display Object

SECURITY FUNCTIONS
(40)  Encrypt file (41) Decrypt file   (42)  Sign
(43)  Verify       (44) Hash file      (45)  Simple Generate Key
(46)  Digest Key

HIGH AVAILABILITY RECOVERY FUNCTIONS
(50) HA Init       (51) HA Login       (52) HA Status

KEY FUNCTIONS
(60) Wrap key      (61) Unwrap key     (62) Generate random number
(63) Derive Key    (64) PBE Key Gen    (65) Create known keys
(66) Seed RNG      (67) EC User Defined Curves

CA FUNCTIONS
(70) Set Domain    (71) Clone Key      (72) Set MofN
(73) Generate MofN (74) Activate MofN  (75) Generate Token Keys
(76) Get Token Cert(77) Sign Token Cert(78) Generate CertCo Cert
(79) Modify MofN   (86) Dup. MofN Keys (87) Deactivate MofN

CCM FUNCTIONS
(80) Module List   (81) Module Info    (82) Load Module
(83) Load Enc Mod  (84) Unload Module  (85) Module function Call

OTHERS
(90) Self Test     (94) Open Access    (95) Close Access
(97) Set App ID    (98) Options

OFFBOARD KEY STORAGE:
(101) Extract Masked Object    (102) Insert Masked Object
(103) Multisign With Value     (104) Clone Object
(105) SIMExtract               (106) SIMInsert
(107) SimMultiSign

SCRIPT EXECUTION:
(108) Execute Script
(109) Execute Asynchronous Script
(110) Execute Single Part Script
(0) Quit demo
Enter your choice : 52
```



```
Slots available:
   slot#1 - LunaNet Slot
   slot#2 - LunaNet Slot
   slot#3 - HA Virtual Card Slot

Select a slot: 3

HA group 1599447001 status:
   HSM 599447001      - CKR_TOKEN_NOT_PRESENT
   HSM 78665001       - CKR_OK
Status: Doing great, no errors (CKR_OK)
--- end ---
```

Migrating Keys From Software to a SafeNet HSM

SafeNet HSMs expect key material to be in PKCS#8 format. PKCS#8 format follows BER (Basic encoding rules) /DER (distinguished encoding rules) encoding. An example of this format can be found in the document "Some examples of PKCS standards" produced by RSA, and available on their web site (http://www.rsasecurity.com/rsalabs/pkcs/index.html at the bottom of the page, under “Related Documents”).

Here is an example of a formatted key:

```
 0x30,
 0x82, 0x04, 0xbc, 0x02, 0x01, 0x00, 0x30, 0x0d, 0x06, 0x09, 0x2a, 0x86,
 0x48, 0x86, 0xf7, 0x0d, 0x01, 0x01, 0x01, 0x05, 0x00, 0x04, 0x82, 0x04,
 0xa6, 0x30, 0x82, 0x04, 0xa2, 0x02, 0x01, 0x00, 0x02, 0x82, 0x01, 0x01,
 0x00, 0xb8, 0xb5, 0x0f, 0x49, 0x46, 0xb5, 0x5d, 0x58, 0x04, 0x8e, 0x52,
 0x59, 0x39, 0xdf, 0xd6, 0x29, 0x45, 0x6b, 0x6c, 0x96, 0xbb, 0xab, 0xa5,
 0x6f, 0x72, 0x1b, 0x16, 0x96, 0x74, 0xd5, 0xf9, 0xb4, 0x41, 0xa3, 0x7c,
 0xe1, 0x94, 0x73, 0x4b, 0xa7, 0x23, 0xff, 0x61, 0xeb, 0xce, 0x5a, 0xe7,
 0x7f, 0xe3, 0x74, 0xe8, 0x52, 0x5b, 0xd6, 0x5d, 0x5c, 0xdc, 0x98, 0x49,
 0xfe, 0x51, 0xc2, 0x7e, 0x8f, 0x3b, 0x37, 0x5c, 0xb3, 0x11, 0xed, 0x85,
 0x91, 0x15, 0x92, 0x24, 0xd8, 0xf1, 0x7b, 0x3d, 0x2f, 0x8b, 0xcd, 0x1b,
 0x30, 0x14, 0xa3, 0x6b, 0x1b, 0x4d, 0x27, 0xff, 0x6a, 0x58, 0x84, 0x9e,
 0x79, 0x94, 0xca, 0x78, 0x64, 0x01, 0x33, 0xc3, 0x58, 0xfc, 0xd3, 0x83,
 0xeb, 0x2f, 0xab, 0x6f, 0x85, 0x5a, 0x38, 0x41, 0x3d, 0x73, 0x20, 0x1b,
 0x82, 0xbc, 0x7e, 0x76, 0xde, 0x5c, 0xfe, 0x42, 0xd6, 0x7b, 0x86, 0x4f,
 0x79, 0x78, 0x29, 0x82, 0x87, 0xa6, 0x24, 0x43, 0x39, 0x74, 0xfe, 0xf2,
 0x0c, 0x08, 0xbe, 0xfa, 0x1e, 0x0a, 0x48, 0x6f, 0x14, 0x86, 0xc5, 0xcd,
 0x9a, 0x98, 0x09, 0x2d, 0xf3, 0xf3, 0x5a, 0x7a, 0xa4, 0xe6, 0x8a, 0x2e,
 0x49, 0x8a,  0xde,
 0x73, 0xe9, 0x37, 0xa0, 0x5b, 0xef, 0xd0, 0xe0, 0x13, 0xac, 0x88, 0x5f,
 0x59, 0x47, 0x96, 0x7f, 0x78, 0x18, 0x0e, 0x44, 0x6a, 0x5d,  0xec,
 0x6e, 0xed, 0x4f, 0xf6, 0x6a, 0x7a, 0x58, 0x6b, 0xfe, 0x6c, 0x5a, 0xb9,
 0xd2, 0x22, 0x3a, 0x1f, 0xdf, 0xc3, 0x09, 0x3f, 0x6b, 0x2e, 0xf1, 0x6d,
 0xc3, 0xfb, 0x4e, 0xd4, 0xf2, 0xa3, 0x94, 0x13, 0xb0, 0xbf, 0x1e, 0x06,
 0x2e, 0x29, 0x55, 0x00, 0xaa, 0x98, 0xd9, 0xe8, 0x77, 0x84, 0x8b, 0x3f,
 0x5f, 0x5e, 0xf7, 0xf8, 0xa7, 0xe6, 0x02, 0xd2, 0x18, 0xb0, 0x52, 0xd0,
 0x37, 0x2e, 0x53, 0x02, 0x03, 0x01, 0x00, 0x01, 0x02, 0x82, 0x01, 0x00,
 0x0c, 0xdf, 0xd1, 0xe8, 0xf1, 0x9c, 0xc2, 0x9c, 0xd7, 0xf4, 0x73, 0x98,
 0xf4, 0x87, 0xbd, 0x8d, 0xb2, 0xe1, 0x01, 0xf8, 0x9f, 0xac, 0x1f, 0x23,
 0xdd, 0x78, 0x35, 0xe2, 0xd6, 0xd1, 0xf3, 0x4d, 0xb5, 0x25, 0x88, 0x16,
 0xd1, 0x1a, 0x18, 0x33, 0xd6, 0x36, 0x7e, 0xc4, 0xc8, 0xe5, 0x5d, 0x2d,
 0x74, 0xd5, 0x39, 0x3c, 0x44, 0x5a, 0x74, 0xb7, 0x7c, 0x48, 0xc1, 0x1f,
 0x90, 0xe3, 0x55, 0x9e, 0xf6, 0x29, 0xad, 0xb4, 0x6d, 0x93, 0x78, 0xb3,
 0xdc, 0x25, 0x0b, 0x9c, 0x73, 0x78, 0x7b, 0x93, 0x4c, 0xd3, 0x47, 0x09,
```



```
0xda, 0xe6, 0x69, 0x18, 0xc6, 0x0f, 0xfb, 0xa5, 0x95, 0xf5, 0xe8, 0x75,
0xe1, 0x01, 0x1b, 0xd3, 0x1c, 0xa2, 0x57, 0x03, 0x64, 0xdb, 0xf9, 0x5d,
0xf3, 0x3c, 0xa7, 0xd1, 0x4b, 0xb0, 0x90, 0x1b, 0x90, 0x62, 0xb4, 0x88,
0x30, 0x4b, 0x40, 0x4d, 0xcf, 0x7d, 0x89, 0x7a, 0xfb, 0x29, 0xc9, 0x64,
0x34, 0x0a, 0x52, 0xf6, 0x70, 0x7c, 0x76, 0x5a, 0x2e, 0x8f, 0x50, 0xd4,
0x92, 0x15, 0x97, 0xed, 0x4c, 0x2e, 0xf2, 0x3a, 0xd0, 0x58, 0x7e, 0xdb,
0xf1, 0xf4, 0xdd, 0x07, 0x76, 0x04, 0xf0, 0x55, 0x8b, 0x72, 0x2b, 0xa7,
0xa8, 0x78, 0x78, 0x67, 0xe6, 0xd8, 0xa5, 0xde, 0xe7, 0xc9, 0x1f, 0x5a,
0xa0, 0x89, 0xc7, 0x24, 0xa2, 0x71, 0xb6, 0x7b, 0x3b, 0xe6, 0x92, 0x69,
0x22, 0xaa, 0xe2, 0x47, 0x4b, 0x80, 0x3f, 0x6a, 0xab, 0xce, 0x4e, 0xcd,
0xe8, 0x94, 0x6c, 0xf7, 0x84, 0x73, 0x85, 0xfd, 0x85, 0x1d, 0xae, 0x81,
0xf7, 0xec, 0x12, 0x31, 0x7d, 0xc1, 0x99, 0xc0, 0x3c, 0x51, 0xb0, 0xdc,
0xb0, 0xba, 0x9c, 0x84, 0xb8, 0x70, 0xc2, 0x09, 0x7f, 0x96, 0x3d, 0xa1,
0xe2, 0x64, 0x27, 0x7a, 0x22, 0xb8, 0x75, 0xb9, 0xd1, 0x5f, 0xa5, 0x23,
0xf9, 0x62, 0xe0, 0x41, 0x02, 0x81, 0x81, 0x00, 0xf4, 0xf3, 0x08, 0xcf,
0x83, 0xb0, 0xab, 0xf2, 0x0f, 0x1a, 0x08, 0xaf, 0xc2, 0x42, 0x29, 0xa7,
0x9c, 0x5e, 0x52, 0x19, 0x69, 0x8d, 0x5b, 0x52, 0x29, 0x9c, 0x06, 0x6a,
0x5a, 0x32, 0x8f, 0x08, 0x45, 0x6c, 0x43, 0xb5, 0xac, 0xc3, 0xbb, 0x90,
0x7b, 0xec, 0xbb, 0x5d, 0x71, 0x25, 0x82, 0xf8, 0x40, 0xbf, 0x38, 0x00,
0x20, 0xf3, 0x8a, 0x38, 0x43, 0xde, 0x04, 0x41, 0x19, 0x5f, 0xeb, 0xb0,
0x50, 0x59, 0x10, 0xe1, 0x54, 0x62, 0x5c, 0x93, 0xd9, 0xdc, 0x63, 0x24,
0xd0, 0x17, 0x00, 0xc0, 0x44, 0x3e, 0xfc, 0xd1, 0xda, 0x4b, 0x24, 0xf7,
0xcb, 0x16, 0x35, 0xe6, 0x9f, 0x67, 0x96, 0x5f, 0xb0, 0x94, 0xde, 0xfa,
0xa1, 0xfd, 0x8c, 0x8a, 0xd1, 0x5c, 0x02, 0x8d, 0xe0, 0xa0, 0xa0,  0x02,
0x1d, 0x56, 0xaf, 0x13, 0x3a, 0x65, 0x5e, 0x8e, 0xde, 0xd1, 0xa8, 0x28,
0x8b, 0x71, 0xc9, 0x65, 0x02, 0x81, 0x81, 0x00, 0xc1, 0x0a,  0x47,
0x39, 0x91, 0x06, 0x1e, 0xb9, 0x43, 0x7c, 0x9e, 0x97, 0xc5, 0x09, 0x08,
0xbc, 0x22, 0x47, 0xe2, 0x96, 0x8e, 0x1c, 0x74, 0x80, 0x50, 0x6c, 0x9f,
0xef, 0x2f, 0xe5, 0x06, 0x3e, 0x73, 0x66, 0x76, 0x02, 0xbd, 0x9a, 0x1c,
0xfc, 0xf9, 0x6a, 0xb8, 0xf9, 0x36, 0x15, 0xb5, 0x20, 0x0b, 0x6b, 0x54,
0x83, 0x9c, 0x86, 0xba, 0x13, 0xb7, 0x99, 0x54, 0xa0, 0x93, 0x0d, 0xd6,
0x1e, 0xc1, 0x12, 0x72, 0x0d, 0xea, 0xb0, 0x14, 0x30, 0x70, 0x73, 0xef,
0x6b, 0x4c, 0xae, 0xb6, 0xff, 0xd4, 0xbb, 0x89, 0xa1, 0xec, 0xca, 0xa6,
0xe9, 0x95, 0x56, 0xac, 0xe2, 0x9b, 0x97, 0x2f, 0x2c, 0xdf, 0xa3, 0x6e,
0x59, 0xff, 0xcd, 0x3c, 0x6f, 0x57, 0xcc, 0x6e, 0x44, 0xc4, 0x27, 0xbf,
0xc3, 0xdd, 0x19, 0x9e, 0x81, 0x16, 0xe2, 0x8f, 0x65, 0x34, 0xa7, 0x0f,
0x22, 0xba, 0xbf, 0x79, 0x57, 0x02, 0x81, 0x80, 0x2e, 0x21, 0x0e, 0xc9,
0xb5, 0xad, 0x31, 0xd4, 0x76, 0x0f, 0x9b, 0x0f, 0x2e, 0x70, 0x33, 0x54,
0x03, 0x58, 0xa7, 0xf1, 0x6d, 0x35, 0x57, 0xbb, 0x53, 0x66, 0xb4, 0xb6,
0x96, 0xa1, 0xea, 0xd9, 0xcd, 0xe9, 0x23, 0x9f, 0x35, 0x17, 0xef, 0x5c,
0xb8, 0x59, 0xce, 0xb7, 0x3c, 0x35, 0xaa, 0x42, 0x82, 0x3f, 0x00, 0x96,
0xd5, 0x9d, 0xc7, 0xab, 0xec, 0xec, 0x04, 0xb5, 0x15, 0xc8, 0x40, 0xa4,
0x85, 0x9d, 0x20, 0x56, 0xaf, 0x03, 0x8f, 0x17, 0xb0, 0xf1, 0x96, 0x22,
0x3a, 0xa5, 0xfa, 0x58, 0x3b, 0x01, 0xf9, 0xae, 0xb3, 0x83, 0x6f, 0x44,
0xd3, 0x14, 0x2d, 0xb6, 0x6e, 0xd2, 0x9d, 0x39, 0x0c, 0x12, 0x1d, 0x23,
0xea, 0x19, 0xcb, 0xbb, 0xe0, 0xcd, 0x89, 0x15, 0x9a, 0xf5, 0xe4, 0xec,
0x41, 0x06, 0x30, 0x16, 0x58, 0xea, 0xfa, 0x31, 0xc1, 0xb8, 0x8e, 0x08,
0x84, 0xaa, 0x3b, 0x19, 0x02, 0x81, 0x80, 0x70, 0x4c, 0xf8, 0x6e, 0x86,
0xed, 0xd6, 0x85, 0xd4, 0xba, 0xf4, 0xd0, 0x3a, 0x32, 0x2d, 0x40, 0xb5,
0x78, 0xb8, 0x5a, 0xf9, 0xc5, 0x98, 0x08, 0xe5, 0xc0, 0xab, 0xb2, 0x4c,
0x5c, 0xa2, 0x2b, 0x46, 0x9b, 0x3e, 0xe0, 0x0d, 0x49, 0x50, 0xbf, 0xe2,
0xa1, 0xb1, 0x86, 0x59, 0x6e, 0x7b, 0x76, 0x6e, 0xee, 0x3b, 0xb6, 0x6d,
0x22, 0xfb, 0xb1, 0x68, 0xc7, 0xec, 0xb1, 0x95, 0x9b, 0x21, 0x0b, 0xb7,
0x2a, 0x71, 0xeb, 0xa2, 0xb2, 0x58, 0xac, 0x6d, 0x5f, 0x24, 0xd3, 0x79,
0x42, 0xd2, 0xf7, 0x35, 0xdc, 0xfc, 0x0e, 0x95, 0x60, 0xb7, 0x85, 0x7f,
0xf9, 0x72, 0x8e, 0x4a, 0x11, 0xc3, 0xc2, 0x09, 0x40, 0x5c, 0x7c, 0x43,
0x12, 0x34, 0xac, 0x59, 0x99, 0x76, 0x34,  0xcf,
```

```
0x20, 0x88, 0xb0, 0xfb, 0x39, 0x62, 0x3a, 0x9b, 0x03, 0xa6, 0x84, 0x2c,
0x03, 0x5c, 0x0c, 0xca, 0x33, 0x85, 0xf5, 0x02, 0x81, 0x80,  0x56,
0x99, 0xe9, 0x17, 0xdc, 0x33, 0xe1, 0x33, 0x8d, 0x5c, 0xba, 0x17, 0x32,
0xb7, 0x8c, 0xbd, 0x4b, 0x7f, 0x42, 0x3a, 0x79, 0x90, 0xe3,  0x70,
0xe3, 0x27, 0xce, 0x22, 0x59, 0x02, 0xc0, 0xb1, 0x0e, 0x57, 0xf5, 0xdf,
0x07, 0xbf, 0xf8, 0x4e, 0x10, 0xef, 0x2a, 0x62, 0x30, 0x03,  0xd4,
0x80, 0xcf, 0x20, 0x84, 0x25, 0x66, 0x3f, 0xc7, 0x4f, 0x56, 0x8c, 0x1e,
0xe1, 0x18, 0x91, 0xc1, 0xfd, 0x71, 0x5f, 0x65, 0x9b, 0xe4,  0x4f,
0xe0, 0x1a, 0x3a, 0xf8, 0xc1, 0x69, 0xdb, 0xd3, 0xbb, 0x8d, 0x91, 0xd1,
0x11, 0x4f, 0x7e, 0x91, 0x1b, 0xb4, 0x27, 0xa5, 0xab, 0x7c,  0x7b,
0x76, 0xd4, 0x78, 0xfe, 0x63, 0x44, 0x63, 0x7e, 0xe3, 0xa6, 0x60, 0x4f,
0xb9, 0x55, 0x28, 0xba, 0xba, 0x83, 0x1a, 0x2d, 0x43, 0xd5,  0xf7,
0x2e, 0xe0, 0xfc, 0xa8, 0x14, 0x9b, 0x91, 0x2a, 0x36, 0xbf, 0xc7, 0x14
```

The example above contains the exponent, the modulus, and private key material.

Other Formats of Key Material

The format of key material depends on the application, and is therefore unpredictable. Key material commonly exists in any of the following formats; ASN1, PEM, P12, PFX, etc. Key material in those formats, or in another format, can likely be re-formatted to be acceptable for moving onto the SafeNet HSM.

Sample Program

The sample program below encrypts a known RSA private key, then unwraps the key pair onto the SafeNet HSM Partition.

```
/*******************************************************************************\

*

* File: UnwrapKey.cpp*

* Encrypts a PrivateKeyInfo structure with a generated DES key and then

* unwraps the RSA key onto a token.

*

* This file is provided as an example only.

*

*

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*

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* proprietary to SafeNet, Inc. and may not be

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* SafeNet, Inc.

