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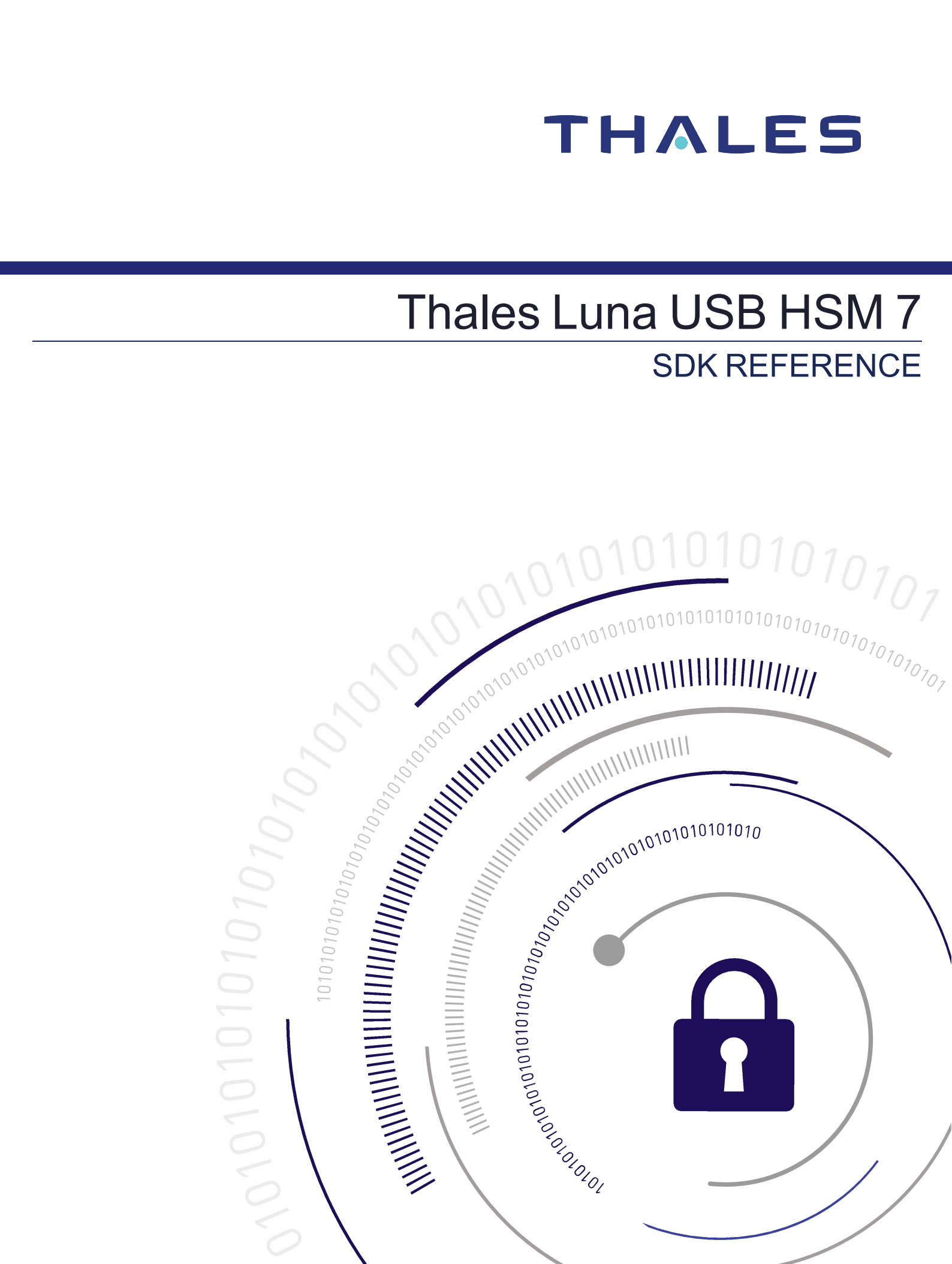
Thales Luna USB HSM 7

SDK REFERENCE



Document Information

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Canada

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Europe

This product is in conformity with the protection requirements of EC Council Directive 2014/30/EU. This product satisfies the CLASS B limits of EN55032.

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PREFACE: About the SDK Reference

This document describes how to use the Luna SDK to create applications that interact with Luna USB HSM 7s. It contains the following chapters:

> "Luna SDK Overview" on page 19
> "PKCS#11 Support" on page 21
> "Extensions to PKCS#11" on page 27
> Supported Mechanisms
> "Using the Luna SDK" on page 166
> "Design Considerations" on page 199
> "Java Interfaces" on page 236
> "Microsoft Interfaces" on page 263

The preface includes the following information about this document:

> "Customer Release Notes" below
> "Audience" below
> "Document Conventions" on the next page
> "Support Contacts" on page 18

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 specific releases. Read the CRN to fully understand the capabilities, limitations, and known issues for each release. You can view the latest version of the CRN at www.thalesdocs.com.

Audience

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

All products manufactured and distributed by Thales 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

Format	Convention
bold	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**.)
italics	In type, the italic attribute is used for emphasis or to indicate a related document. (See the *Installation Guide* for more information.)

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Format	Convention
<variable>	In command descriptions, angle brackets represent variables. You must substitute a value for command line arguments that are enclosed in angle brackets.
[**optional**] [<optional>]	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.
{**a**|**b**|**c**} {<a>|<b>|<c>}	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.
[**a**|**b**|**c**] [<a>|<b>|<c>]	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.

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Support Contacts

If you encounter a problem while installing, registering, or operating this product, please refer to the documentation before contacting support. If you cannot resolve the issue, contact your supplier or Thales Customer Support. Thales Customer Support operates 24 hours a day, 7 days a week. Your level of access is governed by the support plan negotiated between Thales and your organization. Please consult this plan for details regarding your entitlements, including the hours when telephone support is available to you.

Customer Support Portal

The Customer Support Portal, at https://supportportal.thalesgroup.com, is where you can find solutions for most common problems and create and manage support cases. It offers a comprehensive, fully searchable database of support resources, including software and firmware downloads, release notes listing known problems and workarounds, a knowledge base, FAQs, product documentation, technical notes, and more.

> **NOTE** You require an account to access the Customer Support Portal. To create a new account, go to the portal and click on the **REGISTER** link.

Telephone

The support portal also lists telephone numbers for voice contact (Contact Us).

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CHAPTER 1: Luna SDK Overview

This chapter provides an overview of the Luna Software Development Kit (SDK), a development platform you can use to integrate a Luna USB HSM 7 into your application or system. It contains the following topics:

> "Supported Cryptographic Algorithms" below
> Application Programming Interface (API) Overview
> "Supported Integrations" below

Supported Cryptographic Algorithms

The K7 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

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

Supported Integrations

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 https://supportportal.thalesgroup.com website for third-party applications that have been integrated and tested with Luna USB HSM 7s 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 Luna USB HSM 7 product are mentioned in an Integration document, then those items will definitely work together. A newer version of the Luna USB HSM 7 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 Luna USB HSM 7s 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, Thales 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 Thales Customer Support for the latest list of third-party applications that are tested and supported with Luna USB HSM 7s.

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 Thales Luna 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 Thales, 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 Luna USB HSM 7s 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 Thales website library of integration documents because we have not verified them in our own labs. If you contact Thales 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.

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CHAPTER 2: PKCS#11 Support

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

> "PKCS#11 Compliance" below
> "Using the PKCS#11 Sample" on page 25

PKCS#11 Compliance

This section shows the compliance of Luna 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 Luna Software Development Kit supports. The table following lists other features of PKCS#11 and identifies the compliance of this version of the Luna Software Development Kit to these features.

Table 1: PKCS#11 function support

Category	Function	Supported on Luna partitions	Supported on Luna keyrings
General purpose functions	C_Initialize	Yes	Yes
	C_Finalize	Yes	Yes
	C_GetInfo	Yes	Yes
	C_GetFunctionList	Yes	Yes

Category	Function	Supported on Luna partitions	Supported on Luna keyrings
Slot and token management functions	C_GetSlotList	Yes	Yes
	C_GetSlotInfo	Yes	Yes
	C_GetTokenInfo	Yes	Yes
	C_WaitForSlotEvent	No	No
	C_GetMechanismList	Yes	Yes
	C_GetMechanismInfo	Yes	Yes
	C_InitToken	Yes	Yes
	C_InitPIN	Yes	Yes
	C_SetPIN	Yes	Yes
Session management functions	C_OpenSession	Yes	Yes
	C_CloseSession	Yes	Yes
	C_CloseAllSessions	Yes	Yes
	C_GetSessionInfo	Yes	Yes
	C_GetOperationState	Yes	No
	C_SetOperationState	Yes	No
	C_Login	Yes	Yes
	C_Logout	Yes	Yes

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Category	Function	Supported on Luna partitions	Supported on Luna keyrings
Object management functions	C_CreateObject	Yes	Yes
	C_CopyObject	Yes	No
	C_DestroyObject	Yes	Yes
	C_GetObjectSize	Yes	Yes
	C_GetAttributeValue	Yes	Yes
	C_SetAttributeValue	Yes	Yes
	C_FindObjectsInit	Yes	Yes
	C_FindObjects	Yes	Yes
	C_FindObjectsFinal	Yes	Yes
Encryption functions	C_EncryptInit	Yes	Yes
	C_Encrypt	Yes	Yes
	C_EncryptUpdate	Yes	Yes
	C_EncryptFinal	Yes	Yes
Decryption functions	C_DecryptInit	Yes	Yes
	C_Decrypt	Yes	Yes
	C_DecryptUpdate	Yes	Yes
	C_DecryptFinal	Yes	Yes
Message digesting functions	C_DigestInit	Yes	Yes
	C_Digest	Yes	Yes
	C_DigestUpdate	Yes	Yes
	C_DigestKey	Yes	Yes
	C_DigestFinal	Yes	Yes

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Category	Function	Supported on Luna partitions	Supported on Luna keyrings
Signing and MACing functions	C_SignInit	Yes	Yes
	C_Sign	Yes	Yes
	C_SignUpdate	Yes	Yes
	C_SignFinal	Yes	Yes
	C_SignRecoverInit	No	No
	C_SignRecover	No	No
Functions for verifying signatures and MACs	C_VerifyInit	Yes	Yes
	C_Verify	Yes	Yes
	C_VerifyUpdate	Yes	Yes
	C_VerifyFinal	Yes	Yes
	C_VerifyRecoverInit	No	No
	C_VerifyRecover	No	No
Dual-purpose cryptographic functions	C_DigestEncryptUpdate	No	No
	C_DecryptDigestUpdate	No	No
	C_SignEncryptUpdate	No	No
	C_DecryptVerifyUpdate	No	No
Key management functions	C_GenerateKey	Yes	Yes
	C_GenerateKeyPair	Yes	Yes
	C_WrapKey	Yes	Yes
	C_UnwrapKey*	Yes	Yes
	C_DeriveKey	Yes	Yes

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Category	Function	Supported on Luna partitions	Supported on Luna keyrings
Random number generation functions	C_SeedRandom	Yes	No
	C_GenerateRandom	Yes	Yes
Parallel function management functions	C_GetFunctionStatus	No	No
	C_CancelFunction	No	No
Callback function		No	No

*C_UnwrapKey has support for the CKA_Unwrap_Template object. All mechanisms which perform the unwrap function support an unwrap template. Nested templates are not supported.

Table 2: PKCS#11 feature support

Feature	Supported?
Exclusive sessions	Yes
Parallel sessions	No

Key Check Values

The Luna HSM firmware calculates a checksum or key check value for each key object created by the HSM. This value or checksum length is fixed at 3 bytes, as defined by PKCS#11.

Additional Functions

Please note that certain additional functions have been implemented by Thales as extensions to the standard. These include aspects of object cloning, and are described in detail in "Luna Extensions to PKCS#11" on page 27.

Using the PKCS#11 Sample

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

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

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

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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 Luna 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 Luna extension API functions supported by the library.
6. At this point, if successful, Luna extension APIs may be invoked like the following:

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

> **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.

CHAPTER 3: Extensions to PKCS#11

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

> "Luna Extensions to PKCS#11" below
> "Secure PIN Port Authentication" on page 113
> "MofN Secret Sharing (quorum or multi-person access control)" on page 114
> "Key Export Features" on page 115
> Luna HSM Cloning API CPv4 Extensions to PKCS#11
> "Secure External Scalable Key Storage Extensions" on page 117
> "Derivation of Symmetric Keys with 3DES_ECB" on page 123
> "Counter Mode KDF Mechanisms" on page 124
> ECIES Enhancement for HKDF
> "BIP32 Mechanism Support and Implementation" on page 124
> SLIP 10
> "Derive Template" on page 133
> "3GPP Mechanisms for 5G Mobile Networks" on page 135
> "SM2/SM4 Mechanisms" on page 139
> "SHA-3 Mechanisms" on page 141

Luna Extensions to PKCS#11

The following table provides a list of the Luna PKCS#11 C-API extensions. 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. In the following table, if no firmware version/series is mentioned, then the extension applies to all. If a firmware version is mentioned, then the extension applies to that firmware series, but not to others.

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

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

CA_ActivateMofN

Activate a token that has the secret sharing feature enabled.

```
CA_ActivateMofN(CK_SESSION_HANDLE      hSession,
                CA_MOFN_ACTIVATION_PTR pVectors,
                CK_ULONG               ulVectorCount);
```

CA_AddKCV

Allows the Partition Security Officer to add an additional Key Cloning Vector (KCV or *cloning domain*) to the partition. See also Universal Cloning and Luna HSM Cloning API CPv4 Extensions to PKCS#11.

```
CA_AddKCV(CK_SESSION_HANDLE hSession,
          CK_ULONG          ulKCVLength,
          CK_BYTE_PTR       pKCV,
          CK_ULONG          ulLabelLength,
          CK_BYTE_PTR       pLabel,
          CK_BBOOL          bMakePrimary);
```

I/O	Argument	Description
In	hSession	A session on the partition authenticated by the Partition Security Officer.
	ulKCVLength	The length of the KCV pointed to by `pKCV`. If the KCV is to be entered via a Luna PED, the length must be zero.
	pKCV	A pointer to a byte array that contains the KCV value. If the KCV is to be entered via a Luna PED, this pointer must be set to NULL.
	ulLabelLength	The length of the label pointed to by `pLabel`. The label length cannot be 0.
	pLabel	A pointer to a buffer that contains the label for the domain to be added. The label must be between 1 and 32 bytes in length and is NOT a NULL terminated string. This parameter cannot be NULL.
	bMakePrimary	Boolean flag to indicate that the new domain should be the primary domain.

Return Code	Hex	Description
CKR_DOMAIN_LABEL_ALREADY_EXISTS		This error is returned when the label provided for a new domain, or when changing the label of an existing domain, already exists. This includes trying to create a domain with no label when there is already a domain with no label.
CKR_DOMAIN_MANAGEMENT_NOT_ALLOWED		**Partition policy 44:** Allow Extended Domain Management is disabled, or the domain specified is of a different authentication type than the HSM (specifying a multifactor quorum domain on a password-authenticated HSM or vice-versa).
CKR_DOMAIN_MAX_REACHED		This error is returned when an attempt to add a domain is made, but the limit has already been reached.

CA_AssignKey

Flag a key as assigned by setting its CKA_ASSIGNED attribute to 1, and is available to the CO role only, and only for the unassigned keys.

```
CA_AssignKey(CK_SESSION_HANDLE hSession,
             CK_OBJECT_HANDLE  hObject);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
	hObject	The object handle. The key specified has to satisfy the following conditions: > It must have CKA_AUTH_DATA > It must have CKA_EXTRACTABLE = false > It must have CKA_SENSITIVE = true > It must have CKA_MODIFIABLE = false

Return Code	Hex	Description
CKR_ASSIGNED_KEY_ REQUIRES_AUTH_DATA		
CKR_ROLE_CANNOT_MAKE_ KEYS_ASSIGNED		
CKR_INVALID_ASSIGNED_ ATTRIBUTE_TRANSITION		
CKR_ASSIGNED_KEY_FAILED_ ATTRIBUTE_DEPENDENCIES		

See also "Per-Key Authorization API" on page 146.

CA_AuthorizeKey

Explicitly authorize a key (assigned or unassigned) by key handle in a given session. This function can be used only in an already-authenticated session for any role.

```
CA_AuthorizeKey(CK_SESSION_HANDLE hSession,
                CK_OBJECT_HANDLE  hObject,
                CK_UTF8CHAR_PTR   pAuthData,
                CK_ULONG          ulAuthDataLen);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
	hObject	The object handle.
	pAuthData	The user's authentication data.
	ulAuthDataLen	The length of the authentication data.

See also "Per-Key Authorization API" on page 146.

CA_Bip32ExportPublicKey

Export BIP32 public keys. The specified object is extracted from the HSM and encoded in the BIP32 format. The result is a NULL-terminated string and is placed in the `pPublicSerialData` parameter. The length of `pPublicSerialData` has a maximum of 112 characters. This constant is defined as `CKG_BIP32_MAX_SERIALIZED_LEN`. It's possible that not all characters are needed to serialize the key. Any unused characters are set to 0.

```
CA_Bip32ExportPublicKey(CK_SESSION_HANDLE hSession,
                        CK_ULONG          ulObjectHandle,
                        CK_BYTE_PTR       pPublicSerialData,
                        CK_ULONG_PTR      pulPublicSerialLen); //in: max.buffer size
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
	ulObjectHandle	The object handle.
Out	pPublicSerialData	A NULL-terminated string containing the exported key, in "BIP32 Serialization Format" on page 129.
	pulPublicSerialLen	The length of the exported key string in **pPublicSerialData**.

Private Key Export

Use existing PKCS#11 functions to import private keys. Key Export Mode must be set on the HSM. Export keys by calling `C_WrapKey()` followed by `C_Decrypt*()`. Use `C_WrapKey()` and `C_UnwrapKey()` to store keys off the HSM, or to move them between HSMs.

See also "BIP32 Mechanism Support and Implementation" on page 124.

CA_Bip32ImportPublicKey

Import BIP32 public keys. The function is similar to `C_CreateObject()` but it takes an additional parameter for the serialized public key. The template passed in should contain all the desired non-BIP32 attributes like `CKA_TOKEN`, `CKA_PRIVATE`, `CKA_DERIVE`, etc. The function decodes the public key to get all the BIP32 attributes. Both sets of attributes are then used to create the public key on the HSM.

> **NOTE** When importing a serialized extended public key, implementations must verify whether the X coordinate in the public key data corresponds to a point on the curve. If not, the extended public key is invalid.

```
CA_Bip32ImportPublicKey(CK_SESSION_HANDLE    hSession,
                        CK_BYTE_PTR          pBase58Key,
                        CK_ULONG             usKeyLen,
                        CK_ATTRIBUTE_PTR     pTemplate,
                        CK_ULONG             usCount,
                        CK_OBJECT_HANDLE_PTR phImportedObject);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
	pBase58Key	The key to be imported, in "BIP32 Serialization Format" on page 129.
	usKeyLen	The length of the key to be imported.

	pTemplate	The template for the key attributes to be applied to the imported key, as follows:
		`CK_ATTRIBUTE template[] =`
		`{`
		`  {CKA_TOKEN, &bToken, sizeof(bToken)},`
		`  {CKA_PRIVATE, &bTrue, sizeof(bTrue)},`
		`  {CKA_DERIVE, &bTrue, sizeof(bTrue)},`
		`  {CKA_MODIFIABLE, &bTrue, sizeof(bTrue)},`
		`  {CKA_LABEL, pbLabel, strlen(pbLabel)},`
		`};`

	usCount	The length of the array of attributes in **pTemplate**.
Out	phImportedObject	The handle for the newly-created key is stored here, if the import was successful.

Private Key Import

Use existing PKCS#11 functions to import private keys. Key Export Mode must be set on the HSM. Import a key by calling `C_Encrypt*()` on the serialized key followed by `C_UnwrapKey()`.

See also "BIP32 Mechanism Support and Implementation" on page 124.

CA_CapabilityUpdate

Apply a configuration update file as Security Officer only.

```
CA_CapabilityUpdate(CK_SESSION_HANDLE hSession,
                    CK_ULONG          ulManifestLen,
                    CK_BYTE_PTR       pManifest,
                    CK_ULONG          ulAuthcodeLen,
                    CK_BYTE_PTR       pAuthcode);
```

CA_ChangeKCVLabel

Allows the Partition Security Officer to change the label of a KCV (cloning domain). The primary use of this API is to add a label to a pre-existing KCV that does not already have a label. It can also be used to change an existing label of a KCV, which may be useful when merging/splitting domains and the same domain label has been used for different KCV values. See also Universal Cloning and Luna HSM Cloning API CPv4 Extensions to PKCS#11.

```
CA_ChangeKCVLabel(CK_SESSION_HANDLE hSession,
                  CK_ULONG          ulOldLabelLength,
                  CK_BYTE_PTR       pOldLabel,
                  CK_ULONG          ulNewLabelLength,
                  CK_BYTE_PTR       pNewLabel);
```

I/O	Argument	Description
In	hSession	A session on the partition authenticated by the Partition Security Officer.
	ulOldLabelLength	The length of the label pointed to by `pOldLabel`. If `pOldLabel` is NULL, then this value must be 0.
	pOldLabel	A pointer to a buffer that contains the label for the domain to be re-labelled. To add a label to a domain that does not already have one, this value must be NULL.
	ulNewLabelLength	The length of the label pointed to by `pNewLabel`. The label length cannot be 0.
	pNewLabel	A pointer to a buffer that contains the new label for the domain. The label must be between 1 and 32 bytes in length and is NOT a NULL terminated string. This parameter cannot be NULL.

Return Code	Hex	Description
CKR_DOMAIN_LABEL_ALREADY_EXISTS		This error is returned when the label provided for a new domain, or when changing the label of an existing domain, already exists. This includes removing a domain's label when there is already a domain with no label.
CKR_DOMAIN_LABEL_INVALID		The specified domain label does not match a domain that is currently assigned to the partition, or the new label does not meet the length requirement.

CA_ChangeLabel

```
CA_ChangeLabel(CK_SESSION_HANDLE hSession,
               CK_SLOT_ID        ulSlotID,
               CK_CHAR_PTR       pulLabel,
               CK_ULONG          ulLabelLen);
```

CA_CheckOperationState

Check if the specified cryptographic operation (encrypt, decrypt, sign, verify, digest) is in progress or not in the given session.

```
CA_CheckOperationState(CK_SESSION_HANDLE hSession,
                       CK_ULONG          operation,
                       CK_BBOOL          *pactive);
```

CA_ChoosePrimarySlot

```
CA_ChoosePrimarySlot(CK_SESSION_HANDLE hSession);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.

CA_ChooseSecondarySlot

```
CA_ChooseSecondarySlot(CK_SESSION_HANDLE hSession);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.

CA_CloneAllObjectsToSession

```
CA_CloneAllObjectsToSession(CK_SESSION_HANDLE hSession,
                            CK_SLOT_ID        slotId);
```

CA_CloneAsSource

Clone an object from the source token.

```
CA_CloneAsSource(CK_SESSION_HANDLE hSession,
                 CK_ULONG          hType,
                 CK_ULONG          hHandle,
                 CK_BYTE_PTR       pPart1,
                 CK_ULONG          ulPart1Size,
                 CK_BBOOL          bReplicate,
                 CK_BYTE_PTR       pPart2,
                 CK_ULONG_PTR      pulPart2Size);
```

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I/O	Argument	Description
In	hSession	The authenticated session handle.
	hType	Always specify `CK_CRYPTOKI_ELEMENT` for cloning standard PKCS#11 objects.
	hHandle	The handle of the object being cloned.
	pPart1	The Part1 buffer.
	ulPart1Size	The size of the Part1 buffer.
	bReplicate	Boolean indicates whether this is a pure cloning operation, or uses network replication: > Cloning to/from Luna PCIe HSM 7 or Luna USB HSM 7: **FALSE** > Cloning to/from Luna Network HSM 7: **TRUE**
Out	pPart2	The Part2 buffer.
	pulPart2Size	The size of the Part2 buffer.

See also Luna HSM Cloning API CPv1 - Extensions to PKCS #11, Luna HSM Cloning API CPv3 - Extensions to PKCS #11, and Luna HSM Cloning API CPv4 Extensions to PKCS#11.

CA_CloneAsSourceInit

Initialize the cloning operation on the source token.

```
CA_CloneAsSourceInit(CK_SESSION_HANDLE hSession,
                     CK_BYTE_PTR       pInParameter,
                     CK_ULONG          ulInParameterSize,
                     CK_BYTE_PTR       pOutParameter,
                     CK_ULONG_PTR      pulOutParameterSize,
                     CK_BBOOL          bReplicate);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
	pInParameter	Always `NULL`.
	ulInParameterSize	Always `0`.

I/O	Argument	Description
Out	pOutParameter	The output of the initialization data (TWC).
	pulOutParameterSize	The size of the initialization data (TWC).
	bReplicate	Boolean indicates whether this is a pure cloning operation, or uses network replication: > Cloning to/from Luna PCIe HSM 7 or Luna USB HSM 7: **FALSE** > Cloning to/from Luna Network HSM 7: **TRUE**

See also Luna HSM Cloning API CPv3 - Extensions to PKCS #11 and Luna HSM Cloning API CPv4 Extensions to PKCS#11.

CA_CloneAsTarget

Clone an object to the target token.

```
CA_CloneAsTarget(CK_SESSION_HANDLE    hSession,
                 CK_BYTE_PTR          pKEV,
                 CK_ULONG             ulKEVSize,
                 CK_BYTE_PTR          pPart2,
                 CK_ULONG             ulPart2Size,
                 CK_ULONG             hType,
                 CK_ULONG             hHandle,
                 CK_BBOOL             bReplicate,
                 CK_OBJECT_HANDLE_PTR phClonedHandle);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
	pKEV	The KEV for the target token. See "CA_GenerateCloningKEV" on page 50.
	ulKEVSize	The size of the KEV.
	pPart2	The Part2 buffer.
	ulPart2Size	The size of the Part2 buffer.
	hType	Always specify `CK_CRYPTOKI_ELEMENT` for cloning standard PKCS#11 objects.
	hHandle	The handle of the object being cloned.
	bReplicate	Boolean indicates whether this is a pure cloning operation, or uses network replication: > Cloning to/from Luna PCIe HSM 7 or Luna USB HSM 7: **FALSE** > Cloning to/from Luna Network HSM 7: **TRUE**

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I/O	Argument	Description
Out	phClonedHandle	The handle of the cloned object on the target token.

See also Luna HSM Cloning API CPv1 - Extensions to PKCS #11, Luna HSM Cloning API CPv3 - Extensions to PKCS #11, and Luna HSM Cloning API CPv4 Extensions to PKCS#11.

CA_CloneAsTargetInit

Initializes the cloning operation on the target token.

```
CA_CloneAsTargetInit(CK_SESSION_HANDLE hSession,
                     CK_BYTE_PTR       pTWC,
                     CK_ULONG          ulTWCSize,
                     CK_BYTE_PTR       pKEV,
                     CK_ULONG          ulKEVSize,
                     CK_BBOOL          bReplicate,
                     CK_BYTE_PTR       pPart1,
                     CK_ULONG_PTR      pulPart1Size);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
	pTWC	The Token Wrapping Certificate (TWC). See "CA_GetTokenCertificates" on page 64.
	ulTWCSize	The size of the TWC.
	pKEV	The KEV for the target token. See "CA_GenerateCloningKEV" on page 50.
	ulKEVSize	The size of the KEV.
	bReplicate	Boolean indicates whether this is a pure cloning operation, or uses network replication: > Cloning to/from Luna PCIe HSM 7 or Luna USB HSM 7: **FALSE** > Cloning to/from Luna Network HSM 7: **TRUE**
Out	pPart1	The Part1 buffer.
	pulPart1Size	The size of the Part1 buffer.

See also Luna HSM Cloning API CPv1 - Extensions to PKCS #11, Luna HSM Cloning API CPv3 - Extensions to PKCS #11, and Luna HSM Cloning API CPv4 Extensions to PKCS#11.

CA_CloneObject

Clone an object from one token to another eligible token (matching domains), visible to the same client.

```
CA_CloneObject(CK_SESSION_HANDLE    hTargetSession,
               CK_SESSION_HANDLE    hSourceSession,
               CK_ULONG             ulObjectType,
               CK_OBJECT_HANDLE     hObjectHandle,
               CK_OBJECT_HANDLE_PTR phClonedObject);
```

I/O	Argument	Description
In	hTargetSession	The handle of the open session on the target token.
	hSourceSession	The handle of the open session on the source token.
	ulObjectType	Always specify `CK_CRYPTOKI_ELEMENT` for cloning standard PKCS#11 objects.
	hObjectHandle	The handle of the object on the source token to be cloned.
Out	phClonedObject	The object handle of the newly cloned object on the target token.

See also Luna HSM Cloning API CPv1 - Extensions to PKCS #11, Luna HSM Cloning API CPv3 - Extensions to PKCS #11, and Luna HSM Cloning API CPv4 Extensions to PKCS#11.

CA_CloneObjectToAllSessions

```
CA_CloneObjectToAllSessions(CK_SESSION_HANDLE hSession,
                            CK_OBJECT_HANDLE  hObject);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
Out	hObject	The object handle.