*

\*****************************************************************/

#ifdef UNIX
```

```
#define _POSIX_SOURCE 1
#endif
#ifdef USING_STATIC_CHRYSTOKI
# define STATIC  ckdemo_cpp
#endif
#include <assert.h>
#include <iostream.h>
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <fcntl.h>
#include <sys/stat.h>
#include <time.h>
#ifdef _WINDOWS
#include <conio.h>
#include <io.h>
#include <windows.h>
#endif
#ifdef UNIX
#include <unistd.h>
#endif
#include "source/cryptoki.h"
#include "source/Ckbridge.h"
#define DIM(a)          (sizeof(a)/sizeof(a[0]))
CK_BBOOL no = FALSE;
CK_BBOOL yes = TRUE;
const int MAX =100;
// Function Prototypes
CK_RV  Pinlogin(CK_SESSION_HANDLE hSession);
int getPinString(CK_CHAR_PTR pw);
// Main
int main( void )
{
  int error = 0;
  CK_RV retCode = CKR_OK;
  CK_SESSION_HANDLE hSessionHandle;
```



```
  CK_CHAR_PTR userPIN = (CK_CHAR_PTR)"default";
  CK_USHORT lenuserPIN = 7;
  CK_CHAR_PTR soPIN = (CK_CHAR_PTR)"default";
  CK_USHORT lensoPIN = 7;
  CK_USHORT usNumberOfSlots;
  CK_SLOT_ID_PTR pSlotList;
  CK_OBJECT_HANDLE hKey;
  CK_MECHANISM mech;
  CK_VERSION version;
  struct
  {
    CK_INFO info;
    char reserved[100]; // This is in case the library that we are
                // talking to requires a larger info structure
                // then the one defined.
  } protectedInfo;
//Disclaimer
  cout << "\n\n\n\n";
cout << "THE SOFTWARE IS PROVIDED BY SAFENET INCORPORATED (SAFENET) ON AN 'AS IS' BASIS, \n";
cout << "WITHOUT ANY OTHER WARRANTIES OR CONDITIONS, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED \n";
cout << "TO, WARRANTIES OF MERCHANTABLE QUALITY, SATISFACTORY QUALITY, MERCHANTABILITY OR FITNESS FOR\n";
cout << "A PARTICULAR PURPOSE, OR THOSE ARISING BY LAW, STATUTE, USAGE OF TRADE, COURSE OF DEALING OR\n";
cout << "OTHERWISE.  SAFENET DOES NOT WARRANT THAT THE SOFTWARE WILL MEET YOUR REQUIREMENTS OR \n";
cout << "THAT OPERATION OF THE SOFTWARE WILL BE UNINTERRUPTED OR THAT THE SOFTWARE WILL BE ERROR-FREE.\n";
cout << "YOU ASSUME THE ENTIRE RISK AS TO THE RESULTS AND PERFORMANCE OF THE SOFTWARE. NEITHER \n";
cout << "SAFENET NOR OUR LICENSORS, DEALERS OR SUPPLIERS SHALL HAVE ANY LIABILITY TO YOU OR ANY\n";
cout << "OTHER PERSON OR ENTITY FOR ANY INDIRECT, INCIDENTAL, SPECIAL, CONSEQUENTIAL, PUNITIVE, \n";
cout << "EXEMPLARY OR AY OTHER DAMAGES WHATSOEVER, INCLUDING, BUT NOT LIMITED TO, LOSS OF REVENUE OR \n";
```

```
cout << "PROFIT, LOST OR DAMAGED DATA, LOSS OF USE OR OTHER COMMERCIAL OR ECONOMIC LOSS, EVEN IF \n";
cout << "SAFENET HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, OR THEY ARE FORESEEABLE. \n";
cout << "SAFENET IS ALSO NOT RESPONSIBLE FOR CLAIMS BY A THIRD PARTY.  THE MAXIMUM AGGREGATE \n";
cout << "LIABILITY OF SAFENET TO YOU AND THAT OF SAFENET'S LICENSORS, DEALERS AND SUPPLIERS \n";
cout << "SHALL NOT EXCEED FORTY DOLLARS ($40.00CDN). THE LIMITATIONS IN THIS SECTION SHALL APPLY \n";
cout << "WHETHER OR NOT THE ALLEGED BREACH OR DEFAULT IS A BREACH OF A FUNDAMENTAL CONDITION OR TERM \n";
cout << "OR A FUNDAMENTAL BREACH.  SOME STATES/COUNTRIES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF\n";
cout << "LIABILITY FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES, SO THE ABOVE LIMITATION MAY NOT APPLY TO \n";
cout << "YOU.\n";
cout << "THE LIMITED WARRANTY, EXCLUSIVE REMEDIES AND LIMITED LIABILITY SET OUT HEREIN ARE FUNDAMENTAL \n";
cout << "ELEMENTS OF THE BASIS OF THE BARGAIN BETWEEN YOU AND SAFENET.  \n";
cout << "NO SUPPORT.  YOU ACKNOWLEDGE AND AGREE THAT THERE ARE NO SUPPORT SERVICES PROVIDED BY SAFENET\n";
cout << "INCORPORATED FOR THIS SOFTWARE\n" << endl;
  // Display Generic Warning
  cout << "\nInsert a token for the test...";
  cout << "\n\nWARNING!!! This test initializes the first ";
  cout << " token detected in the card reader.";
  cout << "\nDo not use a token that you don't want erased.";
  cout << "\nYou can use CTRL-C to abort now...Otherwise...";
  cout << "\n\n... press <Enter> key to continue ...\n";
  cout.flush();
  getchar(); // Wait for keyboard hit
#ifndef STATIC
  // Connect to Chrystoki
if(!CrystokiConnect())
{
cout << "\n" "Unable to connect to Chrystoki. Error = " << LibError() << "\n";
error = -1;
    goto exit_routine_1;
```

```
}
#endif
  // Verify this is the version of the library required
  retCode = C_GetInfo(&protectedInfo.info);
  if( retCode != CKR_OK )
  {
    cout << endl << "Unable to call C_GetInfo() before C_Initialize()\n";
error = -2;
    goto exit_routine_2;
  }
  else
  {
    CK_BYTE majorVersion = protectedInfo.info.version.major;
    CK_BYTE expectedVersion;
#ifndef PKCS11_2_0
    expectedVersion = 1;
#else
    expectedVersion = 2;
#endif
    if( expectedVersion != majorVersion )
    {
      cout << endl << "This version of the program was built for Cryptoki version "
          << (int)expectedVersion << ".\n"
          << "The loaded Cryptoki library reports its version to be "
          << (int)majorVersion << ".\n"
          << "Program will terminate.\n";
      // Wait to exit until user read message and acknowledges
      cout << endl << "Press <Enter> key to end.";
      getchar(); // Wait for keyboard hit
  error = -3;
      goto exit_routine_2;
    }
  }
  // Initialize the Library
retCode = C_Initialize(NULL);
if(retCode != CKR_OK)
```



```
{
cout << "\n" "Error 0x" << hex << retCode << " initializing cryptoki.\n";
error = -4;
    goto exit_routine_3;
}
// Get the number of tokens possibly available
retCode = C_GetSlotList(TRUE, NULL, &usNumberOfSlots);
if(retCode != CKR_OK)
{
cout << "\n" "Error 0x" << hex << retCode << " getting slot list.\n";
error = -5;
    goto exit_routine_3;
}
// Are any tokens present?
if(usNumberOfSlots == 0)
{
cout << "\n" "No tokens found\n";
error = -6;
    goto exit_routine_3;
  }
  // Get a list of slots
pSlotList = new CK_SLOT_ID[usNumberOfSlots];
retCode = C_GetSlotList(TRUE, pSlotList, &usNumberOfSlots);
if(retCode != CKR_OK)
{
cout << "\n" "Error 0x" << hex << retCode << " getting slot list.\n";
error = -7;
    goto exit_routine_4;
}
  // Open a session
retCode = C_OpenSession(pSlotList[0], CKF_RW_SESSION | CKF_SERIAL_SESSION,
    NULL, NULL, &hSessionHandle);
if(retCode != CKR_OK)
{
cout << "\n" "Error 0x" << hex << retCode << " opening session.\n";
error = -9;
```



```
    goto exit_routine_4;
}
Pinlogin(hSessionHandle);
if(retCode != CKR_OK)
{
cout << "\n" "Error 0x" << hex << retCode << " Calling PinLogin fn";
exit(hSessionHandle);
}
  // Encrypt an RSA Key and then unwrap it onto the token
  {
    // The following is an RSA Key that is formatted as a PrivateKeyInfo structure
  //BER encoded format
    const CK_BYTE pRsaKey[] = {
 0x30, 0x82, 0x04, 0xbc, 0x02, 0x01, 0x00, 0x30, 0x0d, 0x06, 0x09, 0x2a, 0x86, 0x48, 0x86, 0xf7, 0x0d, 0x01, 0x01,
0x01, 0x05, 0x00, 0x04,
 0x82, 0x04, 0xa6, 0x30, 0x82, 0x04, 0xa2, 0x02, 0x01, 0x00, 0x02, 0x82, 0x01, 0x01, 0x00, 0xb8, 0xb5, 0x0f, 0x49,
0x46, 0xb5, 0x5d, 0x58,
 0x04, 0x8e, 0x52, 0x59, 0x39, 0xdf, 0xd6, 0x29, 0x45, 0x6b, 0x6c, 0x96, 0xbb, 0xab, 0xa5, 0x6f, 0x72, 0x1b, 0x16,
0x96, 0x74, 0xd5, 0xf9,
 0xb4, 0x41, 0xa3, 0x7c, 0xe1, 0x94, 0x73, 0x4b, 0xa7, 0x23, 0xff, 0x61, 0xeb, 0xce, 0x5a, 0xe7, 0x7f, 0xe3, 0x74,
0xe8, 0x52, 0x5b, 0xd6,
 0x5d, 0x5c, 0xdc, 0x98, 0x49, 0xfe, 0x51, 0xc2, 0x7e, 0x8f, 0x3b, 0x37, 0x5c, 0xb3, 0x11, 0xed, 0x85, 0x91, 0x15,
0x92, 0x24, 0xd8, 0xf1,
 0x7b, 0x3d, 0x2f, 0x8b, 0xcd, 0x1b, 0x30, 0x14, 0xa3, 0x6b, 0x1b, 0x4d, 0x27, 0xff, 0x6a, 0x58, 0x84, 0x9e, 0x79,
0x94, 0xca, 0x78, 0x64,
 0x01, 0x33, 0xc3, 0x58, 0xfc, 0xd3, 0x83, 0xeb, 0x2f, 0xab, 0x6f, 0x85, 0x5a, 0x38, 0x41, 0x3d, 0x73, 0x20, 0x1b,
0x82, 0xbc, 0x7e, 0x76,
 0xde, 0x5c, 0xfe, 0x42, 0xd6, 0x7b, 0x86, 0x4f, 0x79, 0x78, 0x29, 0x82, 0x87, 0xa6, 0x24, 0x43, 0x39, 0x74, 0xfe,
0xf2, 0x0c, 0x08, 0xbe,
 0xfa, 0x1e, 0x0a, 0x48, 0x6f, 0x14, 0x86, 0xc5, 0xcd, 0x9a, 0x98, 0x09, 0x2d, 0xf3, 0xf3, 0x5a, 0x7a, 0xa4, 0xe6,
0x8a, 0x2e, 0x49, 0x8a, 0xde, 0x73, 0xe9, 0x37, 0xa0, 0x5b, 0xef,
 0xd0, 0xe0, 0x13, 0xac, 0x88, 0x5f, 0x59, 0x47, 0x96, 0x7f, 0x78, 0x18, 0x0e, 0x44, 0x6a, 0x5d, 0xec, 0x6e, 0xed,
0x4f, 0xf6, 0x6a, 0x7a,
 0x58, 0x6b, 0xfe, 0x6c, 0x5a, 0xb9, 0xd2, 0x22, 0x3a, 0x1f, 0xdf, 0xc3, 0x09, 0x3f, 0x6b, 0x2e, 0xf1, 0x6d, 0xc3,
0xfb, 0x4e, 0xd4, 0xf2,
 0xa3, 0x94, 0x13, 0xb0, 0xbf, 0x1e, 0x06, 0x2e, 0x29, 0x55, 0x00, 0xaa, 0x98, 0xd9, 0xe8, 0x77, 0x84, 0x8b, 0x3f,
```

```
0x5f, 0x5e, 0xf7, 0xf8,
 0xa7, 0xe6, 0x02, 0xd2, 0x18, 0xb0, 0x52, 0xd0, 0x37, 0x2e, 0x53, 0x02, 0x03, 0x01, 0x00, 0x01, 0x02, 0x82, 0x01,
0x00, 0x0c, 0xdf, 0xd1,
 0xe8, 0xf1, 0x9c, 0xc2, 0x9c, 0xd7, 0xf4, 0x73, 0x98, 0xf4, 0x87, 0xbd, 0x8d, 0xb2, 0xe1, 0x01, 0xf8, 0x9f, 0xac,
0x1f, 0x23, 0xdd, 0x78,
 0x35, 0xe2, 0xd6, 0xd1, 0xf3, 0x4d, 0xb5, 0x25, 0x88, 0x16, 0xd1, 0x1a, 0x18, 0x33, 0xd6, 0x36, 0x7e, 0xc4, 0xc8,
0xe5, 0x5d, 0x2d, 0x74,
 0xd5, 0x39, 0x3c, 0x44, 0x5a, 0x74, 0xb7, 0x7c, 0x48, 0xc1, 0x1f, 0x90, 0xe3, 0x55, 0x9e, 0xf6, 0x29, 0xad, 0xb4,
0x6d, 0x93, 0x78, 0xb3,
 0xdc, 0x25, 0x0b, 0x9c, 0x73, 0x78, 0x7b, 0x93, 0x4c, 0xd3, 0x47, 0x09, 0xda, 0xe6, 0x69, 0x18, 0xc6, 0x0f, 0xfb,
0xa5, 0x95, 0xf5, 0xe8,
 0x75, 0xe1, 0x01, 0x1b, 0xd3, 0x1c, 0xa2, 0x57, 0x03, 0x64, 0xdb, 0xf9, 0x5d, 0xf3, 0x3c, 0xa7, 0xd1, 0x4b, 0xb0,
0x90, 0x1b, 0x90, 0x62,
 0xb4, 0x88, 0x30, 0x4b, 0x40, 0x4d, 0xcf, 0x7d, 0x89, 0x7a, 0xfb, 0x29, 0xc9, 0x64, 0x34, 0x0a, 0x52, 0xf6, 0x70,
0x7c, 0x76, 0x5a, 0x2e,
 0x8f, 0x50, 0xd4, 0x92, 0x15, 0x97, 0xed, 0x4c, 0x2e, 0xf2, 0x3a, 0xd0, 0x58, 0x7e, 0xdb, 0xf1, 0xf4, 0xdd, 0x07,
0x76, 0x04, 0xf0, 0x55,
 0x8b, 0x72, 0x2b, 0xa7, 0xa8, 0x78, 0x78, 0x67, 0xe6, 0xd8, 0xa5, 0xde, 0xe7, 0xc9, 0x1f, 0x5a, 0xa0, 0x89, 0xc7,
0x24, 0xa2, 0x71, 0xb6,
 0x7b, 0x3b, 0xe6, 0x92, 0x69, 0x22, 0xaa, 0xe2, 0x47, 0x4b, 0x80, 0x3f, 0x6a, 0xab, 0xce, 0x4e, 0xcd, 0xe8, 0x94,
0x6c, 0xf7, 0x84, 0x73,
 0x85, 0xfd, 0x85, 0x1d, 0xae, 0x81, 0xf7, 0xec, 0x12, 0x31, 0x7d, 0xc1, 0x99, 0xc0, 0x3c, 0x51, 0xb0, 0xdc, 0xb0,
0xba, 0x9c, 0x84, 0xb8,
 0x70, 0xc2, 0x09, 0x7f, 0x96, 0x3d, 0xa1, 0xe2, 0x64, 0x27, 0x7a, 0x22, 0xb8, 0x75, 0xb9, 0xd1, 0x5f, 0xa5, 0x23,
0xf9, 0x62, 0xe0, 0x41,
 0x02, 0x81, 0x81, 0x00, 0xf4, 0xf3, 0x08, 0xcf, 0x83, 0xb0, 0xab, 0xf2, 0x0f, 0x1a, 0x08, 0xaf, 0xc2, 0x42, 0x29,
0xa7, 0x9c, 0x5e, 0x52,
 0x19, 0x69, 0x8d, 0x5b, 0x52, 0x29, 0x9c, 0x06, 0x6a, 0x5a, 0x32, 0x8f, 0x08, 0x45, 0x6c, 0x43, 0xb5, 0xac, 0xc3,
0xbb, 0x90, 0x7b, 0xec,
 0xbb, 0x5d, 0x71, 0x25, 0x82, 0xf8, 0x40, 0xbf, 0x38, 0x00, 0x20, 0xf3, 0x8a, 0x38, 0x43, 0xde, 0x04, 0x41, 0x19,
0x5f, 0xeb, 0xb0, 0x50,
 0x59, 0x10, 0xe1, 0x54, 0x62, 0x5c, 0x93, 0xd9, 0xdc, 0x63, 0x24, 0xd0, 0x17, 0x00, 0xc0, 0x44, 0x3e, 0xfc, 0xd1,
0xda, 0x4b, 0x24, 0xf7,
 0xcb, 0x16, 0x35, 0xe6, 0x9f, 0x67, 0x96, 0x5f, 0xb0, 0x94, 0xde, 0xfa, 0xa1, 0xfd, 0x8c, 0x8a, 0xd1, 0x5c, 0x02,
0x8d, 0xe0, 0xa0, 0xa0,
 0x02, 0x1d, 0x56, 0xaf, 0x13, 0x3a, 0x65, 0x5e, 0x8e, 0xde, 0xd1, 0xa8, 0x28, 0x8b, 0x71, 0xc9, 0x65, 0x02, 0x81,
```


0x81, 0x00, 0xc1, 0x0a,

0x47, 0x39, 0x91, 0x06, 0x1e, 0xb9, 0x43, 0x7c, 0x9e, 0x97, 0xc5, 0x09, 0x08, 0xbc, 0x22, 0x47, 0xe2, 0x96, 0x8e, 0x1c, 0x74, 0x80, 0x50,

0x6c, 0x9f, 0xef, 0x2f, 0xe5, 0x06, 0x3e, 0x73, 0x66, 0x76, 0x02, 0xbd, 0x9a, 0x1c, 0xfc, 0xf9, 0x6a, 0xb8, 0xf9, 0x36, 0x15, 0xb5, 0x20,

0x0b, 0x6b, 0x54, 0x83, 0x9c, 0x86, 0xba, 0x13, 0xb7, 0x99, 0x54, 0xa0, 0x93, 0x0d, 0xd6, 0x1e, 0xc1, 0x12, 0x72, 0x0d, 0xea, 0xb0, 0x14,

0x30, 0x70, 0x73, 0xef, 0x6b, 0x4c, 0xae, 0xb6, 0xff, 0xd4, 0xbb, 0x89, 0xa1, 0xec, 0xca, 0xa6, 0xe9, 0x95, 0x56, 0xac, 0xe2, 0x9b, 0x97,

0x2f, 0x2c, 0xdf, 0xa3, 0x6e, 0x59, 0xff, 0xcd, 0x3c, 0x6f, 0x57, 0xcc, 0x6e, 0x44, 0xc4, 0x27, 0xbf, 0xc3, 0xdd, 0x19, 0x9e, 0x81, 0x16,

0xe2, 0x8f, 0x65, 0x34, 0xa7, 0x0f, 0x22, 0xba, 0xbf, 0x79, 0x57, 0x02, 0x81, 0x80, 0x2e, 0x21, 0x0e, 0xc9, 0xb5, 0xad, 0x31, 0xd4, 0x76,

0x0f, 0x9b, 0x0f, 0x2e, 0x70, 0x33, 0x54, 0x03, 0x58, 0xa7, 0xf1, 0x6d, 0x35, 0x57, 0xbb, 0x53, 0x66, 0xb4, 0xb6, 0x96, 0xa1, 0xea, 0xd9,

0xcd, 0xe9, 0x23, 0x9f, 0x35, 0x17, 0xef, 0x5c, 0xb8, 0x59, 0xce, 0xb7, 0x3c, 0x35, 0xaa, 0x42, 0x82, 0x3f, 0x00, 0x96, 0xd5, 0x9d, 0xc7,

0xab, 0xec, 0xec, 0x04, 0xb5, 0x15, 0xc8, 0x40, 0xa4, 0x85, 0x9d, 0x20, 0x56, 0xaf, 0x03, 0x8f, 0x17, 0xb0, 0xf1, 0x96, 0x22, 0x3a, 0xa5,

0xfa, 0x58, 0x3b, 0x01, 0xf9, 0xae, 0xb3, 0x83, 0x6f, 0x44, 0xd3, 0x14, 0x2d, 0xb6, 0x6e, 0xd2, 0x9d, 0x39, 0x0c, 0x12, 0x1d, 0x23, 0xea,

0x19, 0xcb, 0xbb, 0xe0, 0xcd, 0x89, 0x15, 0x9a, 0xf5, 0xe4, 0xec, 0x41, 0x06, 0x30, 0x16, 0x58, 0xea, 0xfa, 0x31, 0xc1, 0xb8, 0x8e, 0x08,

0x84, 0xaa, 0x3b, 0x19, 0x02, 0x81, 0x80, 0x70, 0x4c, 0xf8, 0x6e, 0x86, 0xed, 0xd6, 0x85, 0xd4, 0xba, 0xf4, 0xd0, 0x3a, 0x32, 0x2d, 0x40,

0xb5, 0x78, 0xb8, 0x5a, 0xf9, 0xc5, 0x98, 0x08, 0xe5, 0xc0, 0xab, 0xb2, 0x4c, 0x5c, 0xa2, 0x2b, 0x46, 0x9b, 0x3e, 0xe0, 0x0d, 0x49, 0x50,

0xbf, 0xe2, 0xa1, 0xb1, 0x86, 0x59, 0x6e, 0x7b, 0x76, 0x6e, 0xee, 0x3b, 0xb6, 0x6d, 0x22, 0xfb, 0xb1, 0x68, 0xc7, 0xec, 0xb1, 0x95, 0x9b,

0x21, 0x0b, 0xb7, 0x2a, 0x71, 0xeb, 0xa2, 0xb2, 0x58, 0xac, 0x6d, 0x5f, 0x24, 0xd3, 0x79, 0x42, 0xd2, 0xf7, 0x35, 0xdc, 0xfc, 0x0e, 0x95,

0x60, 0xb7, 0x85, 0x7f, 0xf9, 0x72, 0x8e, 0x4a, 0x11, 0xc3, 0xc2, 0x09, 0x40, 0x5c, 0x7c, 0x43, 0x12, 0x34, 0xac, 0x59, 0x99, 0x76, 0x34,

0xcf, 0x20, 0x88, 0xb0, 0xfb, 0x39, 0x62, 0x3a, 0x9b, 0x03, 0xa6, 0x84, 0x2c, 0x03, 0x5c, 0x0c, 0xca, 0x33, 0x85, 0xf5, 0x02, 0x81, 0x80,

0x56, 0x99, 0xe9, 0x17, 0xdc, 0x33, 0xe1, 0x33, 0x8d, 0x5c, 0xba, 0x17, 0x32, 0xb7, 0x8c, 0xbd, 0x4b, 0x7f, 0x42, 0x3a, 0x79, 0x90, 0xe3,

0x70, 0xe3, 0x27, 0xce, 0x22, 0x59, 0x02, 0xc0, 0xb1, 0x0e, 0x57, 0xf5, 0xdf, 0x07, 0xbf, 0xf8, 0x4e, 0x10, 0xef,

0x2a, 0x62, 0x30, 0x03,

0xd4, 0x80, 0xcf, 0x20, 0x84, 0x25, 0x66, 0x3f, 0xc7, 0x4f, 0x56, 0x8c, 0x1e, 0xe1, 0x18, 0x91, 0xc1, 0xfd, 0x71,

0x5f, 0x65, 0x9b, 0xe4,

0x4f, 0xe0, 0x1a, 0x3a, 0xf8, 0xc1, 0x69, 0xdb, 0xd3, 0xbb, 0x8d, 0x91, 0xd1, 0x11, 0x4f, 0x7e, 0x91, 0x1b, 0xb4,

0x27, 0xa5, 0xab, 0x7c,

0x7b, 0x76, 0xd4, 0x78, 0xfe, 0x63, 0x44, 0x63, 0x7e, 0xe3, 0xa6, 0x60, 0x4f, 0xb9, 0x55, 0x28, 0xba, 0xba, 0x83,

0x1a, 0x2d, 0x43, 0xd5,

0xf7, 0x2e, 0xe0, 0xfc, 0xa8, 0x14, 0x9b, 0x91, 0x2a, 0x36, 0xbf, 0xc7, 0x14

};

CK_BYTE

knownRSA1Modulus[] = {

0xb8, 0xb5, 0x0f, 0x49, 0x46, 0xb5, 0x5d, 0x58, 0x04, 0x8e, 0x52, 0x59, 0x39, 0xdf, 0xd6,

0x29,

0x45, 0x6b, 0x6c, 0x96, 0xbb, 0xab, 0xa5, 0x6f, 0x72, 0x1b, 0x16, 0x96, 0x74, 0xd5, 0xf9,

0xb4,

0x41, 0xa3, 0x7c, 0xe1, 0x94, 0x73, 0x4b, 0xa7, 0x23, 0xff, 0x61, 0xeb, 0xce, 0x5a, 0xe7,

0x7f,

0xe3, 0x74, 0xe8, 0x52, 0x5b, 0xd6, 0x5d, 0x5c, 0xdc, 0x98, 0x49, 0xfe, 0x51, 0xc2, 0x7e,

0x8f,

0x3b, 0x37, 0x5c, 0xb3, 0x11, 0xed, 0x85, 0x91, 0x15, 0x92, 0x24, 0xd8, 0xf1, 0x7b, 0x3d,

0x2f,

0x8b, 0xcd, 0x1b, 0x30, 0x14, 0xa3, 0x6b, 0x1b, 0x4d, 0x27, 0xff, 0x6a, 0x58, 0x84, 0x9e,

0x79,

0x94, 0xca, 0x78, 0x64, 0x01, 0x33, 0xc3, 0x58, 0xfc, 0xd3, 0x83, 0xeb, 0x2f, 0xab, 0x6f,

0x85,

0x5a, 0x38, 0x41, 0x3d, 0x73, 0x20, 0x1b, 0x82, 0xbc, 0x7e, 0x76, 0xde, 0x5c, 0xfe, 0x42,

0xd6,

0x7b, 0x86, 0x4f, 0x79, 0x78, 0x29, 0x82, 0x87, 0xa6, 0x24, 0x43, 0x39, 0x74, 0xfe, 0xf2,

0x0c,

0x08, 0xbe, 0xfa, 0x1e, 0x0a, 0x48, 0x6f, 0x14, 0x86, 0xc5, 0xcd, 0x9a, 0x98, 0x09, 0x2d,

0xf3,

0xf3, 0x5a, 0x7a, 0xa4, 0xe6, 0x8a, 0x2e, 0x49, 0x8a, 0xde, 0x73, 0xe9, 0x37, 0xa0, 0x5b,

0xef,

0xd0, 0xe0, 0x13, 0xac, 0x88, 0x5f, 0x59, 0x47, 0x96, 0x7f, 0x78, 0x18, 0x0e, 0x44, 0x6a,