CA_ClonePrivateKey

Permit secure transfer of a private key (RSA) between a source token and a target token.

```
CA_ClonePrivateKey(CK_SESSION_HANDLE    hTargetSession,
                   CK_SESSION_HANDLE    hSourceSession,
                   CK_OBJECT_HANDLE     hObjectToCloneHandle,
                   CK_OBJECT_HANDLE_PTR phClonedKey);
```

CA_CloningDisableCipherSuite

Allows the Partition Security Officer to disable a cloning cipher suite. Requires Luna HSM Client 10.4.0 or newer.

```
CA_CloningDisableCipherSuite(CK_SESSION_HANDLE hSession,
                             CK_ULONG          CipherID);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
	CipherID	The cipher ID.

CA_CloningEnableCipherSuite

Allows the Partition Security Officer to enable a cloning cipher suite. Requires Luna HSM Client 10.4.0 or newer.

```
CA_CloningEnableCipherSuite(CK_SESSION_HANDLE hSession,
                            CK_ULONG          CipherID);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
	CipherID	The cipher ID.

CA_CloningGetCipherNameByID

Allows an unauthenticated user to query the asci name for any cloning cipher suite. Requires Luna HSM Client 10.4.0 or newer.

```
CA_CloningGetCipherNameByID(CK_SLOT_ID   slotID,
                            CK_ULONG     ulCipherID,
                            CK_CHAR_PTR  pszName,
                            CK_ULONG_PTR pulNameBufSize);
```

I/O	Argument	Description
In	slotID	The slot number.
	ulCipherID	The ID of the cipher suite.
	pszName	A pointer to an array to receive the name of the cipher suite. If `pszName` is NULL, then no name is returned and `pulNameBufSize` is set to the size of the array required to receive the cipher suite name.
	pulNameBufSize	The length of the array pointed to by `pszName`. This parameter cannot be NULL. The value pointed to by `pulNameBufSize` is set to the actual size of the cipher suite name.

Return Code	Hex	Description
CKR_BUFFER_TOO_SMALL		The array pointed to by `pszName` is too small to receive the array of cipher suite states.

CA_CloningGetCipherSuiteStates

Allows an unauthenticated user to retrieve the status of each cloning cipher suite. Requires Luna HSM Client 10.4.0 or newer.

```
CA_CloningGetCipherSuiteStates(CK_SLOT_ID   slotID,
                               CK_ULONG_PTR pulArray,
                               CK_BYTE_PTR  pbArraySize);
```

I/O	Argument	Description
In	slotID	The slot number.
	pulArray	A pointer to an array to receive the status (1=enabled, 0=disabled) of each cipher suite. If `pulArray` is NULL, no information is returned and `pbArraySize` is set to the size of the array required to receive the cipher suite states.
	pbArraySize	A pointer to the size of the array pointed to by `pulArray`. This parameter cannot be NULL. The value pointed to by `pbArraySize` is set to the actual size of the cipher suite states.

Return Code	Hex	Description
CKR_BUFFER_TOO_SMALL		The array pointed to by `pulArray` is too small.

CA_CloseAllSecondarySessions

```
CA_CloseAllSecondarySessions(CK_SESSION_HANDLE hSession);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.

CA_CloseApplicationID

Deactivate an application identifier. This function is deprecated in Luna HSM Firmware 7.7.0 and newer. Use "CA_CloseApplicationIDV2" on the next page instead.

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

CA_CloseApplicationIDForContainer

Deactivate an application identifier for a container. This function is deprecated in Luna HSM Firmware 7.7.0 and newer. Use "CA_CloseApplicationIDForContainerV2" on the next page instead.

```
CA_CloseApplicationIDForContainer(CK_SLOT_ID slotID,
                                  CK_ULONG   ulHigh,
                                  CK_ULONG   ulLow,
                                  CK_ULONG   ulContainerNumber);
```

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CA_CloseApplicationIDForContainerV2

Deactivate an application identifier for a container. For older firmware/client versions, use "CA_CloseApplicationIDForContainer" on the previous page.

```
CA_CloseApplicationIDForContainerV2(CK_SLOT_ID              slotID,
                                    const CK_APPLICATION_ID * pAppId,
                                    CK_ULONG                ulContainerNumber);
```

CA_CloseApplicationIDV2

Deactivate an application identifier. For older firmware/client versions, use "CA_CloseApplicationID" on the previous page.

```
CA_CloseApplicationIDV2(CK_SLOT_ID              slotID,
                        const CK_APPLICATION_ID * pAppId);
```

CA_CloseSecondarySession

```
CA_CloseSecondarySession(CK_SESSION_HANDLE hSession,
                         CK_SLOT_ID        slotID,
                         CK_ULONG          slotInstance);
```

CA_ConfigureRemotePED

Configure the specified slot to use the provided remote PED information (Luna Network HSM 7 only).

```
CA_ConfigureRemotePED(CK_SLOT_ID   slotId,
                      CK_CHAR_PTR  pHostName,
                      CK_ULONG     ulPort,
                      CK_ULONG_PTR pulPedId);
```

CA_ConnectRemotePED

Requires Luna HSM Client 10.1.0 or newer.

```
CA_ConnectRemotePED(CK_SLOT_ID  slotId,
                    CK_ULONG    ulPedId,
                    CK_BBOOL    bpwdBased,
                    CK_CHAR_PTR pPwd);
```

CA_CreateContainerLoginChallenge

Create a challenge for a partition role.

```
CA_CreateContainerLoginChallenge(CK_SESSION_HANDLE hSession,
                                 CK_SLOT_ID        targetSlotID,
                                 CK_USER_TYPE      userType,
                                 CK_ULONG          ulChallengeDataSize,
                                 CK_CHAR_PTR       pChallengeData,
                                 CK_ULONG_PTR      ulOutputDataSize,
                                 CK_CHAR_PTR       pOutputData);
```

CA_CreateLoginChallenge

Create a login challenge for the specified user.

```
CA_CreateLoginChallenge(CK_SESSION_HANDLE hSession,
                        CK_USER_TYPE      userType,
                        CK_ULONG          ulChallengeDataSize,
                        CK_CHAR_PTR       pChallengeData,
                        CK_ULONG_PTR      ulOutputDataSize,
                        CK_CHAR_PTR       pOutputData);
```

CA_CV_IssueAdminRequest

Requires Luna HSM Client 10.1.0 or newer.

```
CA_CV_IssueAdminRequest(CK_SLOT_ID   slotID,
                        CK_BYTE_PTR  pRequest,
                        CK_ULONG     requestLen,
                        CK_BYTE_PTR  pResponse,
                        CK_ULONG_PTR responseLen,
                        CK_BYTE_PTR  pAuditLogOut,
                        CK_ULONG_PTR auditLogOutLen);
```

CA_CV_IssueContainerRequest

Requires Luna HSM Client 10.1.0 or newer.

```
CA_CV_IssueContainerRequest(CK_SLOT_ID   slotID,
                            CK_BYTE_PTR  pRequest,
                            CK_ULONG     requestLen,
                            CK_BYTE_PTR  pContainerIn,
                            CK_ULONG     containerInLen,
                            CK_BYTE_PTR  pResponse,
                            CK_ULONG_PTR responseLen,
                            CK_BYTE_PTR  pAuditLogOut,
                            CK_ULONG_PTR auditLogOutLen,
                            CK_BYTE_PTR  pContainerOut,
                            CK_ULONG_PTR containerOutLen);
```

CA_CV_IssueP11Request

Requires Luna HSM Client 10.1.0 or newer.

```
CA_CV_IssueP11Request(CK_SLOT_ID       slotID,
                      CK_BYTE_PTR      req,
                      CK_ULONG         req_len,
                      CK_BYTE_PTR      resp,
                      CK_ULONG         resp_len,
                      CK_ULONG_PTR     resp_used,
                      CK_FRAGMENTS_PTR fragments);
```

CA_Deactivate

Deactivate the specified partition.

```
CA_Deactivate(CK_SLOT_ID   slotId,
              CK_USER_TYPE userType);
```

I/O	Argument	Description
In	slotId	The slot number.
	userType	The user role on the partition.

CA_DecapsulateKey

Creates a new secret key object based on the private key and cipher text generated by an encapsulate operation. The new key is identical to the key returned by encapsulate. This function is a KEM style function. The CKA_DECAPSULATE attribute of the private key, which indicates whether the key supports decapsulation, MUST be CK_TRUE.

```
CA_DecapsulateKey(CK_SESSION_HANDLE    hSession,
                  CK_MECHANISM_PTR     pMechanism,
                  CK_OBJECT_HANDLE     hPrivateKey,
                  CK_ATTRIBUTE_PTR     pTemplate,
                  CK_ULONG             ulAttributeCount,
                  CK_BYTE_PTR          pCiphertextKey,
                  CK_ULONG             ulCiphertextLen,
                  CK_OBJECT_HANDLE_PTR phKey);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
	pMechanism	Specifies the mechanism and optional parameters to use for the operation.
	hPrivateKey	The handle of the decapsulating key.
	pTemplate	The attributes of the new key.
	ulAttributeCount	The number of attributes specified in `pTemplate`.
	pCiphertextKey	The encrypted key.
	ulCiphertextLen	The length of the encrypted key specified in `pCiphertextKey`.
Out	phKey	The handle of the new decapsulated key.

The new key has:

- the **CKA_ALWAYS_SENSITIVE** attribute set to CK_FALSE,
- the **CKA_NEVER_EXTRACTABLE** attribute set to CK_FALSE.
- the **CKA_EXTRACTABLE** set to the value of the input template with a default of CK_TRUE if not provided,
- the **CKA_LOCAL** attribute set to CKA_FALSE

CA_DeleteContainer

Delete a partition.

```
CA_DeleteContainer(CK_SESSION_HANDLE hSession);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.

CA_DeleteContainerWithHandle

Deletes a partition.

```
CA_DeleteContainerWithHandle(CK_SESSION_HANDLE hSession,
                             CK_ULONG          ulContainerNumber);
```

CA_DeleteKCV

Allows the Partition Security Officer to delete domains on the partition. See also Universal Cloning and Luna HSM Cloning API CPv4 Extensions to PKCS#11.

```
CA_DeleteKCV(CK_SESSION_HANDLE hSession,
             CK_ULONG          ulLabelLength,
             CK_BYTE_PTR       pLabel);
```

I/O	Argument	Description
In	hSession	A session on the partition authenticated by the Partition Security Officer.
	ulLabelLength	The length of the label pointed to by `pLabel`. If `pLabel` is NULL, then this parameter must be set to 0.
	pLabel	A pointer to a buffer that contains the label for the domain to be deleted. If `ulLabelLength` is 0, then this parameter must be set to NULL.

Return Code	Hex	Description
CKR_DOMAIN_MANAGEMENT_NOT_ALLOWED		**Partition policy 44:** Allow Extended Domain Management is disabled, or the domain specified is of a different authentication type than the HSM (specifying a multifactor quorum domain on a password-authenticated HSM or vice-versa).
CKR_DOMAIN_LABEL_INVALID		The specified domain label does not does not match a domain that is currently assigned to the partition.

CA_DeleteRemotePEDVector

Delete the Remote PED Vector (RPV).

```
CA_DeleteRemotePEDVector(CK_SESSION_HANDLE hSession);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.

CA_DeriveKeyandWrap

This function 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_DeriveKeyAndWrap(CK_SESSION_HANDLE hSession,
                    CK_MECHANISM_PTR  pMechanismDerive,
                    CK_OBJECT_HANDLE  hBaseKey,
                    CK_ATTRIBUTE_PTR  pTemplate,
                    CK_ULONG          ulAttributeCount,
                    CK_MECHANISM_PTR  pMechanismWrap,
                    CK_OBJECT_HANDLE  hWrappingKey,
                    CK_BYTE_PTR       pWrappedKey,
                    CK_ULONG_PTR      pulWrappedKeyLen);
```

CA_DescribeUtilizationBinId

This operation is supported on the Admin partition of Luna PCIe HSM 7 only.

```
CA_DescribeUtilizationBinId(CK_ULONG    ulBinId,
                            CK_CHAR_PTR CK_PTR describe);
```

CA_DescribeUtilizationCounterId

This operation is supported on the Admin partition of Luna PCIe HSM 7 only.

```
CA_DescribeUtilizationCounterId(CK_ULONG    ulCounterId,
                                CK_CHAR_PTR CK_PTR describe);
```

CA_DestroyMultipleObjects

Delete multiple objects on the specified token.

```
CA_DestroyMultipleObjects(CK_SESSION_HANDLE    hSession,
                          CK_ULONG             ulHandleCount,
                          CK_OBJECT_HANDLE_PTR pHandleList,
                          CK_ULONG_PTR         pulIndex);
```

CA_DisableUnauthTokenInsertion

```
CA_DisableUnauthTokenInsertion(CK_SESSION_HANDLE hSession,
                               CK_ULONG          ulContextHandle);
```

CA_DisconnectRemotePED

Requires Luna HSM Client 10.1.0 or newer.

```
CA_DisconnectRemotePED(CK_SLOT_ID slotId,
                       CK_ULONG   ulPedId);
```

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CA_DismantleRemotePED

Reverse the operation of "CA_ConfigureRemotePED" on page 40. Deletes remote PED information for the partition in the specified slot.

```
CA_DismantleRemotePED(CK_SLOT_ID slotId,
                      CK_ULONG   ulPedId);
```

CA_DuplicateMofN

Create duplicates of all M of N secret splits.

```
CA_DuplicateMofN(CK_SESSION_HANDLE hSession);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.

CA_EnableUnauthTokenInsertion

```
CA_EnableUnauthTokenInsertion(CK_SESSION_HANDLE hSession,
                              CK_ULONG          ulMaxUsageCount,
                              CK_ULONG_PTR      ulContextHandle);
```

CA_EncapsulateKey

```
CA_EncapsulateKey(CK_SESSION_HANDLE    hSession,
                  CK_MECHANISM_PTR     pMechanism,
                  CK_OBJECT_HANDLE     hPublicKey,
                  CK_ATTRIBUTE_PTR     pTemplate,
                  CK_ULONG             ulAttributeCount,
                  CK_BYTE_PTR          pCiphertext,
                  CK_ULONG_PTR         pulCiphertextLen,
                  CK_OBJECT_HANDLE_PTR phKey);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
	pMechanism	Specifies the mechanism to use for the operation.
	hPublicKey	The other party's public key.
	pTemplate	Attributes of the new symmetric key.
	ulAttributeCount	The number of attributes specified in `pTemplate`.
Out	pCiphertext	The encrypted key, or NULL.
	pulCiphertextLen	The length of the encrypted key returned in `pCiphertext`.
	phKey	The handle of the new key.

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The CKA_ENCAPSULATE attribute of the private key, which indicates whether the key supports encapsulation, MUST be CK_TRUE.

The new key has:

- the **CKA_ALWAYS_SENSITIVE** attribute set to CK_FALSE,
- the **CKA_NEVER_EXTRACTABLE** attribute set to CK_FALSE.
- the **CKA_EXTRACTABLE** set to the value of the input template with a default of CK_TRUE if not provided,
- the **CKA_LOCAL** attribute set to CKA_FALSE
- a value for **CKA_UNIQUE_ID** generated and assigned

CA_EncodeECChar2Params

Encode EC curve parameters for user defined curves.

```
CA_EncodeECChar2Params(CK_BYTE_PTR  DerECParams,
                       CK_ULONG_PTR DerECParamsLen,
                       CK_ULONG     m,
                       CK_ULONG     k1,
                       CK_ULONG     k2,
                       CK_ULONG     k3,
                       CK_BYTE_PTR  a,
                       CK_ULONG     alen,
                       CK_BYTE_PTR  b,
                       CK_ULONG     blen,
                       CK_BYTE_PTR  seed,
                       CK_ULONG     seedlen,
                       CK_BYTE_PTR  x,
                       CK_ULONG     xlen,
                       CK_BYTE_PTR  y,
                       CK_ULONG     ylen,
                       CK_BYTE_PTR  order,
                       CK_ULONG     orderlen,
                       CK_BYTE_PTR  cofactor,
                       CK_ULONG     cofactorlen);
```

CA_EncodeECParamsFromFile

Encode EC curve parameters for user defined curves.

```
CA_EncodeECParamsFromFile(CK_BYTE_PTR  DerECParams,
                          CK_ULONG_PTR DerECParamsLen,
                          CK_BYTE_PTR  paramsFile);
```

CA_EncodeECPrimeParams

Encode EC curve parameters for user defined curves.

```
CA_EncodeECPrimeParams(CK_BYTE_PTR  DerECParams,
                       CK_ULONG_PTR DerECParamsLen,
                       CK_BYTE_PTR  prime,
                       CK_ULONG     primelen,
                       CK_BYTE_PTR  a,
                       CK_ULONG     alen,
                       CK_BYTE_PTR  b,
                       CK_ULONG     blen,
```

```
                    CK_BYTE_PTR  seed,
                    CK_ULONG     seedlen,
                    CK_BYTE_PTR  x,
                    CK_ULONG     xlen,
                    CK_BYTE_PTR  y,
                    CK_ULONG     ylen,
                    CK_BYTE_PTR  order,
                    CK_ULONG     orderlen,
                    CK_BYTE_PTR  cofactor,
                    CK_ULONG     cofactorlen);
```

CA_Extract

This API extracts objects or internal CSPs using the specified session id. The API functionality is defined by a mechanism and a mechanism parameter which allows for any functionality to be defined on a per-mechanism basis. This makes it ideal for the CPv4 extract/insert operations and is consistent with the PKCS#11 API.

```
CA_Extract(CK_SESSION_HANDLE hSession,
           CK_MECHANISM_PTR  pMechanism);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
In/Out	pMechanism	Specify CKM_CPV4_EXTRACT (0x80000208) for CPv4 extract operations. It takes a parameter, CK_CPV4_EXTRACT_PARAMS (see below).

The parameter CK_CPV4_EXTRACT_PARAMS is structured as follows:

```
CK_CPV4_EXTRACT_PARAMS {
  CK_ULONG_PTR         sessionIdLength;
  CK_BYTE              sessionId;
  CK_ULONG             inputLength;
  CK_BYTE_PTR          input;
  CK_ULONG             extractionFlags;
  CK_ULONG             numberOfObjects;
  CK_ULONG_PTR         objectType;
  CK_ULONG_PTR         objectHandle;
  CK_RV_PTR            result;
  CK_ULONG_PTR         keyBlobLength;
  CK_BYTE_PTR_PTR      keyBlob;
}
```

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I/O	Argument	Description
In	sessionIdLength	The length of the session ID.
	sessionId	The identifier for the session to be used to extract the key blob(s).
	inputLength	The length of data pointed by “input”.
	input	When executing step 4 in the API flow, “input” and “inputLength” must refer to a valid memory location with a non-zero size; specifically the output of the final call to "CA_MigrationContinueSessionNegotiation" on page 81. All other calls to this API should be NULL and 0.
	extractionFlags	Flags used to define how errors are handled during extraction. The default value is 0, which is to return on the first error. The following flag is accepted: > **CKF_CONTINUE_ON_ERR** (0x01): If specified, the API continues attempting to extract objects if an individual object fails. If the flag is not specified, the API fails after the first failure is encountered.
	numberOfObjects	Number of objects to be extracted.
	objectType	An array of object types to define the type of objects pointed to by the array of object handles. Possible values are CK_CRYPTOKI_ELEMENT and CK_PARAM_ELEMENT.
	objectHandle	An array of object handles, defining the objects to be extracted.
Out	result	An array of result codes defining the result of each object extraction. This field should be initialized to CKR_CLONE_NOT_ATTEMPTED for all objects. If an error is encountered trying to extract an object, then that error is set in the `result` field that corresponds to that object. Callers of this API should verify the `result` field for each object to determine if the object was successfully extracted.
	keyBlobLength	An array of length fields that correspond to the array of memory buffers pointed by “keyBlob”. This value and the value pointed to by each array cannot be NULL.
	keyBlob	An array of the memory buffers to receive the extracted key blobs. This value cannot be NULL. If all of the array elements are NULL, then the required buffer size is returned in keyBlobLength array. Otherwise all values in the array must be non-NULL.

For information on error codes, see CPv4 PKCS#11 Error Code Summary.

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CA_ExtractMaskedObject

```
CA_ExtractMaskedObject(CK_SESSION_HANDLE hSession,
                       CK_ULONG          ulObjectHandle,
                       CK_BYTE_PTR       pMaskedKey,
                       CK_ULONG_PTR      pusMaskedKeyLen);
```

CA_FactoryReset

Resets the HSM to factory conditions.

```
CA_FactoryReset(CK_SLOT_ID slotId,
                CK_FLAGS   flags);
```

CA_FindAdminSlotForSlot

Get the Admin slot for the current slot.

```
CA_FindAdminSlotForSlot(CK_SLOT_ID  inputSlot,
                        CK_SLOT_ID* pSlotId,
                        CK_SLOT_ID* pPrevSlotId);
```

CA_FirmwareRollback

Rolls back the HSM firmware to the stored previous version.

```
CA_FirmwareRollback(CK_SESSION_HANDLE hSession);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.

CA_FMActivateSMFS

```
CA_FMActivateSMFS(CK_SESSION_HANDLE hTokenSession);
```

CA_FMDelete

```
CA_FMDelete(CK_SESSION_HANDLE hTokenSession,
            CK_ULONG          fmid);
```

CA_FMDownload

```
CA_FMDownload(CK_SESSION_HANDLE hTokenSession,
              CK_OBJECT_HANDLE  hObject,
              CK_ULONG          ulParamLen,
              CK_BYTE_PTR       pParam,
              CK_ULONG          ulImageLen,
              CK_BYTE_PTR       pImage,
              CK_ULONG          ulSignatureLen,
              CK_BYTE_PTR       pSignature);
```

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CA_GenerateCloneableMofN

Create a cloneable secret-splitting vector on a token.

```
CA_GenerateCloneableMofN(CK_SESSION_HANDLE      hSession,
                         CK_ULONG               ulM,
                         CA_MOFN_GENERATION_PTR pVectors,
                         CK_ULONG               ulVectorCount,
                         CK_ULONG               isSecurePortUsed,
                         CK_VOID_PTR            pReserved);
```

CA_GenerateCloningKEV

Generate a KEV for the token.

```
CA_GenerateCloningKEV(CK_SESSION_HANDLE hSession,
                      CK_BYTE_PTR       pKEV,
                      CK_ULONG_PTR      pulKEVSize);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
Out	pKEV	The KEV for the target token. See "CA_GenerateCloningKEV" above.
	pulKEVSize	The size of the KEV.

See also Luna HSM Cloning API CPv1 - Extensions to PKCS #11, Luna HSM Cloning API CPv3 - Extensions to PKCS #11, and Luna HSM Cloning API CPv4 Extensions to PKCS#11.

CA_GenerateMofN

Generate the secret information on a token.

```
CA_GenerateMofN(CK_SESSION_HANDLE      hSession,
                CK_ULONG               ulM,
                CA_MOFN_GENERATION_PTR pVectors,
                CK_ULONG               ulVectorCount,
                CK_ULONG               isSecurePortUsed,
                CK_VOID_PTR            pReserved);
```

CA_GenerateTokenKeys

Generate the private keys used for secure key cloning operations.

```
CA_GenerateTokenKeys(CK_SESSION_HANDLE hSession,
                     CK_ATTRIBUTE_PTR  pTemplate,
                     CK_ULONG          usTemplateLen);
```

CA_GenerateTWK

```
CA_GenerateTWK(CK_SLOT_ID        slotID,
               CK_SESSION_HANDLE hSession,
               CK_ULONG          ulKeyType,
               CK_ULONG          ulExpSize,
               CK_BYTE_PTR       pExponent,
```

```
                CK_ULONG          ulModulusBitSize,
                CK_ULONG_PTR      pulModSize,
                CK_BYTE_PTR       pModulus);
```

CA_Get

Get HSM parameters such as the serial number and certificates.

```
CA_Get(CK_SLOT_ID   slotID,
       CK_ULONG     ulItem,
       CK_BYTE_PTR  pBuffer,
       CK_ULONG_PTR pulBufferLen);
```

CA_GetActualSlotList

```
CA_GetActualSlotList(CK_SLOT_ID     slotId,
                     CK_ULONG_PTR   phsmidx,
                     CK_SLOT_ID_PTR pActualslotID,
                     CK_ULONG_PTR   pulCount);
```

CA_GetApplicationID

Get an application's AccessID.

```
CA_GetApplicationID(CK_APPLICATION_ID * pAppId,
                    CK_VOID_PTR       pApplication);*/);
```

CA_GetBlFirmwareVersion

```
CA_GetBlFirmwareVersion(CK_SLOT_ID   slotID,
                        CK_ULONG_PTR fwMajor,
                        CK_ULONG_PTR fwMinor,
                        CK_ULONG_PTR fwSubminor);
```

CA_GetClusterState

```
CA_GetClusterState(CK_SLOT_ID           slotId,
                   CK_CLUSTER_STATE_PTR pState);
```

I/O	Argument	Description
In	slotId	The slot number.

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I/O	Argument	Description

Out	pState	The reported state of the HA group, as defined by the following structure:
		`typedef struct CK_HA_MEMBER{`
		`  CK_CHAR  memberSerial[16];`
		`  CK_RV  memberStatus;`
		`}CK_HA_MEMBER;`
		
		`typedef struct CK_HA_STATUS{`
		`  CK_CHAR  groupSerial[16];`
		`  CK_HA_MEMBER  memberList[32];`
		`  CK_ULONG  listSize;`
		`}CK_HA_STATUS;`
		
		`typedef CK_HA_MEMBER CK_POINTER CK_HA_MEMBER_PTR;`
		
		`typedef CK_HA_STATUS  CK_POINTER CK_HA_STATE_PTR;`
		Returns:
		> **groupSerial**: The 16-byte serial number of the HA group.
		> **memberList**: Array of information on up to 32 HA member partitions as follows:
		• **memberSerial**: The 16-byte serial number of the member partition.
		• **memberStatus**: The status of the member.
		> **listSize**: The length of the **memberList** array.

CA_GetConfigurationElementDescription

Get capability and policy descriptions and settings.

Using Luna HSM Client 7.1.0 or newer:

```
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_ULONG_PTR pDesBufSize);
```

Using Luna HSM Client 7.0.0:

```
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);
```

CA_GetContainerCapabilitySet

Get all partition capability values.

```
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);
```

CA_GetContainerCapabilitySetting

Get a single specified capability value.

```
CA_GetContainerCapabilitySetting(CK_SLOT_ID   slotID,
                                 CK_ULONG     ulContainerNumber,
                                 CK_ULONG     ulPolicyId,
                                 CK_ULONG_PTR pulPolicyValue);
```

CA_GetContainerList

Get the list of all partitions on a slot.

```
CA_GetContainerList(CK_SLOT_ID   slotID,
                    CK_ULONG     ulGroupHandle,
                    CK_ULONG     ulContainerType,
                    CK_ULONG_PTR pulContainerHandles,
                    CK_ULONG_PTR pulNumberOfHandles);
```

CA_GetContainerName

Get the name of the partition in the specified slot.

```
CA_GetContainerName(CK_SLOT_ID   slotID,
                    CK_ULONG     ulContainerHandle,
                    CK_BYTE_PTR  pContainerName,
                    CK_ULONG_PTR pulContainerNameLen);
```

CA_GetContainerPolicySet

Get all the partition policy values on the specified partition slot.

```
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);
```

CA_GetContainerPolicySetting

Get the value of the specified partition policy setting on the specified partition slot.

```
CA_GetContainerPolicySetting(CK_SLOT_ID   uPhysicalSlot,
                             CK_ULONG     ulContainerNumber,
                             CK_ULONG     ulPolicyId,
                             CK_ULONG_PTR pulPolicyValue);
```

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CA_GetContainerStatus

Get partition status, which returns authentication status flags.

```
CA_GetContainerStatus(CK_SLOT_ID   slotID,
                      CK_ULONG     ulContainerNumber,
                      CK_ULONG_PTR pulContainerStatusFlags,
                      CK_ULONG_PTR pulFailedSOLogins,
                      CK_ULONG_PTR pulFailedUserLogins,
                      CK_ULONG_PTR pulFailedLimitedUserLogins);
```

CA_GetContainerStorageInformation

Get partition storage information such as size, usage, and number of objects.

```
CA_GetContainerStorageInformation(CK_SLOT_ID   slotID,
                                  CK_ULONG     ulContainerNumber,
                                  CK_ULONG_PTR pulContainerOverhead,
                                  CK_ULONG_PTR pulTotal,
                                  CK_ULONG_PTR pulUsed,
                                  CK_ULONG_PTR pulFree,
                                  CK_ULONG_PTR pulObjectCount);
```

CA_GetCurrentHAState

Get HA status from the application perspective. Same functional behavior as "CA_GetHAState" on page 57, but uses parallel checks of members, avoids delays once a peer is found unreachable, and returns all member statuses within 3 seconds. The 3-second return is expected to be achievable for an HA group up to 32 members and is verified in laboratory conditions, when not affected by appliance CPU, memory, network, or HSM bottlenecks that are outside the control of the cryptographic module and its host.

Any failed member statuses are returned following the configured timeout. Timeout defaults to 3 seconds for the check of all group members, but can be set as high as 60 seconds by the statusTimeout configuration option in the *HAConfiguration* section of the **Chrystoki.conf** / **crystoki.ini** file.