```
0x5d,
0xec, 0x6e, 0xed, 0x4f, 0xf6, 0x6a, 0x7a, 0x58, 0x6b, 0xfe, 0x6c, 0x5a, 0xb9, 0xd2, 0x22,
0x3a,
0x1f, 0xdf, 0xc3, 0x09, 0x3f, 0x6b, 0x2e, 0xf1, 0x6d, 0xc3, 0xfb, 0x4e, 0xd4, 0xf2, 0xa3,
0x94,
0x13, 0xb0, 0xbf, 0x1e, 0x06, 0x2e, 0x29, 0x55, 0x00, 0xaa, 0x98, 0xd9, 0xe8, 0x77, 0x84,
0x8b,
0x3f, 0x5f, 0x5e, 0xf7, 0xf8, 0xa7, 0xe6, 0x02, 0xd2, 0x18, 0xb0, 0x52, 0xd0, 0x37, 0x2e,
0x53,
    },
    knownRSA1PubExponent[] = { 0x01, 0x00, 0x01 };
    char *pPlainData = 0;
    unsigned long ulPlainDataLength;
    char *pEncryptedData = 0;
    unsigned long ulEncryptedDataLength = 0;
    CK_MECHANISM mech;
    CK_USHORT usStatus=0,
            usKeyLength;
    CK_OBJECT_HANDLE hKey;
    CK_OBJECT_CLASS SymKeyClass = CKO_SECRET_KEY;
    CK_BBOOL bTrue = 1,
                bFalse = 0,
                bToken = bTrue,
                bSensitive = bTrue,
                bPrivate = bTrue,
                bEncrypt = bTrue,
                bDecrypt = bTrue,
                bSign = bFalse, // "..."
                bVerify = bFalse, //Will not allow sign/verify operation.
                bWrap = bTrue,
                bUnwrap = bTrue,
#ifdef EXTRACTABLE
                bExtract = bTrue,
#endif //EXTRACTABLE
                bDerive = bTrue;
    CK_KEY_TYPE keyType;
```

```
    CK_USHORT usValueBits;
    char pbPublicKeyLabel[128];
    CK_ATTRIBUTE_PTR pPublicTemplate;
    CK_USHORT usPublicTemplateSize = 0;
    char iv[8] = { '1', '2', '3', '4', '5', '6', '7', '8' };
    CK_ATTRIBUTE SymKeyTemplate[] = {
      {CKA_CLASS, 0, sizeof(SymKeyClass)},
      {CKA_KEY_TYPE, 0, sizeof(keyType)},
      {CKA_TOKEN, 0, sizeof(bToken)},
      {CKA_SENSITIVE, 0, sizeof(bSensitive)},
      {CKA_PRIVATE, 0, sizeof(bPrivate)},
      {CKA_ENCRYPT, 0, sizeof(bEncrypt)},
      {CKA_DECRYPT, 0, sizeof(bDecrypt)},
      {CKA_SIGN, 0, sizeof(bSign)},
      {CKA_VERIFY, 0, sizeof(bVerify)},
      {CKA_WRAP, 0, sizeof(bWrap)},
      {CKA_UNWRAP, 0, sizeof(bUnwrap)},
      {CKA_DERIVE, 0, sizeof(bDerive)},
      {CKA_VALUE_LEN,0, sizeof(usKeyLength) },
      {CKA_LABEL, 0, 0}  // Always keep last!!!
#ifdef EXTRACTABLE     //Conditional stuff must be at the end!!!!!
      {CKA_EXTRACTABLE, 0, sizeof(bExtract)},
#endif //EXTRACTABLE
    };
    CK_OBJECT_HANDLE hUnWrappedKey, hPublicRSAKey;
    char *pbWrappedKey;
    unsigned long   ulWrappedKeySize;
    CK_OBJECT_CLASS privateKey = CKO_PRIVATE_KEY,
publicKey = CKO_PUBLIC_KEY;
    CK_KEY_TYPE rsaType = CKK_RSA;
    CK_BYTE pLabel[] = "RSA private Key",
pbPublicRSAKeyLabel[] = "RSA Public Key";
    CK_ATTRIBUTE *pTemplate;
    CK_ULONG usTemplateSize,
ulPublicRSAKeyTemplateSize;
    CK_ATTRIBUTE pPublicRSAKeyTemplate[] = {
```

```
      {CKA_CLASS, 0, sizeof(publicKey) },
      {CKA_KEY_TYPE, 0,   sizeof(rsaType) },
      {CKA_TOKEN, 0, sizeof(bToken) },
      {CKA_PRIVATE, 0,  sizeof(bPrivate) },
      {CKA_ENCRYPT, 0,  sizeof(bEncrypt) },
      {CKA_VERIFY, 0, sizeof(bSign) },
      {CKA_WRAP, 0, sizeof(bWrap) },
 {CKA_MODULUS, 0, sizeof(knownRSA1Modulus) },
 {CKA_PUBLIC_EXPONENT, 0, sizeof(knownRSA1PubExponent) },
      {CKA_LABEL, 0, sizeof(pbPublicRSAKeyLabel) }
    };
    CK_ATTRIBUTE pPrivateKeyTemplate[] = {
      {CKA_CLASS, &privateKey, sizeof(privateKey) },
      {CKA_KEY_TYPE, &rsaType,   sizeof(rsaType) },
      {CKA_TOKEN, &bToken, sizeof(bToken) },
      {CKA_SENSITIVE,&bSensitive, sizeof(bSensitive) },
      {CKA_PRIVATE, &bPrivate, sizeof(bPrivate) },
      {CKA_DECRYPT, &bEncrypt, sizeof(bEncrypt) },
      {CKA_SIGN, &bSign, sizeof(bSign) },
 //{CKA_SIGN_RECOVER, &bTrue, sizeof(bTrue)    },
      {CKA_UNWRAP, &bWrap, sizeof(bWrap) },
{CKA_EXTRACTABLE, &bFalse, sizeof(bFalse)    },
{CKA_LABEL,     pLabel, sizeof(pLabel) }
    };
    // Generate a DES3 Key
    SymKeyTemplate[0].pValue = &SymKeyClass;
    SymKeyTemplate[1].pValue = &keyType;
    SymKeyTemplate[2].pValue = &bToken;
    SymKeyTemplate[3].pValue = &bSensitive;
    SymKeyTemplate[4].pValue = &bPrivate;
    SymKeyTemplate[5].pValue = &bEncrypt;
    SymKeyTemplate[6].pValue = &bDecrypt;
    SymKeyTemplate[7].pValue = &bSign;
    SymKeyTemplate[8].pValue = &bVerify;
    SymKeyTemplate[9].pValue = &bWrap;
    SymKeyTemplate[10].pValue = &bUnwrap;
```

```
    SymKeyTemplate[11].pValue = &bDerive;
    SymKeyTemplate[12].pValue =  &usKeyLength;
    SymKeyTemplate[13].pValue = pbPublicKeyLabel;
#ifdef EXTRACTABLE
    SymKeyTemplate[14].pValue = &bExtract;
#endif //EXTRACTABLE
    mech.mechanism = CKM_DES3_KEY_GEN;
    mech.pParameter = 0;
    mech.usParameterLen = 0;
    keyType = CKK_DES3;
    usKeyLength = 24;
    strcpy( pbPublicKeyLabel, "Generated DES3 Key" );
    pPublicTemplate = SymKeyTemplate;
    usPublicTemplateSize = DIM(SymKeyTemplate);
    // Adjust size of label (ALWAYS LAST ENTRY IN ARRAY)
    pPublicTemplate[usPublicTemplateSize-1].usValueLen = strlen(
pbPublicKeyLabel );
    retCode = C_GenerateKey(   hSessionHandle,
                        (CK_MECHANISM_PTR)&mech,
                        pPublicTemplate,
                        usPublicTemplateSize,
                        &hKey);
    if(retCode == CKR_OK)
    {
      cout << pbPublicKeyLabel << ": " << hKey << endl;
    }
    else
    {
  cout << "\n" "Error 0x" << hex << retCode;
      cout << " generating the DES3 Key.\n";
  error = -11;
      goto exit_routine_6;
    }
    // Encrypt the RSA Key
    mech.mechanism = CKM_DES3_CBC;
    mech.pParameter = iv;
```



```
    mech.usParameterLen = sizeof(iv);
    pPlainData = (char *)(pRsaKey);
    ulPlainDataLength = sizeof(pRsaKey);
    // Allocate memory for output buffer
    if( retCode == CKR_OK )
    {
      pEncryptedData = new char [ulPlainDataLength + 2048]; // Leave
// extra room for
// RSA Operations
      if( !pEncryptedData )
      {
        retCode = CKR_DEVICE_ERROR;
      }
    }
    // Start encrypting
    if( retCode == CKR_OK )
    {
      retCode = C_EncryptInit(hSessionHandle, &mech, hKey);
    }
    // Continue encrypting
    if( retCode == CKR_OK )
    {
      CK_USHORT usInDataLen,
             usOutDataLen = (CK_USHORT) (ulPlainDataLength + 2048);
      CK_ULONG ulBytesRemaining = ulPlainDataLength;
      char *    pPlainTextPointer = pPlainData;
      char *    pEncryptedDataPointer = pEncryptedData;
      while (ulBytesRemaining > 0)
      {
        if (ulBytesRemaining > 0xfff0) // We are longer than a USHORT can handle
        {
          usInDataLen = 0xfff0;
          ulBytesRemaining -= usInDataLen;
        }
        else
        {
```

```
      usInDataLen = (CK_USHORT) ulBytesRemaining;
      ulBytesRemaining -= usInDataLen;
    }
    retCode = C_EncryptUpdate( hSessionHandle,
                  (CK_BYTE_PTR)pPlainTextPointer,
                  usInDataLen,
                  (CK_BYTE_PTR)pEncryptedDataPointer,
                  &usOutDataLen );
    pPlainTextPointer += usInDataLen;
    pEncryptedDataPointer += usOutDataLen;
    ulEncryptedDataLength += usOutDataLen;
  }
}

// Finish encrypting
if( retCode == CKR_OK )
{
  CK_USHORT usOutDataLen;
  CK_BYTE_PTR pOutData = (CK_BYTE_PTR)pEncryptedData;
  pOutData += ulEncryptedDataLength;
  retCode = C_EncryptFinal(hSessionHandle, pOutData, &usOutDataLen);
  ulEncryptedDataLength += usOutDataLen;
}
else
{
cout << "\n" "Error 0x" << hex << retCode;
  cout << " somewhere in the encrypting.\n";
  if( pEncryptedData )
  {
    delete pEncryptedData;
  }
error = -12;
  goto exit_routine_6;
}
mech.mechanism = CKM_DES3_CBC;
mech.pParameter = (void*) "12345678"; // 8 byte IV
```



```
  mech.usParameterLen = 8;
  pTemplate = pPrivateKeyTemplate;
  usTemplateSize = DIM(pPrivateKeyTemplate);
 pbWrappedKey = pEncryptedData;
  ulWrappedKeySize = ulEncryptedDataLength;
  if( retCode == CKR_OK )
  {
    retCode = C_UnwrapKey( hSessionHandle,
                    &mech,
                    hKey,
                    (CK_BYTE_PTR)pbWrappedKey,
                    (CK_USHORT)ulWrappedKeySize,
                    pTemplate,
                    usTemplateSize,
                    &hUnWrappedKey);
  }
  // Report unwrapped key handle
  if( retCode == CKR_OK )
  {
    cout << "\n Private key Unwrapped key is:" << hUnWrappedKey <<"\n\n";
  }
  else
  {
cout << "\n" "Error 0x" << hex << retCode;
    cout << " unwrapping.\n";
    if( pEncryptedData )
    {
      delete pEncryptedData;
    }
error = -13;
    goto exit_routine_6;
  }
  // Release temporary memory
  if( pEncryptedData )
  {
    delete pEncryptedData;
```

```
    }
  // Create the Public Key that goes with the Private Key
  if( retCode == CKR_OK )
  {
 // Unwrap it onto the token
 pPublicRSAKeyTemplate[0].pValue = &publicKey;
 pPublicRSAKeyTemplate[1].pValue = &rsaType;
 pPublicRSAKeyTemplate[2].pValue = &bToken;
 pPublicRSAKeyTemplate[3].pValue = &bPrivate;
 pPublicRSAKeyTemplate[4].pValue = &bEncrypt;
 pPublicRSAKeyTemplate[5].pValue = &bSign;
 pPublicRSAKeyTemplate[6].pValue = &bWrap;
 pPublicRSAKeyTemplate[7].pValue = knownRSA1Modulus;
 pPublicRSAKeyTemplate[8].pValue = knownRSA1PubExponent;
 pPublicRSAKeyTemplate[9].pValue = pbPublicRSAKeyLabel;
 pTemplate = pPublicRSAKeyTemplate;
 usTemplateSize = DIM(pPublicRSAKeyTemplate);
 retCode = C_CreateObject(  hSessionHandle,
pTemplate,
 usTemplateSize,
 &hPublicRSAKey);
 if(retCode == CKR_OK)
 {
 cout << pbPublicRSAKeyLabel << ": " << hPublicRSAKey << endl;
 }
 else
 {
 cout << "\n" "Error 0x" << hex << retCode;
 cout << " creating the RSA Public Key.\n";
 error = -14;
 goto exit_routine_6;
 }
  }
if( retCode == CKR_OK )
  {
CK_CHAR label[] = "RSA Key";
```

```
CK_ATTRIBUTE RSAFindPriTemplate[] =
{
CKA_LABEL, label, sizeof(label)
};
CK_ULONG numHandles;
CK_OBJECT_HANDLE handles[1000];
retCode = C_FindObjectsInit( hSessionHandle, RSAFindPriTemplate, 1 );
if(retCode != CKR_OK)
{
cout << "C_FindObjectsInit not returning OK (" << hex << retCode << ")\n\n";
goto exit_routine_6;
}
retCode =C_FindObjects( hSessionHandle , handles, 90,
&numHandles );
if(retCode != CKR_OK)
{
cout << "C_FindObjects not returning OK (" << hex <<
retCode << ")\n\n";
goto exit_routine_6;
}
cout << "Everything's GOOD\n\n";
for(int i=0; i < numHandles; i++)
{
cout << handles[i] << "\n";
}
}
}
//CJM-> END OF TEST CODE
  // Beginning of exit routines
exit_routine_6:
  // Logout
  retCode = C_Logout(hSessionHandle);
  if(retCode != CKR_OK)
{
cout << "\n" "Error 0x" << hex << retCode << " logging out.";
}
```



```
exit_routine_5:
// Close the session
  retCode = C_CloseSession(hSessionHandle);
if(retCode != CKR_OK)
{
cout << "\n" "Error 0x" << hex << retCode << " closing session.";
}
exit_routine_4:
  delete pSlotList;
exit_routine_3:
#ifdef PKCS11_2_0
  C_Finalize(0);
#else
  C_Terminate();
#endif
exit_routine_2:
#ifndef STATIC
  // No longer need Chrystoki
  CrystokiDisconnect();
#endif
exit_routine_1:
  cout << "\nDone. (" << dec << error << ")\n";
  cout.flush();
  return error;
}
CK_RV  Pinlogin(CK_SESSION_HANDLE hSession)
{

CK_RV retCode;
unsigned char buffer[MAX];
int count =0;
cout << "Please enter the USER password : " << endl;
//calling get PinString to mask input, variable "count"
//holds length of "buffer"(password)
//needed for Login call
count = getPinString(buffer);
```



```
//Login as user on  token in slot
retCode = C_Login(hSession, CKU_USER, buffer, count);
if(retCode != CKR_OK)
{
cout << "\n" "Error 0x" << hex << retCode;
     cout << " logging in as user.";
  exit(hSession);
  return -3;
}
cout << "logging into the token....";
cout << "\nlogged into token " << endl;
return retCode;
}
/////////////////////////////////////////////////////////////////////
// getPinString()
// ==============
//
// This function retrieves a pin string from the user.  It modifies the
// console mode before starting so that the characters the user types are
// not echoed, and a '*' character is displayed for each typed character
// instead.
//
// Backspace is supported, but we don't get any fancier than that.
/////////////////////////////////////////////////////////////////////
int getPinString(CK_CHAR_PTR pw)
{
   int len=0;
   char c=0;
   // Unfortunately, the method of turning off character echo is
// different for Windows and Unix platforms.  So we have to
// conditionally compile the appropriate section.  Even the basic
// password retrieval is slightly different, since
   // Windows and Unix use different character codes for the return key.
#ifdef WIN32
   DWORD mode;
   // This console mode stuff only applies to windows.  We'll have to
```



```
// do something else when it comes to unix.
   if (GetConsoleMode(GetStdHandle(STD_INPUT_HANDLE), &mode)) {
      if (SetConsoleMode(GetStdHandle(STD_INPUT_HANDLE), mode & (!ENABLE_ECHO_INPUT))) {
         while (c  != '\r') {
            // wait for a character to be hit
            while (!_kbhit()) {
               Sleep(100);
            }
            // get it
            c = _getch();
            // check for carriage return
            if (c != '\r') {
               // check for backspace
               if (c!='\b') {
                  // neither CR nor BS -- add it to the password string
                  printf("*");
                  *pw++ = c;
                  len++;
               } else {
// handle backspace -- delete the last character &
// erase it from the screen
                  if (len > 0) {
                     pw--;
                     len--;
                     printf("\b \b");
}
}
}
}
         // Add the zero-termination
         *pw = '\0';
         SetConsoleMode(GetStdHandle(STD_INPUT_HANDLE), mode);
         printf("\n");
}
   }
#endif
```