> **NOTE** This feature includes internal fail-safes to avoid race conditions, but invocation from an outside application *must be threadsafe*.

Requires minimum Luna HSM Client 10.7.0. For older client versions, use "CA_GetHAState" on page 57.

```
CA_GetCurrentHAState(CK_SLOT_ID      slotId,
                     CK_HA_STATE_PTR pState);
```

I/O	Argument	Description
In	slotId	The slot number.

I/O	Argument	Description

Out	pState	The reported state of the HA group, as defined by the following structure:
		`typedef struct CK_HA_MEMBER{`
		`  CK_CHAR  memberSerial[16];`
		`  CK_RV  memberStatus;`
		`}CK_HA_MEMBER;`
		
		`typedef struct CK_HA_STATUS{`
		`  CK_CHAR  groupSerial[16];`
		`  CK_HA_MEMBER  memberList[32];`
		`  CK_ULONG  listSize;`
		`}CK_HA_STATUS;`
		
		`typedef CK_HA_MEMBER CK_POINTER CK_HA_MEMBER_PTR;`
		
		`typedef CK_HA_STATUS  CK_POINTER CK_HA_STATE_PTR;`
		Returns:
		> **groupSerial**: The 16-byte serial number of the HA group.
		> **memberList**: Array of information on up to 32 HA member partitions as follows:
		• **memberSerial**: The 16-byte serial number of the member partition.
		• **memberStatus**: The status of the member.
		> **listSize**: The length of the **memberList** array.

CA_GetCVFirmwareVersion

Get the Luna Cloud HSM firmware version. Requires Luna HSM Client 10.1.0 or newer.

```
CA_GetCVFirmwareVersion(CK_SLOT_ID   slotID,
                        CK_ULONG_PTR fwMajor,
                        CK_ULONG_PTR fwMinor,
                        CK_ULONG_PTR fwSubminor);
```

I/O	Argument	Description
In	slotID	The slot number.
Out	fwMajor	The major firmware version (X.x.x).
	fwMinor	The minor firmware version (x.X.x).
	fwSubminor	The sub-minor firmware version (x.x.X).

CA_GetDefaultHSMPolicyValue

Get the default value of the specified HSM policy. See also HSM Capabilities and Policies.

```
CA_GetDefaultHSMPolicyValue(CK_SLOT_ID   slotID,
                            CK_ULONG     ulPolicyId,
                            CK_ULONG_PTR pulPolicyValue);
```

I/O	Argument	Description
In	slotID	The slot number.
	ulPolicyId	The ID number of the policy.
Out	pulPolicyValue	The current setting for the specified policy.

CA_GetDefaultPartitionPolicyValue

Get the default value of the specified partition policy. See also Partition Capabilities and Policies.

```
CA_GetDefaultPartitionPolicyValue(CK_SLOT_ID   slotID,
                                  CK_ULONG     ulPolicyId,
                                  CK_ULONG_PTR pulPolicyValue);
```

I/O	Argument	Description
In	slotID	The slot number.
	ulPolicyId	The ID number of the policy.
Out	pulPolicyValue	The current setting for the specified policy.

CA_GetExtendedTPV

Retrieves the token's TPV and extended TPV.

```
CA_GetExtendedTPV(CK_SLOT_ID   slotID,
                  CK_ULONG_PTR pulTpv,
                  CK_ULONG_PTR pulTpvExt);
```

CA_GetFirmwareVersion

Get the currently-installed Luna HSM firmware version.

```
CA_GetFirmwareVersion(CK_SLOT_ID   slotID,
                      CK_ULONG_PTR fwMajor,
                      CK_ULONG_PTR fwMinor,
                      CK_ULONG_PTR fwSubminor);
```

I/O	Argument	Description
In	slotID	The slot number.

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I/O	Argument	Description
Out	fwMajor	The major firmware version (X.x.x).
	fwMinor	The minor firmware version (x.X.x).
	fwSubminor	The sub-minor firmware version (x.x.X).

CA_GetFPV

Retrieves the token's Fixed Policy Vector (FPV).

```
CA_GetFPV(CK_SLOT_ID   slotID,
          CK_ULONG_PTR pulFpv);
```

I/O	Argument	Description
In	slotID	The slot number.
Out	pulFpv	The token's FPV.

CA_GetFunctionList

```
CA_GetFunctionList(CK_SFNT_CA_FUNCTION_LIST_PTR_PTR ppSfntFunctionList);
```

CA_GetHAState

Get the status of the HA group. This function calls each group member one at a time. Deprecated in Luna HSM Client 10.7.0 and newer; use "CA_GetCurrentHAState" on page 54 instead for improved performance.

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

I/O	Argument	Description
In	slotId	The virtual slot number of the HA group.

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I/O	Argument	Description

Out	pState	The reported state of the HA group, as defined by the following structure:
		`typedef struct CK_HA_MEMBER{`
		`  CK_CHAR  memberSerial[16];`
		`  CK_RV  memberStatus;`
		`}CK_HA_MEMBER;`
		
		`typedef struct CK_HA_STATUS{`
		`  CK_CHAR  groupSerial[16];`
		`  CK_HA_MEMBER  memberList[32];`
		`  CK_ULONG  listSize;`
		`}CK_HA_STATUS;`
		
		`typedef CK_HA_MEMBER CK_POINTER CK_HA_MEMBER_PTR;`
		
		`typedef CK_HA_STATUS  CK_POINTER CK_HA_STATE_PTR;`
		Returns:
		> **groupSerial**: The 16-byte serial number of the HA group.
		> **memberList**: Array of information on up to 32 HA member partitions as follows:
		• **memberSerial**: The 16-byte serial number of the member partition.
		• **memberStatus**: The status of the member.
		> **listSize**: The length of the **memberList** array.

CA_GetHSMCapabilitySet

Get all HSM capability values. See also HSM Capabilities and Policies.

```
CA_GetHSMCapabilitySet(CK_SLOT_ID   uPhysicalSlot,
                       CK_ULONG_PTR pulCapIdArray,
                       CK_ULONG_PTR pulCapIdSize,
                       CK_ULONG_PTR pulCapValArray,
                       CK_ULONG_PTR pulCapValSize);
```

CA_GetHSMCapabilitySetting

Get the specified HSM capability value. See also HSM Capabilities and Policies.

```
CA_GetHSMCapabilitySetting(CK_SLOT_ID   slotID,
                           CK_ULONG     ulPolicyId,
                           CK_ULONG_PTR pulPolicyValue);
```

I/O	Argument	Description
In	slotID	The slot number.
	ulPolicyId	The ID number of the capability.
Out	pulPolicyValue	The setting for the specified capability.

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CA_GetHSMPolicySet

Get all HSM policy values on the specified HSM slot. See also HSM Capabilities and Policies.

```
CA_GetHSMPolicySet(CK_SLOT_ID   uPhysicalSlot,
                   CK_ULONG_PTR pulPolicyIdArray,
                   CK_ULONG_PTR pulPolicyIdSize,
                   CK_ULONG_PTR pulPolicyValArray,
                   CK_ULONG_PTR pulPolicyValSize);
```

CA_GetHSMPolicySetting

Get the value of a specified HSM policy. See also HSM Capabilities and Policies.

```
CA_GetHSMPolicySetting(CK_SLOT_ID   slotID,
                       CK_ULONG     ulPolicyId,
                       CK_ULONG_PTR pulPolicyValue);
```

I/O	Argument	Description
In	slotID	The slot number.
Out	ulPolicyId	The ID number of the policy.
	pulPolicyValue	The current setting for the specified policy.

CA_GetHSMStats

Get HSM usage information such as operational counters.

```
CA_GetHSMStats(CK_SLOT_ID       slotID,
               CK_ULONG         ulStatsIdsCount,
               CK_ULONG_PTR     pStatsIds,
               HSM_STATS_PARAMS *pStatsParams);
```

CA_GetHSMStorageInformation

```
CA_GetHSMStorageInformation(CK_SLOT_ID   slotID,
                            CK_ULONG_PTR pulContainerOverhead,
                            CK_ULONG_PTR pulTotal,
                            CK_ULONG_PTR pulUsed,
                            CK_ULONG_PTR pulFree);
```

CA_GetKCVLabels

Allows any logged-in role to retrieve the domain labels. See also Universal Cloning and Luna HSM Cloning API CPv4 Extensions to PKCS#11.

```
CA_GetKCVLabels(CK_SLOT_ID   slotID,
                CK_ULONG_PTR ulNumberOfLabels,
                CK_ULONG_PTR ulFlags,
                CK_ULONG_PTR ulLabelLengths,
                CK_BYTE_PTR  pLabels);
```

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I/O	Argument	Description
In	slotID	The slot number.
In/Out	ulNumberOfLabels	A pointer to receive the number of labels. This parameter cannot be NULL. When requesting the number of labels, this parameter must be set to CK_ULONG value that is set to 0 and it will be populated with the number of labels. If a non-zero value is provided, then it must define the size of the `ulLabelLengths` and `pLabels` arrays. If the non-zero value provided is too small, this parameter will be populated with the number of labels.
	ulFlags	
	ulLabelLengths	A pointer to an array to receive the lengths of each label. When retrieving the number of labels, this parameter is ignored. Otherwise, it must be set to an array of `ulNumberOfLabels` CK_ULONG values. On output, the array will be populated with the length of each label.
	pLabels	A pointer to an array of CK_BYTE_PTR. When retrieving the number of labels, this parameter is ignored. Otherwise, it must be set to an array of length `ulNumberOfLabels`, where each element of the array is at least 32 bytes in size. On output, each element of the array is populated with the domain label.

Return Code	Hex	Description
CKR_BUFFER_TOO_SMALL		The non-zero value provided for `ulNumberOfLabels` is too small.

CA_GetModuleInfo

```
CA_GetModuleInfo(CK_SLOT_ID           slotId,
                 CKCA_MODULE_ID       moduleId,
                 CKCA_MODULE_INFO_PTR pInfo);
```

CA_GetModuleList

```
CA_GetModuleList(CK_SLOT_ID         slotId,
                 CKCA_MODULE_ID_PTR pList,
                 CK_ULONG           ulListLen,
                 CK_ULONG_PTR       pulReturnedSize);
```

CA_GetMofNStatus

Get the M of N information for the specified partition.

```
CA_GetMofNStatus(CK_SLOT_ID         slotID,
                 CA_MOFN_STATUS_PTR pMofNStatus);
```

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CA_GetNumberOfAllowedContainers

Gets the licensed number of partitions on the HSM. See also Upgrading HSM Capabilities and Partition Licenses.

```
CA_GetNumberOfAllowedContainers(CK_SLOT_ID   slot,
                                CK_ULONG_PTR pulAllowedContainers);
```

I/O	Argument	Description
In	slot	The slot number of the HSM Admin partition.
Out	pulAllowedContainers	The maximum number of partitions that can be created on the HSM, based on the number of licenses installed.

CA_GetObjectHandle

Get the object handle for the specified OUID.

```
CA_GetObjectHandle(CK_SLOT_ID   slotID,
                   CK_ULONG     ulContainerNum,
                   CK_BYTE      ouid[12],
                   CK_ULONG_PTR pulObjectType,
                   CK_ULONG_PTR pulObjectHandle);
```

CA_GetObjectUID

Get the OUID for the specified object handle.

```
CA_GetObjectUID(CK_SLOT_ID slotID,
                CK_ULONG   ulContainerNum,
                CK_ULONG   ulObjectType,
                CK_ULONG   ulObjectHandle,
                CK_BYTE    ouid[12]);
```

CA_GetPedId

Gets the PED ID.

```
CA_GetPedId(CK_SLOT_ID slotId,
            CK_ULONG   *usPedId);
```

CA_GetPluginModuleInfo

```
CA_GetPluginModuleInfo(CK_SLOT_ID            slotID,
                       CK_PLUGIN_MODULE_INFO * plugin_info);
```

CA_GetPrimarySlot

```
CA_GetPrimarySlot(CK_SESSION_HANDLE hSession,
                  CK_SLOT_ID_PTR    slotId_p);
```

CA_GetRemotePEDVectorStatus

Get the status of the Remote PED Vector on the HSM; initialized or not initialized.

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```
CA_GetRemotePEDVectorStatus(CK_SLOT_ID   slotID,
                            CK_ULONG_PTR pulStatus);
```

CA_GetRollbackFirmwareVersion

Get the firmware version currently stored on the HSM, available for rollback. See also Rolling Back the Luna HSM Firmware.

```
CA_GetRollbackFirmwareVersion(CK_SLOT_ID   slotID,
                              CK_ULONG_PTR pulVersion);
```

I/O	Argument	Description
In	slotID	The slot number.
Out	pulVersion	The stored previous firmware version available for rollback.

CA_GetSecondarySlot

```
CA_GetSecondarySlot(CK_SESSION_HANDLE hSession,
                    CK_SLOT_ID_PTR    slotId_p);
```

CA_GetServerInstanceBySlotID

Get the instance number in the chrystoki.conf/crystoki.ini file for the Luna Network HSM 7 the specified slot maps to.

```
CA_GetServerInstanceBySlotID(CK_SLOT_ID   slotID,
                             CK_ULONG_PTR pulInstanceNumber);
```

CA_GetSessionInfo

Get information about the specified session, including vendor-specific information such as authentication state and the container handle.

```
CA_GetSessionInfo(CK_SESSION_HANDLE hSession,
                  CK_ULONG_PTR      pulAidHigh,
                  CK_ULONG_PTR      pulAidLow,
                  CK_ULONG_PTR      pulContainerNumber,
                  CK_ULONG_PTR      pulAuthenticationLevel);
```

CA_GetSessionInfoV2

Get information about the specified session, including vendor-specific information such as authentication state and the container handle.

```
CA_GetSessionInfoV2(CK_SESSION_HANDLE hSession,
                    CK_APPLICATION_ID * pAppID,
                    CK_ULONG_PTR      pulContainerNumber,
                    CK_ULONG_PTR      pulAuthenticationLevel);
```

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CA_GetSlotId

Resolve the ID of the token(s) from the given label. This extension applies to Luna keyrings only (see also Cluster Extensions). Thales requires minimum Luna Appliance Software 7.8.5 with the lnh_cluster-1.0.4 package, Luna HSM Firmware 7.8.4, and Luna HSM Client 10.7.2 to use clusters in production environments.

```
CA_GetSlotId(CK_UTF8CHAR    label[32],
             CK_SLOT_ID_PTR pSlotId,
             CK_ULONG_PTR   pulCount);
```

I/O	Argument	Description
In	label[32]	The 32-byte label of the token to be resolved. The label must be padded with blank characters and not be null-terminated.
	pSlotId	Pointer to the list of ID of the matched token(s). Can be NULL_PTR.
Out	pulCount	Number of slotID entries in the buffer. The size of the buffer is number of entries x sizeof(CK_SLOT_ID) If **pSlotId** is NULL_PTR, the number of slot IDs is returned. If **pSlotId** is not NULL_PTR, the pointer **pulCount** contains the size (in terms of CK_SLOT_ID elements) of the buffer pointed to by **pSlotId**. If that buffer is large enough to hold the lists of slot IDs, then the list is returned in it. The value of the **pulCount** is set to hold the number of slot IDs.

Return Code	Hex	Description
CKR_OK	0x0000	Successful
CKR_ARGUMENTS_BAD	0x0007	
CKR_DEVICE_ERROR	0x0030	
CKR_BUFFER_TOO_SMALL	0x0150	The buffer pointed to by **pSlotId** is not large enough to hold the list of slot IDs.
CKR_CRYPTOKI_NOT_INITIALIZED	0x0190	

CA_GetSlotIdForContainer

Get the slot for a given container handle.

```
CA_GetSlotIdForContainer(CK_ULONG       slotID,
                         CK_ULONG       ulContainerNumber,
                         CK_SLOT_ID_PTR pSlotID);
```

CA_GetSlotIdForPhysicalSlot

Get the slot for a given physical slot.

```
CA_GetSlotIdForPhysicalSlot(CK_ULONG       physicalSlot,
                            CK_SLOT_ID_PTR pSlotId);
```

CA_GetSlotListFromServerInstance

Get the list of slots for the specified appliance/server instance number, as defined in the chrystoki.conf/crystoki.ini file.

```
CA_GetSlotListFromServerInstance(CK_ULONG       instanceNumber,
                                 CK_SLOT_ID_PTR slotList,
                                 CK_ULONG_PTR   pulCount);
```

CA_GetTime

Get the current HSM time.

```
CA_GetTime(CK_SESSION_HANDLE hSession,
           CK_ULONG_PTR      pulTime);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
Out	pulTime	The current HSM time.

CA_GetTokenCapabilities

Get the capabilities for the specified partition. See also Partition Capabilities and Policies.

```
CA_GetTokenCapabilities(CK_SLOT_ID   ulSlotID,
                        CK_ULONG_PTR pulCapIdArray,
                        CK_ULONG_PTR pulCapIdSize,
                        CK_ULONG_PTR pulCapValArray,
                        CK_ULONG_PTR pulCapValSize);
```

CA_GetTokenCertificateInfo

Get the cloning certificate for the specified partition.

```
CA_GetTokenCertificateInfo(CK_SLOT_ID   slotID,
                           CK_ULONG     ulAccessLevel,
                           CK_BYTE_PTR  pCertificate,
                           CK_ULONG_PTR pulCertificateLen);
```

CA_GetTokenCertificates

Get a certificate from the source token. Token Wrapping Certificates (TWR) are used for cloning.

```
CA_GetTokenCertificates(CK_SLOT_ID   slotID,
                        CK_ULONG     ulCertType,
                        CK_BYTE_PTR  pCertificate,
                        CK_ULONG_PTR pulCertificateLen);
```

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I/O	Argument	Description
In	slotID	The slot number.
	ulCertType	Specify cert type TWC3, defined in **cryptoki_v2.h** as follows: `#define CKHSC_CERT_TYPE_TWC3 0x0000000B`
Out	pCertificate	The TWC certificate, retrieved from the primary member.
	pulCertificateLen	The length of the certificate.

The ulCertType parameter is defined in the cryptoki_v2.h header file as follows:

```
#define CKHSC_CERT_TYPE_TWC                0x00000009
#define CKHSC_CERT_TYPE_TWC2               0x0000000A
#define CKHSC_CERT_TYPE_TWC3               0x0000000B
```

CA_GetTokenInsertionCount

Get the insertion or reset count of HSM in the specified slot.

```
CA_GetTokenInsertionCount(CK_SLOT_ID   slotID,
                          CK_ULONG_PTR pulCount);
```

CA_GetTokenObjectHandle

Get a partition's object handle, if there is a partition security officer. Same as "CA_GetObjectHandle" on page 61.

```
CA_GetTokenObjectHandle(CK_SLOT_ID   slotID,
                        CK_BYTE      ouid[12],
                        CK_ULONG_PTR pulObjectType,
                        CK_ULONG_PTR pulObjectHandle);
```

CA_GetTokenObjectUID

Get a partition's OUID, if there is a partition security officer. Same as "CA_GetObjectUID" on page 61.

```
CA_GetTokenObjectUID(CK_SLOT_ID slotID,
                     CK_ULONG   ulObjectType,
                     CK_ULONG   ulObjectHandle,
                     CK_BYTE    ouid[12]);
```

CA_GetTokenPolicies

Get the policy settings on the partition in the specified slot. See also Partition Capabilities and Policies.

```
CA_GetTokenPolicies(CK_SLOT_ID   ulSlotID,
                    CK_ULONG_PTR pulPolicyIdArray,
                    CK_ULONG_PTR pulPolicyIdSize,
                    CK_ULONG_PTR pulPolicyValArray,
                    CK_ULONG_PTR pulPolicyValSize);
```

CA_GetTokenStatus

Get the status of the partition in the specified slot.

```
CA_GetTokenStatus(CK_SLOT_ID   slotID,
                  CK_ULONG_PTR pulStatusFlags,
                  CK_ULONG_PTR pulCurSessionCnt,
                  CK_ULONG_PTR pulCurRdWrSessionCnt);
```

CA_GetTokenStorageInformation

Get storage information for the partition in the specified slot.

```
CA_GetTokenStorageInformation(CK_SLOT_ID   slotID,
                              CK_ULONG_PTR pulContainerOverhead,
                              CK_ULONG_PTR pulTotal,
                              CK_ULONG_PTR pulUsed,
                              CK_ULONG_PTR pulFree,
                              CK_ULONG_PTR pulObjectCount);
```

CA_GetTPV

Retrieves the token's Token Policy Vector (TPV).

```
CA_GetTPV(CK_SLOT_ID   slotID,
          CK_ULONG_PTR pulTpv);
```

CA_GetTSV

```
CA_GetTSV(CK_SLOT_ID   slotID,
          CK_ULONG_PTR pTSV);
```

CA_GetTunnelSlotNumber

Get the tunnel slot number for a given slot.

```
CA_GetTunnelSlotNumber(CK_SLOT_ID     slotID,
                       CK_SLOT_ID_PTR pTunnelSlotID);
```

CA_GetUnassignedSlot

Get the ID of the next unassigned token from the unordered list of created tokens in the system. This extension applies to Luna keyrings only (see also Cluster Extensions). Thales requires minimum Luna Appliance Software 7.8.5 with the lnh_cluster-1.0.4 package, Luna HSM Firmware 7.8.4, and Luna HSM Client 10.7.2 to use clusters in production environments.

The token is considered unassigned when its original label matches the current label. Each token has an associated lock which is intended to be held by an application that is in the process of assigning it. Only the application holding a lock on the token should proceed to assign the token. A slot returned by this call will have its lock set on return. The lock can also be directly manipulated via "CA_LockClusteredSlot" on page 77 or "CA_UnlockClusteredSlot" on page 106 functions (these operations are thread/process safe). The only time the mutex lock will automatically unset itself is when the application is disconnected before it has a chance to execute the "CA_UnlockClusteredSlot" on page 106 function. A token's lock status must be enforced by the client application as the system will not block any operations based on the lock.

```
CA_GetUnassignedSlot(const CK_CHAR_PTR           clusterID,
                     CK_UNASSIGNED_SLOT_INFO_PTR pUnassignedSlot);
```

I/O	Argument	Description
In	clusterID	The cluster OUID.

Out	pUnassignedSlot	CK_UNASSIGNED_SLOT_INFO_PTR is defined as a pointer of the following structure:
		`typedef struct CK_UNASSIGNED_SLOT_INFO {`
		`  CK_SLOT_ID  slotID;`
		`  CK_UTF8CHAR  label[32];  /* blank padded */`
		`} CK_UNASSIGNED_SLOT_INFO;`
		Returns:
		> **slotID**: the ID of the unassigned token.
		> **label[32]**: the 32-byte label of the unassigned token. It is not null-terminated and is padded with space characters.

Return Code	Hex	Description
CKR_OK	0x0000	Successful
CKR_FUNCTION_FAILED	0x0006	Cannot find any unassigned tokens.
CKR_ARGUMENTS_BAD	0x0007	
CKR_DEVICE_ERROR	0x0030	
CKR_BUFFER_TOO_SMALL	0x0150	
CKR_CRYPTOKI_NOT_INITIALIZED	0x0190	

CA_GetUnauthTokenInsertionStatus

```
CA_GetUnauthTokenInsertionStatus(CK_SESSION_HANDLE hSession,
                                 CK_ULONG          ulContextHandle,
                                 CK_ULONG          *pulMaxUsageCount,
                                 CK_ULONG          *pulCurUsageCount);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
	ulContextHandle	describe plz
	*pulMaxUsageCount	
	*pulCurUsageCount	
Out		

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CA_GetUserContainerName

```
CA_GetUserContainerName(CK_SLOT_ID   slotID,
                        CK_BYTE_PTR  pName,
                        CK_ULONG_PTR pulNameLen);
```

CA_GetUserContainerNumber

```
CA_GetUserContainerNumber(CK_SLOT_ID   slotID,
                          CK_ULONG_PTR pulContainerNumber);
```

CA_HAActivateMofN

Perform M of N authentication using the masked M of N secret. The resulting M of N secret is checked against the CRC stored in the MofN PARAM structure.

```
CA_HAActivateMofN(CK_SESSION_HANDLE hSession,
                  CK_BYTE_PTR       pMofNSecretBlob,
                  CK_ULONG          ulMofNSecretBlobLen);
```

I/O	Argument	Description
In	hSession	The private session handle.
	pMofNSecretBlob	Pointer to M of N secret blob that is passed in.
	ulMofNSecretBlobLen	The length of the M of N secret blob.

CA_HAAnswerLoginChallenge

Called on the primary member token, this function accepts the login challenge blob and returns the encrypted SO or CO credential, as appropriate.

```
CA_HAAnswerLoginChallenge(CK_SESSION_HANDLE hSession,
                          CK_OBJECT_HANDLE  hLoginPrivateKey,
                          CK_BYTE_PTR       pChallengeBlob,
                          CK_ULONG          ulChallengeBlobLen,
                          CK_BYTE_PTR       pEncryptedPin,
                          CK_ULONG_PTR      pulEncryptedPinLen);
```

I/O	Argument	Description
In	hSession	The public session handle.
	hLoginPrivateKey	The object handle of the login key.
	pChallengeBlob	Pointer to the buffer holding the encrypted credential challenge blob.
	ulChallengeBlobLen	The length of the encrypted credential challenge blob.
Out	pEncryptedPin	Pointer to the buffer holding the encrypted credential.
	pulEncryptedPinLen	Pointer to the value holding the encrypted credential length.

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CA_HAAnswerMofNChallenge

Get the primary token's masked M of N secret. You must supply the M of N challenge blob. This function must be called on the primary HA member.

```
CA_HAAnswerMofNChallenge(CK_SESSION_HANDLE hSession,
                         CK_BYTE_PTR       pMofNBlob,
                         CK_ULONG          ulMofNBlobLen,
                         CK_BYTE_PTR       pMofNSecretBlob,
                         CK_ULONG_PTR      pulMofNSecretBlobLen);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
	pMofNBlob	Pointer to the M of N challenge blob.
	ulMofNBlobLen	The length of the M of N challenge blob.
Out	pMofNSecretBlob	Pointer to the buffer to hold the M of N secret blob.
	pulMofNSecretBlobLen	Pointer to value that holds the M of N secret blob.

CA_HAGetLoginChallenge

Called on a non-primary member token, this function accepts the TWC blob and returns the member's login challenge blob.

```
CA_HAGetLoginChallenge(CK_SESSION_HANDLE hSession,
                       CK_USER_TYPE      userType,
                       CK_BYTE_PTR       pCertificate,
                       CK_ULONG          ulCertificateLen,
                       CK_BYTE_PTR       pChallengeBlob,
                       CK_ULONG_PTR      pulChallengeBlobLen);
```

I/O	Argument	Description
In	hSession	The public session handle.
	userType	The user role on the partition. **Valid Values: SO** (for Partition Security Officer) or **USER** (for Crypto Officer)
	pCertificate	The Token Wrapping Certificate (TWC).
	ulCertificateLen	The TWC certificate length.
Out	pChallengeBlob	Pointer to the buffer holding the encrypted credential challenge blob.
	pulChallengeBlobLen	Pointer to the value to hold the challenge blob length.

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CA_HAGetMasterPublic

Called on the primary token, this function retrieves the primary token's Token Wrapping Certificate (TWC) and returns it as a blob (octet string and length).

```
CA_HAGetMasterPublic(CK_SLOT_ID   slotId,
                     CK_BYTE_PTR  pCertificate,
                     CK_ULONG_PTR pulCertificate);
```

I/O	Argument	Description
In	slotId	The slot number.
Out	pCertificate	Pointer to the TWC certificate string.
	pulCertificate	Pointer to the value to hold the TWC certificate length.

CA_HAGetMasterPublic_V1_1

```
CA_HAGetMasterPublic_V1_1(CK_SESSION_HANDLE hSession,
                          CK_BYTE_PTR       pMasterPublicData,
                          CK_ULONG_PTR      pulMasterPublicDataLen);
```

CA_HAGetMasterPublicData

```
CA_HAGetMasterPublicData(CK_SESSION_HANDLE hSession,
                         CK_OBJECT_HANDLE  hLoginPrivateKey,
                         CK_BYTE_PTR       pMasterPublicData,
                         CK_ULONG_PTR      pulMasterPublicDataLen);
```

CA_HAInit

Initialize a token in an HA environment. This function requires an RSA private key that has been cloned to all members in the environment.

```
CA_HAInit(CK_SESSION_HANDLE hSession,
          CK_OBJECT_HANDLE  hLoginPrivateKey);
```

I/O	Input	Description
In	hSession	The session handle, logged-in by the user who owns the login key.
	hLoginPrivateKey	The object handle of the login key.

CA_HAInitExtended

```
CA_HAInitExtended(CK_SESSION_HANDLE hSession,
                  CK_OBJECT_HANDLE  hLoginPrivateKey,
                  CK_BYTE_PTR       pLoginPrivateKeyPKC,
                  CK_ULONG          ulLoginPrivateKeyPKCLen,
```

```
                CK_ULONG_PTR      pulUserTypes,
                CK_ULONG_PTR      pulTokenTypes,
                CK_ULONG          ulNumberOfRole);
```

CA_HALogin

Called on a non-primary member token, this function accepts the encrypted credential and logs the token in. If the token requires M of N authentication, an M of N challenge blob is returned.

```
CA_HALogin(CK_SESSION_HANDLE hSession,
           CK_BYTE_PTR       pEncryptedPin,
           CK_ULONG          ulEncryptedPinLen,
           CK_BYTE_PTR       pMofNBlob,
           CK_ULONG_PTR      pulMofNBlobLen);
```

I/O	Input	Description
In	hSession	The public session handle.
	pEncryptedPin	Pointer to the buffer holding the encrypted credential.
	ulEncryptedPinLen	Length of the encrypted credential.
Out	pMofNBlob	Pointer to the buffer to hold the M of N blob. If no M of N authentication is required, a zero-length blob is returned.
	pulMofNBlobLen	Pointer to the value to hold the length of the M of N blob.

CA_IncrementFailedAuthCount

Increment the CKA_FAILED_KEY_AUTH_COUNT for a key. This function is used to keep members of an HA group in sync.

```
CA_IncrementFailedAuthCount(CK_SESSION_HANDLE hSession,
                            CK_OBJECT_HANDLE  hObject);
```

I/O	Input	Description
In	hSession	The authenticated session handle.
	hObject	The object handle.

CA_IndirectLogin

Performs an indirect login operation.

```
CA_IndirectLogin(CK_SESSION_HANDLE hSession,
                 CK_USER_TYPE      userType,
                 CK_SESSION_HANDLE hPrimarySession);
```

CA_InitAudit

Initialize the Auditor role on the HSM. See also Configuring Audit Logging.

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```
CA_InitAudit(CK_SLOT_ID  slotID,
             CK_CHAR_PTR pPin,
             CK_ULONG    usPinLen,
             CK_CHAR_PTR pLabel);
```

CA_InitializeRemotePEDVector

Initialize the Remote PED Vector (RPV) on the HSM. See also Initializing the Remote PED Vector and Creating an Orange Remote iKey.

```
CA_InitializeRemotePEDVector(CK_SESSION_HANDLE hSession);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.

CA_InitIndirectPIN

Initialize a user PIN so that it may be used normally or indirectly.

```
CA_InitIndirectPIN(CK_SESSION_HANDLE hSession,
                   CK_CHAR_PTR       pPin,
                   CK_ULONG          usPinLen,
                   CK_SESSION_HANDLE hPrimarySession);
```

CA_InitIndirectToken

```
CA_InitIndirectToken(CK_SLOT_ID        slotID,
                     CK_CHAR_PTR       pPin,
                     CK_ULONG          usPinLen,
                     CK_CHAR_PTR       pLabel,
                     CK_SESSION_HANDLE hPrimarySession);
```

CA_InitRolePIN

Initialize a role on the partition in the current slot.

```
CA_InitRolePIN(CK_SESSION_HANDLE hSession,
               CK_USER_TYPE      userType,
               CK_CHAR_PTR       pPin,
               CK_ULONG          usPinLen);
```

CA_InitSlotRolePIN

Initialize a role on the partition on a different, specified slot.

```
CA_InitSlotRolePIN(CK_SESSION_HANDLE hSession,
                   CK_SLOT_ID        slotID,
                   CK_USER_TYPE      userType,
                   CK_CHAR_PTR       pPin,
                   CK_ULONG          usPinLen);
```

CA_InitToken

Initialize a partition using a policy template. See also Setting Partition Policies Using a Template.

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Using Luna HSM Client 10.5.0 or newer:

```
CA_InitToken(CK_SLOT_ID          slotID,
             CK_CHAR_PTR         pPin,
             CK_ULONG            usPinLen,
             CK_CHAR_PTR         pLabel,
             CK_BYTE_PTR         pDomain,
             CK_ULONG            ulDomainLen,
             CK_BYTE_PTR         pDomainId,
             CK_ULONG            ulDomainIdLen,
             CK_ULONG            ulPolicyCount,
             CK_POLICY_INFO_PTR pPolicyData,
             CK_ULONG            ulHSMPolicyCount,
             CK_POLICY_INFO_PTR pHSMPolicyData);
```

Using Luna HSM Client 10.4.1 or older:

```
CA_InitToken(CK_SLOT_ID          slotID,
             CK_CHAR_PTR         pPin,
             CK_ULONG            usPinLen,
             CK_CHAR_PTR         pLabel,
             CK_BYTE_PTR         pDomain,
             CK_ULONG            ulDomainLen,
             CK_ULONG            ulPolicyCount,
             CK_POLICY_INFO_PTR pPolicyData,
             CK_ULONG            ulHSMPolicyCount,
             CK_POLICY_INFO_PTR pHSMPolicyData);
```

CA_InitTokenIPD

Requires Luna HSM Client 10.4.1 or newer.

Using Luna HSM Client 10.5.0 or newer:

```
CA_InitTokenIPD(CK_SLOT_ID          slotID,
                CK_CHAR_PTR         pPin,
                CK_ULONG            usPinLen,
                CK_CHAR_PTR         pLabel,
                CK_BYTE_PTR         pDomain,
                CK_ULONG            ulDomainLen,
                CK_BYTE_PTR         pDomainId,
                CK_ULONG            ulDomainIdLen,
                CK_ULONG            ulPolicyCount,
                CK_POLICY_INFO_PTR pPolicyData,
                CK_ULONG            ulHSMPolicyCount,
                CK_POLICY_INFO_PTR pHSMPolicyData);
```

Using Luna HSM Client 10.4.1:

```
CA_InitTokenIPD(CK_SLOT_ID          slotID,
                CK_CHAR_PTR         pPin,
                CK_ULONG            usPinLen,
                CK_CHAR_PTR         pLabel,
                CK_BYTE_PTR         pDomain,
                CK_ULONG            ulDomainLen,
                CK_ULONG            ulPolicyCount,
                CK_POLICY_INFO_PTR pPolicyData,
                CK_ULONG            ulHSMPolicyCount,
                CK_POLICY_INFO_PTR pHSMPolicyData);
```

CA_InitTokenWithAType

Requires Luna HSM Client 10.1.0 or newer.

Using Luna HSM Client 10.5.0 or newer:

```
CA_InitTokenWithAType(CK_ULONG           uAuthenticationType,
                      CK_SLOT_ID         slotID,
                      CK_CHAR_PTR        pPin,
                      CK_ULONG           usPinLen,
                      CK_CHAR_PTR        pLabel,
                      CK_BYTE_PTR        pDomain,
                      CK_ULONG           ulDomainLen,
                      CK_BYTE_PTR        pDomainId,
                      CK_ULONG           ulDomainIdLen,
                      CK_ULONG           ulPolicyCount,
                      CK_POLICY_INFO_PTR pPolicyData,
                      CK_ULONG           ulHSMPolicyCount,
                      CK_POLICY_INFO_PTR pHSMPolicyData);
```

Using Luna HSM Client 10.4.1 or older:

```
CA_InitTokenWithAType(CK_ULONG           uAuthenticationType,
                      CK_SLOT_ID         slotID,
                      CK_CHAR_PTR        pPin,
                      CK_ULONG           usPinLen,
                      CK_CHAR_PTR        pLabel,
                      CK_BYTE_PTR        pDomain,
                      CK_ULONG           ulDomainLen,
                      CK_ULONG           ulPolicyCount,
                      CK_POLICY_INFO_PTR pPolicyData,
                      CK_ULONG           ulHSMPolicyCount,
                      CK_POLICY_INFO_PTR pHSMPolicyData);
```

CA_Insert

This API inserts objects, or internal CPS, using the specified session id. The API functionality is defined by a mechanism and a mechanism parameter which allows for any functionality to be defined on a per-mechanism basis. This makes it ideal for the CPv4 extract/insert operations and is consistent with the PKCS#11 API.

```
CA_Insert(CK_SESSION_HANDLE hSession,
          CK_MECHANISM_PTR  pMechanism);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
In/Out	pMechanism	Specify CKM_CPV4_INSERT (0x80000209) for CPv4 insert operations. It takes a parameter, CK_CPV4_INSERT_PARAMS (see below).

The parameter CK_CPV4_INSERT_PARAMS is structured as follows:

```
CK_CPV4_INSERT_PARAMS {
  CK_ULONG_PTR         sessionIdLength;
  CK_BYTE              sessionId;
  CK_ULONG             insertionFlags;
  CK_ULONG             numberOfObjects;
  CK_ULONG_PTR         storageType;
```

```
  CK_ULONG_PTR          objectType;
  CK_ULONG_PTR          keyBlobLength;
  CK_BYTE_PTR_PTR       keyBlob;
  CK_RV_PTR             result;
  CK_ULONG_PTR          objectHandle;
}
```

I/O	Argument	Description
In	sessionIdLength	The length of the session ID.
	sessionId	The identifier for the session to be used to insert the key blob(s).
	insertionFlags	Flags used to define how errors are handled during insertion. The default value is 0, which is to return on the first error. The following flag is accepted: > **CKF_CONTINUE_ON_ERR** (0x01): If specified, the API continues attempting to insert objects if an individual object fails. If the flag is not specified, the API fails after the first failure is encountered.
	numberOfObjects	Number of objects to be inserted
	storageType	An array of storage type identifiers used to define how the object should be inserted.
	objectType	An array of object types to define the type of objects pointed to by the array of object handles. Possible values are CK_CRYPTOKI_ELEMENT and CK_PARAM_ELEMENT.
	keyBlobLength	An array of length fields that correspond to the array of memory buffers pointed by “keyBlobs”. This value and the value pointed to by each array cannot be NULL.
	keyBlob	An array of the memory buffers that contain key blob. This value and each array element cannot be NULL.
Out	result	An array of result codes defining the result of each object insertion. This field should be initialized to CKR_CLONE_NOT_ATTEMPTED for all objects. If an error is encountered trying to insert an object, then that error is set in the result field that corresponds to that object. Callers of this API should verify the `result` field for each object to determine if the object was successfully inserted.
	objectHandle	An array of object handles, to receive the object handle for the inserted objects.

For information on error codes, see CPv4 PKCS#11 Error Code Summary.

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CA_InsertMaskedObject

```
CA_InsertMaskedObject(CK_SESSION_HANDLE hSession,
                      CK_ULONG_PTR      pulObjectHandle,
                      CK_BYTE_PTR       pMaskedKey,
                      CK_ULONG          usMaskedKeyLen);
```

CA_InvokeService

```
CA_InvokeService(CK_SESSION_HANDLE hSession,
                 CK_BYTE_PTR       pBufferIn,
                 CK_ULONG          ulBufferInLength,
                 CK_ULONG_PTR      pulBufferOutLength);
```

CA_InvokeServiceAsynch

```
CA_InvokeServiceAsynch(CK_SESSION_HANDLE hSession,
                       CK_ULONG          ulPortNumber,
                       CK_BYTE_PTR       pBufferIn,
                       CK_ULONG          ulBufferInLength);
```

CA_InvokeServiceFinal

```
CA_InvokeServiceFinal(CK_SESSION_HANDLE hSession,
                      CK_BYTE_PTR       pBufferOut,
                      CK_ULONG_PTR      pulBufferOutLength);
```

CA_InvokeServiceInit

```
CA_InvokeServiceInit(CK_SESSION_HANDLE hSession,
                     CK_ULONG          ulPortNumber);
```

CA_InvokeServiceUnit

```
CA_InvokeServiceSinglePart(CK_SESSION_HANDLE hSession,
                           CK_ULONG          ulPortNumber,
                           CK_BYTE_PTR       pBufferIn,
                           CK_ULONG          ulBufferInLength,
                           CK_BYTE_PTR       pBufferOut,
                           CK_ULONG_PTR      pulBufferOutLength);
```

CA_IsPluginDevice

Requires Luna HSM Client 10.1.0 or newer.

```
CA_IsPluginDevice(CK_SLOT_ID slotID,
                  CK_BBOOL   * plugin);
```

CA_LoadEncryptedModule

```
CA_LoadEncryptedModule(CK_SESSION_HANDLE  hSession,
                       CK_OBJECT_HANDLE   hKey,
                       CK_BYTE_PTR        pIv,
                       CK_ULONG           ulIvLen,
                       CK_BYTE_PTR        pModuleCode,
                       CK_ULONG           ulModuleCodeSize,
```

```
                        CK_BYTE_PTR        pModuleSignature,
                        CK_ULONG           ulModuleSignatureSize,
                        CK_BYTE_PTR        pCertificate,
                        CK_ULONG           ulCertificateSize,
                        CKCA_MODULE_ID_PTR pModuleId);
```

CA_LoadModule

```
CA_LoadModule(CK_SESSION_HANDLE  hSession,
              CK_BYTE_PTR        pModuleCode,
              CK_ULONG           ulModuleCodeSize,
              CK_BYTE_PTR        pModuleSignature,
              CK_ULONG           ulModuleSignatureSize,
              CK_BYTE_PTR        pCertificate,
              CK_ULONG           ulCertificateSize,
              CK_BYTE_PTR        pControlData,
              CK_ULONG           ulControlDataSize,
              CKCA_MODULE_ID_PTR pModuleId);
```

CA_LockClusteredSlot

Lock the specified keyring. This extension applies to Luna keyrings only (see also Cluster Extensions). Thales requires minimum Luna Appliance Software 7.8.5 with the lnh_cluster-1.0.4 package, Luna HSM Firmware 7.8.4, and Luna HSM Client 10.7.2 to use clusters in production environments.

```
CA_LockClusteredSlot(CK_SLOT_ID slotId);
```

I/O	Argument	Description
In	slotId	The slot number.

Return Code	Hex	Description
CKR_OK	0x0000	Successful
CKR_SLOT_ID_INVALID	0x0003	
CKR_DEVICE_ERROR	0x0030	

CA_LogExportSecret

Export the audit log HMAC key. See also Exporting the Audit Logging Secret and Importing to a Verifying HSM.

```
CA_LogExportSecret(CK_SESSION_HANDLE hSession,
                   CK_BYTE_PTR       pStr,
                   CK_ULONG_PTR      pStrSize);
```

CA_LogExternal

Push an application-provided message to the HSM and enters it in the audit log.

```
CA_LogExternal(CK_SLOT_ID        slotID,
               CK_SESSION_HANDLE hSession,
               const CK_CHAR     *pStr,
               CK_ULONG          ulLen);
```

CA_LogGetConfig

Get the audit log configuration. See also lunacm:> audit config **get**.

```
CA_LogGetConfig(CK_SESSION_HANDLE hSession,
                CK_ULONG          *mask,
                CK_ULONG          *logRotateOffset,
                CK_ULONG          *logRotateInterval,
                CK_ULONG          *maxLogSize,
                CK_BYTE_PTR       pLogPath);
```

CA_LogGetStatus

Get the audit log status (audit role, logs needing export, HSM to PedClient communication status).

```
CA_LogGetStatus(CK_SLOT_ID slotId,
                CK_ULONG   *auditInitStatus,
                CK_ULONG   *lastPollResult,
                CK_ULONG   *lastSetConfigResult,
                CK_ULONG   *isConfigInParamArea,
                CK_ULONG   *numRecordsInFlash);
```

CA_LogImportSecret

Import an audit log HMAC key. See also Exporting the Audit Logging Secret and Importing to a Verifying HSM.

```
CA_LogImportSecret(CK_SESSION_HANDLE hSession,
                   CK_BYTE_PTR       pStr,
                   CK_ULONG          strSize);
```

CA_LogoutOther

Requires Luna HSM Client 10.5.1 or newer.

```
CA_LogoutOther(CK_SESSION_HANDLE hSession,
               CK_USER_TYPE      userType);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
Out	userType	The user role on the partition.

CA_LogSetConfig

Modify the audit log configuration. See also Configuring Audit Logging.

```
CA_LogSetConfig(CK_SESSION_HANDLE hSession,
                CK_ULONG          mask,
                CK_ULONG          logRotateOffset,
```

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```
                CK_ULONG          logRotateInterval,
                CK_ULONG          maxLogSize,
                CK_BYTE_PTR       pLogPath);
```

CA_LogVerify

Verify the audit log records. See also lunacm:> **audit verify**.

```
CA_LogVerify(CK_SESSION_HANDLE hSession,
             CK_BYTE_PTR       pLogMsgs,
             CK_ULONG          ulMsgCount,
             CK_ULONG          bChainToHSM,
             CK_ULONG_PTR      pulNumVerified);
```

CA_LogVerifyFile

Verify the audit log record file. See also lunacm:> **audit verify**.

```
CA_LogVerifyFile(CK_SESSION_HANDLE hSession,
                 CK_CHAR_PTR       pFileName,
                 CK_ULONG_PTR      ulNumVerified);
```

CA_ManualKCV

Set the cloning domain (key cloning vector) on the partition.

```
CA_ManualKCV(CK_SESSION_HANDLE hSession);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.

CA_MdPriv_Initialize

```
CA_MdPriv_Initialize(void     *pMdPrivIf,
                     unsigned int len,
                     void     *pLogIf);
```

CA_MigrateKeys

This API clones one-or-more objects from a source session to a target session. The API can clone user objects (a.k.a. CryptokiObjects) or parameters like the SMK (a.k.a. ParamObjects). The API also supports a “flags” field to alter/change the behavior of the API when errors are encountered.

In addition to implementing CPv4, the top level API takes on the behavior that allows it to use existing key migration methods.

```
CA_MigrateKeys(CK_SESSION_HANDLE            sourceSession,
               CK_SESSION_HANDLE            targetSession,
               CK_ULONG                     migrationFlags,
               CK_ULONG                     numberOfObjects,
               CK_OBJECT_MIGRATION_DATA_PTR migrationData);
```

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I/O	Argument	Description
In	sourceSession	An authenticated session on the source partition.
	targetSession	An authenticated session on the target partition.
	migrationFlags	Flags used to define the behavior of the migration protocol. The following flag is accepted: > **CKF_CONTINUE_ON_ERR** (0x01): If specified, the API continues attempting to clone objects if an individual object fails to clone. If the flag is not specified, the API fails after the first failure is encountered.
	numberOfObjects	The number of objects to migrate. Implicitly defines the size of the array pointed to by “migrationData”. This parameter cannot be 0.

In/Out	migrationData	An array of CK_MIGRATION_DATA objects whose length is defined by “numberOfObjects”. This parameter cannot be NULL. The array is defined by the following structure:
		`typedef struct CK_OBJECT_MIGRATION_DATA (`
		`  CK_ULONG  objectType;`
		`  CK_OBJECT_HANDLE sourceHandle;`
		`  CK_OBJECT_HANDLE targetHandle;`
		`  CK_RV  rv`
		`} CK_OBJECT_MIGRATION_DATA;`
		Fields:
		> **objectType**: used to specify if the object is a CryptokiObject or a ParamObject.
		> **sourceHandle**: the handle of the object to be cloned.
		> **targetHandle**: the handle of the object after it has been cloned to the target device.
		> **rv**: the result of the clone operation for this specific object. This field is initialized to CKR_CLONE_NOT_ATTEMPTED for every object. If an object fails to clone, then the `rv` field for that object is populated with the specific error code for the failure. Callers of CA_MigrateKeys should verify the `rv` field for each object to determine if the object was successfully cloned.

If an individual object fails to clone, CA_MigrateKeys returns `CKR_OK`. If an error is encountered in the core logic of CA_MigrateKeys, then the error code for that event is returned by the API, and the value of **rv** remains CKR_CLONE_NOT_ATTEMPTED for all objects that were not attempted to be cloned.

For information on error codes, see CPv4 PKCS#11 Error Code Summary.

CA_MigrationCloseSession

This API terminates a session. When it is called, the session key and all of its context/state is deleted. If the session key does not exist, no error is returned. This is because some implementations might proactively clean up sessions that have expired, so it is expected that by the time this API is called, the session might no longer

exist. In this case, CKR_SESSION_ID_INVALID is returned.

```
CA_MigrationCloseSession(CK_SESSION_HANDLE hSession,
                         CK_ULONG          sessionUidLen,
                         CK_BYTE_PTR       sessionUid);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
	sessionUidLen	The length of the session ID.
	sessionUid	The identifier for the session to be closed.

CA_MigrationContinueSessionNegotiation

This is called to continue the negotiation; when it is first called on the second HSM, it technically starts the negotiation there. As the API is called from one HSM to the next, all of the output values are passed to the “other” HSM as input values.

The first call to CA_MigrationContinueSessionNegotiation invokes a session ID for the session being negotiation. All following calls to this API are required to pass in the same session ID.

When the negotiation is complete, `status=2` is returned. The content of the output values must be passed in to the other HSM as input to the first call to either "CA_Extract" on page 47 or "CA_Insert" on page 74 to complete the negotiation on the other HSM.

```
CA_MigrationContinueSessionNegotiation(CK_SESSION_HANDLE hSession,
                                       CK_ULONG          inputStep,
                                       CK_ULONG          inputLength,
                                       CK_BYTE_PTR       input,
                                       CK_ULONG          sessionUidInputLen,
                                       CK_BYTE_PTR       sessionUidInput,
                                       CK_ULONG_PTR      outputStep,
                                       CK_ULONG_PTR      outputLength,
                                       CK_BYTE_PTR       output,
                                       CK_ULONG_PTR      status,
                                       CK_ULONG_PTR      sessionUidOutputLen,
                                       CK_BYTE_PTR       sessionUidOutput);
```

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I/O	Argument	Description
In	hSession	The authenticated session on the partition on the source or target HSM, depending on which step of the protocol is being implemented.
	inputStep	The step identifier used by the HSM to identify the content of the `input` memory buffer.
	inputLength	The length of the buffer pointed to by `input`. This value cannot be 0.
	input	A memory buffer of size `inputLength`. This value cannot be NULL.
	sessionUidInputLen	Defines the length of the memory buffer pointed to by `sessionUidInput`.
	sessionUidInput	The Identifier for the session used to extract/insert key blobs. During a negotiation phase, the first time this API is called, this length+value pair can be NULL and zero. For all following calls to this API, the value returned via the sessionUidOutput and sessionUidOutputLength parameters should be passed in via this length+value pair.
Out	outputStep	The step identifier used by the HSM to identify the content of the `output`.
In/Out	outputLength	Defines the length of the memory buffer pointed to by `output`. This parameter cannot be NULL. If `output` is NULL, this parameter is updated with the size of the memory buffer required.
Out	output	A pointer to a memory buffer of size `outputLength`. This pointer can be set to NULL to request the length of the required buffer.
	status	The status of the negotiation. This field is set to either **1** (MORE) or **2** (DONE), which indicates if "CA_MigrationContinueSessionNegotiation" on the previous page needs to be called again on the other member.
	sessionUidOutputLen	Defines the length of the memory buffer pointed to by `sessionUidOutput`. This parameter cannot be NULL. If `sessionUidOutput` is NULL, this parameter is updated with the size of the memory buffer required.
	sessionUidOutput	The Identifier for the session used to extract/insert key blobs. If this parameter is not NULL, then this buffer receives the session identifier for the session being negotiated.

This API can return more than one piece of output data. Simplify the application and the API implementation, when querying the required buffer size, by providing a NULL pointer; all possible output fields must be queried at the same time.

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For information on error codes, see CPv4 PKCS#11 Error Code Summary.

CA_MigrationStartSessionNegotiation

This API starts a session key negotiation with a partition on the source or target HSM.

```
CA_MigrationStartSessionNegotiation(CK_SESSION_HANDLE hSession,
                                    CK_ULONG          inputLength,
                                    CK_BYTE_PTR       input,
                                    CK_ULONG_PTR      step,
                                    CK_ULONG_PTR      outputLength,
                                    CK_BYTE_PTR       output);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
	inputLength	The length of the buffer pointed to by “input”. Using CPv4, this value must be **0**, but the APIs and library support passing this value to the HSM. If this value is not zero, a valid memory buffer must be pointed to by “input”.
	input	This parameter is not currently used and is defined for future use. A memory buffer of size “inputLength”. Using CPv4, this value must be **NULL**, but the APIs and library support passing this value to the HSM. If “inputLength” is not zero, this pointer must point to a valid memory buffer.
Out	step	A “step” identifier used by the HSM to identify the step of the protocol being returned by the specific call to this API. The value is used by the HSM to identify the content of the opaque blob referred to by “output”.
In/Out	outputLength	Defines the length of the memory buffer pointed to by “output”. This parameter cannot be NULL. If “output” is NULL, this parameter is updated with the size of the memory buffer required.
Out	output	A pointer to a memory buffer of size “outputLength”. This pointer can be set to NULL to request the length of the required buffer.

For information on error codes, see CPv4 PKCS#11 Error Code Summary.

CA_ModifyMofN

Modify the M of N secret splitting vector on a token.

```
CA_ModifyMofN(CK_SESSION_HANDLE      hSession,
              CK_ULONG               ulM,
              CA_MOFN_GENERATION_PTR pVectors,
              CK_ULONG               ulVectorCount,
              CK_ULONG               isSecurePortUsed,
              CK_VOID_PTR            pReserved);
```

CA_MTKModifyUsageCount

Modify the usage count on a key object.

```
CA_ModifyUsageCount(CK_SESSION_HANDLE hSession,
                    CK_OBJECT_HANDLE  hObject,
                    CK_ULONG          ulCommandType,
                    CK_ULONG          ulValue);
```

CA_MTKResplit

Generate a new MTK split and set a new purple iKey value.

```
CA_MTKResplit(CK_SLOT_ID slotID);
```

I/O	Argument	Description
In	slotID	The slot number.

CA_MTKRestore

Return the MTK. You must provide the purple key to recover from tamper.

```
CA_MTKRestore(CK_SLOT_ID slotID);
```

I/O	Argument	Description
In	slotID	The slot number.

CA_MTKSetStorage

Create purple key, enable STM/SRK.

```
CA_MTKSetStorage(CK_SESSION_HANDLE ulSessionNumber,
                 CK_ULONG          ulStorageSetting);
```

CA_MTKZeroize

Erase the MTK, user invoked tamper. Put HSM into Secure Transport Mode.

```
CA_MTKZeroize(CK_SLOT_ID slotID);
```

I/O	Argument	Description
In	slotID	The slot number.

CA_MultisignValue

```
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);
```

CA_OpenApplicationID

Activate an application identifier, independent of any open sessions. This function is deprecated in Luna HSM Firmware 7.7.0 and newer. Use "CA_OpenApplicationIDV2" below instead.

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

CA_OpenApplicationIDForContainer

Activate an application identifier for a specified partition, independent of any open sessions.This function is deprecated in Luna HSM Firmware 7.7.0 and newer. Use "CA_OpenApplicationIDForContainerV2" below instead.

```
CA_OpenApplicationIDForContainer(CK_SLOT_ID slotID,
                                 CK_ULONG   ulHigh,
                                 CK_ULONG   ulLow,
                                 CK_ULONG   ulContainerNumber);
```

CA_OpenApplicationIDForContainerV2

Activate an application identifier for a specified partition, independent of any open sessions.For older firmware/client versions, use "CA_OpenApplicationIDForContainer" above.

```
CA_OpenApplicationIDForContainerV2(CK_SLOT_ID              slotID,
                                   const CK_APPLICATION_ID * pAppId,
                                   CK_ULONG                ulContainerNumber);
```

CA_OpenApplicationIDV2

For older firmware/client versions, use "CA_OpenApplicationID" above.

```
CA_OpenApplicationIDV2(CK_SLOT_ID              slotID,
                       const CK_APPLICATION_ID * pAppId);
```

CA_OpenSession

Open a session on the specified partition.

```
CA_OpenSession(CK_SLOT_ID            slotID,
               CK_ULONG              ulContainerNumber,
               CK_FLAGS              flags,
               CK_VOID_PTR           pApplication,
               CK_NOTIFY             Notify,
               CK_SESSION_HANDLE_PTR phSession);
```

CA_OpenSessionWithAppID

Open a session on the specified partition, using the specified AppID. This function is deprecated in Luna HSM Firmware 7.7.0 and newer. Instead, use "CA_OpenSessionWithAppIDV2" on the next page.

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```
CA_OpenSessionWithAppID(CK_SLOT_ID            slotID,
                        CK_FLAGS              flags,
                        CK_ULONG              ulHigh,
                        CK_ULONG              ulLow,
                        CK_VOID_PTR           pApplication,
                        CK_NOTIFY             Notify,
                        CK_SESSION_HANDLE_PTR phSession);
```

CA_OpenSessionWithAppIDV2

```
CA_OpenSessionWithAppIDV2(CK_SLOT_ID              slotID,
                          CK_FLAGS                flags,
                          const CK_APPLICATION_ID * pAppId,
                          CK_VOID_PTR             pApplication,
                          CK_NOTIFY               Notify,
                          CK_SESSION_HANDLE_PTR   phSession);
```

CA_PerformModuleCall

```
CA_PerformModuleCall(CK_SESSION_HANDLE hSession,
                     CKCA_MODULE_ID    moduleId,
                     CK_BYTE_PTR       pRequest,
                     CK_ULONG          ulRequestSize,
                     CK_BYTE_PTR       pAnswer,
                     CK_ULONG          ulAnswerSize,
                     CK_ULONG_PTR      pulAnswerAvailable);
```

CA_PerformSelfTest

Perform a self-test on the HSM of RNG statistics and cryptographic algorithms.