```
   return len;
}
```

Object Usage Count

You may wish to create keys that have a limited number of uses. You can set attributes on a key object to track and limit the number of cryptographic operations that object may perform. The relevant attributes are:

- CKA_USAGE_COUNT: the number of operations that have been performed using the key
- CKA_USAGE_LIMIT: the maximum number of operations allowed for the key.

When the limit set by CKA_USAGE_LIMIT is reached, attempts to use the key for operations like encrypt/decrypt, sign/verify, etc. return an error (CKR_KEY_NOT_ACTIVE).

Setting CKA_USAGE_LIMIT on a key using CKDEMO

You can use CKDEMO to set this limit for a specific key on the HSM.

To set CKA_USAGE_LIMIT on a key:

1. Navigate to the SafeNet LunaClient directory and run CKDEMO.
2. Select **Option 1 (Open Session)**.
3. Select **Option 3 (Login)**, select the partition where the key is located, and present the Crypto Officer login credential.
4. If you do not know the key's object handle, select **Option 27 (Display Object)** and enter 0 to view a list of available objects.
5. Select **Option 25 (Set Attribute)**, and enter the key's object handle when prompted.
6. Select **Sub-option 1 (Add Attribute)**, and **53 (CKA_USAGE_LIMIT)** from the list of attributes.
7. Enter the desired maximum number of uses in hexadecimal (Allowable range: 1 - FFFFFFFF).
8. Select **Option 27** and enter the key's object handle to view the key attributes. When you set CKA_USAGE_LIMIT in step 7, CKA_USAGE_COUNT is also set, with a value of 0:

```
Enter your choice: 27

Enter handle of object to display (0 to list available objects) : 247
Object handle=247
CKA_CLASS=0003 (3)
CKA_TOKEN=01
CKA_PRIVATE=01
CKA_LABEL=Generated RSA Private Key
CKA_KEY_TYPE=0000 (0)
CKA_SUBJECT=
CKA_ID=
CKA_SENSITIVE=01
CKA_DECRYPT=01
CKA_UNWRAP=01
CKA_SIGN=01
CKA_SIGN_RECOVER=00
CKA_DERIVE=00
CKA_START_DATE=
CKA_END_DATE=
CKA_MODULUS=bc613525ae8c5b30ca086c0e688f2f0ed6928805bf007d4fc...
```

```
CKA_MODULUS_BITS=0400 (1024)
CKA_PUBLIC_EXPONENT=010001
CKA_LOCAL=01
CKA_MODIFIABLE=01
CKA_EXTRACTABLE=01
CKA_ALWAYS_SENSITIVE=01
CKA_NEVER_EXTRACTABLE=00
CKA_CCM_PRIVATE=00
CKA_FINGERPRINT_SHA1=6beddef34f9f5c8023e3422daecd6bd91c2dc40d
CKA_OUID=b00800000300000d1b030100
CKA_X9_31_GENERATED=00
CKA_EKM_UID=
CKA_USAGE_LIMIT=000e (15)
CKA_USAGE_COUNT=0000 (0)
CKA_GENERIC_1=
CKA_GENERIC_2=
CKA_GENERIC_3=
CKA_FINGERPRINT_SHA256=a8293ea9ddb578bcca644279c9753de4df772958563d259bed28c5d2a2e04e7d

Status: Doing great, no errors (CKR_OK)
```

Each use of this key to perform cryptographic operations now increments the value of CKA_USAGE_COUNT.

Creating multiple keys with CKA_USAGE_LIMIT using CKDEMO

If you are creating multiple, usage-limited keys in CKDEMO, you can simplify this procedure by changing a CKDEMO setting. You then have the option to set a usage limit for all new keys created in that session.

To create multiple keys with CKA_USAGE_LIMIT set:

1. Navigate to the SafeNet LunaClient directory and run CKDEMO.
2. Select **Option 98 (Options)**.
3. Select **Option 10 (Object Usage Counters)**.

   Note that the option value has changed from "disabled" to "selectable".
4. Enter **0** to exit the **(Options)** menu.
5. Open a session and begin creating your new keys. In addition to setting the attributes governing key capabilities, you are prompted to enter a value for CKA_USAGE_LIMIT (in hexadecimal):

```
Select type of key to generate
[ 1] DES     [ 2] DES2    [ 3] DES3             [ 5]  CAST3
[ 6] Generic [ 7] RSA     [ 8] DSA    [ 9] DH    [10]  CAST5
[11] RC2     [12] RC4     [13] RC5    [14] SSL3  [15]  ECDSA
[16] AES     [17] SEED    [18] KCDSA-1024    [19] KCDSA-2048
[20] DSA Domain Param     [21] KCDSA Domain Param
[22] RSA X9.31            [23] DH X9.42          [24] ARIA
[25] DH PKCS Domain Param [26] RSA 186-3 Aux Primes
[27] RSA 186-3 Primes      [28] DH X9.42 Domain Param
[29] ECDSA with Extra Bits [30] EC Edwards
[31] EC Montgomery
> 7

Enter Key Length in bits: 1024

Enter Is Token Attribute [0-1]: 1

Enter Is Sensitive Attribute [0-1]: 1
```



```
Enter Is Private Attribute [0-1]: 1

Enter Is Modifiable Attribute [0-1]: 1

Enter Extractable Attribute [0-1]: 1

Enter Encrypt/Decrypt Attribute [0-1]: 1

Enter Sign/Verify Attribute [0-1]: 1

Enter Wrap/Unwrap Attribute [0-1]: 1

Enter Derive Attribute [0-1]: 1

Would you like to specify a usage count limit? [0-no, 1-yes]: 1

Please enter the limit in HEX: 0E
Generated RSA Public Key:        160 (0x000000a0)
Generated RSA Private Key:        247 (0x000000f7)

Status: Doing great, no errors (CKR_OK)
```

PED-Authenticated HSMs

In systems or applications using SafeNet HSMs, SafeNet PED is required for FIPS 140-2 level 3 security. In normal use, SafeNet PED supplies PINs and certain other critical security parameters to the token/HSM, invisibly to the user. This prevents other persons from viewing PINs, etc. on a computer screen or watching them typed on a keyboard, which in turn prevents such persons from illicitly cloning token or HSM contents.

Two classes of users operate SafeNet PED: the ordinary HSM Partition Owner, and the HSM Administrator, (also called Security Officer or SO). The person handling new HSMs and using SafeNet PED is normally the HSM SO, who:

- initializes the HSM,
- conducts HSM maintenance, such as firmware and capability upgrades,
- initializes HSM Partitions and tokens,
- creates users (sets PINs),
- changes policy settings,
- changes passwords.

Following these initial activities, the SafeNet PED may be required to present the HSM Partition Owner’s PED Key or keys (in case of MofN operations) to enable ordinary signing cryptographic operations carried out by your applications.

With the combination of Activation and AutoActivation, the black PED Key is required only upon initial authentication and then not again unless the authentication is interrupted by power failure or by deliberate action on the part of the PED Key holders.

About CKDemo with SafeNet PED

As its name suggests, CKDemo (CryptoKi Demonstration) is a demonstration program, allowing you to explore the capabilities and functions of several SafeNet products. The demo program breaks out a number of PKCS 11 functions, as well as the SafeNet extensions to Cryptoki that allow the enhanced capabilities of our HSMs.However the flexibility, combined with the bare-bones nature of the program, can result in some confusion as to whether certain operations and combinations are permissible. Where these come up, in the explanation of CKDemo with SafeNet HSM with PED [Trusted Path] Authentication, and SafeNet PED, they are mentioned and explained if necessary.

The demo program appears to make it optional to permit several of the security operations via the keyboard and program interface, or to require that they be done only via the SafeNet PED keypad. In fact, the option is dictated by the SafeNet HSM, as it was configured and shipped from the factory, and cannot be changed by you. That is, you can use CKDemo to work/experiment with either type of SafeNet HSM – i.e., SafeNet HSM with Password Authentication or SafeNet HSM with PED Authentication, requiring SafeNet PED), but you cannot make one type behave like the other.

Security and design requirements, enforced by the SafeNet HSM with PED Authentication HSM, dictate that use of SafeNet PED be mandatory within the applications that you develop for it.

Interchangeability

As mentioned above, several secrets and security parameters related to HSMs are imprinted on PED Keys which provide "something you have" access control, as opposed to the "something you know" access control provided by password-authenticated HSMs. The HSM can create each type of secret, which is then also imprinted on a suitably labeled PED Key. Alternatively, the secret can be accepted from a PED Key (previously imprinted by another HSM) and imprinted on the current HSM. This is mandatory for the cloning domain, when HSMs (or HSM partitions) are to clone objects one to the other. It is optional for the other HSM secrets, as a matter of convenience or of your security policy, allowing more than one HSM to be accessed for administration by a single SO (blue PED Key holder) or more than one HSM Partition to be administered by a single Partition Owner/User. The exception is the SRK (purple PED Key) which carries a secret unique to its HSM and which cannot be imprinted on any other HSM.

PED Keys that have never been imprinted are completely interchangeable. They can be used with any modern SafeNet HSM, and can be imprinted with any of the various secrets. The self-stick labels are provided as a visual identifier of which type of secret has been imprinted on a PED Key, or is about to be imprinted .Imprinted PED Keys are tied to their associated HSMs and cannot be used to access HSMs or partitions that have been imprinted with different secrets.

Any SafeNet PED2 can be used with any SafeNet HSM - the PED itself contains no secrets; it simply provides the interface between you and your HSM(s). The exception is that only some SafeNet PEDs have the capability to be used remotely from the HSM. Any Remote-capable SafeNet PED2 is interchangeable with any other Remote-capable SafeNet PED2, and any SafeNet PED2 (remote-capable or not) is interchangeable with any other when locally connected to a SafeNet HSM.

HSM Partitions and Backup Tokens and PED Keys can be “re-cycled” for use in different combinations, but this reuse requires re-initializing the HSM(s) and re-imprinting the PED Keys with new secrets or security parameters. Re-initializing a token or HSM wipes previous information from it. Re-imprinting a PED Key overwrites any previous information it carried (PIN, domain, etc.).

Startup

SafeNet PED expects to be connected to a SafeNet HSM with Trusted Path Authentication. At power-up, it presents a message showing its firmware version. After a few seconds, the message changes to "Awaiting command.." The SafeNet PED is waiting for a command from the token/HSM.

The SafeNet PED screen remains in this status until the CKDemo program, or your own application, initiates a command through the token/HSM.

For the purposes of demonstration, you would now go ahead and create some objects and perform other transactions with the HSM.

Note: To perform most actions you must be logged in. CKDemo may not remind you before you perform actions out-of-order, but it generates error messages after such attempts. So, in general, if you receive an error message from the program, review your recent actions to determine if you have logged out or closed sessions and then not formally logged into a new session before attempting to create an object or perform other token/HSM actions.

When you do wish to end activities, be sure to formally log out and close sessions. With CKDemo, it would be merely an inconvenience to have old sessions still open when you attempt new activities. An orderly shutdown of your application, however, should include logging out any users and closing all sessions on HSMs.

Cloning of Tokens

To securely copy the contents of a SafeNet Network HSM Partition to another SafeNet Network HSM Partition (on the same SafeNet Network HSM or on another), you must perform a backup to a SafeNet Backup HSM from the source HSM Partition followed by a restore operation from the Backup HSM to the new destination HSM Partition. This is done via lunash command line, and cannot be accomplished via CKDemo.

Scalable Key Storage (formerly SIM) APIs

Note: The SafeNet Network HSM HA feature and Scalable Key Storage can be used simultaneously in SafeNet Network HSM release 3.0 and later.

Applications use the following APIs to extract/insert keys under Scalable Key Storage. The multisign function call is an optimization that allows you to insert and sign (potentially) many objects at once.

```
CK_RV CK_ENTRY CA_ExtractMaskedObject(CK_SESSION_HANDLE hSession,
   CK_ULONG ulObjectHandle,
   CK_BYTE_PTR pMaskedKey,
   CK_USHORT_PTR pusMaskedKeyLen);
CK_RV CK_ENTRY CA_InsertMaskedObject( CK_SESSION_HANDLE hSession,
   CK_ULONG_PTR pulObjectHandle,
   CK_BYTE_PTR pMaskedKey,
   CK_USHORT usMaskedKeyLen);
CK_RV CK_ENTRY CA_MultisignValue( CK_SESSION_HANDLE hSession,
   CK_MECHANISM_PTR pMechanism,
   CK_ULONG ulMaskedKeyLen,
   CK_BYTE_PTR pMaskedKey,
   CK_ULONG_PTR pulBlobCount,
   CK_ULONG_PTR pulBlobLens,
   CK_BYTE_PTR CK_PTR ppBlobs,
   CK_ULONG_PTR pulSignatureLens,
   CK_BYTE_PTR CK_PTR ppSignatures);
```

The SafeNet Software Developers Kit contains example code in our ckdemo example program that shows how to use this API.

In general, the normal life cycle of a key pair is assumed to consist of the following steps:

- the key pair is generated
- the public exponent and modulus are extracted for the creation of a certificate (CA_ExtractMaskedObject)

- the keys are used (some number of times, over a period of years) for cryptographic operations

You can use **CA_MultisignValue** to perform signing operations on multiple objects at one time. **CA_MultisignValue** is a self-contained call that cleans up after itself by destroying the inserted key before exiting.

You can use **CA_InsertMaskedObject** to use the inserted key for other operations (such as encryption) that you would invoke via standard cryptoki calls. You must clean up by deleting the object when you have finished, to free the volatile memory that was used.

The external keys are destroyed (wiped from the database) when no longer needed.

SIM II (Enhancements to SIM)

SIM II provides enhancements to SIM for the Cyptoki API and the Java API, as described in the following sections:

Cryptoki API

Three forms of authorization data are supported:

- text-based PINs
- a challenge/response mechanism similar to the one used in SafeNet HSM (with Trusted Path Authentication) login
- a PED key mechanism similar to our legacy M-of-N activation for the HSM.

The form of authorization data is identified using the following definitions:

```
typedef CK_ULONG SIM_AUTHORIZATION_FORM;
#define SIM_AUTHORIZATION_PIN 0
#define SIM_AUTHORIZATION_CHALLENGE 1
#define SIM_AUTHORIZATION_PED 2
```

Three new API functions are added to cryptoki.h, as follows:

The CK_RV CA_SIMExtract function

```
CK_RV CA_SIMExtract(CK_ULONG handleCount, CK_ULONG *handleList,
   CK_ULONG authForm, CK_ULONG authDataCount, CK_ULONG subsetRequired,
   CK_BYTE **authDataList,
   CK_BOOL deleteAfterExtract,
   CK_ULONG *pBlobSize, CK_BYTE *pBlob );
```

This function takes a list of object handles, extracts them using the given authorization data for protection and returns the extracted set of objects as a single data blob. The objects are left on the partition or destroyed, based on the value of the delete-after-extract flag.

The **authDataCount** parameter defines the N value. The **subsetRequired** parameter defines the M value. The **authDataList** parameter should have N entries in it if it is used.

For an authorization data form of PED or challenge/response, **authDataList** parameter is null – values are defined through the PED.

The CK_RV SIMInsert function

```
CK_RV SIMInsert( CK_ULONG blobSize, CK_BYTE *pBlob,
   CK_ULONG authForm, CK_ULONG authDataCount, CK_BYTE **authDataList,
   CK_ULONG *pHandleListSize, CK_ULONG *pHandleList );
```

This function takes a previously extracted blob as input, validates the authorization data, inserts the objects contained in the blob into the HSM, and returns the list of handles assigned to the objects.

For an authorization data form of PED, the **authDataCount** and **authDataList** parameters are not used. For other authorization data forms, the **authDataCount** value should equal M, and the **authDataList** should have M elements in it.

The CK_RV SIMMultiSign function