```
CA_PerformSelfTest(CK_SLOT_ID   slotID,
                   CK_ULONG     typeOfTest,
                   CK_BYTE_PTR  inputData,
                   CK_ULONG     sizeOfInputData,
                   CK_BYTE_PTR  outputData,
                   CK_ULONG_PTR sizeOfOutputData);
```

CA_Put

```
CA_Put(CK_SLOT_ID        slotID,
       CK_SESSION_HANDLE hSession,
       CK_ULONG          ulParamId,
       CK_ULONG          ulParamSize,
       CK_BYTE_PTR       pParamBuffer);
```

CA_QueryLicense

Get information about licenses and capability upgrades on the HSM. See also Upgrading HSM Capabilities and Partition Licenses.

```
CA_QueryLicense(CK_SLOT_ID   slotID,
                CK_ULONG     licenseIdLow,
                CK_ULONG     licenseIdHigh,
                CK_ULONG_PTR pulLicenseType,
```

```
                CK_ULONG_PTR pulDescVersion,
                CK_ULONG_PTR pulDescSize,
                CK_BYTE_PTR  pbDescBuffer);
```

CA_RandomizeApplicationID

Set an application accessID to a random value.

```
CA_RandomizeApplicationID(void );
```

CA_ReadAllUtilizationCounters

This operation is supported on the Admin partition of Luna PCIe HSM 7 only.

```
CA_ReadAllUtilizationCounters(CK_SESSION_HANDLE          hSession,
                              CK_UTILIZATION_COUNTER_PTR buff,
                              CK_ULONG_PTR               length);
```

CA_ReadAndResetUtilizationMetrics

This operation is supported on the Admin partition of Luna PCIe HSM 7 only.

```
CA_ReadAndResetUtilizationMetrics(CK_SESSION_HANDLE hSession);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.

CA_ReadCommonStore

```
CA_ReadCommonStore(CK_ULONG     index,
                   CK_BYTE_PTR  pBuffer,
                   CK_ULONG_PTR pulBufferSize);
```

CA_ReadUtilizationCount

This operation is supported on the Admin partition of Luna PCIe HSM 7 only.

```
CA_ReadUtilizationCount(CK_SESSION_HANDLE        hSession,
                        CK_ULONGLONG             serialNum,
                        CK_ULONG                 ulBinId,
                        CK_ULONG                 ulCounterId,
                        CK_UTILIZATION_COUNT_PTR pCount);
```

CA_ReadUtilizationMetrics

This operation is supported on the Admin partition of Luna PCIe HSM 7 only.

```
CA_ReadUtilizationMetrics(CK_SESSION_HANDLE hSession);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.

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CA_ReplaceFastPathKEK

```
CA_ReplaceFastPathKEK(CK_SESSION_HANDLE hSession);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.

CA_ResetAuthorizationData

Reset the authorization data for a key. This function is available to the CO role only, and only for the unassigned keys. This function also resets the authorization failure count (CKA_FAILED_KEY_AUTH_COUNT) for a locked-out key and unlocks it.

```
CA_ResetAuthorizationData(CK_SESSION_HANDLE hSession,
                          CK_OBJECT_HANDLE  hObject,
                          CK_UTF8CHAR_PTR   pAuthData,
                          CK_ULONG          ulAuthDataLen);
```

I/O	Input	Description
In	hSession	The authenticated session handle.
	hObject	The object handle.
	pAuthData	The user's authentication data.
	ulAuthDataLen	The length of the authentication data.

Return Code	Hex	Description
CKR_AUTH_DATA_TOO_LARGE		
CKR_AUTH_DATA_TOO_SMALL		

CA_ResetDevice

Resets the HSM. See also lunacm:> hsm restart.

```
CA_ResetDevice(CK_SLOT_ID slotId,
               CK_FLAGS   flags);
```

CA_ResetPIN

Allow the Partition SO to reset the Crypto Officer credential if that role has been locked out. **HSM policy 15:** SO can reset partition PIN must be set to . See also Resetting the Crypto Officer, Limited Crypto Officer, or Crypto User Credential.

```
CA_ResetPIN(CK_SESSION_HANDLE hSession,
            CK_CHAR_PTR       pPin,
            CK_ULONG          usPinLen);
```

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CA_Restart

Clean up all sessions on the specified slot.

```
CA_Restart(CK_SLOT_ID slotID);
```

I/O	Argument	Description
Input	slotID	The slot number.

CA_RestartForContainer

Clean up all sessions for a specified partition.

```
CA_RestartForContainer(CK_SLOT_ID slotID,
                       CK_ULONG   ulContainerNumber);
```

CA_RetrieveLicenseList

Get a list of all HSM licenses and capabilities.

```
CA_RetrieveLicenseList(CK_SLOT_ID   slotID,
                       CK_ULONG_PTR pulidArraySize,
                       CK_ULONG_PTR pulidArray);
```

CA_RoleStateGet

Get the state of a specified role (initialized, activated, failed logins, challenge created, etc) on a specified slot.

```
CA_RoleStateGet(CK_SLOT_ID    slotID,
                CK_USER_TYPE  userType,
                CA_ROLE_STATE *pRoleState);
```

CA_RoleStateGetExtended

```
CA_RoleStateGetExtended(CK_SLOT_ID            slotID,
                        CK_USER_TYPE          userType,
                        CA_ROLE_STATE_EXT_PTR pRoleState);
```

CA_SessionCancel

```
CA_SessionCancel(CK_SESSION_HANDLE hSession,
                 CK_FLAGS          flags);
```

CA_SetApplicationID

Set the application's identifier. This function is deprecated in Luna HSM Firmware 7.7.0 and newer. Use "CA_SetApplicationIDV2" below instead.

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

CA_SetApplicationIDV2

Set the application's identifier. For older firmware/client versions, use "CA_SetApplicationID" above.

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```
CA_SetApplicationIDV2(const CK_APPLICATION_ID * pAppId);
```

CA_SetAuthorizationData

Modify the authorization data for a key. This function is available to all the roles without explicit requirement to have been authorized first with "CA_AuthorizeKey" on page 29, since the call itself takes in the current authorization data as a parameter. Old (current) auth data is an optional parameter. This case appears to the end-user as though they are setting the per-key auth of an imported key for the first time.

```
CA_SetAuthorizationData(CK_SESSION_HANDLE hSession,
                        CK_OBJECT_HANDLE  hObject,
                        CK_UTF8CHAR_PTR   pOldAuthData,
                        CK_ULONG          ulOldAuthDataLen,
                        CK_UTF8CHAR_PTR   pNewAuthData,
                        CK_ULONG          ulNewAuthDataLen);
```

I/O	Input	Description
In	hSession	The authenticated session handle.
	hObject	The object handle.
	pOldAuthData	The user's old/current authentication data. Optional. If not provided, this data is filled in by the library to the “Luna” value to accommodate the case of keys imported through the migration scenarios in section (which will have their auth data set initially from the access, hence “Luna” as well).
	ulOldAuthDataLen	The length of the old/current authentication data. Optional (see **pOldAuthData** above).
	pNewAuthData	The user's new authentication data.
	ulNewAuthDataLen	The length of the new authentication data.

Return Code	Hex	Description
CKR_AUTH_DATA_TOO_LARGE		
CKR_AUTH_DATA_TOO_SMALL		

CA_SetCloningDomain

Set the domain string used during token initialization.

```
CA_SetCloningDomain(CK_BYTE_PTR pCloningDomainString,
                    CK_ULONG    ulCloningDomainStringLen);
```

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CA_SetContainerPolicies

Set multiple partition policies simultaneously on the specified partition. See also Setting Partition Policies Manually.

```
CA_SetContainerPolicies(CK_SESSION_HANDLE hSession,
                        CK_ULONG          ulContainer,
                        CK_ULONG          ulPolicyCount,
                        CK_ULONG_PTR      pulPolicyIdArray,
                        CK_ULONG_PTR      pulPolicyValueArray);
```

CA_SetContainerPolicy

Set a single policy on the specified partition. See also Setting Partition Policies Manually.

```
CA_SetContainerPolicy(CK_SESSION_HANDLE hSession,
                      CK_ULONG          ulContainer,
                      CK_ULONG          ulPolicyId,
                      CK_ULONG          ulPolicyValue);
```

CA_SetContainerSize

Set the size of the storage on a partition. See also Customizing Partition Sizes.

```
CA_SetContainerSize(CK_SESSION_HANDLE hSession,
                    CK_ULONG          ulContainerNumber,
                    CK_ULONG          ulSize);
```

CA_SetDestructiveHSMPolicies

Set multiple destructive HSM policies simultaneously. See also Setting HSM Policies Manually.

```
CA_SetDestructiveHSMPolicies(CK_SESSION_HANDLE hSession,
                             CK_ULONG          ulPolicyCount,
                             CK_ULONG_PTR      pulPolicyIdArray,
                             CK_ULONG_PTR      pulPolicyValueArray);
```

CA_SetDestructiveHSMPolicy

Set a single destructive HSM policy. See also Setting HSM Policies Manually.

```
CA_SetDestructiveHSMPolicy(CK_SESSION_HANDLE hSession,
                           CK_ULONG          ulPolicyId,
                           CK_ULONG          ulPolicyValue);
```

CA_SetExtendedTPV

Sets the token's TPV and extended TPV.

```
CA_SetExtendedTPV(CK_SESSION_HANDLE hSession,
                  CK_ULONG          ulTpv,
                  CK_ULONG          ulTpvExt);
```

CA_SetHSMPolicies

Set multiple non-destructive HSM policies simultaneously. See also Setting HSM Policies Manually.

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```
CA_SetHSMPolicies(CK_SESSION_HANDLE hSession,
                  CK_ULONG          ulPolicyCount,
                  CK_ULONG_PTR      pulPolicyIdArray,
                  CK_ULONG_PTR      pulPolicyValueArray);
```

CA_SetHSMPolicy

Set a single non-destructive HSM policy. See also Setting HSM Policies Manually.

```
CA_SetHSMPolicy(CK_SESSION_HANDLE hSession,
                CK_ULONG          ulPolicyId,
                CK_ULONG          ulPolicyValue);
```

CA_SetKCV

Set the cloning domain (Key Cloning Vector) on the partition.

```
CA_SetKCV(CK_SESSION_HANDLE hSession,
          CK_BYTE_PTR       pCloningDomainString,
          CK_ULONG          ulCloningDomainStringLen);
```

CA_SetLKCV

Set a Legacy cloning domain (Key Cloning Vector) on the partition. Used only on password-authenticated HSMs, and not recommended. Kept for compatibility with previous, existing configurations; will be discontinued in a future release.

```
CA_SetLKCV(CK_SESSION_HANDLE hSession,
           CK_BYTE_PTR       pLegacyCloningDomainString,
           CK_ULONG          ulLegacyCloningDomainStringLen);
```

CA_SetMofN

Set the security policy for the token to use the secret sharing feature.

```
CA_SetMofN(CK_BBOOL bFlag);
```

CA_SetPedID

Set the PED ID for the specified slot.

```
CA_SetPedId(CK_SLOT_ID slotId,
            CK_ULONG   usPedId);
```

CA_SetRDK

Set the RDK (role-specific KCV) for the current role.

```
CA_SetRDK(CK_SESSION_HANDLE hSession,
          const CK_BYTE     *pCloningDomainString,
          CK_ULONG          ulCloningDomainStringLen);
```

CA_SetTokenCertificateSignature

Sign the cloning certificate with the private keys generated for key cloning operations.

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```
CA_SetTokenCertificateSignature(CK_SESSION_HANDLE hSession,
                                CK_ULONG          ulAccessLevel,
                                CK_ULONG          ulCustomerId,
                                CK_ATTRIBUTE_PTR  pPublicTemplate,
                                CK_ULONG          usPublicTemplateLen,
                                CK_BYTE_PTR       pSignature,
                                CK_ULONG          ulSignatureLen);
```

CA_SetTokenPolicies

Set partition policies for the specified slot.

```
CA_SetTokenPolicies(CK_SESSION_HANDLE hSession,
                    CK_SLOT_ID        ulSlotID,
                    CK_ULONG          ulPolicyCount,
                    CK_ULONG_PTR      pulPolicyIdArray,
                    CK_ULONG_PTR      pulPolicyValueArray);
```

CA_SetTPV

Sets the token's TPV.

```
CA_SetTPV(CK_SESSION_HANDLE hSession,
          CK_ULONG          ulTpv);
```

CA_SIMExtract

Takes a list of object handles, extracts the objects using the given blob (**b**inary **l**arge **ob**ject) authorization data for protection and returns the extracted set of objects as a single data blob.

> **NOTE** Individual SKS blobs are limited to 64KB in size. Large groups of keys, or larger data objects might need to be split across multiple blobs for extraction or insertion.

```
CA_SIMExtract(CK_SESSION_HANDLE    hSession,
              CK_ULONG             ulHandleCount,
              CK_OBJECT_HANDLE_PTR pHandleList,
              CK_ULONG             ulAuthSecretCount,
              CK_ULONG             ulAuthSubsetCount,
              CKA_SIM_AUTH_FORM    authForm,
              CK_ULONG_PTR         pulAuthSecretSizes,
              CK_BYTE_PTR          *ppbAuthSecretList,
              CK_BBOOL             deleteAfterExtract,
              CK_ULONG_PTR         pulBlobSize,
              CK_BYTE_PTR          pBlob);
```

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I/O	Argument	Description
In	hSession	The authenticated session handle.
	ulHandleCount	The number of objects specified in **pHandleList**.
	pHandleList	Pointer to an array of object handles to be extracted.
	ulAuthSecretCount	The N value -- the total number of accepted authentication passwords.
	ulAuthSubsetCount	The M value -- the minimum number of acceptable passwords required to decrypt the blob.
	authForm	Two forms of authorization are supported: no authorization, and M-of-N passwords. Note that the password form of authorization does not cryptographically protect the key material, it consists of a comparison between the N encrypted values stored in the header versus M plain-text passwords specified upon insertion. > **0**: no authentication > **1**: M of N passwords
	pulAuthSecretSizes	Pointer to an array of M string lengths for the passwords supplied in **ppbAuthSecretList**. NULL when **0** is specified for **authForm**.
	*ppbAuthSecretList	Pointer to an array of M password strings to use to authenticate the blob. NULL when **0** is specified for **authForm**.
	deleteAfterExtract	Boolean determining whether to delete the keys from the partition after extracting the blob.
Out	pulBlobSize	The size of the extracted blob.
	pBlob	The encrypted blob.

See also Scalable Key Storage.

CA_SIMInsert

Takes a previously extracted blob as input, validates the blob authorization data, inserts the objects contained in the blob into the HSM, and returns the list of handles assigned to the objects.

> **NOTE** Individual SKS blobs are limited to 64KB in size. Large groups of keys, or larger data objects might need to be split across multiple blobs for extraction or insertion.

```
CA_SIMInsert(CK_SESSION_HANDLE    hSession,
             CK_ULONG             ulAuthSecretCount,
             CKA_SIM_AUTH_FORM    authForm,
```

```
CK_ULONG_PTR         pulAuthSecretSizes,
CK_BYTE_PTR          *ppbAuthSecretList,
CK_ULONG             ulBlobSize,
CK_BYTE_PTR          pBlob,
CK_ULONG_PTR         pulHandleCount,
CK_OBJECT_HANDLE_PTR pHandleList);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
	ulAuthSecretCount	The number of authentication passwords supplied. Must be equal to M as defined during blob extraction.
	authForm	Two forms of authorization are supported: no authorization, and M-of-N passwords. Note that the password form of authorization does not cryptographically protect the key material, it consists of a comparison between the N encrypted values stored in the header versus M plain-text passwords specified upon insertion. > **0**: no authentication > **1**: M of N passwords
	pulAuthSecretSizes	Pointer to an array of M string lengths for the passwords supplied in **ppbAuthSecretList**.
	*ppbAuthSecretList	Pointer to an array of M password strings to use to authenticate the blob.
	ulBlobSize	The size of the encrypted blob.
	pBlob	The encrypted blob.
Out	pulHandleCount	Pointer to the number of objects that were inserted.
	pHandleList	Pointer to an array of object handles assigned to the inserted objects.

See also Scalable Key Storage.

CA_SIMInsertExtended

Takes a previously extracted blob as input, validates the blob authorization data, inserts the objects contained in the blob into the HSM, and returns the list of handles assigned to the objects. Requires Luna HSM Client 10.6.0 or newer.

```
CA_SIMInsertExtended(CK_SESSION_HANDLE    hSession,
                     CK_ULONG             ulAuthSecretCount,
                     CKA_SIM_AUTH_FORM    authForm,
                     CK_ULONG_PTR         pulAuthSecretSizes,
                     CK_BYTE_PTR          *ppbAuthSecretList,
                     CK_ULONG             ulBlobSize,
                     CK_BYTE_PTR          pBlob,
                     CK_ULONG_PTR         pulHandleCount,
```

```
                    CK_OBJECT_HANDLE_PTR pHandleList,
                    CK_ULONG             ulStorageType,
                    CK_ULONG             ulInsertMode);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
	ulAuthSecretCount	The N value -- the total number of accepted authentication passwords.
	authForm	Two forms of authorization are supported: no authorization, and M-of-N passwords. Note that the password form of authorization does not cryptographically protect the key material, it consists of a comparison between the N encrypted values stored in the header versus M plain-text passwords specified upon insertion. > **0**: no authentication > **1**: M of N passwords
	pulAuthSecretSizes	Pointer to an array of M string lengths for the passwords supplied in **ppbAuthSecretList**.
	*ppbAuthSecretList	Pointer to an array of M password strings to use to authenticate the blob.
	pulHandleCount	Pointer to the number of objects that were inserted.
	pHandleList	Pointer to an array of object handles to be extracted.
	ulStorageType	
	ulInsertMode	
Out	ulBlobSize	The size of the encrypted blob.
	pBlob	The encrypted blob.

See also Scalable Key Storage.

CA_SIMMultiSign

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 exists on the HSM only during the processing of the command and does not persist afterward.

If the blob contains more than one key, the key in the blob that is suitable for the requested signature mechanism is used to sign the data. If there are multiple candidates, an error is returned.

```
CA_SIMMultiSign(CK_SESSION_HANDLE hSession,
                CK_MECHANISM_PTR  pMechanism,
                CK_ULONG          ulAuthSecretCount,
                CKA_SIM_AUTH_FORM authForm,
```

```
CK_ULONG_PTR      pulAuthSecretSizes,
CK_BYTE_PTR       *ppbAuthSecretList,
CK_ULONG          ulBlobSize,
CK_BYTE_PTR       pBlob,
CK_ULONG          ulInputDataCount,
CK_ULONG_PTR      pulInputDataLengths,
CK_BYTE_PTR       *ppbInputDataList,
CK_ULONG_PTR      pulSignatureLengths,
CK_BYTE_PTR       *ppbSignatureList);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
	pMechanism	Specifies the mechanism to use for the operation.
	ulAuthSecretCount	The N value -- the total number of accepted authentication passwords.
	authForm	Two forms of authorization are supported: no authorization, and M-of-N passwords. Note that the password form of authorization does not cryptographically protect the key material, it consists of a comparison between the N encrypted values stored in the header versus M plain-text passwords specified upon insertion. > **0**: no authentication > **1**: M of N passwords **NOTE** Per-key authorization data is not passed in to the HSM with this call to authorize the inserted key object. If the inserted key has per-key authorization attribute defined, this function is tied to access-based per-key authorization.
	pulAuthSecretSizes	Pointer to an array of M string lengths for the passwords supplied in **ppbAuthSecretList**.
	*ppbAuthSecretList	Pointer to an array of M password strings to use to authenticate the blob.
	ulBlobSize	The size of the encrypted blob.
	pBlob	The encrypted blob.
	ulInputDataCount	The number of objects to be signed, specified in **ppbInputDataList**.
	pulInputDataLengths	Pointer to an array of lengths of the data objects specified in **ppbInputDataList**.
	*ppbInputDataList	Pointer to an array of data objects to be signed.
Out	pulSignatureLengths	Pointer to the lengths of the signed data objects.
	*ppbSignatureList	Pointer to the signed data objects.

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See also Scalable Key Storage.

CA_SMKRollover

Move the current SMK to the RolloverSMK slot and creates a new Primary SMK - this allows insertion/decrypting of existing blobs with Rollover SMK and re-encryption/extraction with the new Primary. Use again to end the operation and complete the rollover.

```
CA_SMKRollover(CK_SESSION_HANDLE ulSessionNumber,
               CK_ULONG          ulValue);
```

I/O	Argument	Description
In	ulSessionNumber	The session handle.
	ulValue	Specifies whether to begin or end the rollover process, as described below: > **1**: Begin the rollover process. Moves the current SMK to the RolloverSMK location, and creates a new Primary SMK. Blobs that were encrypted with the old SMK can still be inserted, decrypted (see "CA_SIMInsert" on page 94), and then re-extracted with the new SMK (see "CA_SIMExtract" on page 93). > **0**: End the rollover process by deleting the RolloverSMK. Any blobs that are encrypted by this SMK are unrecoverable. Ensure that all important blobs have been re-inserted and re-extracted before using this option.

See also SMK Rollover.

CA_SpRawRead

Legacy PED key migration - read the PED key value from DataKey PED Key.

```
CA_SpRawRead(CK_SLOT_ID   slotId,
             CK_ULONG_PTR data);
```

CA_SpRawWrite

Legacy PED key migration - store the PED key value to iKey PED Key.

```
CA_SpRawWrite(CK_SLOT_ID   slotId,
              CK_ULONG_PTR data);
```

CA_STCClearCipherAlgorithm

Remove the specified Cipher Algorithm from use with STC for the specified slot.

```
CA_STCClearCipherAlgorithm(CK_SESSION_HANDLE hSession,
                           CK_ULONG          TargetSlotID,
                           CK_ULONG          CipherID);
```

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CA_STCClearDigestAlgorithm

Remove the specified Digest Algorithm from use with STC for the specified slot. This function is deprecated in Luna HSM Firmware 7.7.0 and newer.

```
CA_STCClearDigestAlgorithm(CK_SESSION_HANDLE hSession,
                           CK_ULONG          TargetSlotID,
                           CK_ULONG          DigestID); //not supported
```

CA_STCDeregister

Remove STC registration of a client from the specified slot.

```
CA_STCDeregister(CK_SESSION_HANDLE hSession,
                 CK_SLOT_ID        TargetslotID,
                 const CK_CHAR     *username);
```

CA_STCGetAdminPID

```
CA_STCGetAdminPID(CK_SLOT_ID   slotId,
                  CK_ULONG_PTR pType,
                  CK_BYTE_PTR  pPID,
                  CK_ULONG_PTR pPIDLen);
```

CA_STCGetAdminPubKey

Get the public key for the Admin slot's STC identity RSA keypair. This function is deprecated in Luna HSM Firmware 7.7.0 and newer.

```
CA_STCGetAdminPubKey(CK_SLOT_ID   slotId,
                     CK_CHAR      * mod,
                     CK_ULONG_PTR modSize,
                     CK_CHAR      * exp,
                     CK_ULONG_PTR expSize); //not supported
```

CA_STCGetChannelID

Get the Secure Trusted Channel ID for the current slot.

```
CA_STCGetChannelID(CK_SLOT_ID   slotId,
                   CK_ULONG_PTR ulChannelId);
```

CA_STCGetCipherAlgorithm

Get all the valid cipher suites allowed for the specified slot.

```
CA_STCGetCipherAlgorithm(CK_SESSION_HANDLE hSession,
                         CK_ULONG          TargetSlotID,
                         CK_BYTE_PTR       pIDCount,
                         CK_ULONG_PTR      pIDs);
```

CA_STCGetCipherID

Get the ID for the cipher currently in use on active STC to this slot.

```
CA_STCGetCipherID(CK_SLOT_ID   slotId,
                  CK_ULONG_PTR ulCipherId);
```

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CA_STCGetCipherIDs

Get all cipher IDs valid for use with STC to the specified slot.

```
CA_STCGetCipherIDs(CK_SLOT_ID   slotID,
                   CK_ULONG_PTR pulArray,
                   CK_BYTE_PTR  pbArraySize);
```

CA_STCGetCipherNameByID

Get the readable name string for the specified Cipher ID.

```
CA_STCGetCipherNameByID(CK_SLOT_ID  slotID,
                        CK_ULONG    ulCipherID,
                        CK_CHAR_PTR pszName,
                        CK_BYTE     bNameBufSize);
```

CA_STCGetClientInfo

Get the STC registration details (name, public key, active access) about the specified client on the specified slot. This function is deprecated in Luna HSM Firmware 7.7.0 and newer. Use "CA_STCGetClientInfoV2" below instead.

```
CA_STCGetClientInfo(CK_SESSION_HANDLE hSession,
                    CK_SLOT_ID        TargetSlotID,
                    CK_ULONG          ulHandle,
                    CK_CHAR           * username,
                    CK_ULONG_PTR      name_len,
                    CK_ULONG_PTR      access,
                    CK_CHAR           * mod,
                    CK_ULONG_PTR      mod_len,
                    CK_CHAR           * exp,
                    CK_ULONG_PTR      exp_len); //not supported
```

CA_STCGetClientInfoV2

Get the STC registration details (name, public key, active access) about the specified client on the specified slot. For older firmware/client versions, use "CA_STCGetClientInfo" above.

```
CA_STCGetClientInfoV2(CK_SESSION_HANDLE hSession,
                      CK_SLOT_ID        TargetSlotID,
                      CK_ULONG          ulHandle,
                      CK_CHAR           * username,
                      CK_ULONG_PTR      name_len,
                      CK_ULONG_PTR      type,
                      CK_BYTE           * userid,
                      CK_ULONG_PTR      id_len);
```

CA_STCGetClientsList

Get the list of all STC clients registered to the specified slot.

```
CA_STCGetClientsList(CK_SESSION_HANDLE hSession,
                     CK_SLOT_ID        TargetSlotID,
                     CK_ULONG_PTR      pulCIDArray,
                     CK_ULONG_PTR      pulCIDArraySize);
```

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CA_STCGetCurrentKeyLife

Get the remaining lifetime (in operations) for the active negotiated STC session key. This function is deprecated in Luna HSM Firmware 7.7.0 and newer.

```
CA_STCGetCurrentKeyLife(CK_SESSION_HANDLE hSession,
                        CK_ULONG          TargetSlotID,
                        CK_ULONG_PTR      pcurKeyLife); //not supported
```

CA_STCGetDigestAlgorithm

Get all the valid digest algorithms allowed for the specified slot. This function is deprecated in Luna HSM Firmware 7.7.0 and newer.

```
CA_STCGetDigestAlgorithm(CK_SESSION_HANDLE hSession,
                         CK_ULONG          TargetSlotID,
                         CK_BYTE_PTR       pIDCount,
                         CK_ULONG_PTR      pIDs); //not supported
```

CA_STCGetDigestID

Get the ID for the digest currently in use on active STC to this slot. This function is deprecated in Luna HSM Firmware 7.7.0 and newer.

```
CA_STCGetDigestID(CK_SLOT_ID   slotId,
                  CK_ULONG_PTR ulDigestId); //not supported
```

CA_STCGetDigestIDs

Get all digest IDs valid for use with STC to the specified slot. This function is deprecated in Luna HSM Firmware 7.7.0 and newer.

```
CA_STCGetDigestIDs(CK_SLOT_ID   slotID,
                   CK_ULONG_PTR pulArray,
                   CK_BYTE_PTR  pbArraySize); //not supported
```

CA_STCGetDigestNameByID

Get the readable name string for the specified Digest ID. This function is deprecated in Luna HSM Firmware 7.7.0 and newer.

```
CA_STCGetDigestNameByID(CK_SLOT_ID  slotID,
                        CK_ULONG    ulDigestID,
                        CK_CHAR_PTR pszName,
                        CK_BYTE     bNameBufSize); //not supported
```

CA_STCGetKeyActivationTimeout

Get the amount of time allowed between the initiation and completion of STC session negotiation.

```
CA_STCGetKeyActivationTimeOut(CK_SESSION_HANDLE hSession,
                              CK_ULONG          TargetSlotID,
                              CK_ULONG_PTR      ptimeOut);
```

CA_STCGetKeyLifetime

Get the configured session key lifetime (in operations) for the specified slot.

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```
CA_STCGetKeyLifeTime(CK_SESSION_HANDLE hSession,
                     CK_ULONG          TargetSlotID,
                     CK_ULONG_PTR      plifeTime);
```

CA_STCGetMaxSessions

```
CA_STCGetMaxSessions(CK_SESSION_HANDLE hSession,
                     CK_ULONG          TargetSlotID,
                     CK_ULONG_PTR      pmaxSessions);
```

CA_STCGetPartPubKey

Get the public key for the specified slot STC identity RSA keypair. This function is deprecated in Luna HSM Firmware 7.7.0 and newer.

```
CA_STCGetPartPubKey(CK_SESSION_HANDLE hSession,
                    CK_SLOT_ID        TargetSlotID,
                    CK_CHAR           * mod,
                    CK_ULONG_PTR      modSize,
                    CK_CHAR           * exp,
                    CK_ULONG_PTR      expSize); //not supported
```

CA_STCGetPID

```
CA_STCGetPID(CK_SESSION_HANDLE hSession,
             CK_SLOT_ID        TargetSlotID,
             CK_ULONG_PTR      pType,
             CK_BYTE_PTR       pPID,
             CK_ULONG_PTR      pPIDLen);
```

CA_STCGetPubKey

Get the specified slot's public key.