```
CK_RV SIMMultiSign( CK_ULONG blobSize, CK_BYTE *pBlob,
   CK_ULONG authForm, CK_ULONG authDataCount, CK_BYTE **authDataList,
   CK_ULONG inputDataCount,
   CK_ULONG *inputDataLengths, CK_BYTE **inputDataTable,
   CK_ULONG *signatureLengths, CK_BYTE **signatureTable);
```

This function takes a previously extracted blob as input, validates the authorization data, then uses the key material in the given key blob to sign the various pieces of data in the input data table, returning the signatures through the signature table. The key blob must contain a single key, otherwise an error is returned.

The authorization data parameters are handled as for the SIMInsert function.

Java API

The standard java keystore API supports a single password for each keystore, and a single password for each key in the keystore. We provide a keystore implementation that stores key material in a file, using Scalable Key Storage (formerly SIM) to extract the key material. The password on the keystore is not used, but the password for each key is used as authorization data for the Scalable Key Storage masking process.

When a key is stored in this type of keystore, it is extracted using Scalable Key Storage and the appropriate authorization data, but the key is left on the HSM. When a key is retrieved from this type of keystore, it is inserted onto the HSM.

The standard keystore API supports 1-of-1 authorization inputs of the text form. Different authorization data forms are supported through a custom API. The **LunaTokenManager** class is enhanced to provide a new method to allow the authorization data for subsequent keystore operations to be defined. If the password parameter of a keystore **SetKeyEntry** or **SetCertificateEntry** method call is given a null value, the actual authorization data will be taken from the **LunaTokenManager** interface.

Note that it is up to application to serialize calls to **LunaTokenManager** and the keystore object if multiple threads are simultaneously using keystores. That is, each thread must ensure that it sets its authorization data in **LunaTokenManager** and then performs its keystore operation without being interrupted by another thread changing the **LunaTokenManager** authorization data.

Example Operations Using CKDemo

The following examples show how to use the ckdemo utility to perform SIM operations.

Multisign Challenge (Trusted Path Authentication Only)

1. Open Ckdemo and login as user.
2. Create a 1024 bit RSA key pair - 45,7,1024,1,1,1,1,1,1,1,1,1
3. Sim Extract (105)
   Enter your choice : 105
   Enter handle of object to add to blob (0 to end list, -1 to cancel): 10
   Enter handle of object to add to blob (0 to end list, -1 to cancel): 0
   Enter authentication form:
   0 - none
   1 - password

2 - challenge response
3 - PED-based
enter “2”
Enter number of authorization secrets (N value): 3
Enter subset size required for key use (M value): 2

4. The SafeNet PED displays your challenge secrets, be sure to record them.
   Delete after extract? [0 = false, 1 = true] : 1
5. For every instance of data to sign, enter “12345678”.
   The signatures should complete and be placed in a file.
6. Ensure that the private key has been extracted by performing CKDemo command 26,6 . This shows all the objects on the token. The private key handle that you noted earlier should not be there.
7. Now, insert the blobfile back onto the token:
   Select Insert masked object (106)
   Enter “simkey.blob” as the keyblob to be re-inserted
   Input 2 of the 3 challenges that you recorded earlier.
8. CKDemo 26,6 should reveal that the private key has been re-inserted.

SIM2 Multisign PED-based (PED/Trusted Path Configuration Only)

1. Open Ckdemo and login as user.
2. Create a 1024 bit RSA key pair - 45,7,1024,1,1,1,1,1,1,1,1,1. Note the private and public key handles.
3. Sim Extract (105)
   Enter your choice : 105
   Enter handle of object to add to blob (0 to end list, -1 to cancel): 10
   Enter handle of object to add to blob (0 to end list, -1 to cancel): 0
   Enter authentication form:
   3 - none
   4 - password
   5 - challenge response
   6 - PED-based
   Enter “3”
4. Delete after extract? [0 = false, 1 = true] : 1
5. For every instance of data to sign, enter “12345678”.
   The signatures should complete and the key should be placed in the file simkey.blob.
6. Ensure that the private key has been extracted by performing a 26,6 . This will show all the objects on the token. The private key handle that you noted earlier should not be there.
7. Now, insert the blobfile back onto the token:
   Select Insert masked object (106)
   Enter “simkey.blob” as the keyblob to be re-inserted.
   Input 2 of the 3 challenges that you recorded earlier.
8. CKDemo command 26,6 should reveal that the private key has been re-inserted.

Using Scalable Key Storage in a Multi-HSM Environment

Here are the basic steps to follow when setting up to use Scalable Key Storage with two SafeNet appliance units.

1. Initialize the first SafeNet appliance. Refer to the Configuration section of this Help. The domain created during this initialization (a text string for Password Authenticated SafeNet appliance, or a red PED Key for PED Authenticated SafeNet appliance) will be used as the domain for backup tokens and for the second SafeNet appliance.
2. Create the partition on the first SafeNet appliance.
3. Connect the backup HSM to the appliance USB port.
4. Insert the token into SafeNet Dock2, which is connected to the appliance USB port.
5. Initialize the backup HSM or token using token backup init lush command, with the same domain. Follow the on-screen prompts. Use the domain from step 1.
6. Initialize the second SafeNet appliance. Use the same cloning domain as was used on the first SafeNet appliance .
7. Create the partition on the second SafeNet appliance.
8. Connect the backup HSM to the appliance USB port.
9. Insert the token into SafeNet Dock2, which is connected to the appliance USB port.
10. Perform `hsm restore` from the admin shell. Once this is completed, you now have both SafeNet appliances able to mask and unmask keys using the same "master" key.
11. Set up your Clients and register both SafeNet appliances with each Client. In ckdemo, if you select option 14 (Slot List) and select "Only slots with token present", you should see two LunaNet slots.
12. When the lunaSign::Login function executes it will always login to slot 1 and slot 1 will always be there as long as at least 1 SafeNet appliance is operational and accessible. The Login function returns the number of slots with "tokens" present (in other words the number of accessible SafeNet appliance partitions). In normal operation in the above case the value should be 2. If it returns with less than 2, then there is an added function that can be called that will return the identity of the still live unit.

7 Java Interfaces

This chapter describes the Java interfaces to the PKCS#11 API. It contains the following topics:

SafeNet JSP Overview and Installation

The SafeNet JSP is part of an application program interface (API) that allows Java applications to make use of certain SafeNet products.

As with other APIs, some existing Java-based applications might have generic requirements and calls that can already work with SafeNet products. In other cases, it might be necessary for you or your vendor to create an application or to adapt one, using the JSP API.

You have the choice of:

- using a previously integrated third-party application, known to work with this SafeNet product
- performing your own integration with a Java-based application supplied by you or a third party, or
- developing your own application using our Java API.

Develop your own Java apps using our included Software Development Kit, which includes SafeNet Java API usage notes for developers, as well as development support by SafeNet. A standard Java development environment is required, in addition to the API provided by SafeNet.

Please refer to the current-version SafeNet HSM Customer Release Notes (CRN) for the most up-to-date list of supported platforms and APIs.

JDK Compatibility

We formally test SafeNet HSMs and our Java provider with SUN JDK for all platforms except AIX, and with IBM JDK for the AIX platform. We have not had problems with OpenJDK, although it has not been part of our formal test suite. The SafeNet JCE provider is compliant with the JCE specification, and should work with any JVM that implements the Java language specification.

Occasional problems have been encountered with respect to IBM JSSE.

GNU JDK shipped with most Linux systems has historically been incomplete and not suitable.

Installation

To use the SafeNet JavaSP service providers four main components are needed.

Java SDK 7 or 8

First, acquire and install the Java SDK or RTE (available from the Java site, not included with the SafeNet software). Java must be installed before the SafeNet software, as some of the Java files must be manipulated as described in the JSP portions of the Getting Started section of this Help. Note that the JVM 7 or JVM 8 is part of the Java SDK.

Java Cryptographic JCE Policy files (optional)

If you intend to generate large key sizes, you will need two cryptographic JCE Policy files v 7 or 8 (available from the Java web site). The Getting Started section of this Help has instructions on what to do with the two files (local_policy.jar and US_export_policy.jar).

If you see errors like "Invalid Key size", that is usually an indication that the JCE is not properly installed.

SafeNet Client CD

Follow the installation procedure for the SafeNet Client as described in the *Installation Guide*.

SafeNet JavaSP

When installing the SafeNet Client software, also choose the option to install SafeNet JSP. Instructions are provided in the platform-specific pages, including instructions for installing SafeNet JSP for each operating system (files to copy/replace, editing to perform, etc.) so that SafeNet Network HSM and SafeNet JSP can work with the JRE.

> **Note:** Both GMC and GMAC are supported. "GmacAesDemo.java" provides a sample for using GMAC with Java. Java Parameter Specification class LunaGmacParameterSpec.java defines default values recommended by the NIST specification.

Post-Installation Tasks

"Extractable" Option

The Luna provider provides an option to make newly secret keys extractable from the HSM, via the LunaSlotManager.setSecretKeysExtractable() method.

Some situations exist in which keys should be extractable but this method cannot be used; for example, when the Luna provider is performing crypto operations for a TLS server[1]. We now provide a configuration option to enable this behavior. To make secret keys extractable, add the following line to java.security:

com.safenetinc.luna.provider.createExtractableKeys=true

This value will be read by the Luna provider on startup; to change the setting after the application has started, use the LunaSlotManager method. Using that method overrides the setting in the file for that application, but does not overwrite it permanently.

[1][because you cannot call this method from within your application and have it apply to the TLS server]

When Java, the SafeNet Client and SafeNet JSP are installed as directed, you may then perform any integration required for your own, or third-party Java application.

Using SafeNet JCE/JCA with 64-bit Libraries

If you are using SafeNet JCE/JCA with the 64-bit libraries for SafeNet Network HSM, you must include the "-d64" switch in the Java command-line.

For example: java -d64 -jar jMultitoken.jar

For most 64-bit platforms, 64-bit is supported. Some 64-bit platforms support the option of running in 32-bit mode), as a backward compatibility feature.

If you use the 64-bit installation and do not use the "- d64" command-line switch in your Java command lines, the system attempts (by default) to use the 32-bit library (which is not installed, because you installed 64-bit in this example...), and the result is an error message complaining about the kernel model.

Using ECC Keys for TLS with Java 7

For optimal Java performance when using Elliptic Curve keys to perform TLS with Java 7, where those keys reside in the HSM, you must configure the SunEC security provider (sun.security.ec.SunEC) to be **below** the LunaProvider in your java.security file.

We suggest that you **not** attempt to resolve a performance issue by having the LunaProvider as the default because that would result in the symmetric keys also being used in the HSM which is not optimal for performance.

A Security Note for Java Developers

The SafeNet JSP is a Java API that is intended to be used as an interface between customer-written or third-party Java applications and the SafeNet HSM. Managing security issues associated with the overall operational environment in which the application is running, including the user interface, is the responsibility of the application.

A common example would be input and capture of user name and password. The application, or a set of organizational procedures, is responsible for making the access control decision regarding whether the user has the necessary permissions (at the organizational level) to access the HSM's services and then must provide protection for the password as it is entered, and erasure from memory after the operation is completed. The SafeNet JSP will control access to the HSM based on the correct password being input from the application via the Login method, but security outside the HSM is your responsibility.

Non-standard ECDSA

The SafeNet provider maps the "ECDSA" signature algorithm to "NONEwithECDSA". The Java convention is to map it to "SHA1withECDSA". This is noted here in case you wish to use it in provider inter-operability testing. This mapping is noted in the Javadoc as well.

For comparison, "RSA" maps to "NONEwithRSA" while "DSA" maps to "SHA1withDSA".

SafeNet JSP Configuration

SafeNet JSP consists of a single JCA/JCE service provider, that allows a Java-based application to use SafeNet HSM products for secure cryptographic operations. Please refer to the Javadocs accompanying the toolkit, for the most current information regarding the SafeNet JSP packages and LunaProvider functionality.

Installation

You must acquire a Java JDK or JRE separately and install it before installing the SafeNet JSP. See the QuickStart that came with your software package.

In order to use the LunaProvider you must place the jar file in your classpath. We recommend placing it in your <jre>/lib/ext folder. In addition the JNI component, which may be a .dll or .so file depending on your system architecture, should be placed in your library path.

Java -- Encryption policy files for unlimited strength ciphers

Additionally, you might need to apply the unlimited strength ciphers policy. The unlimited strength ciphers policy files can be downloaded from Oracle.

The US_export_policy.jar and local_policy.jar are to be copied to JAVA_HOME/jre/lib/security (or the equivalent directory that applies to your setup).

```
[root@my-sa5client]# echo $JAVA_HOME
/usr/java/default
[root@my-sa5client]# cp -p local_policy.jar /usr/java/default/jre/lib/security/
[root@my-sa5client]# cp -p US_export_policy.jar /usr/java/default/jre/lib/security/
```

SafeNet Java Security Provider

In general, you should use the standard JCA/JCE classes and methods to work with SafeNet HSMs. The following sections provide examples of when you may wish to use the special SafeNet methods.

Class Hierarchy

All public classes in the SafeNet Java crypto provider are included in the com.safenetinc.luna package or subpackages of that package. Thus the full class names are (for example):

- com.safenetinc.luna.LunaSlotManager
- com.safenetinc.luna.provider.key.LunaKey

If your application is compliant with the JCA/JCE spec, you will generally not need to directly reference any SafeNet implementation classes. Use the interfaces defined in the java.security packages instead. The exception is if you need to perform an HSM-specific operation, such as modifying PKCS#11 attributes.

Throughout the rest of this document, the short form of the class names is used for convenience and readability. The full class names (of SafeNet or other classes) are used only where necessary to resolve ambiguity.

Special Classes/Methods

The JCA/JCE interfaces were not designed with hardware security modules (HSMs) in mind and do not include methods for managing aspects of a hardware module. SafeNet JSP provides some additional functions in addition to the standard JCA/JCE API.

The LunaSlotManager class provides custom methods that allow some HSM-specific information to be retrieved. It also provides a way to log in to the HSM if your application cannot make use of the standard KeyStore interface. For details please check the Javadoc which comes with the product.

It is not always necessary to use the LunaSlotManager class. With proper use of the JCE API provided in SafeNet JSP, your code can be completely hardware-agnostic.

The LunaKey class implements the Key interface and provides all of the methods of that class along with custom methods for manipulating key objects on SafeNet hardware.

Note: Sensitive attributes cannot be retrieved from keys stored on SafeNet hardware. Thus certain JCE-specified methods (such as PrivateKeyRSA.getPrivateExponent()) will throw an exception.

The LunaCertificateX509 class implements the X509Certificate methods along with custom methods for manipulating certificate objects on SafeNet hardware.

Examples

The SafeNet JSP comes with several sample applications that show you how to use the Luna provider. The samples include detailed comments.

To compile on windows without an IDE (administrator privileges may be required)

```
cd <SafeNet Network HSM install>/jsp/samples
javac com\safenetinc\luna\sample\*.java
```

To run

```
java com.safenetinc.luna.sample.KeyStoreLunaDemo (or any other sample class in that package)
```

Authenticating to the HSM

In order to make use of an HSM, it is necessary to activate the device through a login. Depending on the security level of the device, the login will require a plain-text password and/or a PED key.

The preferred method of logging in to the module is through the Java KeyStore interface. The store type is “Luna” and the password for the key store is the challenge for the partition specified.

KeyStore files for the Luna KeyStore must be created manually. The content of the KeyStore file differs if you wish to reference the partition by the slot number or label (preferred). Details of authenticating to the HSM via the KeyStore interface are explained in the Javadoc for LunaKeyStore and in the KeyStoreLunaDemo sample application.

Keys in a Luna KeyStore cannot have individual passwords. Only the KeyStore password is used. If your HSM requires PED keys to be presented for authentication and the partition is not already activated, loading the KeyStore will cause the PED to prompt you to present this key.

Other than the KeyStore interface your application may also make use of the LunaSlotManager class or by using a login state created outside of the application through a utility called ‘salogin’. Use of salogin is strongly discouraged unless you have a very specific need.

LunaKeyStoreMP is Deprecated

LunaKeyStoreMP is deprecated for SafeNet JSP, and may be discontinued in a future release. LunaKeyStoreMP was used in previous releases to allow logical partitioning of the key space on HSMs that have only one partition. This allowed you to create a separate MP key store for each individual client that accessed the partition. Recent SafeNet releases, however, support multiple partitions, and dedicating a partition per client is a superior solution for management and security reasons.

Note: LunaKeyStoreMP is retained for backwards compatibility reasons only. Do not use LunaKeyStoreMP when creating new applications.

Logging Out

Logging out of the HSM is performed implicitly when the application is terminated normally. Logging out of the HSM while the application is running can be done with the LunaSlotManager class. Please note that any ephemeral (non-persistent) key material present on the HSM will be destroyed when the session is logged out. Because the link to the HSM will be severed, cryptographic objects that were created by the LunaProvider will no longer be usable. Attempting to use these objects after logging out will result in undefined behaviour.

All key material which was persisted on the HSM (either through the KeyStore interface or using the proprietary Make Persistent method) will remain on the HSM after a logout and will be accessible again when the application logs back in to the HSM.

Keytool

The SafeNet JSP may be used in combination with Java’s keytool utility to store and use keys on a SafeNet HSM, see "Using Java Keytool with SafeNet HSM" on page 464.

Cleaning Up

Keys that are made persistent will continue to exist on the HSM until they are explicitly destroyed, or until the HSM is reinitialized. Persistent keys that are no longer needed can be explicitly destroyed to free resources on the HSM.

Keys may be removed using the Keytool, or programmatically through the KeyStore interface or other methods available through the API.

LunaSlotManager contains methods that report the number of objects that exist on the HSM. See the Javadoc for LunaSlotManager for more information.

PKCS#11/JCA Interaction

Keys created using the SafeNet PKCS#11 API can be used with the SafeNet JSP; the inverse is also true.

Certificate Chains

The PKCS#11 standard does not provide a certificate chain representation. When a Java certificate chain is stored on a SafeNet token, the certificates of the chain appear as individual objects when viewed through the PKCS#11 API. In order for the LunaProvider to properly identify PKCS#11-created certificates as part of a chain attached to a private key, the certificates must follow the labeling scheme described below.

Java Aliases and PKCS#11 Labels

The PKCS#11 standard defines a large set of object attributes, including the object label. This label is analogous to the Object alias in a java KeyStore.

The SafeNet KeyStore key entry or a SafeNet KeyStore certificate entry will have a PKCS#11 object label exactly equal to the Java alias. Similarly, a key created through PKCS#11 will have a Java alias equal to the PKCS#11 label.

Because a java certificate chain cannot be represented as a single PKCS#11 object, the individual certificates in the chain will each appear as individual PKCS#11 objects. The labels of these PKCS#11 objects will be composed of the alias of the corresponding key entry, concatenated with "--certX", where 'X' is the index of the certificate in the java certificate chain.

For example, consider a token that has a number of objects created through the Java API. The objects consist of the following:

- A key entry with alias "signing key", consisting of a private key and a certificate chain of length 2
- A trusted certificate entry with alias "root cert"
- A secret key with alias "session key"

If all objects on the token were viewed through a PKCS#11 interface, 5 objects would be seen:

- A private key with label "signing key"
- A certificate with label "signing key--cert0"
- A certificate with label "signing key--cert1"
- A certificate with label "root cert"
- A secret key with label "session key"

> **Note:** PKCS#11 labels (strings of ascii characters) and Java aliases (of the java.lang.String type) are usually fully compatible, but problems can arise if non-printable characters are used. To maintain compatibility between Java and PKCS#11, avoid embedding non-printable or non-ascii characters in aliases or object labels.

RSA Cipher

Previously, by default, the SafeNet JSP RSA cipher mode used raw RSA X.509 encryption, with no padding.

For improved security and compatibility, default padding for RSA cipher has been changed from NoPadding to PKCS1v1_5.

The JCPROV PKCS#11 Java Wrapper

This section describes how to install and use the JCPROV Java wrapper for the PKCS#11 API. It contains the following topics:

- "JCPROV Overview" below
- "Installing JCPROV" on the next page
- "JCPROV Sample Programs" on page 456
- "JCPROV Sample Classes" on page 457
- "JCPROV API Documentation" on page 460

JCPROV Overview

JCPROV is a Java wrapper for the PKCS#11 API. JCPROV is designed to be as similar to the PKCS#11 API as the Java language allows, allowing developers who are familiar with the PKCS#11 API to rapidly develop Java-based programs that exercise the PKCS#11 API.

> **Note:** AES-GMAC and AES-GCM are supported in JCPROV. Use CK_AES_CMAC_PARAMS.java to define the GMAC operation. Implementation is the same as for PKCS#11.

JDK compatibility

The JCPROV Java API is compatible with JDK 1.5.0 or higher.

The JCPROV library

The JCPROV library is implemented in **jcprov.jar**, under the namespace **safenet.jcprov**. It is accompanied by a shared library that provides the native methods used to access the appropriate PKCS#11 library. The name of the shared library is platform dependent, as follows:

Operating system	Shared library
Windows (32 and 64 bit)	jcprov.dll
Linux	libjcprov.so
Solaris	libjcprov.so
HP-UX	libjcprov.sl
AIX	libjcprov.so

Installing JCPROV

Use the SafeNet Client Installer to install the JCPROV software (runtime and SDK packages). The software is installed in the location specified in the following table:

Operating system	Installation location
Windows	C:\Program Files\safenet\lunaclient\jcprov
Linux	/usr/safenet/lunaclient/jcprov
Solaris	/opt/safenet/lunaclient/jcprov
HP-UX	/opt/safenet/lunaclient/jcprov
AIX	/usr/safenet/lunaclient/jcprov

The installation includes a **samples** subdirectory ( ) and a **javadocs** subdirectory ( ).

Changing the Java JNI libraries (AIX only)

The Java VM on AIX does not support mixed mode JNI libraries. Mixed mode libraries are shared libraries that provide both 32-bit and 64-bit interfaces. It is therefore essential that you select the correct JNI library to use with your Java VM.

> **CAUTION:** When JCPROV is installed, links are automatically created to use the 32-bit versions of the JNI libraries. You need to update the links if you are using a 64-bit operating system.

To configure the JNI library for use with a 32-bit Java VM:

1. Ensure that the **/usr/safenet/lunaclient/jcprov/lib/libjcprov.a** symbolic link points to a 32-bit version of the library

(**libjcprov_32.a**), for example: **/usr/safenet/lunaclient/jcprov/lib/libjcprov_32.a**.

2. Ensure that the **/usr/safenet/lunaclient/jcprov/lib/libjcryptoki.a** symbolic link points to a 32-bit version of the library(**libjcryptoki_32.a**), for example **/usr/safenet/lunaclient/jcprov/lib/libjcryptoki_32.a**.

To configure the JNI library for use with a 64-bit Java VM:

1. Ensure that the **/usr/safenet/lunaclient/jcprov/lib/libjcprov.a** symbolic link points to a 64-bit version of the library (**libjcprov_64.a**), for example **/usr/safenet/lunaclient/jcprov/lib/libjcprov_64.a**.
2. Ensure that the **/usr/safenet/lunaclient/jcprov/lib/libjcryptoki.a** symbolic link points to a 64-bit version of the library (**libjcryptoki_64.a**), for example **/usr/safenet/lunaclient/jcprov/lib/libjcryptoki_64.a**.

JCPROV Sample Programs

Several sample programs are included to help you become familiar with JCPROV. The binaries for the sample programs are included in the **jcprovsamples.jar** file. You must compile the binaries before you can use the sources provided.

Compiling and running the JCPROV sample programs

CAUTION: You require JDK 1.5.0 or newer to compile the JCPROV sample programs.

It is recommended that you compile the samples in their installed locations, so that the path leading to the samples directory in the installation location will allow them to be executed as documented below.

Prerequisites

For best results, perform the following actions before attempting to compile the sample programs:

- Add **jcprov.jar** to your **CLASSPATH** environment variable
- Add a path to the **CLASSPATH** environment variable that allows JCPROV to use the **safenet.jcprov.sample** namespace. This is required since all of the applications are registered under this namespace.

To compile the JCPROV sample programs on UNIX/Linux:

1. Set the **CLASSPATH** environment variable to point to **jcprov.jar** and the root path for the sample programs.
   export CLASSPATH=<jcprov_installation_directory>**/***
2. Change directory to the sample programs path.
   cd /usr/safenet/lunaclient/jcprov/samples/com/safenetinc/jcprov/sample
3. Use the **javac** program to compile the examples.
   javac GetInfo.java
4. Use the **java** program to run the samples.
   java com.safenetinc.jcprov.sample.GetInfo -slot 0 -info

To compile the JCPROV sample programs on Windows

1. Set the **CLASSPATH** environment variable to point to **jcprov.jar** and the root path for the sample programs:
   C:\> **set "CLASSPATH= C:\Program Files\safenet\lunaclient\jcprov\jcprov.jar; C:\program files\safenet\jcprov\samples"**
2. Use the **javac** program to compile the examples:
   C:\Program Files\safenet\lunaclient\jcprov\samples> **javac GetInfo.java**

3. Use the **java** program to run the samples:
   C:\Program Files\safenet\lunaclient\jcprov\samples> **java safenet.jcprov.samples.GetInfo -info**

JCPROV Sample Classes

JCPROV provides sample classes in the <jcprov_installation_directory>/**samples** directory. These include:

- "DeleteKey" below
- "EncDec" on the next page
- "GenerateKey" on the next page
- "GetInfo" on page 459
- "Threading" on page 459

Other samples contained in the **samples** directory may be more or less useful to you depending on what you need. Each relevant sample has a description of both its purpose and its parameters in the header section of its file.

DeleteKey

Demonstrates the deletion of keys.

A generated key is required to use this script. To generate a key, use "GenerateKey" on the next page or refer to "Using Java Keytool with SafeNet HSM" on page 464

Usage

java safenet.jcprov.sample.DeleteKey -keyType <keytype> **-keyName** <keyname> [**-slot** <slotId>] [**-password** <password>]

Parameters

Parameter	Description
-keytype	Specifies the type of key you want to delete. Enter this parameter followed by one of the following supported key types: • **des** - single DES key • **des2** - double-length, triple-DES key • **des3** - triple-length, triple-DES key • **rsa** - RSA key pair
-keyName	Specifies the name (label) of the key you want to delete. Enter this parameter followed by the name (label) of the key you want to delete.
-slot	Specifies the slot for the HSM or partition that contains the key you want to delete. Optionally enter this parameter followed by the slot identifier for the HSM or partition that contains the key you want to delete. If this parameter is not specified, the default slot is used. **Default:** 1
-password	Specifies the password for the slot. Optionally enter this parameter followed by the slot password to delete a private key.

EncDec

Demonstrates encryption and decryption operations by encrypting and decrypting a string.

A generated key is required to use this script. To generate a key, use "GenerateKey" below or refer to "Using Java Keytool with SafeNet HSM" on page 464

Usage

java safenet.jcprov.sample.EncDec -keyType <keytype> **-keyName** <keyname> [**-slot** <slotId>] [**-password** <password>]

Parameters

Parameter	Description
-keytype	Specifies the type of key you want to use to perform the encryption/decryption operation. Enter this parameter followed by one of the following supported key types: • **des** - single DES key • **des2** - double-length, triple-DES key • **des3** - triple-length, triple-DES key • **rsa** - RSA key pair
-keyName	Specifies the name (label) of the key you want to use to perform the encryption/decryption operation. Enter this parameter followed by the name (label) of the key you want to use to perform the encryption/decryption operation.
-slot	Specifies the slot for the HSM or partition that contains the key you want to use to perform the encryption/decryption operation. Optionally enter this parameter followed by the slot identifier for the HSM or partition that contains the key you want to use to perform the encryption/decryption operation. If this parameter is not specified, the default slot is used. **Default:** 1
-password	Specifies the password for the slot. Optionally enter this parameter followed by the slot password to encrypt/decrypt a private key.

GenerateKey

Demonstrates the generation of keys.

Usage

java safenet.jcprov.sample.GenerateKey -keyType <keytype> **-keyName** <keyname> [**-slot** <slotId>] [**-password** <password>]

Parameters

Parameter	Description
-keytype	Specifies the type of key you want to generate. Enter this parameter followed by one of the following supported key types: • **des** - single DES key • **des2** - double-length, triple-DES key

Parameter	Description
	• **des3** - triple-length, triple-DES key • **rsa** - RSA key pair
-keyName	Specifies the name (label) of the key you want to generate. Enter this parameter followed by the name (label) of the key you want to generate.
-slot	Specifies the slot for the HSM or partition where you want to generate the key. Optionally enter this parameter followed by the slot identifier for the HSM or partition where you want to generate the key. If this parameter is not specified, the default slot is used. **Default:** 1
-password	Specifies the password for the slot. Optionally enter this parameter followed by the slot password to generate a private key.

GetInfo

Demonstrates the retrieval of slot and token information.

Usage

java safenet.jcprov.sample.GetInfo {**-info** \| **-slot** [<slotId>] \| **-token** [<slotId>]}

Parameters

Parameter	Description
-info	Retrieve general information.
-slot	Retrieve slot information for the specified slot. Enter this parameter followed by the slot identifier for the slot you want to retrieve information from. If <slotId> is not specified, information is retrieved for all available slots.
-token	Retrieve token information for the HSM or partition in the specified slot. Enter this parameter followed by the slot identifier for the HSM or partition you want to retrieve information from. If <slotId> is not specified, information is retrieved for all available slots.

Threading

This sample program demonstrates different ways to handle multi-threading.

This program initializes the Cryptoki library according to the specified locking model. Then a shared handle to the specified key is created. The specified number of threads is started, where each thread opens a session and then enters a loop which does a triple DES encryption operation using the shared key handle.

It is assumed that the key exists in slot 1, and is a Public Token object.

A generated key is required to use this script. To generate a key, use "GenerateKey" on the previous page or refer to "Using Java Keytool with SafeNet HSM" on page 464

Usage

java ...Threading -numThreads <numthreads> **-keyName** <keyname> **-locking** { **none** | **os** | **functions** } [**-v**]

Parameters

Parameter	Description
-numthreads	Specifies the number of threads you want to start. Enter this parameter followed by an integer that specifies the number of threads you want to start.
-keyName	Specifies the triple-DES key to use for the encryption operation. Enter this parameter followed by the name (label) of the key to use for the encryption operation.
-locking	Specifies the locking model used when initializing the Cryptoki library. Enter this parameter followed by one of the following locking models: • **none** - do not use locking when initializing the Cryptoki library. If you choose this option, some threads should report failures. • **os** - use the native operating system mechanisms to perform locking. • **functions** - use Java functions to perform locking
-v	Specifies the password for the slot. Optionally enter this parameter followed by the slot password to generate a private key.

JCPROV API Documentation

The JCPROV API is documented in a series of javadocs. The documentation is located in the <jcprov_installation_ directory>**/javadocs** directory.

Java or JSP Errors

In the process of using our JSP (Java Service Provider) or programming for Java clients, you might encounter a variety of errors generated by various levels of the system. In rare cases those might be actual problems with the system, but in the vast majority of cases the errors are the system (or the Client-side libraries) telling you that you (or your application) have done something "wrong". In other words, the error messages are guidance to ensure that your actions and your programs are giving the system what it needs (in the right order and format) to complete the tasks that you ask of it.

Keep in mind that there are several levels involved. The SafeNet appliance and its HSM keycard have both software and firmware built in. Among other things, the system software handles the system side of communication between you (either as administrator or as Client) and the HSM on the appliance. In general, a client-side program (or programmer) would not encounter error messages directly from the system. If an error condition arises on the system, the most likely visibility would be error messages in the system logs - viewed by the appliance administrator - or else client-side messages based upon the interaction of the client-side software (ours and yours) with the appliance.

On the client side, the JSP and any Java programs that you use would be overlaid on, and using, the SafeNet library, which is an extended version of PKCS#11, customized to make use of our HSM (the standard itself and the cryptoki library are oriented toward in-software implementation of cryptographic functions, with some generic support of generic HSM functions, leaving room for each HSM supplier to support their own special functions by extending the standard). PKCS#11 is an RSA Laboratories cryptographic standard, and our libraries are a C-language implementation of that standard. You can view all that is known about PKCS #11 error conditions and messages at the RSA website.

See "Library Codes" on page 1 for a summary of error codes and their meanings, which includes the SafeNet extensions to the PKCS#11 standard that are specific to our HSM. Note that "error codes" do not usually indicate a problem with the appliance or HSM - they indicate an exception condition has been encountered, possibly because you (or your application) stopped/canceled a requested action before it could complete, provided incorrect or incomplete or wrongly-formatted input data, and so on, or possibly because a network connection has been disrupted, power has failed, or any of a variety of situations has been detected.

The JSP and your Java programming are overlaid on top of the PKCS#11 and SafeNet libraries. An error reported by a Java application might refer to a problem at the Java or JSP level, or the error might have been passed through from a lower level.

If you receive a cryptic error that looks something like:

```
Exception in thread "main"
com.safenetinc.crypto.LunaCryptokiException: function 'C_Initialize' returns 0x30
```

then this error has been passed through from a lower layer and is not a Java or JSP error. You should look in the Error Codes page (link above) or in the PKCS#11 standard for the meaning of any error in a similar format.

In general, we wrap cryptoki exception codes. Most exceptions thrown by the JSP are in accordance with the specification. Check the Javadoc for the API call that threw the exception.

- LunaException is used to report a LunaProvider-specific exception.
- LunaCryptokiException reports errors returned by the HSM. Those might be wrapped in other Exceptions

Re-Establishing a Connection Between Your Java Application and SafeNet Network HSM

The following snippet of java code re-establishes a connection between a Java Application and SafeNet Network HSM in the event of a disconnect (for example, firewall rules, network issues).

Note: Stop all existing crypto operations before performing the reconnect.

```
public void reconnectHsmServer() {
     LunaSlotManager lsm = LunaSlotManager.getInstance();
     lsm.reinitialize();
     lsm.login("<HSM partition password>");
}
```

Note: The reinitialize() call is a disruptive call. It unloads and reloads the dll, in order to perform a cleanup and refresh. When reinitialize() is called, there are no safe API methods that may be called and any calls in progress will result in undefined behaviour, leading, most-likely, to a JVM crash. Before calling reinitialize(), ensure that all threads making use of the API are halted or stopped, and that no other calls are made until reinitialize() has completed.

Recovering From the Loss of All HA Members

The reinitialize method of the **LunaSlotManager** class takes the role of the PKCS#11 functions **C_Finalize** and **C_Initialize**. It is intended to be used when a complete loss of communication happens with all the members of your High Availability (HA) group.

This section describes the situations in which you should use this method, the effect this method has on a running application, and how to use this method safely. It is assumed that the auto-insert (auto-recovery) features of the HA group are enabled.

You should read this section if you are developing an application that uses the LunaProvider in an environment that leverages an HA group of SafeNet Network HSM appliances, so that you can safely recover an entire HA group.

When to Use the reintialize Method

When using the high-availability (HA) features of SafeNet Network HSM, the auto-insert (auto-recovery) feature will resolve situations where connectivity is lost to a subset of members for a brief time. However, if you lose connection to all members then the connection cannot be automatically recovered. Finalizing the library and initializing it again is the only way to recover other than restarting the application.

Why the Method Must Be Used

In an HA group, we rely on having at least one member present in order to maintain state. If all of the members have been lost, then we cannot make any determination of which member has a known good state. Also, when a connection to a member is lost, the authenticated state is lost. When an individual member returns, we can use the authenticated state from another member to authenticate to the one that has returned. When all members are lost, then the authenticated state is lost on all members.

What Happens on the HSM

The Network Trust Link Service (NTLS) on the HSM appliance is responsible for cleaning up any cryptographic resources, such as session objects, and cryptographic operation contexts when a connection to the client is lost. This happens when the socket closes.

Effect on Running Applications

All resources created within the LunaProvider must be treated as junk after the library is finalized. Sessions will no longer be valid, session objects will point to non-existent objects or worse to a wrong object, and **Signature/Cipher/Mac/etc** objects will have invalid data.

Even **LunaKey** objects, which represent persistent objects, may contain invalid data. When the virtual slot is constructed in the library, the virtual object table is built from the objects present on each individual member. There is no guarantee that objects will have the same handle from one initialization to the next. This is true from the moment the connection to the group is severed. All these resources must be released before calling the reinitialize method. Beyond causing undesirable behavior when used, if these objects are garbage collected after cryptographic operations resume, they can result in the deletion of new objects or sessions.

Using the Method Safely

The first indication that all communications may have been lost with the group is a **LunaException** reporting an error code of **0x30** (Device Error). Other possible error codes that can indicate this status are **0xE0** (Token not present) and **0xB3** (Session Handle invalid). The **LunaException** class does not provide the error code as a discrete value and you will have to parse the message string to determine this value.

At this point, you should validate that the group has been lost. The **com.safenetinc.luna.LunaHAStatus** object is best suited for this. Your application should know the slot number of the HA slot that you are using because it may not be able to query this information from the label when the slot is missing.

Example

```
LunaHAStatus status = new LunaHAStatus(haSlotNumber);
```

You can query the object for detailed information or just use the **isOK()** method to determine if the group has been lost. The **isOK()** method will return true if all members are still present. If all members are gone, an exception will be thrown.

If no application is thrown, the application should be able to proceed operating, and any individual members of the HA group that have been lost will be recovered by the library. Further details on failed members can be queried through the LunaHAStatus object.

In many highly threaded applications, such as web applications, it is desirable to have a singleton, which is responsible for keeping track of the health of the HSM connection. This can be done by having worker threads report information to this singleton, by having a specific health check thread, or through a combination of the two.

Once the error state is discovered, all worker threads should be stopped or allowed to return an error. It may take up to 40 seconds from the time the group was lost for all threads to discover that there is an error. It can take 20 seconds for any given command to time out as a result of network failure. Once this happens, new commands will not be sent to that HSM, but a command may have just been sent and that command will have its own 20-second timeout. As mentioned above, in the section on application effects, all of the objects created or managed by the LunaProvider must be considered at this point to contain junk data. Operating after recovery with this junk data can cause undesired effects. This means all keys, signature, cipher, Mac, KeyGenerator, KeyPairGenerator, X509Certificate, and similar objects must be released to the garbage collector. Instances of most non-SPI (LunaAPI, LunaSlotManager, LunaTokenManager, etc.) objects do not pose a problem, but any instances of LunaSession held in the application during the course of the reinitialize can cause problems if they are returned to the session pool after the reinitialization takes place.

Cryptographic processing in the application should be halted until connection with the HSMs is back to a known good state. It may be appropriate to hold operations in a queue for processing later or to return an Out of Service message.

Once the objects have been released and no further processing will occur, the application should attempt recovery of the connection. This is done through the **com.safenetinc.luna.LunaSlotManager.reinitialize** method. This method will first clear session objects held within the provider before finalizing the library. After the library is finalized, it will initialize it again by invoking the **C_Initialize** method. This method will establish a connection with all the HSMs if possible. The same **isOK()** method of **LunaHAStatus** can be used to determine if the group has been recovered successfully.

It is also important to only have a single thread call the **reinitialize** method. When multiple threads try to unload or load the library at the same time, errors can occur.

Using Java Keytool with SafeNet HSM

This page describes how to use the Java KeyTool application with the LunaProvider.

Limitations

The following limitations apply:

- You cannot use the importkeystore command to migrate keys from a Luna KeyStore to another KeyStore.
- Private keys cannot be extracted from the KeyStore unless you have the Key Export model of the HSM.
- By default secret keys created with the LunaProvider are non-extractable.

The example below uses a KeyStore file containing only the line “slot:1”. This tells the Luna KeyStore to use the token in slot 1.

For information on creating keys through Key Generator or Key Factory classes please see the LunaProvider Javadoc or the JCA/JCE API documentation.

Keys (with self signed certificates) can be generated using the keytool by specifying a valid Luna KeyStore file and specifying the KeyStore type as “Luna”. The password presented to authenticate to the KeyStore is the challenge password of the partition.

Example

```
keytool -genkeypair -alias myKey -keyalg RSA -sigalg SHA256withRSA -keystore keystore.luna -
storetype Luna
Enter keystore password:
What is your first and last name?
[Unknown]:  test
What is the name of your organizational unit?
[Unknown]:  codesigning
What is the name of your organization?
[Unknown]:  SafeNet Inc
What is the name of your City or Locality?
[Unknown]:  Ottawa
What is the name of your State or Province?
[Unknown]:  ON
What is the two-letter country code for this unit?
[Unknown]:  CA
Is CN=test, OU=codesigning, O=SafeNet Inc, L=Ottawa, ST=ON, C=CA correct?
[no]:  yes
Enter key password for <myKey>
(RETURN if same as keystore password):
```

Keytool Usage and Examples

The LunaProvider is unable to determine which PKCS#11 slot to use without providing a keystore file. This file can be manually created to specify the desired slot by either the slot number or partition label. The naming of the files is not important - only the contents.

The keytool examples below refer to a keystore file named bylabel.keystore. Its content is just one line:

```
tokenlabel:a-partition-name
```

where a-partition-name is the name of the partition you want the Java client to use.

Here is the (one line) content of a keystore file that specifies the partition by slot number:


```
slot:1
```

where 1 is the slot number of the partition you want the Java client to use.

To test that the Java configuration is correct, execute:

```
my-sa6client:~/luna-keystores$ keytool -list -v -storetype Luna -keystore
bylabel.keystore
```

The system requests the password of the partition and shows its contents.

Here is a sample command to create an RSA 2048 bit key with SHA256withRSA self-signed certificate.

keytool -genkeypair -alias keyLabel -keyalg RSA -keysize 2048 -sigalg SHA256withRSA -storetype Luna -keystore bylabel.keystore -validity 365

```
Enter keystore password:
What is your first and last name?
  [Unknown]:  mike
What is the name of your organizational unit?
  [Unknown]:  appseng
What is the name of your organization?
  [Unknown]:  safenet
What is the name of your City or Locality?
  [Unknown]:  ottawa
What is the name of your State or Province?
  [Unknown]:  on
What is the two-letter country code for this unit?
  [Unknown]:  ca
Is CN=mike, OU=appseng, O=safenet, L=ottawa, ST=on, C=ca correct?
  [no]:  yes
Enter key password for <keyLabel>
  (RETURN if same as keystore password):
```

With the Luna provider there is no concept of a key password and anything entered is ignored.

The following is a more elaborate sequence of keytool usage where the final goal is to have the private key generated in the HSM through keytool “linked” to its certificate.

Import CA certificate

It is mandatory to import the CA certificate – keytool verifies the chain before importing a client certificate:

```
my-sa5client:~/luna-keystores$ keytool -importcert -storetype Luna -keystore bylabel.keystore -
alias root-projectca -file project_CA.crt
```

It is not required to import this certificate in the Java default cacerts keystore.

Generate private key

Generate the private key. It is NOT important that the sigalg specified matches the one used by the CA. You can also have OU, O, L, ST, and C different from the ones in the CA certificate.

```
my-sa6client:~/luna-keystores$ keytool -genkeypair -alias java-client2-key -keyalg RSA -keysize
2048 -sigalg SHA256withRSA -storetype Luna -keystore bylabel.keystore
Enter keystore password:
What is your first and last name?
[Unknown]:  java-client2
What is the name of your organizational unit?
[Unknown]:  SE
What is the name of your organization?
```



```
[Unknown]:  SFNT
What is the name of your City or Locality?
[Unknown]:  bgy
What is the name of your State or Province?
[Unknown]:  bg
What is the two-letter country code for this unit?
[Unknown]:  IT
Is CN=java-client2, OU=SE, O=SFNT, L=bgy, ST=bg, C=IT correct?
[no]:  yes
Enter key password for <java-client2-key>
(RETURN if same as keystore password):
```

Verify that the private key is in the partition:

```
my-sa6client:~/luna-keystores$ keytool -list -v -storetype Luna -keystore bylabel.keystore
Enter keystore password:
Keystore type: LUNA
Keystore provider: LunaProvider
Your keystore contains 2 entries
Alias name: root-projectca
Creation date: Oct 4, 2012
Entry type: trustedCertEntry
Owner: EMAILADDRESS=manager@computer.org, CN=project CA, OU=SE, O=SFNT, L=bgy, ST=bg, C=IT
Issuer: EMAILADDRESS=manager@computer.org, CN=project CA, OU=SE, O=SFNT, L=bgy, ST=bg, C=IT
Serial number: 1
Valid from: Thu Oct 04 09:02:00 CEST 2012 until: Tue Oct 04 09:02:00 CEST 2022
Certificate fingerprints:
       MD5:  A2:15:4F:94:70:2B:D2:F7:C0:96:B1:47:F2:1D:03:E9
       SHA1: B3:4A:68:0A:8D:12:39:86:11:CE:EF:22:1B:D1:DE:8D:E9:19:2B:F4
       Signature algorithm name: SHA256withRSA
       Version: 3
*****************************************
*****************************************
Alias name: java-client2-key
Creation date: Oct 4, 2012
Entry type: PrivateKeyEntry
Certificate chain length: 1
Certificate[1]:
Owner: CN=java-client2, OU=SE, O=SFNT, L=bgy, ST=bg, C=IT
Issuer: CN=java-client2, OU=SE, O=SFNT, L=bgy, ST=bg, C=IT
Serial number: 506d42dd
Valid from: Thu Oct 04 10:03:41 CEST 2012 until: Wed Jan 02 09:03:41 CET 2013
Certificate fingerprints:
       MD5:  7A:37:72:6B:8A:05:B6:49:91:70:0F:C4:04:1F:69:D9
       SHA1: 05:CD:9F:A5:37:0B:A6:A3:65:24:56:40:5E:29:2D:95:2D:53:8F:5F
       Signature algorithm name: SHA256withRSA
       Version: 3
```

Create the CSR

Create the CSR to be submitted to the CA.