```
CA_STCGetPubKey(CK_SESSION_HANDLE hSession,
                CK_SLOT_ID        TargetSlotID,
                const CK_CHAR     * username,
                CK_CHAR           *pmod,
                CK_ULONG_PTR      mod_len,
                CK_CHAR           *pexp,
                CK_ULONG_PTR      exp_len); //not supported
```

CA_STCGetSequenceWindowSize

Get the replay window size for the specified slot. This function is deprecated in Luna HSM Firmware 7.7.0 and newer.

```
CA_STCGetSequenceWindowSize(CK_SESSION_HANDLE hSession,
                            CK_ULONG          TargetSlotID,
                            CK_ULONG_PTR      pwindowSize); //not supported
```

CA_STCGetState

Get the STC state of the specified slot.

```
CA_STCGetState(CK_ULONG TargetSlotID,
               CK_CHAR  * str,
               CK_BYTE  bbufferSize);
```

CA_STCIsEnabled

Determine if STC is configured for the specified slot.

```
CA_STCIsEnabled(CK_ULONG    TargetSlotID,
                CK_BYTE_PTR pbenabled);
```

CA_STCRegister

Register a client for STC to the specified slot. This function is deprecated in Luna HSM Firmware 7.7.0 and newer. Use "CA_STCRegisterV2" below instead.

```
CA_STCRegister(CK_SESSION_HANDLE hSession,
               CK_SLOT_ID        TargetSlotID,
               const CK_CHAR     *username,
               CK_ULONG          access,
               const CK_CHAR     *pmod,
               CK_ULONG          mod_len,
               const CK_CHAR     *pexp,
               CK_ULONG          exp_len); //not supported
```

CA_STCRegisterV2

Register a client for STC to the specified slot. For older firmware/client versions, use "CA_STCRegister" above.

```
CA_STCRegisterV2(CK_SESSION_HANDLE hSession,
                 CK_SLOT_ID        TargetSlotID,
                 const CK_CHAR     *username,
                 const CK_ULONG    nameLen,
                 CK_ULONG          type,
                 const CK_BYTE     *credential,
                 CK_ULONG          credentialLen);
```

CA_STCSetCipherAlgorithm

Set a cipher algorithm as valid for use with STC on the specified slot.

```
CA_STCSetCipherAlgorithm(CK_SESSION_HANDLE hSession,
                         CK_ULONG          TargetSlotID,
                         CK_ULONG          CipherID);
```

CA_STCSetDigestAlgorithm

Set a digest algorithm as valid for use with STC on the specified slot. This function is deprecated in Luna HSM Firmware 7.7.0 and newer.

```
CA_STCSetDigestAlgorithm(CK_SESSION_HANDLE hSession,
                         CK_ULONG          TargetSlotID,
                         CK_ULONG          DigestID); //not supported
```

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CA_STCSetKeyActivationTimeout

Set the amount of time allowed between the initiation and completion of STC session negotiations for the specified slot.

```
CA_STCSetKeyActivationTimeOut(CK_SESSION_HANDLE hSession,
                              CK_ULONG          TargetSlotID,
                              CK_ULONG          timeOut);
```

CA_STCSetKeyLifetime

Set how long a STC key can live before STC rekeying occurs.

```
CA_STCSetKeyLifeTime(CK_SESSION_HANDLE hSession,
                     CK_ULONG          TargetSlotID,
                     CK_ULONG          lifeTime);
```

CA_STCSetMaxSessions

```
CA_STCSetMaxSessions(CK_SESSION_HANDLE hSession,
                     CK_ULONG          TargetSlotID,
                     CK_ULONG          maxSessions);
```

CA_STCSetSequenceWindowSize

Set the replay window size for the specified slot. This function is deprecated in Luna HSM Firmware 7.7.0 and newer.

```
CA_STCSetSequenceWindowSize(CK_SESSION_HANDLE hSession,
                            CK_ULONG          TargetSlotID,
                            CK_ULONG          windowSize); //not supported
```

CA_STMGetState

Get Secure Transport Mode state (enabled or disabled).

```
CA_STMGetState(CK_SLOT_ID   slotID,
               CK_ULONG_PTR state);
```

I/O	Argument	Description
In	slotID	The slot number.
Out	state	The STM state.

CA_STMToggle

Enter or recover from Secure Transport Mode.

```
CA_STMToggle(CK_SESSION_HANDLE ulSessionNumber,
             CK_ULONG          ulValue,
             CK_ULONG          ulInputDataSize,
             CK_CHAR_PTR       pInputData,
             CK_ULONG_PTR      pulOutputDataSize,
             CK_CHAR_PTR       pOutputData);
```

CA_SwitchSecondarySlot

```
CA_SwitchSecondarySlot(CK_SESSION_HANDLE hSession,
                       CK_SLOT_ID        slotID,
                       CK_ULONG          slotInstance);
```

CA_TamperClear

Clear a tamper condition on the HSM. Available to the HSM SO only. See also Recovering from a Tamper Event.

```
CA_TamperClear(CK_SESSION_HANDLE ulSessionNumber);
```

I/O	Argument	Description
In	ulSessionNumber	The session handle.

CA_TestTrace

```
CA_TestTrace(CK_SLOT_ID   slotID,
             CK_ULONG     ulTypeOfTrace,
             CK_BYTE_PTR  pInData,
             CK_ULONG     ulInDataLength,
             CK_BYTE_PTR  pOutData,
             CK_ULONG_PTR pulOutDataLength);
```

CA_TimeSync

Synchronize the HSM time with the host time.

```
CA_TimeSync(CK_SESSION_HANDLE hSession,
            CK_ULONG          ulTime);
```

CA_TokenDelete

Delete a partition on the HSM. Available to the HSM SO only. See also Creating or Deleting an Application Partition.

```
CA_TokenDelete(CK_SESSION_HANDLE hSession,
               CK_SLOT_ID        slotID);
```

CA_TokenInsert

```
CA_TokenInsert(CK_SESSION_HANDLE   hSession,
               const CT_TokenHndle token,
               CK_SLOT_ID          slotID);
```

CA_TokenInsertNoAuth

```
CA_TokenInsertNoAuth(const CT_TokenHndle token,
                     CK_SLOT_ID          slotID);
```

CA_TokenZeroize

Zeroize a partition in the specified slot.

```
CA_TokenZeroize(CK_SESSION_HANDLE hSession,
                CK_SLOT_ID        slotID,
                CK_FLAGS          flags);
```

CA_UnloadModule

```
CA_UnloadModule(CK_SESSION_HANDLE hSession,
                CKCA_MODULE_ID    moduleId);
```

CA_UnlockClusteredSlot

Unlock the specified keyring. It might have been locked deliberately using "CA_LockClusteredSlot" on page 77 or "CA_GetUnassignedSlot" on page 66. This extension applies to Luna keyrings only (see also Cluster Extensions). Thales requires minimum Luna Appliance Software 7.8.5 with the lnh_cluster-1.0.4 package, Luna HSM Firmware 7.8.4, and Luna HSM Client 10.7.2 to use clusters in production environments.

```
CA_UnlockClusteredSlot(CK_SLOT_ID slotId);
```

I/O	Argument	Description
Input	slotId	The slot number.

Return Code	Hex	Description
CKR_OK	0x0000	Successful
CKR_SLOT_ID_INVALID	0x0003	
CKR_DEVICE_ERROR	0x0030	

CA_ValidateContainerPolicySet

Validate partition policy settings. See also lunacm:> partition showpolicies.

```
CA_ValidateContainerPolicySet(CK_SLOT_ID         slotId,
                              CK_ULONG           ulContainerNumber,
                              CK_POLICY_INFO_PTR policyInfo,
                              CK_ULONG           policyCount,
                              CK_RV_PTR          policyResults);
```

CA_ValidateHSMPolicySet

Validate HSM policy settings. See also lunacm:> hsm showpolicies.

```
CA_ValidateHSMPolicySet(CK_SLOT_ID         slotId,
                        CK_POLICY_INFO_PTR policyInfo,
                        CK_ULONG           policyCount,
                        CK_RV_PTR          policyResults);
```

CA_WaitForSlotEvent

On PCMCIA HSMs, extend C_WaitForSlotEvent and provides some history of events.

```
CA_WaitForSlotEvent(CK_FLAGS       flags,
                    CK_ULONG       history[2],
                    CK_SLOT_ID_PTR pSlot,
                    CK_VOID_PTR    pReserved);
```

CA_WrapKeyWithScheme

This function behaves the same as the existing standard C_WrapKey function, except that the `keyEncodingScheme` and `pUsageInfo` values are passed down to the key encoding operation of the mechanism to guide the selection of the encoding scheme to use and add an optional **Attributes** field.

```
CA_WrapKeyWithScheme(CK_SESSION_HANDLE      hSession,
                     CK_MECHANISM_PTR       pMechanism,
                     CK_OBJECT_HANDLE       hWrappingKey,
                     CK_OBJECT_HANDLE       hKey,
                     CK_KEY_ENCODING_SCHEME keyEncodingScheme,
                     CK_BYTE_PTR            pUsageInfo,
                     CK_ULONG               ulUsageInfoLen,
                     CK_BYTE_PTR            pWrappedKey,
                     CK_ULONG_PTR           pulWrappedKeyLen);
```

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I/O	Argument	Description
In	hSession	The authenticated session handle.

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I/O	Argument	Description
	pMechanism	Specifies the mechanism to use for the operation.

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I/O	Argument	Description
	hKey	The key to be wrapped.

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I/O	Argument	Description

	keyEncodingScheme	To support compatibility between key exporter and importer, "CA_WrapKeyWithScheme" on page 107 supports more than one export scheme with extensions to PKCS#11. ML-DSA and ML-KEM use the same layout and so are treated the same.
		Valid values for `keyEncodingScheme`:
		> **0**: Default. Luna HSM chooses the output (**1** if CKA_SEED is present, otherwise **2**).
		> **1**: Encode Seed.
		`Seed [0] OCTET STRING`
		> **2**: Encode exp
		`expandedKey OCTET STRING`
		> **3**: Encode both
		`both SEQUENCE {`
		`seed OCTET STRING,`
		`expandedKey OCTET STRING`
		`}`
		> **4**: The encoding scheme selected may also specify if the encoding includes the public Key by OR'ing this value.

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I/O	Argument	Description

	pUsageInfo	Pointer to a valid DER encoding of a set of attributes, where Attribute is a SEQ containing an OID followed by one or more values:
		`Attribute ::= SEQUENCE {`
		`  attrType  OBJECT IDENTIFIER,`
		`  attrValues  SET OF ANY`
		`}`
		`Attributes  ::=  SET OF Attribute`
		The maximum supported length is 1024 bytes.
		Here is a sample showing a keyUsage Attribute for a ML-KEM Private key where bit 2 (keyEncipherment) is set:
		`31 0E  ; SET of Attributes 14 bytes long`
		`  30 0C  ; 1st Attribute SEQUENCE 12 bytes long`
		`  06 03 55 1D 0F  ; OID keyUsage (2.5.29.15)`
		`  31 05  ; SEQUENCE 5 bytes long`
		`  03 03 00 20 00  ; BIT STR 3 bytes: 0 unused bits, val 0x2000`
		For illustration, here is a BIT STR with digitalSignature + nonrepudiation set:
		`03 03 00 C0 00  ; BIT STR 3 bytes: 0 unused bits, val 0xC000`
		`KeyUsage ::= BIT STRING {`
		`  digitalSignature  (0),`
		`  nonRepudiation  (1), -- recent editions of X.509 have`
		`  -- renamed this bit to contentCommitment`
		`  keyEncipherment  (2),`
		`  dataEncipherment  (3),`
		`  keyAgreement  (4),`
		`  keyCertSign  (5),`
		`  cRLSign  (6),`
		`  encipherOnly  (7),`
		`  decipherOnly  (8) }`

	ulUsageInfoLen	The length of the set of attributes in `pUsageInfo`. if this value is **0**, no Attributes field will be added to the PKCS#8 encoding.
Out	pWrappedKey	The wrapped key.
	pulWrappedKeyLen	The length of the wrapped key.

CA_WriteCommonStore

```
CA_WriteCommonStore(CK_ULONG    index,
                    CK_BYTE_PTR pBuffer,
                    CK_ULONG    ulBufferSize);
```

CA_Zeroize

Zeroize the HSM.

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```
CA_Zeroize(CK_SLOT_ID slotId,
           CK_FLAGS   flags);
```

CA_ZeroizeContainer

Zeroize an application partition.

```
CA_ZeroizeContainer(CK_SESSION_HANDLE hSession);
```

I/O	Argument	Description
Input	hSession	The authenticated session handle.

GetTotalOperations

```
GetTotalOperations(CK_SLOT_ID slotId,
                   int        *operations);
```

ResetTotalOperations

```
ResetTotalOperations(CK_SLOT_ID slotId);
```

I/O	Argument	Description
Input	slotId	The slot number.

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 Thales's multifactor quorum-authenticated products (such as Luna USB HSM 7), 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 Luna PED (PIN Entry Device) or Luna USB HSM touchscreen 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.

MofN Secret Sharing (quorum or multi-person access control)

Setting up

When a Luna HSM with multifactor quorum authentication is initialized, or a partition on such an HSM is initialized, the roles and domain secrets are mediated by the PIN Entry Device (PED). As each role or secret is brought into existence, iKeys are imprinted with the corresponding secret. This can occur in one of two ways:

- a fresh, unique secret is generated on the HSM, and is imprinted on an iKey, making the current HSM-or-partition completely independent and stand-alone, or the first of a new group
- if the option to reuse an existing iKey is selected, then no new secret is generated, and a secret created for another HSM or partition is read from an already-imprinted iKey and saved to the current HSM - this is how roles and domains can be shared among HSMs and partitions, and how exclusive groups of HSMs and partitions can be created for specific operational and security-regime purposes.

While an authentication or domain secret is being imprinted on iKeys, the HSM (via the Luna PED) offers the following options:

- have the current secret be complete on a single iKey to be held / controlled by one officer
- divide the secret into several splits/shards/components and specify how many of those components must later be brought together to reconstruct that secret

The Luna convention is that "N" is the total number of splits (up to sixteen, but a smaller number is generally recommended*****) into which a secret is divided, and "M" is the necessary-and-sufficient number of splits that must be brought together (usually fewer than N) in order to recreate the full secret.

Using

The HSM prompts, by means of iKey input device (historicallyLuna PED), for the individual components of the MofN split secret that accesses the roles or the cloning/security domain associated with the HSM or partition currently being addressed.

The split values from individual iKeys, as they are passed to the HSM, are validated as being part of the correct type of secret (appropriate role [SO, CO, CU, Audit...], domain, RPV) and as being component members of the particular secret, and as not being an attempt to offer the same split portion more than once.

If the correct type****** and number of the sub-components are received by the HSM to recreate the needed secret, the HSM permits access to the current partition/slot by that role, or permits cloning operations in-or-out of the partition for backup/restore, HA synchronization, etc.

***** Thales recommends that you choose M as a reasonable quorum of officers that must be available every time you need to present the secret, and then choose N sufficiently larger to allow some co-officers to be unavailable

[vacation, sickness, business travel] while still having enough split-holders to achieve quorum. The larger the number for M, the more time it takes to complete authentications, which might run up against timeouts and require you to adjust timeout values.

****** When iKeys containing splits are offered, they must be be part of the specific secret that is needed here, and must not be a split (or a copy of a split) that was already presented during the current attempt. A lapse of any of those requirements results in the attempt being declined.

Key Export Features

The Luna USB HSM 7 with Key Export provides the feature(s) detailed in this section (see Configuring the Partition for Cloning or Export of Private/Secret Keys).

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 using the PKCS #11 function C_WrapKey. The key to wrap must be an RSA private key with CKA_EXTRACTABLE set to TRUE.

This operation requires either:

- a CKK_DES2 or CKK_DES3 key with its CKA_WRAP attribute set to TRUE, using the CKM_DES3_ECB mechanism
- a CKK_AES key with its CKA_WRAP attribute set to TRUE, using the CKM_AES_CBC mechanism

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 Luna 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:

Field element descriptor	Hex code	Description
KM_APPEND_STRING	0x00000000	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.

Field element descriptor	Hex code	Description
KM_APPEND_ ATTRIBUTE	0x00000001	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_ ATTRIBUTE	0x00000002	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 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	0x00000010	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	0x00000011	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	0x00000012	Zero pads the buffer to the next 32-bit word boundary.
KM_APPEND_ INV_XOR_ CHECKSUM	0x00000020	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.

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Field element descriptor	Hex code	Description
KM_DEFINE_IV_FOR_CBC	0x00000030	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;
}
```

Secure External Scalable Key Storage Extensions

The extensions on this page are used for Scalable Key Storage.

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CA_SIMExtract

Takes a list of object handles, extracts the objects using the given blob (**b**inary **l**arge **ob**ject) authorization data for protection and returns the extracted set of objects as a single data blob.

> **NOTE** Individual SKS blobs are limited to 64KB in size. Large groups of keys, or larger data objects might need to be split across multiple blobs for extraction or insertion.

```
CA_SIMExtract(CK_SESSION_HANDLE    hSession,
              CK_ULONG             ulHandleCount,
              CK_OBJECT_HANDLE_PTR pHandleList,
              CK_ULONG             ulAuthSecretCount,
              CK_ULONG             ulAuthSubsetCount,
              CKA_SIM_AUTH_FORM    authForm,
              CK_ULONG_PTR         pulAuthSecretSizes,
              CK_BYTE_PTR          *ppbAuthSecretList,
              CK_BBOOL             deleteAfterExtract,
              CK_ULONG_PTR         pulBlobSize,
              CK_BYTE_PTR          pBlob);
```

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I/O	Argument	Description
In	hSession	The authenticated session handle.
	ulHandleCount	The number of objects specified in **pHandleList**.
	pHandleList	Pointer to an array of object handles to be extracted.
	ulAuthSecretCount	The N value -- the total number of accepted authentication passwords.
	ulAuthSubsetCount	The M value -- the minimum number of acceptable passwords required to decrypt the blob.
	authForm	Two forms of authorization are supported: no authorization, and M-of-N passwords. Note that the password form of authorization does not cryptographically protect the key material, it consists of a comparison between the N encrypted values stored in the header versus M plain-text passwords specified upon insertion. > **0**: no authentication > **1**: M of N passwords
	pulAuthSecretSizes	Pointer to an array of M string lengths for the passwords supplied in **ppbAuthSecretList**. NULL when **0** is specified for **authForm**.
	*ppbAuthSecretList	Pointer to an array of M password strings to use to authenticate the blob. NULL when **0** is specified for **authForm**.
	deleteAfterExtract	Boolean determining whether to delete the keys from the partition after extracting the blob.
Out	pulBlobSize	The size of the extracted blob.
	pBlob	The encrypted blob.

CA_SIMInsert

Takes a previously extracted blob as input, validates the blob authorization data, inserts the objects contained in the blob into the HSM, and returns the list of handles assigned to the objects.

> **NOTE** Individual SKS blobs are limited to 64KB in size. Large groups of keys, or larger data objects might need to be split across multiple blobs for extraction or insertion.

```
CA_SIMInsert(CK_SESSION_HANDLE    hSession,
             CK_ULONG             ulAuthSecretCount,
             CKA_SIM_AUTH_FORM    authForm,
             CK_ULONG_PTR         pulAuthSecretSizes,
             CK_BYTE_PTR          *ppbAuthSecretList,
```

```
CK_ULONG              ulBlobSize,
CK_BYTE_PTR           pBlob,
CK_ULONG_PTR          pulHandleCount,
CK_OBJECT_HANDLE_PTR pHandleList);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
	ulAuthSecretCount	The number of authentication passwords supplied. Must be equal to M as defined during blob extraction.
	authForm	Two forms of authorization are supported: no authorization, and M-of-N passwords. Note that the password form of authorization does not cryptographically protect the key material, it consists of a comparison between the N encrypted values stored in the header versus M plain-text passwords specified upon insertion. > **0**: no authentication > **1**: M of N passwords
	pulAuthSecretSizes	Pointer to an array of M string lengths for the passwords supplied in **ppbAuthSecretList**.
	*ppbAuthSecretList	Pointer to an array of M password strings to use to authenticate the blob.
	ulBlobSize	The size of the encrypted blob.
	pBlob	The encrypted blob.
Out	pulHandleCount	Pointer to the number of objects that were inserted.
	pHandleList	Pointer to an array of object handles assigned to the inserted objects.

CA_SIMInsertExtended

Takes a previously extracted blob as input, validates the blob authorization data, inserts the objects contained in the blob into the HSM, and returns the list of handles assigned to the objects. Requires Luna HSM Client 10.6.0 or newer.

```
CA_SIMInsertExtended(CK_SESSION_HANDLE    hSession,
                     CK_ULONG             ulAuthSecretCount,
                     CKA_SIM_AUTH_FORM    authForm,
                     CK_ULONG_PTR         pulAuthSecretSizes,
                     CK_BYTE_PTR          *ppbAuthSecretList,
                     CK_ULONG             ulBlobSize,
                     CK_BYTE_PTR          pBlob,
                     CK_ULONG_PTR         pulHandleCount,
                     CK_OBJECT_HANDLE_PTR pHandleList,
                     CK_ULONG             ulStorageType,
                     CK_ULONG             ulInsertMode);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
	ulAuthSecretCount	The N value -- the total number of accepted authentication passwords.
	authForm	Two forms of authorization are supported: no authorization, and M-of-N passwords. Note that the password form of authorization does not cryptographically protect the key material, it consists of a comparison between the N encrypted values stored in the header versus M plain-text passwords specified upon insertion. > **0**: no authentication > **1**: M of N passwords
	pulAuthSecretSizes	Pointer to an array of M string lengths for the passwords supplied in **ppbAuthSecretList**.
	*ppbAuthSecretList	Pointer to an array of M password strings to use to authenticate the blob.
	pulHandleCount	Pointer to the number of objects that were inserted.
	pHandleList	Pointer to an array of object handles to be extracted.
	ulStorageType	
	ulInsertMode	
Out	ulBlobSize	The size of the encrypted blob.
	pBlob	The encrypted blob.

CA_SIMMultiSign

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 exists on the HSM only during the processing of the command and does not persist afterward.

If the blob contains more than one key, the key in the blob that is suitable for the requested signature mechanism is used to sign the data. If there are multiple candidates, an error is returned.

```
CA_SIMMultiSign(CK_SESSION_HANDLE hSession,
                CK_MECHANISM_PTR  pMechanism,
                CK_ULONG          ulAuthSecretCount,
                CKA_SIM_AUTH_FORM authForm,
                CK_ULONG_PTR      pulAuthSecretSizes,
                CK_BYTE_PTR       *ppbAuthSecretList,
                CK_ULONG          ulBlobSize,
                CK_BYTE_PTR       pBlob,
                CK_ULONG          ulInputDataCount,
```

```
CK_ULONG_PTR      pulInputDataLengths,
CK_BYTE_PTR       *ppbInputDataList,
CK_ULONG_PTR      pulSignatureLengths,
CK_BYTE_PTR       *ppbSignatureList);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
	pMechanism	Specifies the mechanism to use for the operation.
	ulAuthSecretCount	The N value -- the total number of accepted authentication passwords.
	authForm	Two forms of authorization are supported: no authorization, and M-of-N passwords. Note that the password form of authorization does not cryptographically protect the key material, it consists of a comparison between the N encrypted values stored in the header versus M plain-text passwords specified upon insertion. > **0**: no authentication > **1**: M of N passwords **NOTE** Per-key authorization data is not passed in to the HSM with this call to authorize the inserted key object. If the inserted key has per-key authorization attribute defined, this function is tied to access-based per-key authorization.
	pulAuthSecretSizes	Pointer to an array of M string lengths for the passwords supplied in **ppbAuthSecretList**.
	*ppbAuthSecretList	Pointer to an array of M password strings to use to authenticate the blob.
	ulBlobSize	The size of the encrypted blob.
	pBlob	The encrypted blob.
	ulInputDataCount	The number of objects to be signed, specified in **ppbInputDataList**.
	pulInputDataLengths	Pointer to an array of lengths of the data objects specified in **ppbInputDataList**.
	*ppbInputDataList	Pointer to an array of data objects to be signed.
Out	pulSignatureLengths	Pointer to the lengths of the signed data objects.
	*ppbSignatureList	Pointer to the signed data objects.

CA_SMKRollover

Move the current SMK to the RolloverSMK slot and creates a new Primary SMK - this allows insertion/decrypting of existing blobs with Rollover SMK and re-encryption/extraction with the new Primary. Use again to end the operation and complete the rollover.

```
CA_SMKRollover(CK_SESSION_HANDLE ulSessionNumber,
               CK_ULONG          ulValue);
```

I/O	Argument	Description
In	ulSessionNumber	The session handle.
	ulValue	Specifies whether to begin or end the rollover process, as described below: > **1**: Begin the rollover process. Moves the current SMK to the RolloverSMK location, and creates a new Primary SMK. Blobs that were encrypted with the old SMK can still be inserted, decrypted (see "CA_SIMInsert" on page 94), and then re-extracted with the new SMK (see "CA_SIMExtract" on page 93). > **0**: End the rollover process by deleting the RolloverSMK. Any blobs that are encrypted by this SMK are unrecoverable. Ensure that all important blobs have been re-inserted and re-extracted before using this option.

Derivation of Symmetric Keys with 3DES_ECB

Luna 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 Luna USB HSM 7.

> 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.

Counter Mode KDF Mechanisms

The Luna USB HSM 7s 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.

```
#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;
```

BIP32 Mechanism Support and Implementation

This section describes the BIP32 functions, key attributes, error codes, and mechanisms supported for BIP32 with the HSM.

Curve Support

Only curve secp256k1 is supported. The BIP32 derivation mechanisms fail with CKR_TEMPLATE_INCONSISTENT if you attempt to specify a curve with CKA_ECDSA_PARAMS.

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Key Type and Form

The key type CKK_BIP32 is used to distinguish keys that can be used for BIP32 from all the existing ECDSA keys. Existing ECDSA keys cannot be used with any of the BIP32 mechanisms because they lack a chain code. The serialization format when importing, exporting, wrapping and unwrapping keys is also different from ECDSA keys. All mechanisms supported by ECDSA keys are supported for BIP32 keys.

Extended Keys and Hardened Keys

BIP32 includes hardened and non-hardened (normal) child keys. Each has a 32-bit index. Child keys are considered hardened if the most significant bit of their index is set. This bit is defined as CKF_BIP32_ HARDENED. This allows 2^31 hardened keys and 2^31 non-hardened keys per parent.

Hardened private keys create a firewall through which multi-level key derivation compromises cannot happen. For normal (non-hardened) keys one can derive child public keys of a given parent key without knowing any private key. So if an attacker gets a normal parent chain code and parent public key, he can brute-force all chain codes deriving from it. If the attacker also obtains a child, grandchild, or further-descended private key, he can use the chain code to generate all of the extended private keys descending from that private key. The formula for creating hardened keys makes it impossible to create child public keys without knowing the parent private key.

Key Derivation

Two new mechanisms are added to support all the key derivations in BIP32.

CKM_BIP32_MASTER_DERIVE

This mechanism derives the master key pair from a seed. The input key must have the type `CKK_GENERIC_SECRET` (size between 128 and 512 bits). This mechanism is unique in that it derives two keys from one. This requires us to accept two templates as input, and to output the two derived key handles. In order to avoid confusion, the three last arguments of `C_DeriveKey()(pTemplate, ulAttributeCount` and `phKey`) must be null or zero. `CKR_ARGUMENTS_BAD` is returned if any of those parameters is non-NULL. The templates and returned handles are instead passed in through the mechanism parameters, which are clearly labeled public and private. Choose to not generate the public or private key by leaving those parameters as zero or null.

```
typedef struct CK_BIP32_MASTER_DERIVE_PARAMS {
      CK_ATTRIBUTE_PTR pPublicKeyTemplate;
      CK_ULONG ulPublicKeyAttributeCount;
      CK_ATTRIBUTE_PTR pPrivateKeyTemplate;
      CK_ULONG ulPrivateKeyAttributeCount;
      CK_OBJECT_HANDLE hPublicKey; // output parameter
      CK_OBJECT_HANDLE hPrivateKey; // output parameter
} CK_BIP32_MASTER_DERIVE_PARAMS;
```

See "Code Samples" on page 130 for a code example.

CKM_BIP32_CHILD_DERIVE

This mechanism derives child keys from a parent key. The mechanism can generate both the private and public part of the key pair, and can accept a BIP32 public or private key as input. An error is returned if a public to private derivation is attempted. Like the master key derivation, the templates and key handle outputs are passed through the mechanism parameters. Choose to not generate the public or private key by leaving those parameters as zero or null.

The BIP32 and BIP44 specifications recommend wallet structures and use cases. The specifications provide a good reference for deciding how a key tree should be organized and if a particular key should be hardened or not. Follow the specifications to avoid potential security holes.

This mechanism can be used to generate keys that are several levels deep in the key hierarchy. The path of the key is specified with `pulPath` and `ulPathLen`. The path is an array of 32-bit unsigned integers (key indices).

The highest bit (0x80000000) is used to indicate a hardened key. So a path value for a normal key must be <= 0x7FFFFFFF (decimal 2147483647). For a hardened key, 0x80000000 <= path value <= 0xFFFFFFFF. The path is relative to the input key. For example, if the path is [5, 1, 4] and the path of the input key is m/0 then the resulting path is m/0/5/1/4.

The max number of levels (path length) is 255 for BIP32 in the HSM firmware. This is expected to be generally adequate.

```
typedef struct CK_BIP32_CHILD_DERIVE_PARAMS {
      CK_ATTRIBUTE_PTR pPublicKeyTemplate;
      CK_ULONG ulPublicKeyAttributeCount;
      CK_ATTRIBUTE_PTR pPrivateKeyTemplate;
      CK_ULONG ulPrivateKeyAttributeCount;
      CK_ULONG_PTR pulPath;
      CK_ULONG ulPathLen;
      CK_OBJECT_HANDLE hPublicKey; // output parameter
      CK_OBJECT_HANDLE hPrivateKey; // output parameter
      CK_ULONG ulPathErrorIndex; // output parameter
} CK_BIP32_CHILD_DERIVE_PARAMS;
```

See "Code Samples" on page 130 for a code example.

Error Codes

These mechanisms can fail in ways not applicable to other mechanisms.

CKR_BIP32_CHILD_INDEX_INVALID: This error is returned on the rare occurrence (1 / 2^127) that a child derivation returns an all-zero private key, a private key bigger than or equal to the curve order parameter `n`, or a point at infinity. This error signifies that the child key index cannot be used to derive keys. Choose a different index and try the derivation again. The problematic child index is indicated by `ulPathErrorIndex`.

PCKS#11 does not have fixed width integers. This error can also be returned on platforms where `CK_ULONG` is bigger than 32 bits and a child index is bigger than 2^32 – 1.

CKR_BIP32_INVALID_HARDENED_DERIVATION: This error is returned from an attempt to derive a hardened key from a public key. The BIP32 specification does not support such a derivation.

CKR_BIP32_MASTER_SEED_LEN_INVALID: The BIP32 specification recommends deriving the master key from a seed that is between 128 and 512 bits long. This error is returned if the seed length is outside of that range.

CKR_BIP32_MASTER_SEED_INVALID: This error is returned on the rare occurrence (1 / 2^127) that the master derivation returns an all zero private key, a private key bigger than or equal to the curve order parameter `n`, or a point at infinity. This error signifies that the master seed cannot be used for BIP32. Generate a new master seed and retry the derivation.

CKR_BIP32_INVALID_KEY_PATH_LEN: This error is returned when `ulPathLen` is 0 or greater than 255. The BIP44 standard only requires paths of length 5 so this limit should be acceptable for all customers.

Key Attributes

The following attributes will exist on all keys created with one of the above derivation mechanisms.

CKA_BIP32_CHAIN_CODE: The chain code is essential for BIP32 keys and is used to derive future keys. The public and private key share this value. Read only.

CKA_BIP32_VERSION_BYTES: Version bytes are used to further identify BIP32 keys. The version bytes help determine if a key is used on the main bitcoin network or the test network. This attribute defaults to `CKG_BIP32_VERSION_MAINNET_PUB/PRIV` if it was not specified at key creation time. You can set this value to `CKG_BIP32_VERSION_TESTNET_PUB/PRIV` if applicable.

CKA_BIP32_CHILD_INDEX: The child index stores which index was used to derive this key. An index with the `CKF_BIP32_HARDENED` bit set is considered a hardened child. The child index is 0 for the master key. The public and private key share this value. Read only.

CKA_BIP32_CHILD_DEPTH: The depth of the child key in the key tree. The master key has a depth of 0. The public and private key share this value. Read only.

CKA_BIP32_ID: The unique identifier for the key. This value is derived from the HASH160 of the compressed public key. The first 32 bits of this value is known as the fingerprint. (`CKA_ID` is not used for this purpose because it is writable by the user.) The public and private key share this value. Read only.

> **NOTE** No attribute is included for the parent ID because it should not be required. The anticipated use-case is to derive a key, use it and then delete it. In general, there should not be a need to discover how keys are organized based on the fingerprints or IDs. The parent fingerprint is available in case there is need to rediscover a key tree, but the wallet software must deal with any collisions. The BIP32 designers considered the parent ID not sufficiently important to include in serialized keys; therefore we exclude it as well.

CKA_BIP32_FINGERPRINT and **CKA_BIP32_PARENT_FINGERPRINT**:

The fingerprints for the key and parent key are the first 32 bits of the BIP32 key identifier. These can be used to identify keys but the wallet software must handle any collisions. For identifying keys, it is better to use **CKA_BIP32_ID** because it is long enough that collisions should not be an issue. The public and private key share this value. The master key has a parent fingerprint of 0. Read only.

Key Import/Export

To support importing existing BIP32 keys, Thales uses their serialization format. The following library functions facilitate importing and exporting public keys:

CA_Bip32ImportPublicKey

Import BIP32 public keys. The function is similar to `C_CreateObject()` but it takes an additional parameter for the serialized public key. The template passed in should contain all the desired non-BIP32 attributes like `CKA_TOKEN`, `CKA_PRIVATE`, `CKA_DERIVE`, etc. The function decodes the public key to get all the BIP32 attributes. Both sets of attributes are then used to create the public key on the HSM.

> **NOTE** When importing a serialized extended public key, implementations must verify whether the X coordinate in the public key data corresponds to a point on the curve. If not, the extended public key is invalid.

```
CA_Bip32ImportPublicKey(CK_SESSION_HANDLE    hSession,
                        CK_BYTE_PTR          pBase58Key,
                        CK_ULONG             usKeyLen,
                        CK_ATTRIBUTE_PTR     pTemplate,
                        CK_ULONG             usCount,
                        CK_OBJECT_HANDLE_PTR phImportedObject);
```

I/O	Argument	Description
In	hSession	The authenticated session handle.
	pBase58Key	The key to be imported, in "BIP32 Serialization Format" on the next page.
	usKeyLen	The length of the key to be imported.

	pTemplate	The template for the key attributes to be applied to the imported key, as follows:
		`CK_ATTRIBUTE template[] =`
		`{`
		`  {CKA_TOKEN,  &bToken,  sizeof(bToken)},`
		`  {CKA_PRIVATE,  &bTrue,  sizeof(bTrue)},`
		`  {CKA_DERIVE,  &bTrue,  sizeof(bTrue)},`
		`  {CKA_MODIFIABLE,  &bTrue,  sizeof(bTrue)},`
		`  {CKA_LABEL,  pbLabel,  strlen(pbLabel)},`
		`};`

	usCount	The length of the array of attributes in **pTemplate**.
Out	phImportedObject	The handle for the newly-created key is stored here, if the import was successful.

Private Key Import

Use existing PKCS#11 functions to import private keys. Key Export Mode must be set on the HSM. Import a key by calling `C_Encrypt*()` on the serialized key followed by `C_UnwrapKey()`.

See "Code Samples" on page 130 for code examples.

CA_Bip32ExportPublicKey

Export BIP32 public keys. The specified object is extracted from the HSM and encoded in the BIP32 format. The result is a NULL-terminated string and is placed in the `pPublicSerialData` parameter. The length of `pPublicSerialData` has a maximum of 112 characters. This constant is defined as `CKG_BIP32_MAX_SERIALIZED_LEN`. It's possible that not all characters are needed to serialize the key. Any unused characters are set to 0.

```
CA_Bip32ExportPublicKey(CK_SESSION_HANDLE hSession,
                        CK_ULONG          ulObjectHandle,
                        CK_BYTE_PTR       pPublicSerialData,
                        CK_ULONG_PTR      pulPublicSerialLen); //in: max.buffer size
```

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I/O	Argument	Description
In	hSession	The authenticated session handle.
	ulObjectHandle	The object handle.
Out	pPublicSerialData	A NULL-terminated string containing the exported key, in "BIP32 Serialization Format" below.
	pulPublicSerialLen	The length of the exported key string in **pPublicSerialData**.

Private Key Export

Use existing PKCS#11 functions to import private keys. Key Export Mode must be set on the HSM. Export keys by calling `C_WrapKey()` followed by `C_Decrypt*()`. Use `C_WrapKey()` and `C_UnwrapKey()` to store keys off the HSM, or to move them between HSMs.

See "Code Samples" on the next page for code examples.

BIP32 Serialization Format

Extended public and private keys are serialized as follows:

- 4 byte: version bytes (mainnet: 0x0488B21E public, 0x0488ADE4 private; testnet: 0x043587CF public, 0x04358394 private)
- 1 byte: depth: 0x00 for master nodes, 0x01 for level-1 derived keys, ...
- 4 bytes: the fingerprint of the parent's key (0x00000000 if master key)
- 4 bytes: child number (index) – 32-bit unsigned integer with most significant byte first (0x00000000 if master key)
- 32 bytes: the chain code
- 33 bytes: the public key or private key data

This 78 byte structure is encoded like other Bitcoin data in Base58, by first adding 32 checksum bits (derived from the double SHA-256 checksum), and then converting to the Base58 representation. This results in a Base58-encoded string of up to `CKG_BIP32_MAX_SERIALIZED_LEN` characters. Because of the choice of the version bytes, the Base58 representation will start with "xprv" or "xpub" on mainnet, "tprv" or "tpub" on testnet.

Private Key Import/Export

Private keys can be imported and exported with existing PKCS#11 functions. They can be imported and exported only if the HSM uses the key wrap model instead of cloning. Import a key by calling `C_Encrypt*()` on the serialized key followed by `C_UnwrapKey()`. Exporting keys by calling `C_WrapKey()` followed by `C_Decrypt*()`. Use `C_WrapKey()` and `C_UnwrapKey()` to store keys off the HSM, or to move them between HSMs.

See "Code Samples" on the next page for code examples.

Key Backup and Cloning

Backups and cloning of BIP32 keys are supported only between version 7.x Luna HSMs. Further, cloning of BIP32 keys is supported only in firmware versions that have BIP32 support. BIP32 keys cannot be cloned to older firmware versions made before BIP32 support was added.

Non-FIPS Algorithm

The BIP32 mechanisms are available only if non-FIPS algorithms are allowed.

Host Tools

Multitoken and Ckdemo support BIP32.

Code Samples

Deriving the master key pair

We highly recommend setting `CKA_PRIVATE` on the master public and private keys to TRUE to prevent the chain code from being seen by unauthorized users. The master key should be used only for derivations so it is the only operation allowed. The version bytes default to 0x0488B21E/0x0488ADE4 for the public/private keys if the attribute is missing in the template. Those are the values specified in BIP32 for keys on the main bitcoin network.

```
CK_ATTRIBUTE pubTemplate[] =
{
   {CKA_TOKEN,             &bToken,      sizeof(bToken)},
   {CKA_PRIVATE,           &bTrue,       sizeof(bTrue)},
   {CKA_DERIVE,            &bTrue,       sizeof(bTrue)},
   {CKA_MODIFIABLE,        &bTrue,       sizeof(bTrue)},
   {CKA_LABEL,             pbLabel,      strlen(pbLabel)},
};
CK_ATTRIBUTE privTemplate[] =
{
   {CKA_TOKEN,             &bToken,      sizeof(bToken)},
   {CKA_PRIVATE,           &bTrue,       sizeof(bTrue)},
   {CKA_SENSITIVE,         &bTrue,       sizeof(bTrue)},
   {CKA_DERIVE,            &bTrue,       sizeof(bTrue)},
   {CKA_MODIFIABLE,        &bTrue,       sizeof(bTrue)},
   {CKA_LABEL,             pbLabel,      strlen(pbLabel)},
};

CK_BIP32_MASTER_DERIVE_PARAMS mechParams;
mechParams.pPublicKeyTemplate = pubTemplate;
mechParams.ulPublicKeyAttributeCount = ARRAY_SIZE(pubTemplate);
mechParams.pPrivateKeyTemplate = privTemplate;
mechParams.ulPrivateKeyAttributeCount = ARRAY_SIZE(privTemplate);
CK_MECHANISM mechanism = {CKM_BIP32_MASTER_DERIVE, &mechParams, sizeof(mechParams)};

CK_RV rv = C_DeriveKey(hSession, &mechanism, hSeedKey, NULL, 0, NULL);
// fail if rv != CKR_OK

CK_OBJECT_HANDLE pubKey = mechanism.mechParams->hPublicKey;
CK_OBJECT_HANDLE privKey = mechanism.mechParams->hPrivateKey;
```

The new key handles will be stored in `pubKey` and `privKey` if the derivation was successful.

Deriving a child leaf key

We highly recommend setting `CKA_PRIVATE` on the child public and private keys to TRUE to prevent the chain code from being seen by unauthorized users. A child leaf key (the bottom key in the tree) should not be used for derivation, and is meant for signing, verifying, encrypting and decrypting. Parent child keys need the derive attribute turned on. The version bytes default to 0x0488B21E/0x0488ADE4 for the public/private keys if the attribute is missing. Those are the values specified in BIP32 for keys on the main bitcoin network.

```
CK_ATTRIBUTE pubTemplate[] =
{
   {CKA_TOKEN,             &bToken,      sizeof(bToken)},
   {CKA_PRIVATE,           &bTrue,       sizeof(bTrue)},
   {CKA_ENCRYPT,           &bTrue,       sizeof(bTrue)},
   {CKA_VERIFY,            &bTrue,       sizeof(bTrue)},
   {CKA_MODIFIABLE,        &bTrue,       sizeof(bTrue)},
   {CKA_LABEL,             pbLabel,      strlen(pbLabel)},
};
CK_ATTRIBUTE privTemplate[] =
{
   {CKA_TOKEN,             &bToken,      sizeof(bToken)},
   {CKA_PRIVATE,           &bTrue,       sizeof(bTrue)},
   {CKA_SENSITIVE,         &bTrue,       sizeof(bTrue)},
   {CKA_SIGN,              &bTrue,       sizeof(bTrue)},
   {CKA_DECRYPT,           &bTrue,       sizeof(bTrue)},
   {CKA_MODIFIABLE,        &bTrue,       sizeof(bTrue)},
   {CKA_LABEL,             pbLabel,      strlen(pbLabel)},
};

CK_ULONG path[] = {
       CKF_BIP32_HARDENED | CKG_BIP44_PURPOSE,
       CKF_BIP32_HARDENED | CKG_BIP44_COIN_TYPE_BTC,
       CKF_BIP32_HARDENED | 1,
       CKG_BIP32_EXTERNAL_CHAIN,
       0
};

CK_BIP32_MASTER_DERIVE_PARAMS mechParams;
mechParams.pPublicKeyTemplate = pubTemplate;
mechParams.ulPublicKeyAttributeCount = ARRAY_SIZE(pubTemplate);
mechParams.pPrivateKeyTemplate = privTemplate;
mechParams.ulPrivateKeyAttributeCount = ARRAY_SIZE(privTemplate);
mechParams.pulPath = path;
mechParams.ulPathLen = ARRAY_SIZE(path);
CK_MECHANISM mechanism = {CKM_BIP32_CHILD_DERIVE, &mechParams, sizeof(mechParams)};

CK_RV rv = C_DeriveKey(hSession, &mechanism, hMasterPrivKey, NULL, 0, NULL);
// fail if rv != CKR_OK

CK_OBJECT_HANDLE pubKey = mechanism.mechParams->hPublicKey;
CK_OBJECT_HANDLE privKey = mechanism.mechParams->hPrivateKey;
```

The new key handles are stored in `pubKey` and `privKey` if the derivation was successful. The path generates a key pair that follows the BIP44 convention and can be used to receive BTC.

Importing a public extended key

```
CK_ATTRIBUTE template[] =
{
   {CKA_TOKEN,             &bToken,      sizeof(bToken)},
```

```
   {CKA_PRIVATE,           &bTrue,       sizeof(bTrue)},
   {CKA_DERIVE,            &bTrue,       sizeof(bTrue)},
   {CKA_MODIFIABLE,        &bTrue,       sizeof(bTrue)},
   {CKA_LABEL,             pbLabel,      strlen(pbLabel)},
};

CK_CHAR_PTR encodedKey = "xpub661MyMwAqRbcFtXgS5…"; //BIP32 serialization format
CK_OBJECT_HANDLE pubKey;

CK_RV rv = CA_Bip32ImportPublicKey(hSession, encodedKey, sizeof(encodedKey), template, ARRAY_
SIZE(template), &pubKey);
```

The handle for the newly created key is stored in `pubKey` if the import was successful.

Exporting a public extended key

```
CK_CHAR encodedKey[CKG_BIP32_MAX_SERIALIZED_LEN+1];
CK_ULONG ulEncodedKeySize = sizeof(encodedKey);

CK_RV rv = CA_Bip32ExportPubKey(hSession, hObject, encodedKey, &ulEncodedKeySize );
```

The encoded key is stored in `encodedKey` (BIP32 serialization format) if there were no errors.

Importing a private extended key

```
CK_ATTRIBUTE template[] =
{
   {CKA_CLASS              &keyClass,    sizeof(keyClass)},
   {CKA_TOKEN,             &bToken,      sizeof(bToken)},
   {CKA_KEY_TYPE           &keyType,     sizeof(keyType)},
   {CKA_PRIVATE,           &bTrue,       sizeof(bTrue)},
   {CKA_DERIVE,            &bTrue,       sizeof(bTrue)},
   {CKA_MODIFIABLE,        &bTrue,       sizeof(bTrue)},
   {CKA_LABEL,             pbLabel,      strlen(pbLabel)},
   {CKA_SENSITIVE          &bTrue,       sizeof(bTrue)},
};

CK_CHAR_PTR encodedKey = "xprv9s21ZrQH143K3QTDL4LXw2F…";
CK_MECHANISM mechanism = {CKM_AES_KWP, NULL, 0};
CK_BYTE wrappedKey[256];
CK_ULONG wrappedKeyLen = sizeof(wrappedKey);
CK_OBJECT_HANDLE hUnwrappedKey;

CK_RV rv = C_EncryptInit(hSession, &mechanism, hWrappingKey);
// fail if rv != CKR_OK

rv = C_Encrypt(hSession, encodedKey, sizeof(encodedKey), wrappedKey, &wrappedKeyLen);
// fail if rv != CKR_OK

rv = C_UnwrapKey(hSession, &mechanism, hWrappingKey, wrappedKey, wrappedKeyLen, template,
ARRAY_SIZE(template), &hUnwrappedKey);
```

After unwrapping, the encoded key's BIP32 serialization format is decoded (the template key type is checked for BIP32). The handle of the unwrapped key is stored in `hUnwrappedKey` if there were no errors.

Exporting a private extended key

```
CK_MECHANISM mechanism = {CKM_AES_KWP, NULL, 0};
CK_BYTE key[256];
CK_ULONG keyLen = sizeof(key);
```

```
CK_RV rv = C_WrapKey(hSession, &mechanism, hWrappingKey, hKeyToWrap, key, &keyLen);
// fail if rv != CKR_OK

rv = C_DecryptInit(hSession, &mechanism, hWrappingKey);
// fail if rv != CKR_OK

rv = C_Decrypt(hSession, key, keyLen, key, &keyLen);
// fail if rv != CKR_OK

key[keyLen] = 0 // The key isn't NULL terminated after C_Decrypt().
```

C_WrapKey() must convert the BIP32 key to the BIP32 serialization format before wrapping.

The serialized key is stored in `key` if there were no errors.

PKCS#11 Definitions

```
#define CKK_BIP32 (CKK_VENDOR_DEFINED  | 0x14)
#define CKM_BIP32_MASTER_DERIVE (CKM_VENDOR_DEFINED | 0xE00)
#define CKM_BIP32_CHILD_DERIVE (CKM_VENDOR_DEFINED |  0xE01)
#define CKR_BIP32_CHILD_INDEX_INVALID (CKR_VENDOR_DEFINED |         0x83)
#define CKR_BIP32_INVALID_HARDENED_DERIVATION (CKR_VENDOR_DEFINED | 0x84)
#define CKR_BIP32_MASTER_SEED_LEN_INVALID (CKR_VENDOR_DEFINED |     0x85)
#define CKR_BIP32_MASTER_SEED_INVALID (CKR_VENDOR_DEFINED |         0x86)
#define CKR_BIP32_INVALID_KEY_PATH_LEN (CKR_VENDOR_DEFINED |        0x87)
#define CKA_BIP32_CHAIN_CODE (CKA_VENDOR_DEFINED |         0x1100)
#define CKA_BIP32_VERSION_BYTES (CKA_VENDOR_DEFINED |      0x1101)
#define CKA_BIP32_CHILD_INDEX (CKA_VENDOR_DEFINED |        0x1102)
#define CKA_BIP32_CHILD_DEPTH (CKA_VENDOR_DEFINED |        0x1103)
#define CKA_BIP32_ID (CKA_VENDOR_DEFINED |                 0x1104)
#define CKA_BIP32_FINGERPRINT (CKA_VENDOR_DEFINED |        0x1105)
#define CKA_BIP32_PARENT_FINGERPRINT (CKA_VENDOR_DEFINED | 0x1106)
#define CKG_BIP32_VERSION_MAINNET_PUB   (0x0488B21E)
#define CKG_BIP32_VERSION_MAINNET_PRIV  (0x0488ADE4)
#define CKG_BIP32_VERSION_TESTNET_PUB   (0x043587CF)
#define CKG_BIP32_VERSION_TESTNET_PRIV  (0x04358394)
#define CKG_BIP44_PURPOSE               (0x0000002C)
#define CKG_BIP44_COIN_TYPE_BTC         (0x00000000)
#define CKG_BIP44_COIN_TYPE_BTC_TESTNET (0x00000001)
#define CKG_BIP32_EXTERNAL_CHAIN        (0x00000000)
#define CKG_BIP32_INTERNAL_CHAIN        (0x00000001)
#define CKG_BIP32_MAX_SERIALIZED_LEN    (112)
#define CKF_BIP32_HARDENED              (0x80000000)
#define CKF_BIP32_MAX_PATH_LEN          (255)
```

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.

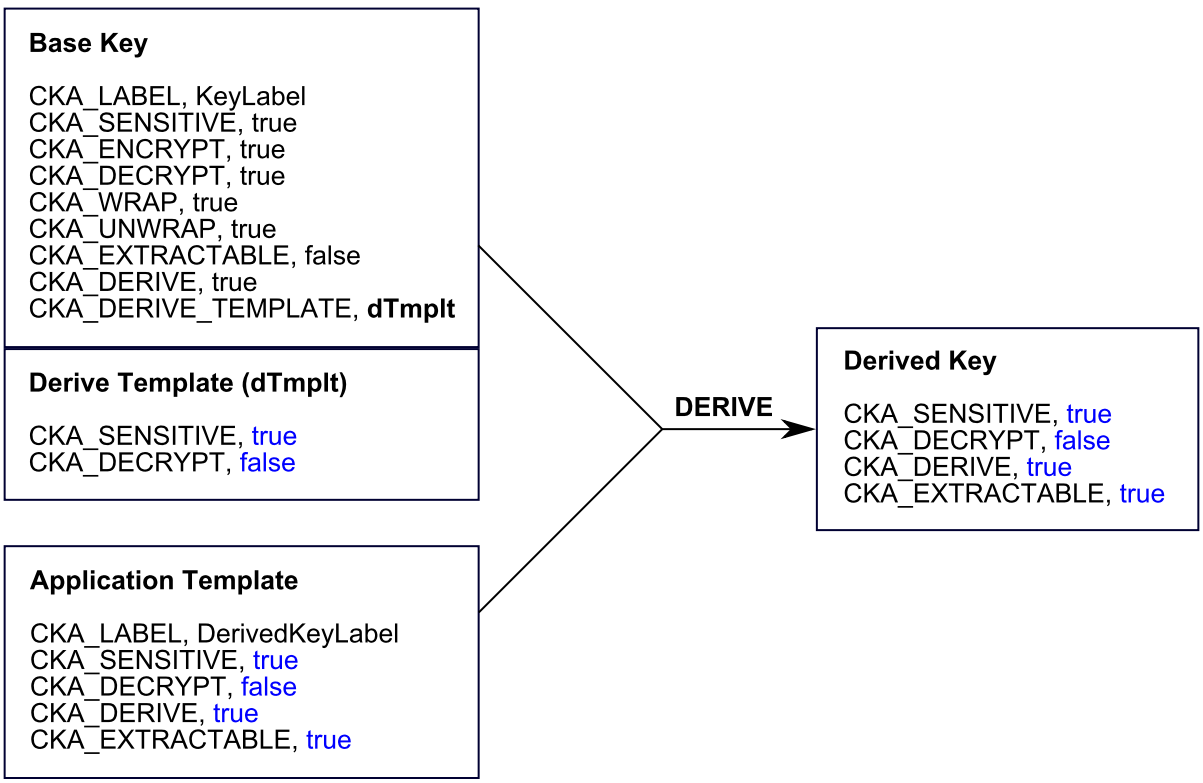
Any and all attributes which are valid for application template of a particular mechanism are also valid for the derive template. For security, the most effective attributes to restrict are those which might allow the derived key to be misused or expose secret information. Broadly these include but are 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.

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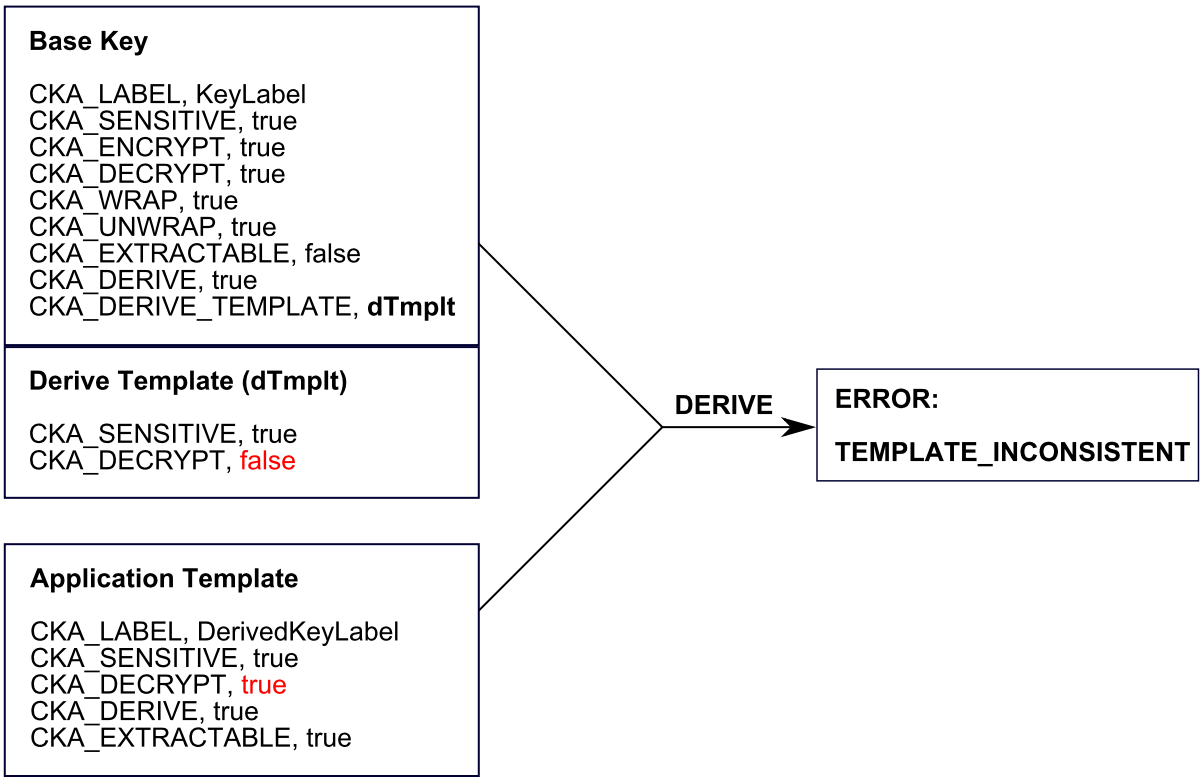

3GPP Mechanisms for 5G Mobile Networks

This section describes the C-based PKCS#11 interface to the 3GPP functions in the HSM firmware. The mechanisms described below are also represented in JCPROV.

> "MILENAGE" below

> "TUAK" on page 138

> "Comp128" on page 138

> "Storage Key (SK)" on page 139

MILENAGE

Authentication

As with all the 3GPP crypto operations, the C_SignInit/C_Sign function calls are made.