```
my-sa5client:~/luna-keystores$ keytool -certreq -alias java-client2-key -file client2-pro-
jectca.csr -storetype Luna -keystore bylabel.keystore
Enter keystore password:
```

Now have the CSR signed by the CA. Have the issued certificate exported to include the certificate chain. Without the chain, keytool fails with the error:

```
java.lang.Exception: Failed to establish chain from reply
```

If you do not have the chain, you can use the steps in the section below to build the chain yourself.

To translate a PKCS#7 exported certificate from DER format to PEM format use the following:

```
my-sa5client $ openssl pkcs7 -inform der -in Luna_Key.p7b -outform pem -out Luna_Key-pem.p7b
```

Microsoft CA exports certificates with chain only in PKCS#7 PEM encoded format.

Import client certificate

Now import the client certificate:

```
user@myserver:~/luna-keystores$ keytool -importcert -storetype Luna -keystore bylabel.keystore -
alias java-client2-key -file java-client2.crt
Enter keystore password:
Certificate reply was installed in keystore
```

Ensure that it is linked to the private key generated previously – the chain length is not 1 (“Certificate chain length: 2)

```
user@myserver:~/luna-keystores$ keytool -list -v -storetype Luna -keystore bylabel.keystore
```

```
Enter keystore password:
Keystore type: LUNA
Keystore provider: LunaProvider
Your keystore contains 2 entries
Alias name: root-projectca
Creation date: Oct 4, 2012
Entry type: trustedCertEntry
Owner: EMAILADDRESS=manager@computer.org, CN=project CA, OU=SE, O=SFNT, L=bgy, ST=bg, C=IT
Issuer: EMAILADDRESS=manager@computer.org, CN=project CA, OU=SE, O=SFNT, L=bgy, ST=bg, C=IT
Serial number: 1
Valid from: Thu Oct 04 09:02:00 CEST 2012 until: Tue Oct 04 09:02:00 CEST 2022
Certificate fingerprints:
      MD5:  A2:15:4F:94:70:2B:D2:F7:C0:96:B1:47:F2:1D:03:E9
      SHA1: B3:4A:68:0A:8D:12:39:86:11:CE:EF:22:1B:D1:DE:8D:E9:19:2B:F4
      Signature algorithm name: SHA256withRSA
      Version: 3
*******************************************
*******************************************
Alias name: java-client2-key
Creation date: Oct 4, 2012
Entry type: PrivateKeyEntry
Certificate chain length: 2
Certificate[1]:
Owner: CN=java-client2, OU=SE, O=SFNT, L=bgy, ST=bg, C=IT
Issuer: EMAILADDRESS=manager@computer.org, CN=project CA, OU=SE, O=SFNT, L=bgy, ST=bg, C=IT
Serial number: 5
Valid from: Thu Oct 04 10:07:00 CEST 2012 until: Fri Oct 04 10:07:00 CEST 2013
Certificate fingerprints:
       MD5:  4B:F0:9E:BC:EB:6A:88:2B:87:3A:76:35:7C:DE:4B:B4
       SHA1: F1:0C:BC:E3:A1:97:E4:8B:24:2D:44:43:7A:EA:71:52:B3:C3:20:D7
       Signature algorithm name: SHA256withRSA
       Version: 3
Certificate[2]:
Owner: EMAILADDRESS=manager@computer.org, CN=project CA, OU=SE, O=SFNT, L=bgy, ST=bg, C=IT
Issuer: EMAILADDRESS=manager@computer.org, CN=project CA, OU=SE, O=SFNT, L=bgy, ST=bg, C=IT
Serial number: 1
Valid from: Thu Oct 04 09:02:00 CEST 2012 until: Tue Oct 04 09:02:00 CEST 2022
Certificate fingerprints:
       MD5:  A2:15:4F:94:70:2B:D2:F7:C0:96:B1:47:F2:1D:03:E9
       SHA1: B3:4A:68:0A:8D:12:39:86:11:CE:EF:22:1B:D1:DE:8D:E9:19:2B:F4
       Signature algorithm name: SHA256withRSA
       Version: 3
```

How to build a certificate with chain ...

When you receive the client certificate without the chain, it is possible to build a PKCS#7 certificate that includes the chain (and then feed it to keytool -importcert). In short, the “single” certificates without the chain can be “stacked” together by manually editing a PEM cert file; this PEM cert file can then be translated into a PKCS#7 cert. How? Like this:

1. Prerequisites. Have all the certs in .crt format. The cert in this format is represented as an ASCII file starting with the line
   ```
   -----BEGIN CERTIFICATE-----
   ```
   and ending with
   ```
   -----END CERTIFICATE-----
   ```
   For example, if the client cert is issued by a subCA and the subCA is signed by a root CA, you will have 3 cert files – the client cert, the subCA cert, and the root CA cert. If the certs are not in .crt format, openssl can be used to transform the format that you have into .crt format. See notes below.
2. Open a new text file, calling it, for example, cert-with-chain.crt. Insert into this file the content of the certificates in the chains. For the above example, you must insert FIRST the client cert, THEN the subCA cert, THEN the root CA cert. The content of the file would then resemble the following:
   ```
   -----BEGIN CERTIFICATE-----
                <-- client cert goes here
   -----END CERTIFICATE-----
   -----BEGIN CERTIFICATE-----
                <-- subCA cert goes here
   -----END CERTIFICATE-----
   -----BEGIN CERTIFICATE-----
                <-- root CA cert goes here
   -----END CERTIFICATE-----
   ```
3. Use the following openssl command to convert the new certificate with chain, that you just created above, to a PKCS#7 certificate with chain:
   ```
   my-sa6 $ openssl crl2pkcs7 -nocrl -certfile HSM_Luna-manual-chain.crt -out
   HSM_Luna-manual-chain.p7b -certfile root_CA.crt
   ```

Keytool is then able to import this .p7b certificate into the Luna keystore and correctly validate the chain.

Additional minor notes

1. Command to add a CA to the default CA cert store “cacerts”:
   ```
   root@myserver:~# keytool -importcert -trustcacerts -alias root-projectca -
   file /home/project/luna-keystores/project_CA.crt -keystore /etc/java-6-sun-
   /security/cacerts
   ```
2. Use the following openssl command to convert a PKCS#7 certificate DER-encoded into a PKCS#7 PEM-encoded certificate:
   ```
   user@myserver:~/tmp/$ openssl pkcs7 -inform der -in java-client2.p7b -out
   java-client2-pem.p7b
   ```
3. Use the following openssl command to convert a PKCS#7 DER-encoded certificate into a .crt PEM certificate :
   ```
   user@myserver:~/tmp/$ openssl pkcs7 -print_certs -inform der -in project_
   CA.p7b -out project_CA-p7-2-crt.crt
   ```


4. Use the following openssl command to convert a PEM certificate with chain to a PKCS#7 with chain:
```
user@myserver:~/tmp/$ openssl crl2pkcs7 -nocrl -certfile HSM_Luna-manual-
chain.crt -out HSM_Luna-manual-chain.p7b -certfile project_CA.crt
```


JSP Dynamic Registration Sample

You may prefer to dynamically register the SafeNet provider in order to avoid possible negative impacts on other applications running on the same machine. Using dynamic registration also allows you to keep installation as straightforward as possible for your customers.

This sample code shows an example of dynamic registration with SafeNet's SafeNet provider. The SafeNet provider is registered in position 2, ensuring that the "SUN" provider is still the default. If you want the SafeNet provider to be used when no provider is explicitly specified, it should be registered at position 1.

Sample Code

```
try {
  com.safenetinc.luna.LunaSlotManager.getInstance().login("<HSM Partition Password>");
  java.security.Provider provider = new com.safenetinc.luna.provider.LunaProvider();
  // removing the provider is only necessary if it is already registered
  // and you want to change its position
  java.security.Security.removeProvider(provider.getName());
  java.security.Security.insertProviderAt(provider, 2);
  com.safenetinc.luna.LunaSlotManager.getInstance().logout();
} catch (Exception e) {
  System.out.println("Exception caught during loading of the providers: "
      + ex.getMessage());
}
```

8
Microsoft Interfaces

This chapter describes the Microsoft interfaces to the PKCS#11 API. It contains the following topics:

- "The SafeNet CSP Registration Tool and Utilities" below
- "KSP for CNG" on page 476
- "SafeNet CSP Calls and Functions" on page 482

The SafeNet CSP Registration Tool and Utilities

This section describes how to use the SafeNet CSP registration tool and related utilities to configure the SafeNet HSM client to use a SafeNet HSM with Microsoft Certificate Services. You must be the Administrator or a member of the Administrators group to run the SafeNet CSP tools.

The SafeNet CSP can be used by any application that acquires the context of the SafeNet CSP. All users who login and use the applications that acquired the context have access to the SafeNet CSP. After you register the SafeNet HSM partitions with SafeNet CSP, your CSP and KSP code should work in the same manner whether our HSM (crypto provider) is selected, or the default provider is used.

Note: The SafeNet CSP is an optional installation. It is installed by default in <luna_client_install_dir>/**CSP**. If the CSP is not installed, re-run the installer.

The Keymap Utility

Use the **keymap** utility if you have previously been using another provider (with its keys in the SafeNet HSM) and wish to migrate to MS CSP keeping your established keys. The keymap utility simply creates on the SafeNet HSM the data object that MS CSP expects, which in turn makes your existing keys available to MS CSP. See <luna_client_install_dir>/**CSP/keymap.exe**.

The ms2Luna Utility

Use the **ms2Luna** utility if you already have MS CSP in use with software key storage and you now wish to continue with your keys held on the SafeNet HSM. See <luna_client_install_dir>/**CSP/ms2luna.exe**.

The CSP Registration Tool

You can use the CSP registration tool (<luna_client_install_dir>/**CSP/register.exe**) to perform the following functions:

- register HSM partitions for use with the SafeNet CSP. The password for each HSM Partition is secured such that only the user for which the password was secured is able to un-secure it. See "Registering Partitions" on the next page

- register which non-RSA cryptographic algorithms you want performed in software only. See "Registering the Cryptographic Algorithms to be Performed in Software" on page 474
- enable key counting in KSP/CSP. See "Enabling Key Counting" on page 475.

Command Syntax

register.exe [**/partition** | **/algorithms** | **/library** | **/usagelimit**] [**/highavailability**] [**/strongprotect**] [**/cryptouser**] **[/?**]

Parameter	Shortcut	Description
/partition	**/p**	Register a partition and it's encrypted challenge. You are prompted through the required steps to select and register a SafeNet HSM partition. This is the default option. If you type **register** with no additional parameters, then **/partition** is assumed. For example, if you type **register /highavail** or **register /strongprotect**, then **/partition** is invoked and the additional option that you selected (i.e., **/highavail** or **/strongprotect**) is run along with it . That is, typing **register /highavail** is the same as typing **register /partition /highavail**.
/highavail	**/h**	Register only high availability (HA) partitions.
/strongprotect	**/s**	Strongly protect the challenge for registered partition
/algorithms	**/a**	Register the desired software ONLY algorithms
/library	**/l**	Register CSP library and signature in the registry
/usagelimit	**/u**	Register CSP RSA key maximum usage limit
/cryptouser	**/c**	Use CSP as Crypto User

Registering Partitions

The syntax used to register partitions depends on whether the partitions use high availability (HA) or not, as detailed in the following procedures.

To register a standard HSM partition

1. Enter the following command and respond to the prompts:
2. C:\Program Files\SafeNetLunaClient\CSP> **register**

   For example:

```
*************************************************************
SafeNet Luna CSP, Partition Registration
Protect the HSM's challenge for the selected partitions.
NOTE:
This is a WEAK protection of the challenge!!
After you have configured all applications that will use
the Luna CSP, and run them once, you MUST run:
register /partition /strongprotect *
to strongly protect the registered challenges!!
*************************************************************
This procedure is a destructive procedure and will completely replace
any previous settings!!
Do you wish to continue?: [y/n]
```

```
Do you want to register the partition named 'nes'? [y/n]:
Please enter the SafeNet Network HSM challenge for the partition 'nes' :
Success registering the ENCRYPTED challenge for partition 'nes'.
Only the Luna CSP will be able to use this data!
Registered 1 partition(s) for use by the Luna CSP!

All available Partitions are presented for you to register or not.
```

3. Install and/or configure your application(s).
4. Run each of your applications once to use SafeNet CSP.
5. Enter the following command to strongly protect the registered challenges:

   register /partition /strongprotect *

> **CAUTION:** You must run **register /strongprotect** to ensure the protection of the HSM partition passwords.

> **Note:** Once you run the **/strongprotect** option, only those users that existed previous to the **/strongprotect** command are allowed to use the SafeNet CSP. If the **/strongprotect** option is not used, then any/all users can use the SafeNet CSP.

6. Enter the following command to reconnect to the library:

   register.exe /library
7. Run all applications as usual.

To register an HA partition

When registering an HA Partition for use, follow these steps.

1. Enter the following command and respond to the prompts:

   C:\Program Files\SafeNet\LunaClient\CSP> **register /highavail**

> **Note:** Use the **/highavail** option only if you have HA set up for your SafeNet Enterprise HSMs.

2. For example:

```
**************************************************************
SafeNet Luna CSP, Partition Registration
Protect the HSM's challenge for the selected partitions.
NOTE:
This is a WEAK protection of the challenge!!
After you have configured all applications that will use
the Luna CSP, and run them once, you MUST run:
 register /partition /strongprotect *
to strongly protect the registered challenges!!
**************************************************************
This procedure is a destructive procedure and will completely replace
any previous settings!!
Do you wish to continue?: [y/n]
Do you want to register the partition named 'nes'? [y/n]:
Please enter the SafeNet Network HSM challenge for the partition 'nes' :
Success registering the ENCRYPTED challenge for partition 'nes'.
```

```
Only the Luna CSP will be able to use this data!
Registered 1 partition(s) for use by the Luna CSP!
```

Note: If you are using HA, then only the HA virtual partition is presented for registering.

3. Install and/or configure your application(s).
4. Run each of your applications once to use SafeNet CSP.
5. Enter the following command to strongly protect the registered challenges:

   register /partition /strongprotect *

CAUTION: You must run **register /strongprotect** to ensure the protection of the HSM partition passwords.

Note: Once you run the **/strongprotect** option, only those users that existed previous to the **/strongprotect** command are allowed to use the SafeNet CSP. If the **/strongprotect** option is not used, then any/all users can use the SafeNet CSP.

6. Enter the following command to reconnect to the library:

   register.exe /library

7. Run all applications as usual.

Registering the Cryptographic Algorithms to be Performed in Software

Certain operations (symmetric), such as the hash operation may be performed faster in software than on the SafeNet HSM. The **register /algorithms** command allows you to choose which algorithms to de-register from the SafeNet HSM. The trade-off is a gain in speed, at the cost of some security (exposing the operation in software). Signing and other asymmetric operations are always done on the HSM.

To register algorithms for software-only use

1. Enter the following command and respond to the prompts:

   ```
   C:\Program Files\SafeNet\LunaClient\CSP> register /algorithms
   ```

2. You are prompted for yes or no responses about which algorithms are to be registered for software-only use. For example:

   ```
   ************************************************************************
   SafeNet Luna CSP, Algorithm Registration

   Register algorithms to be done in software by the Microsoft CSP(s).
   BY DEFAULT, ALL ALGORITHMS ARE DONE IN HARDWARE BY THE SafeNet Network HSM.
   ONLY NON RSA ALGORITHMS MAY BE CONFIGURED FOR SOFTWARE.
   RSA PUBLIC/PRIVATE ALGORITHMS WILL ALWAYS BE IN HARDWARE.
   ************************************************************************
   Do you want algorithm 'CALG_RC2', done in software?(y/n):
   Do you want algorithm 'CALG_RC4', done in software?(y/n):
   Do you want algorithm 'CALG_RC5', done in software?(y/n):
   Do you want algorithm 'CALG_DES', done in software?(y/n):
   Do you want algorithm 'CALG_3DES_112', done in software?(y/n):
   Do you want algorithm 'CALG_3DES', done in software?(y/n):
   Do you want algorithm 'CALG_MD2', done in software?(y/n):
   ```



```
Do you want algorithm 'CALG_MD5', done in software?(y/n):
Do you want algorithm 'CALG_SHA', done in software?(y/n):
Do you want algorithm 'CALG_MAC', done in software?(y/n):
Do you want algorithm 'CALG_HMAC', done in software?(y/n):
Success registering software only algorithms:
CALG_RC2,CALG_RC4,CALG_RC5,...!
```

If you chose **no** for all prompts, then all algorithms revert to hardware and the following is displayed:

```
All algorithms have been de-registered and will now only be done in hardware!
```

Enabling Key Counting

Key counting allows you to specify the maximum number of times that a key can be used. It sets the upper limit from 0 to MAX(UInt32).

To enable key counting

1. Enter the following command and respond to the prompts. Enter the key usage limit, or enter 0 to turn off the feature:

   C:\Program Files\SafeNet\LunaClient\CSP> **register /usagelimit**

   For example:

   ```
   C:\Program Files\SafeNet\LunaClient\CSP>register /usagelimit
   register v1.0.1

   Enter the key usage limit: 2000

   Successfully configured the key usage limit to 2000 uses.
   ```

KSP for CNG

CNG (Cryptography Next Generation) is Microsoft's cryptographic application programming environment (API) replacing the Windows cryptoAPI (CAPI). CNG is applicable to Windows Server 2008 and Windows Server 2012. CNG adds new algorithms along with additional flexibility and functionality, compared with the old API.

Just as SafeNet provides our CSP for applications running in older Windows crypto environments (and JSP for Java), we offer KSP to allow your Windows Server 2008 CNG applications to make use of the SafeNet HSM. You can still use CSP with Windows Server 2008 and CAPI for your legacy applications, but future development will all take place using CNG, for which you will need to install KSP.

KSP must be installed on any computer that is intended to act via CNG as a Client of the HSM, running crypto operations in hardware. You need KSP to integrate SafeNet cryptoki with CNG and to use the newer functions and algorithms in Microsoft IIS.

After you register the SafeNet HSM partitions with SafeNet KSP, your KSP code should work in the same manner whether our HSM (crypto provider) is selected, or the default provider is used.

Note: TRANSITION ISSUES Be aware when working in a mixed environment or updating applications that previously used CAPI and the SafeNet CSP - the new algorithms supported by CNG (such as SHA512 and ECDSA) in Certificate Services are not recognized by systems that use CAPI. If Certificate Services is configured to use any of these new Algorithms then the signed certificates can be installed only on systems that are aware of these new algorithms. Any of the systems that use CAPI will not be able to use this feature. The installation of certificate will fail.

Installing KSP

KSP is installed using the SafeNet Client installer. Note that it is not installed by default and must be explicitly selected when you install the SafeNet Client. You can also install KSP after you install the SafeNet Client by re-running the installer.

The KSP installer installs the following utilities in the C:\Program Files\SafeNet\LunaClient\KSP folder:

Utility name	Description
KspConfig.exe	A GUI utility used to configure KSP.
kspcmd.exe	A command-line utility used to configure KSP.
ksputil.exe	A command-line utility used to make keys available to other clients, such as in a clustering configuration.
ms2Luna.exe	A command-line utility used to migrate software-based keys to a SafeNet HSM.

Configuring KSP

After installing KSP, use the KSP configuration wizard to register your HSM Partitions for use with CNG. The KSP configuration tool secures the Password for each HSM Partition such that only the user for which the Password was secured is able to un-secure it.

Briefly, the important points are:

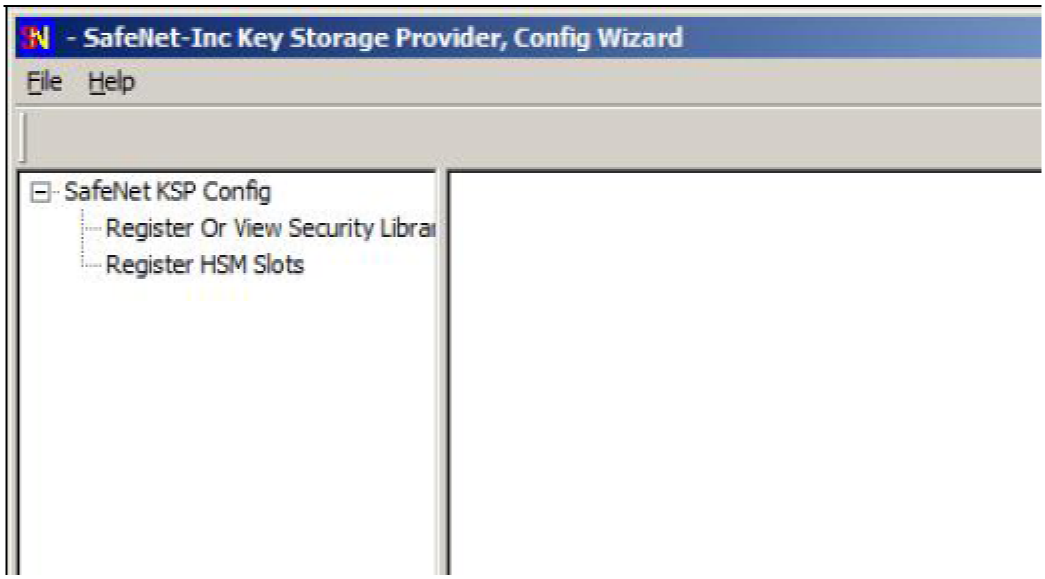
- Register the cryptoki to be used.

- Register the slot-to-be-used to the local admin (which allows the admin to interact with the slot)
- Register the slot-to-be-used to the local system (which allows the operating system to interact with the slot).

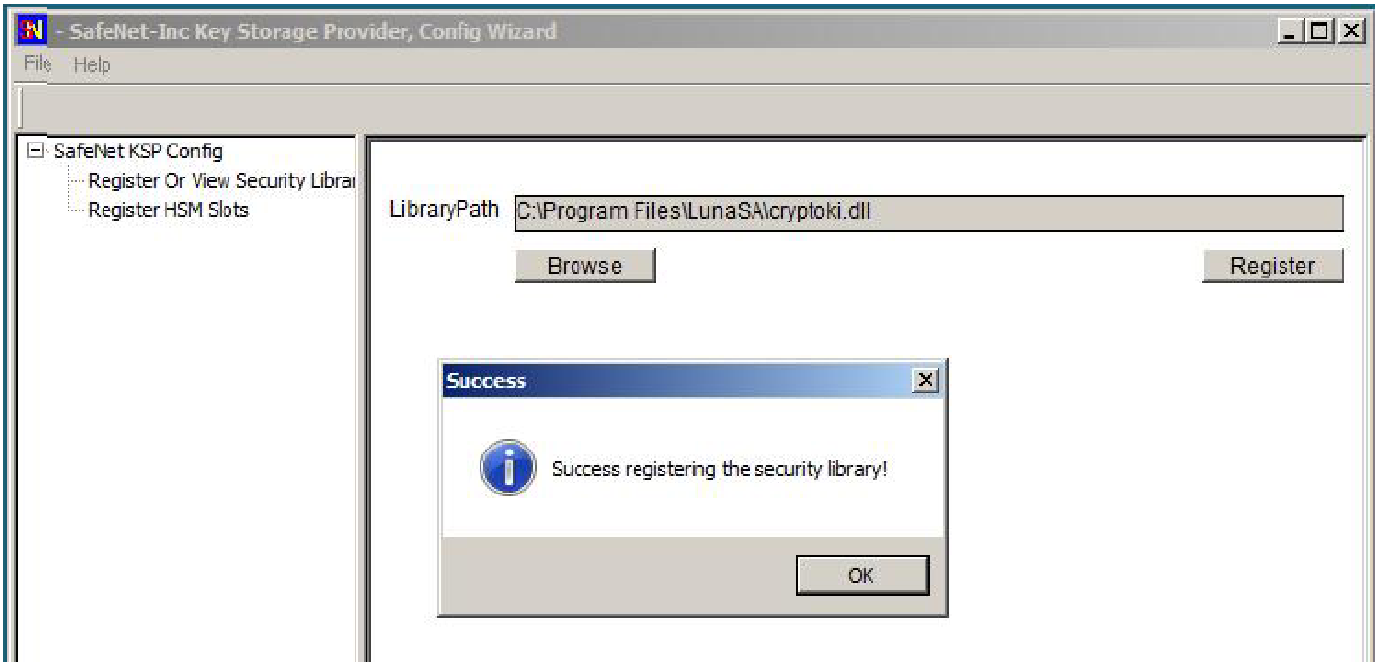
Note: Only the Administrator or a member of the Administrators group can run "KspConfig.exe". The SafeNet KSP can be used by any application that acquires the context of the SafeNet KSP. All users who login and use the applications that acquired the context have access to the SafeNet KSP.

To configure KSP

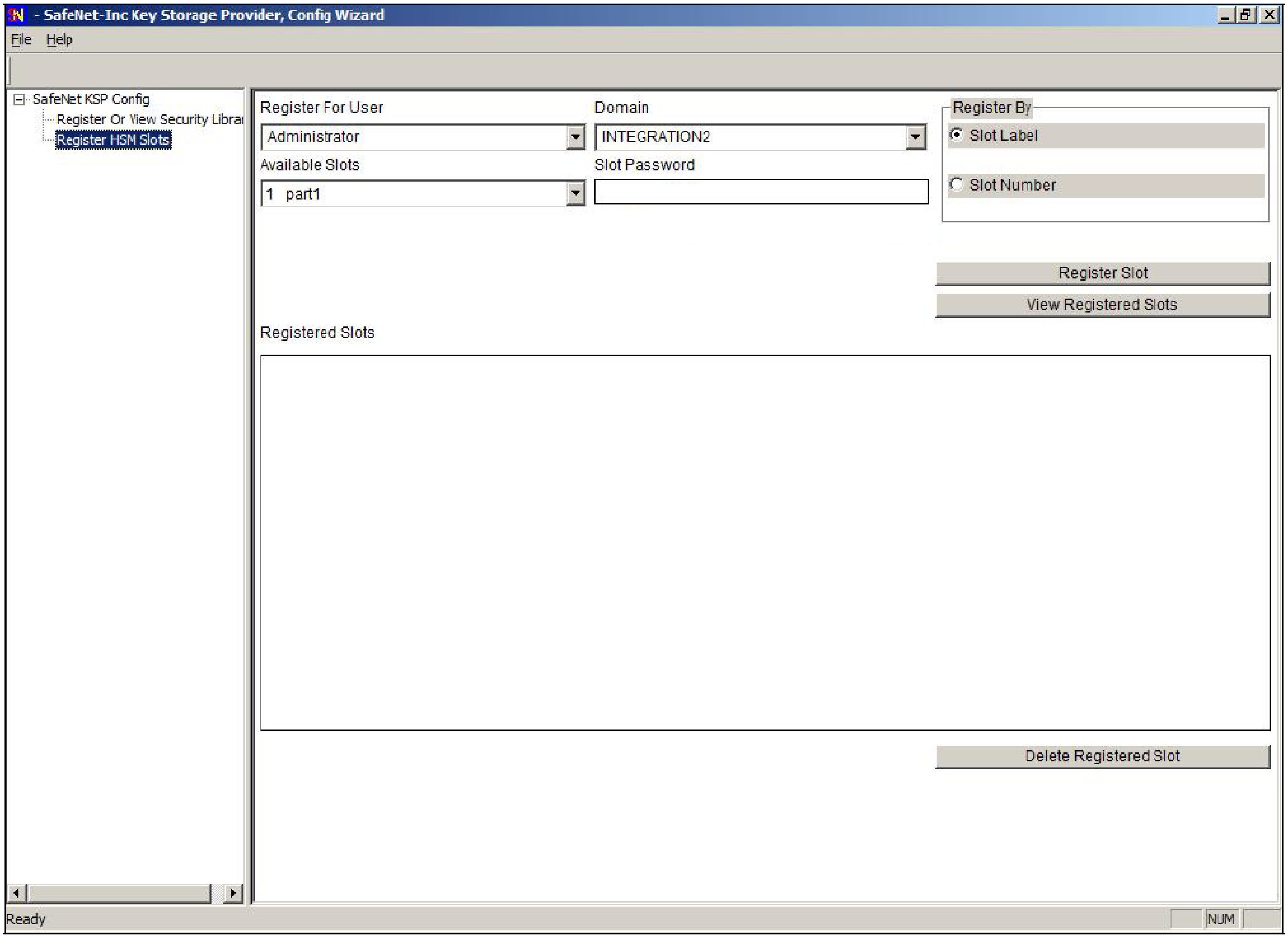
1. Go to C:\Program Files\SafeNet\LunaClient\KSP and launch KspConfig.exe (the KSP configuration wizard).
2. In the left-hand pane (tree view) double-click "Register Or View Security Library"



3. In the right-hand pane, browse to the library C:\Program Files\SafeNet\LunaClient\cryptoki.dll and click **Register**.
4. When the success message appears, click **OK**.

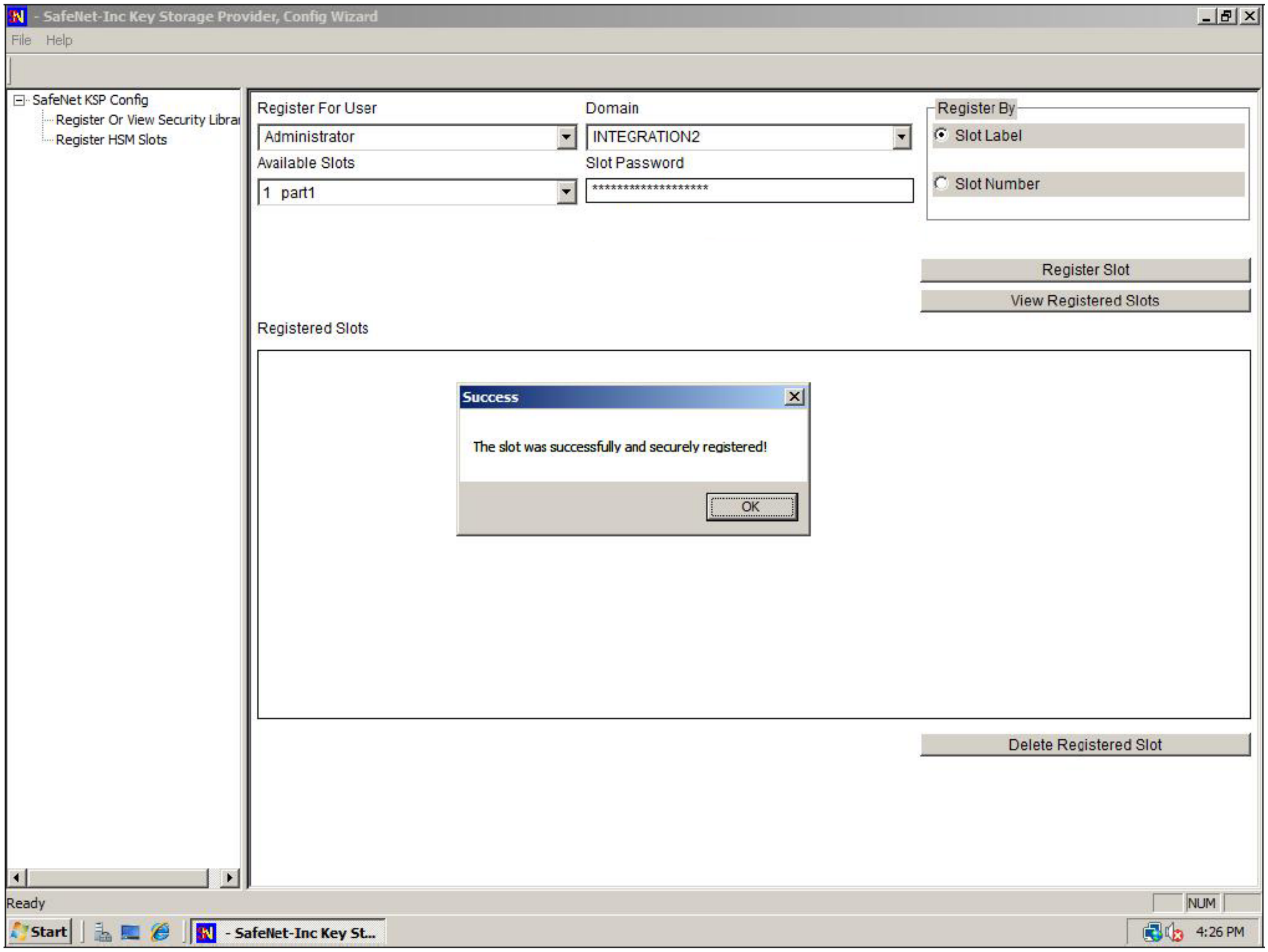


5. Return to the left-hand pane and double-click "Register HSM Slots", and click [Next]. In general, we recommend that you register by slot label, rather than slot number, if you are using an HA configuration .

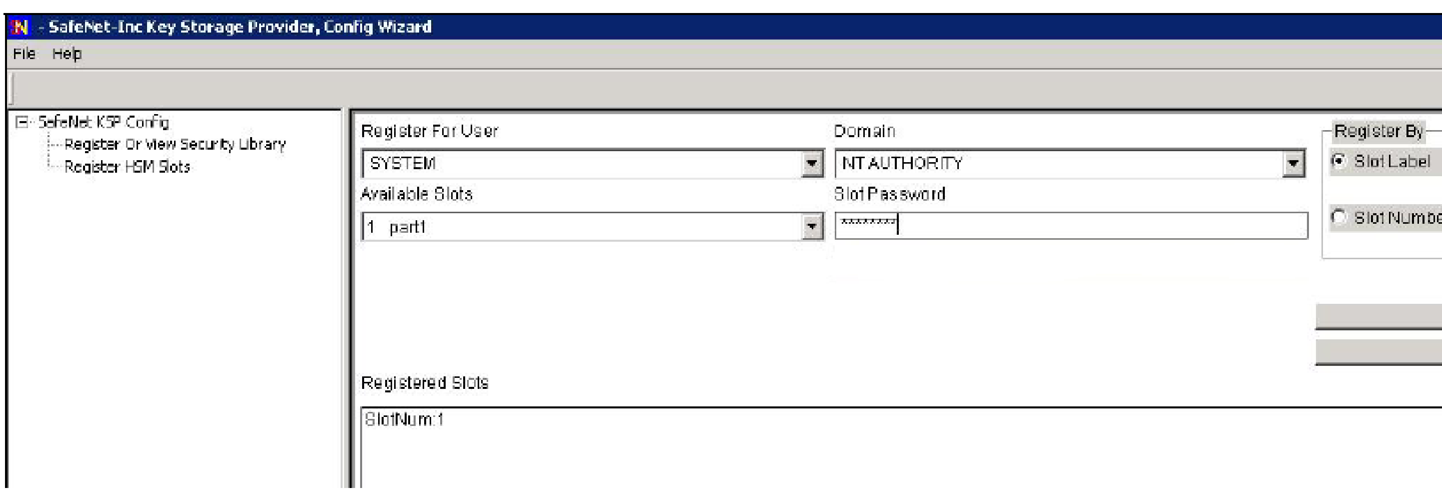


6. In the "Slot Password" field, type in the password for the indicated slot. To the right of the window, click the [Register Slot] button to register the slot for Domain/User. A success message appears.

   Note that the "Register for User" field should be Administrator (or the admin equivalent account that will be managing this setup) and "Domain" should match the domain or local computer with which you are logged in.



7. Return to the "Domain" pull-down list select "SYSTEM" under "Register for User"and select "NT AUTHORITY" under "Domain", supply the password for the slot being registered, and again click Register Slot] to complete the KSP configuration.



8. Once you have the slots registered, you can begin connecting with your client application to perform crypto operations in your HSM Partitions (or HA virtual slots). If a SafeNet-tested Integration procedure for your application is not available for download from the SafeNet website, contact SafeNet Customer Support.

If It Doesn't Work?

When you open the KspConfig program, if it fails to display a list of available slots, then it might be that you have not properly set up your SafeNet HSM.

Open a Windows Command Prompt window, change directory to the "C:\Program Files\SafeNet\LunaClient\" directory, and use the "lunacm" command-line utility to see and modify the status of the HSM and HSM Partitions.

Algorithms Supported

Here, for comparison, are the algorithms supported by our CSP and KSP APIs.

Algorithms supported by the SafeNet CSP

CALG_RSA_SIGN

CALG_RSA_KEYX

CALG_RC2

CALG_RC4

CALG_RC5

CALG_DES

CALG_3DES_112

CALG_3DES

CALG_MD2

CALG_MD5

CALG_SHA

CALG_SHA_256

CALG_SHA_384

CALG_SHA_512

CALG_MAC

CALG_HMAC

Algorithms supported by the SafeNet KSP

NCRYPT_RSA_ALGORITHM

NCRYPT_DSA_ALGORITHM

NCRYPT_ECDSA_P256_ALGORITHM

NCRYPT_ECDSA_P384_ALGORITHM

NCRYPT_ECDSA_P521_ALGORITHM

NCRYPT_ECDH_P256_ALGORITHM

NCRYPT_ECDH_P384_ALGORITHM

NCRYPT_ECDH_P521_ALGORITHM

NCRYPT_DH_ALGORITHM

NCRYPT_RSA_ALGORITHM

Enabling Key Counting

Key counting allows you to specify the maximum number of times that a key can be used. It sets the upper limit from 0 to MAX(UInt32).

To enable key counting

1. Enter the following command and respond to the prompts. Enter the key usage limit, or enter 0 to turn off the feature:

   C:\Program Files\SafeNet\LunaClient\KSP> **kspcmd usagelimit**

   For example:

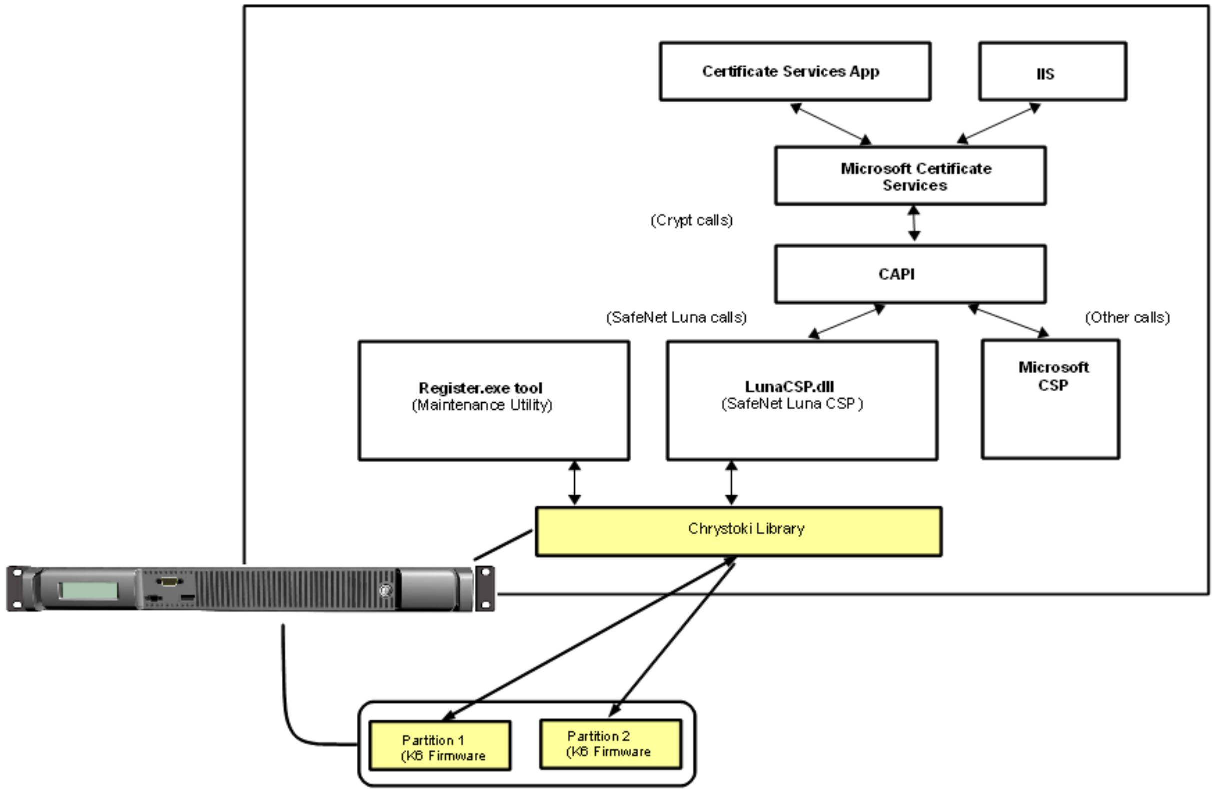
```
C:\Program Files\SafeNet\LunaClient\KSP>kspcmd usageLimit 2000
This Servers Host Name is: LUNA_CLIENT and the logged on user is: admin@LUNA_CLIENT

Enter the key usage limit: 2000

Successfully configured the key usage limit to 2000 uses.


C:\Program Files\SafeNet\LunaClient\KSP>kspcmd u
This Servers Host Name is: LUNA_CLIENT and the logged on user is: admin@LUNA_CLIENT

Warning, max key usage is already set to 2000.
Changing this will not modify previously created keys!
Only keys created subsequent to making this change will be affected!
Do you wish to continue?[y/n]:
```

SafeNet CSP Calls and Functions

For integration with Microsoft Certificate Services and other applications, the LunaCSP.dll library accepts Crypt calls and gives access to token functions (via CP calls) as listed in this section. Key pairs and certificates are generated, stored and used on the SafeNet HSM.

The diagram below depicts the relationship of the SafeNet components to the other layers in the certificate system.

Figure 1: SafeNet CSP architecture



Note, in the diagram, that the SafeNet CSP routes relevant calls through the statically linked Crystoki library to the HSM via CP calls. Other calls from the application layer – those not directed at the token/HSM, and not matching the SafeNet CSP supported functions (see next section) – are passed to the Microsoft CSP.

Programming for SafeNet HSM with SafeNet CSP

The SafeNet CSP DLL exports the following functions, each one corresponding to an equivalent (and similarly named) Crypt call from the application layer:

- CPAcquireContext
- CPGetProvParam
- CPSetProvParam
- CPReleaseContext
- CPDeriveKey
- CPDestroyKey
- CPDuplicateKey
- CPExportKey
- CPGenKey
- CPGenRandom

- CPGetKeyParam
- CPGetUserKey
- CPImportKey
- CPSetKeyParam
- CPDecrypt
- CPEncrypt
- CPCreateHash
- CPDestroyHash
- CPGetHashParam
- CPHashData
- CPHashSessionKey
- CPSetHashParam
- CPSignHash
- CPVerifySignature

Note: The CPVerifySignature function is able to verify signatures of up to 2048 bits, regardless of the size of the signatures produced by CPSignHash. This ensures that the CSP is able to validate all compatible certificates, even those signed with large keys.

Note: The MSDN (Microsoft Developers Network) web site provides syntax and descriptions of the corresponding Crypt calls that invoke the functions in the above list.

Algorithms

SafeNet CSP supports the following algorithms:

- CALG_RSA_SIGN [RSA Signature] [256 - 4096 bits]. The CSP uses the RSA Public-Key Cipher for digital signatures.
- CALG_RSA_KEYX [RSA Key Exchange] [256- 4096 bits] The CSP must use the RSA Public-Key Cipher key exchange. The exchange key pair can be used both to exchange session keys and to verify digital signatures.
- CALG_RC2 [RSA Data Securities RC2 (block cipher)] [8 - 1024 bits].
- CALG_RC4 [RSA Data Securities RC4 (stream cipher)] [8 - 2048 bits].
- CALG_RC5 [RSA Data Securities RC5 (block cipher)] [8 - 2048 bits].
- CALG_DES [Data Encryption Standard (block cipher)] [56 bits].
- CALG_3DES_112 [Double DES (block cipher)] [112 bits].
- CALG_3DES [Triple DES (block cipher)] [168 bits].
- CALG_MAC [Message Authentication Code] (with RC2 only).
- CALG_HMAC [Hash-based MAC].
- CALG_MD2 [Message Digest 2 (MD2)] [128 bits].

- CALG_MD5 [Message Digest 5 (MD5)] [128 bits].
- CALG_SHA [Secure Hash Algorithm (SHA-1)] [160 bits].
- CALG_SHA224 [Secure Hash Algorithm (SHA-2)] [224 bits].
- CALG_SHA256 [Secure Hash Algorithm (SHA-2)] [256 bits].
- CALG_SHA384 [Secure Hash Algorithm (SHA-2)] [384 bits].
- CALG_SHA512 [Secure Hash Algorithm (SHA-2)] [512 bits].

Note: If you intend to perform key exchanges between the SafeNet CSP and the Microsoft CSP with RC2 keys, the attribute KP_ EFFECTIVE_KEYLEN must be set to 128 bits. For RC2 and RC4, the salt value of the keys must be transferred by making a call to get the salt value of the original key and to set the salt value of an imported key. This is done with the CryptGetKeyParam(KP_ SALT) and CryptSetKeyParam(KP_ SALT) functions respectively.