C_SignInit

```
(
    CK_SESSION_HANDLE hSession,               // the session's handle
    CK_MECHANISM_PTR  pMechanism,      // the signature mechanism
                      mechanism               // mechanism type   CKM_MILENAGE
                      pParameter      // pointer to the milenage mechanism CK_MILENAGE_SIGN_PARAMS
                      ulParameterLen  // length (sizeof) in bytes of the parameter

    CK_OBJECT_HANDLE  hKey            // AES storage key used to encrypt/decrypt Ki and OP (optional)
);
```

C_Sign

```
(
    CK_SESSION_HANDLE hSession,        // the session's handle
    CK_BYTE_PTR       pData,           // should be NULL for CKM_MILENAGE (see CKM_MILENAGE_RESYNC)
    CK_ULONG          ulDataLen,       // should be set to zero for CKM_MILENAGE
    CK_BYTE_PTR       pSignature,      // gets the signature - see OUTPUT response string below
    CK_ULONG_PTR      pulSignatureLen  // gets signature length
);
```

Mechanism: CKM_MILENAGE

Parameter Structure:

```
typedef struct CK_MILENAGE_SIGN_PARAMS {
    CK_ULONG          ulMilenageFlags;
    CK_ULONG          ulEncKiLen;
    CK_BYTE_PTR       pEncKi;
    CK_ULONG          ulEncOPcLen;
    CK_BYTE_PTR       pEncOPc;         // Encrypted or plain - see flags
    CK_OBJECT_HANDLE  hSecondaryKey;   // optional OP object handle - see flags
    CK_OBJECT_HANDLE  hRCKey;          // optional R and C params - see flags
    CK_BYTE           sqn[6];
    CK_BYTE           amf[2];
} CK_MILENAGE_SIGN_PARAMS;
typedef CK_MILENAGE_SIGN_PARAMS CK_PTR CK_MILENAGE_SIGN_PARAMS_PTR;
```

The ulMilenageFlags can consist of one or more of the following:

```
#define LUNA_5G_OPC                0x00000001      // OPC is provided rather than OP
#define LUNA_5G_ENCRYPTED_OP       0x00000002      // OP or OPC is encrypted by Storage Key
#define LUNA_5G_OP_OBJECT          0x00000004      // OP or OPC is an object in HSM partition
#define LUNA_5G_USE_TLV            0x00000008      // Use the Tag/Len/Val format in response
#define LUNA_5G_USER_DEFINED_RC    0x00000010      // User defined R and C constants
```

> **NOTE** If the **LUNA_5G_OP_OBJECT** flag is specified, then the hSecondaryKey parameter should contain the handle of the generic secret object which holds the OP string. As well, if the **LUNA_5G_USER_DEFINED_RC** flag is set, then set the hRCKey to point to the RC generic secret object.

Although the R and C values are hard-coded (per the 3GPP specification) the Luna implementation allows the user to define his own constants. It is first necessary to create a generic secret object on the HSM where the CKA_VALUE attribute contains a concatenation of the R and C fields as follows:

C1[16 bytes], C2[16 bytes], C3[16 bytes], C4[16 bytes], C5[16 bytes], R1[1 byte], R2[1 byte], R3[1 byte], R4[1 byte], R5[1 byte]

> **TIP** Use a hex editor to create the binary RC file. Use the API or the **ckdemo** utility to encrypt the file with the SK, and subsequently unwrap it onto the HSM as an 85 byte generic secret object.

Output: The signature (output) produced from the above function call will contain the following data (note the exact function as per the 3GPP spec is show in parentheses):

| RANDOM | XRES(f2) | CK(f3) | IK(f4) | AUTN | where AUTN = | SQN xor AK(f5) | AMF | MAC-A(f1) |

Although by default the data is returned as one concatenated binary string, the user may have the data returned in TLV (Tag/Length/Value) format by setting the “LUNA_5G_USE_TLV” flag. The output will appear as follows:

| Tag (UINT8) | Length (UINT8) | Value | Tag (UINT8) | Length (UINT8) | Value | …

The tag values are defined as follows:

```
#define LUNA_5G_TAG_RANDOM          0x00000001      // Random data generated in HSM
#define LUNA_5G_TAG_RES             0x00000002      // Response string
#define LUNA_5G_TAG_CK              0x00000003      // Confidentiality Key
#define LUNA_5G_TAG_IK              0x00000004      // Integrity Key
#define LUNA_5G_TAG_SQN_XOR_AK      0x00000005      // Sequence # xor'd with Anonymity Key (AK)
#define LUNA_5G_TAG_AMF             0x00000006      // Authentication Management Field
#define LUNA_5G_TAG_MAC             0x00000007      // MAC-A for authentication
#define LUNA_5G_TAG_SEQUENCE        0x00000008      // Sequence # in resynch operation
```

Resynchronization

C_SignInit and C_Sign function calls same as Authentication.

Mechanism: **CKM_MILENAGE_RESYNC**

Parameter Structure: same as for Authentication.

The API allows the USIM to resynchronize with a new SQN number in the event that a message was lost. The SQN is not sent in the clear however; rather it is XOR’ed with the AK (f5*). As well the MAC-S (f1*) is also sent to verify that this request is coming from a legitimate subscriber. This requires that the USIM sends the random data and an AUTS (Auth string) to the AUC which contains the following:

AUTS = | SQN xor AK | MAC-S |

The user should format the pData (data to sign in the C_Sign call) as follows:

pData = | RAND | AUTS |

This mechanism uses the same mechanism parameter structure as for authentication, as the Ki, OP and AMF are required to generate the sequence number. (The sqn[] field in the param structure will be ignored.) The LUNA_5G_OP_OBJECT, LUNA_5G_USE_TLV, and LUNA_5G_USER_DEFINED_RC are valid flags.

Output: The HSM will first generate the new SQN number but will check the MAC-S signature to ensure the legitimacy of the request. If the MAC-S signature passed in is not equal to the signature calculated by the HSM, the HSM will return the error CKR_SIGNATURE_INVALID. If the return code is CKR_OK, the signature will contain the new 6 byte SQN number.

AUTS Generation (Testing Only)

The HSM supports generating the AUTS string for the purpose of testing the Resynchronization operation.

C_SignInit and C_Sign function calls same as Authentication.

Mechanism: **CKM_MILENAGE_AUTS**

Parameter Structure: same as for Authentication. The user should pass in the random string in the pData field of the C_Sign function call.

Output: The signature returned from the HSM will be a concatenation of the Random string plus the AUTS as follows (no TLV):

| RAND | SQN xor AK | MAC-S |

This string may be fed directly into the pData field of the C_Sign call when doing the RESYNC operation.

TUAK

Authentication

TUAK is similar to MILENAGE in respect to the output data however the calculated components are largely based upon the Keccak (SHA-3) hashing scheme. In addition, TUAK allows some variability in the lengths of the output components. The desired lengths can be specified in input parameter structure as follows:

```
typedef struct CK_TUAK_SIGN_PARAMS {
    CK_ULONG             ulTuakFlags;
    CK_ULONG             ulEncKiLen;
    CK_BYTE_PTR          pEncKi;
    CK_ULONG             ulEncTOPcLen;
    CK_BYTE_PTR          pEncTOPc;       // Encrypted or plain - see flags
    CK_ULONG             ulIterations;   // # of Keccak iterations
    CK_OBJECT_HANDLE     hSecondaryKey;  // optional OP key handle
    CK_ULONG             ulResLen;       // length of expected response (XRES)
    CK_ULONG             ulMacALen;      // length of MAC
    CK_ULONG             ulCkLen;        // length of crypto key CK
    CK_ULONG             ulIkLen;        // length of identity key IK
    CK_BYTE              sqn[6];
    CK_BYTE              amf[2];
} CK_TUAK_SIGN_PARAMS;

typedef CK_TUAK_SIGN_PARAMS CK_PTR CK_TUAK_SIGN_PARAMS_PTR;
```

The ulTuakFlags are the same as the MILENAGE flags with the exception of the LUNA_5G_USER_DEFINED_RC flag which is not applicable to TUAK.

Output: same as MILENAGE authentication output.

Resynchronization

Mechanism: **CKM_TUAK_RESYNC**

Parameter Structure: same as for authentication, although some fields are not be required (key length fields, for example).

Format of the input data, and the resulting output are the same as MILENAGE.

AUTS Generation (Testing Only)

As with MILENAGE, this function supports generation of the AUTS string for subsequent testing of the RESYNC operation.

Comp128

Authentication

The Comp128 algorithms supports device authentication for the legacy GSM 2/2.5 mobile networks.

Mechanism: CKM_COMP128

Parameter Structure:

```
typedef struct CK_COMP128_SIGN_PARAMS {
    CK_ULONG            ulVersion;              // Version of Comp128
    CK_ULONG            ulEncKiLen;
    CK_BYTE_PTR         pEncKi;
} CK_COMP128_SIGN_PARAMS;

typedef CK_COMP128_SIGN_PARAMS CK_PTR CK_COMP128_SIGN_PARAMS_PTR;
```

This API supports the 3 versions of the COMP128 algorithm. This is passed in via the ulVersion field.

As with the other mechanisms, it is expected that the Ki will be encrypted under the Storage Key (SK) – the handle for this key is passed in as the signing key in C_SignInit function call.

Output: The signature (output) produced from the above function call will contain the following data:

| RANDOM | SRES | Kc |

> **NOTE** Unlike MILENAGE and TUAK, the output is only in binary form, and the TLV formatting is not supported at this time. Only a single triplet output is supported via this API.

Storage Key (SK)

It is assumed that under the security constraints imposed by the HSM, the subscribers key (Ki) will always be encrypted by the HSM resident Storage Key (SK). The SK is an AES key and can be any size although a 256 bit (32 byte) value is recommended. Currently, the encryption/decryption mechanism used is the NIST approved CKM_AES_KWP (PKCS#11 definition) and where the default IV (per NIST SP800-38F) is used. The Ki (and optionally the OP) must be encrypted using this mechanism for later use in the authentication and resynchronization operations.

SM2/SM4 Mechanisms

This section describes the C-based PKCS#11 interface to the SM2/SM4 functions in the HSM firmware. Although PKCS#11 constitutes the core client-side API to the HSM, it is expected that other API layers (like Java) will be required in order to support the customers' application environment. These APIs are yet to be defined.

> **NOTE** You require a backup HSM with minimum Luna Backup HSM 7 Firmware 7.7.1 to back up these objects.

> "SM2" below

> "SM4" on page 141

SM2

Generate Key Pair

Generate a keypair of type CKK_SM2.

```
CK_BYTE sm2p256v1[] =  { 0x06, 0x08, 0x2A, 0x81, 0x1C, 0xCF, 0x55, 0x01, 0x82, 0x2D };

CK_RV C_GenerateKeyPair(
CK_SESSION_HANDLE hSession,
```

```
CK_MECHANISM_PTR pMechanism,           // CKM_SM2_KEY_PAIR_GEN
CK_ATTRIBUTE_PTR pPublicKeyTemplate,   // eg CKA_EC_PARAMS with curve sm2p256v1 or any other
curve
CK_ULONG ulPublicKeyAttributeCount,
CK_ATTRIBUTE_PTR pPrivateKeyTemplate,
CK_ULONG ulPrivateKeyAttributeCount,
CK_OBJECT_HANDLE_PTR phPublicKey,
CK_OBJECT_HANDLE_PTR phPrivateKey
);
```

Sign

Use the C_Sign* family of functions.

```
typedef struct CK_SM2DSA_PARAMS {
   CK_MECHANISM_TYPE zhashAlg;         // eg CKM_SM3
   CK_ULONG ulUserIdLen;
   CK_VOID_PTR pUserId;
} CK_SM2DSA_PARAMS;

CK_RV C_SignInit(
CK_SESSION_HANDLE hSession,
CK_MECHANISM_PTR pMechanism,           // eg CKM_SM3_SM2DSA with CK_SM2DSA_PARAMS
CK_OBJECT_HANDLE hKey
);

CK_RV C_Sign(
CK_SESSION_HANDLE hSession,
CK_BYTE_PTR pData,
CK_ULONG ulDataLen,
CK_BYTE_PTR pSignature,
CK_ULONG_PTR pulSignatureLen
);
```

Also supported:

- C_SignUpdate, C_SignFinal for multi-part operations
- C_VerifyInit, C_Verify for verifying (single-part operations)
- C_VerifyUpdate, C_VerifyFinal for verifying (multi-part operations)

Available mechanisms for signing include:

- **CKM_SM2DSA**
- **CKM_SM3_SM2DSA**
- **CKM_SHA1_SM2DSA**
- **CKM_SHA224_SM2DSA**
- **CKM_SHA256_SM2DSA**
- **CKM_SHA384_SM2DSA**
- **CKM_SHA512_SM2DSA**

Available mechanisms for field **zHashAlg** include:

- **CKM_SM3**
- **CKM_SHA1**
- **CKM_SHA224**

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- **CKM_SHA256**
- **CKM_SHA384**
- **CKM_SHA512**

SM4

Generate Key

Generate a secret key of type CKK_SM4.

```
CK_RV C_GenerateKey(
CK_SESSION_HANDLE hSession
CK_MECHANISM_PTR pMechanism,           // CKM_SM4_KEY_GEN
CK_ATTRIBUTE_PTR pTemplate,
CK_ULONG ulCount,
CK_OBJECT_HANDLE_PTR phKey
);
```

Encrypt

Use the C_Encrypt* family of functions.

```
CK_RV C_EncryptInit(
CK_SESSION_HANDLE hSession,
CK_MECHANISM_PTR pMechanism,           // eg CKM_SM4_CBC_PAD with InitializationVector [16 bytes]
CK_OBJECT_HANDLE hKey
);

CK_RV C_Encrypt(
CK_SESSION_HANDLE hSession,
CK_BYTE_PTR pData,
CK_ULONG ulDataLen,
CK_BYTE_PTR pEncryptedData,
CK_ULONG_PTR pulEncryptedDataLen
);
```

Also supported:

- C_EncryptUpdate, C_EncryptFinal for multi-part operations
- C_DecryptInit, C_Decrypt for decrypting (single-part operations)
- C_DecryptUpdate, C_DecryptFinal for decrypting (multi-part operations)

Available mechanisms for encryption include:

- **CKM_SM4_ECB**
- **CKM_SM4_CBC**
- **CKM_SM4_CBC_PAD**

SHA-3 Mechanisms

This section describes the PKCS#11 interface to the **SHA-3** mechanisms in the HSM firmware for the digest bit lengths of **224**, **256**, **384** and **512**.

> **NOTE** You require a backup HSM with minimum Luna Backup HSM 7 Firmware 7.7.1 to back up these objects.

> "Digest Mechanisms" below
> "HMAC Mechanisms" below
> "Signature/Verification Mechanisms" on the next page
> "Encrypt/Decrypt Mechanisms" on page 144
> "Digest Key Derive Mechanisms" on page 145
> "Key Derivation Function (KDF) Mechanisms" on page 145

Digest Mechanisms

Mechanism Type	Description
SHA-3	The following mechanisms for performing a **SHA-3** hash have been added: > **CKM_SHA3_224** > **CKM_SHA3_256** > **CKM_SHA3_384** > **CKM_SHA3_512**
SHAKE	The following mechanisms for performing a **SHAKE XOF** have been added: > **CKM_SHAKE_128** > **CKM_SHAKE_256** These mechanisms require a **CK_SHAKE_PARAMS** mechanism parameters structure defined as follows: `typedef struct CK_SHAKE_PARAMS { CK_ULONG ulOutputLen; } CK_SHAKE_PARAMS` The output length of the digest can be specified using the **ulOutputLen** field with a maximum value of **2048**.
KECCAK	There are variants of the **SHA-3** mechanisms that are included for compatibility with implementations that preceded the publication of **FIPS PUB 202** where there is a difference in a single padding byte. These mechanisms are: > **CKM_KECCAK_224** > **CKM_KECCAK_256** > **CKM_KECCAK_384** > **CKM_KECCAK_512**

HMAC Mechanisms

The following mechanisms for performing an **HMAC** with **SHA-3** have been added:

> **CKM_SHA3_224_HMAC**

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- **CKM_SHA3_224_HMAC_GENERAL**
- **CKM_SHA3_256_HMAC**
- **CKM_SHA3_256_HMAC_GENERAL**
- **CKM_SHA3_384_HMAC**
- **CKM_SHA3_384_HMAC_GENERAL**
- **CKM_SHA3_512_HMAC**
- **CKM_SHA3_512_HMAC_GENERAL**

Signature/Verification Mechanisms

Mechanism Type	Description
RSA PKCS	The following mechanisms for performing a **RSA PKCS #1 v1.5** signature/verification with a **SHA-3** digest have been added: > **CKM_SHA3_224_RSA_PKCS** > **CKM_SHA3_256_RSA_PKCS** > **CKM_SHA3_384_RSA_PKCS** > **CKM_SHA3_512_RSA_PKCS**
RSA PSS	The following mechanisms for performing a **RSA** signature/verification with **PSS** encoding with a **SHA-3** digest have been added: > **CKM_SHA3_224_RSA_PKCS_PSS** > **CKM_SHA3_256_RSA_PKCS_PSS** > **CKM_SHA3_384_RSA_PKCS_PSS** > **CKM_SHA3_512_RSA_PKCS_PSS** The following **MGF1** constants have been defined with corresponding support: > **CKG_MGF1_SHA3_224** > **CKG_MGF1_SHA3_256** > **CKG_MGF1_SHA3_384** > **CKG_MGF1_SHA3_512** These values can be specified via the **mgf** field of the CK_RSA_PKCS_PSS_PARAMS mechanism parameters. The **hashAlg** field of the CK_RSA_PKCS_PSS_PARAMS mechanism parameters can be given the new values of **CKM_SHA3_224**, **CKM_SHA3_256**, **CKM_SHA3_384** or **CKM_SHA3_512**.
DSA	The following mechanisms for performing a **DSA** signature/verification with a **SHA-3** digest have been added: > **CKM_DSA_SHA3_224** > **CKM_DSA_SHA3_256** > **CKM_DSA_SHA3_384** > **CKM_DSA_SHA3_512**

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Mechanism Type	Description
ECDSA	The following mechanisms for performing an **ECDSA** signature/verification with a **SHA-3** digest have been added: > **CKM_ECDSA_SHA3_224** > **CKM_ECDSA_SHA3_256** > **CKM_ECDSA_SHA3_384** > **CKM_ECDSA_SHA3_512**
EDDSA	The following mechanisms for performing an **EDDSA** signature/verification with a **SHA-3** digest have been added: > **CKM_SHA3_224_EDDSA** > **CKM_SHA3_256_EDDSA** > **CKM_SHA3_384_EDDSA** > **CKM_SHA3_512_EDDSA**

Encrypt/Decrypt Mechanisms

CKM_RSA_PKCS_OAEP
For the **CKM_RSA_PKCS_OAEP** mechanism, the following values can be specified for the **mgf** field of the **CK_RSA_PKCS_OAEP_PARAMS** mechanism parameters:

> **CKG_MGF1_SHA3_224**

> **CKG_MGF1_SHA3_256**

> **CKG_MGF1_SHA3_384**

> **CKG_MGF1_SHA3_512**

For the **hashAlg** field of the **CK_RSA_PKCS_OAEP_PARAMS** mechanism parameters, the following hash algorithms can be specified:

> **CKM_SHA3_224**

> **CKM_SHA3_256**

> **CKM_SHA3_384**

> **CKM_SHA3_512**

Digest Key Derive Mechanisms

Mechanism Type	Description
SHA-3	The following mechanisms can be used to derive a key using **SHA-3**: > **CKM_SHA3_224_KEY_DERIVE** > **CKM_SHA3_256_KEY_DERIVE** > **CKM_SHA3_384_KEY_DERIVE** > **CKM_SHA3_512_KEY_DERIVE**
SHAKE	The following mechanisms can be used to derive a key using **SHAKE**: > **CKM_SHAKE_128_KEY_DERIVE** > **CKM_SHAKE_256_KEY_DERIVE**

Key Derivation Function (KDF) Mechanisms

Mechanism Type	Description
CKM_X9_42_DH_DERIVE **CKM_ECDH1_DERIVE**	The following values can be specified for the **kdf** field of the **CK_X9_42_DH1_DERIVE_PARAMS** and **CK_ECDH1_DERIVE_PARAMS** mechanism parameters to make use of the **SHA-3** variants: > **CKD_SHA3_224_KDF** > **CKD_SHA3_256_KDF** > **CKD_SHA3_384_KDF** > **CKD_SHA3_512_KDF** > **CKD_SHA3_224_NIST_KDF** > **CKD_SHA3_256_NIST_KDF** > **CKD_SHA3_384_NIST_KDF** > **CKD_SHA3_512_NIST_KDF** > **CKD_SHA3_224_SES_KDF** > **CKD_SHA3_256_SES_KDF** > **CKD_SHA3_384_SES_KDF** > **CKD_SHA3_512_SES_KDF**
CKM_PRF_KDF	The following values can be specified for the **prfType** field of the **CK_PRF_KDF_PARAMS** mechanism parameters to make use of the **SHA-3** variants: > **CK_NIST_PRF_KDF_HMAC_SHA3_224** > **CK_NIST_PRF_KDF_HMAC_SHA3_256** > **CK_NIST_PRF_KDF_HMAC_SHA3_384** > **CK_NIST_PRF_KDF_HMAC_SHA3_512**

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CHAPTER 4: Per-Key Authorization API

Design

Changes and additions to the Luna HSM firmware and libraries for the Per Key Authorization (PKA) feature were introduced to implement the feature in compliance with eIDAS standards, and to ensure co-existence of the new feature with existing behavior and use-cases.

The Luna use-case

This use-case covers traditional Luna customers who want the latest firmware and host software, but do *not* need the new per-key authorization and sole control functionality, and do not want to make changes to their existing applications, and yet want to be able to maintain the HSM in the Common Criteria mode of operations.

Subject to the installation of the new Client Cryptoki library and the use of regular APIs without per-key auth parameters, the existing APIs will continue to work as usual, while the new PKCS#11 APIs, attributes, and roles, related to the per-key authorization and sole-control functionality, are dealt with within the library and remain invisible to the user.

In the Luna use-case, we have

- the Crypto Officer role (CO) for creating/modifying/administering key material in an application partition
- the Crypto User role (CU) with read/use capability

The eIDAS use-case

This use-case covers all the scenarios where client applications need to take advantage of the per-key authorization and sole control (assigned keys) capabilities. It includes all eIDAS scenarios such as remote server signing/sealing with external/internal SAM, local server signing/sealing (no SAM), long-lived signing keys, single-use signing keys, etc.

In the eIDAS use-case,

- the Crypto Officer role (the CO) does much the same as in the Luna use-case, and maps to the eIDAS "*Administrator*" role
- a new Limited Crypto Officer role (the LCO), in line with the principle of least privilege, and mapping to the eIDAS "*User*" role, allows signing applications to provide key access to users, thus reserving the CO role for administrative purposes only

The CU role has insufficient capability and is not employed for the eIDAS use case.

Applications need the new firmware, new host software, and use new P11 APIs, attributes, and roles related to the per-key authorization and sole control.

Customer applications and tools explicitly use the new features:

- Applications specify the Authorization Data and Assigned Flag attributes in templates and may later change the attributes via new P11 APIs.

> Applications use new PKCS#11 API to explicitly authorize each individual key before it can be used in crypto operations.

> Applications also deal with the re-authorization logic and the authorization failure handling.

The following sections detail the changes implemented for this feature.

New Assigned Key Attribute

The Protection Profile defines two types of secret keys (PP defines “secret key” as either a symmetric or a private key), **assigned** and **unassigned** (general). Assigned keys have tighter controls around them, their security attributes are non-modifiable, and they are also non-exportable. Both key types, however, require per-key authorization.

We support the following use-cases:

> CO (Crypto Officer a.k.a. the eIDAS Administrator) generates the key unassigned, then assigns it later.

> CO (Administrator) generates the key assigned.

> Limited-CO (the eIDAS User) generates the key assigned.

> Limited-CO (User) generates the key unassigned (which might or might not be assigned by the Administrator later).

To differentiate between assigned and unassigned keys, we introduce an attribute, CKA_ASSIGNED. This attribute is initialized and modified through regular templates and commands. CKA_ASSIGNED defaults to FALSE, and as such, it does not need to be present in the templates for the Luna use-case, since we exclusively want to use unassigned keys in that use-case.

Getting Assigned Keys

There are two ways to get assigned keys:

> Direct generation of assigned keys

  This is accomplished by generating keys with the CKA_ASSIGNED attribute set to TRUE. The keys must also have the following attributes:

  - CKA_EXTRACTABLE set to FALSE.
  - CKA_MODIFIABLE set to FALSE.
  - CKA_AUTH_DATA set to some authorization data. For more information about this attribute, see "New Authorization Data Attribute" on the next page.

> Assignment of previously created keys

  This is accomplished by performing an unassigned-to-assigned transition as the eIDAS Administrator (the CO role) and changing the CKA_ASSIGNED attribute from FALSE to TRUE by using the CA_AssignKey command (see "CA_AssignKey" on page 153). The keys must also have the following attributes:

  - CKA_ALWAYS_SENSITIVE set to TRUE.
  - CKA_NEVER_EXTRACTABLE set to TRUE.
  - CKA_AUTH_DATA set to some authorization data. For more information about this attribute, see "New Authorization Data Attribute" on the next page.

A template for key assignment must have the following attributes:

> CKA_MODIFIABLE set to FALSE.

> CKA_ASSIGNED set to TRUE.

New Authorization Data Attribute

The authorization data is a new sensitive attribute (CKA_AUTH_DATA) on each symmetric/private key object. It is initialized through the regular means of passing in attribute values in templates during key generation. As in other sensitive attributes, it is possible to query the value. It is presented as a byte array password, therefore no multifactor quorum options are possible. This attribute is available in the eIDAS and Luna use-cases (V1 Partitions), but not in the non-PP-compatible legacy use-case (V0).

Unassigned keys use the authorization data simply to verify access rights. The initial authorization data is hashed, along with a random pepper value (stored encrypted in the partition structure with the PSK) and the hash is stored in the key object metadata. Authorization operation involves hashing of the incoming authorization data and comparing the result to the reference one in the key object.

For assigned keys, the use of the authorization data is more complex, and is detailed in the following section.

Initializing the Authorization Data

The auth data is initialized through regular means of passing in the CKA_AUTH_DATA attribute value in templates during key generation, key derivation and key unwrapping.

Modifying the Authorization Data

For authorization data modification, the Protection Profile introduces the following conditions:

> In the case of *assigned* keys, the auth data can be “modified only when modification operation includes successful validation of current (pre-modification) authorisation data”

> In the case of *unassigned* keys, the auth data can be “modified only when modification operation includes successful validation of current (pre-modification) authorisation data, that is by anybody who already has that auth data, or by an Administrator”

To this end, the following command modifies the authorization data when in possession of current auth data:

```
CA_SetAuthorizationData(
           CK_SESSION_HANDLE hSession,          // the session's handle
           CK_OBJECT_HANDLE  hObject,           // the object's handle
           CK_UTF8CHAR_PTR   pOldAuthData,      // the user's old/current auth data
           CK_ULONG          ulOldAuthDataLen   // the length of the old/current auth data
           CK_UTF8CHAR_PTR   pNewAuthData,      // the user's new auth data
           CK_ULONG          ulNewAuthDataLen   // the length of the new auth data
         )
```

This command will be available to all the roles without explicit requirement to have authorized first with CA_AuthorizeKey(), since the call itself will take in the current authorization data as a parameter.

On assigned keys, this command will decrypt and re-encrypt the KUSK with the new authorization data.

Resetting the Authorization Data

For authorization data modification, the Protection Profile introduces the following conditions:

> In the case of assigned keys, it can be “modified only when modification operation includes successful validation of current (pre-modification) authorisation data”

> In the case of unassigned keys, it can be “modified only when modification operation includes successful validation of current (pre-modification) authorisation data, or by an Administrator”

To this end, the following command at the PKCS#11 API level allows the CO (Administrator) to reset the authorization data on unassigned keys without having to present the current auth data:

```
CA_ResetAuthorizationData(
          CK_SESSION_HANDLE hSession,       // the session's handle
          CK_OBJECT_HANDLE  hObject,        // the object's handle
          CK_UTF8CHAR_PTR   pAuthData,      // the user's auth data
          CK_ULONG          ulAuthDataLen   // the length of the auth data
        )
```

This command is available only to the CO role, and only for unassigned keys.

This command also resets the authorization failure count (CKA_FAILED_KEY_AUTH_COUNT) for a locked-out key and unlocks it.

Authorizing/Rescinding Authorization on a Key *per Session*

To preserve compatibility with the PKCS#11 API, and rather than require the input of per-key authorization data on every single “keyed” operation such as sign, verify, encrypt, decrypt, derive, etc., the following command explicitly authorizes a key (assigned or unassigned) by key handle in a given session. Once authorized, the key remains authorized within that session only (meaning that the authorization is not inherited by the other sessions under that access), until authorization is explicitly rescinded. In line with PP 419 221-5, FIA_UAU.6/KeyAuth Re-authenticating, other re-authorization conditions are not supported (time/count-based, or otherwise).

```
CA_AuthorizeKey(
          CK_SESSION_HANDLE hSession,       // the session's handle
          CK_OBJECT_HANDLE  hObject,        // the object's handle
          CK_UTF8CHAR_PTR   pAuthData,      // the user's auth data
          CK_ULONG          ulAuthDataLen   // the length of the auth data
        )
```

The command above can be used only in an already authenticated session for any role, and attempts to authorize the given key. If successful it marks and stores the key's OUID in the session as authorized. Further requests to use that key within that session will simply verify that the key is still marked as authorized, and will proceed with the operation (provided that the key usage attributes are respected) without having to re-authorize.

Only one authorized key at a time is supported per session. The command can be used to overwrite the existing authorization in a session with authorization for a different key.

If the application wants to authorize a second key concurrently, a second session will be required.

The same command will also allow explicit authorization rescinding in that given session alone, if the auth data length is 0 (object handle still must be set to the correct one). Other rescinding methods include but are not limited to:

> Pull the power plug

> Decommission

> Delete the partition

> Close the session

> Logout

> Change auth data on the key (this will revoke any existing authorizations for that key in any sessions/accesses)

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> Delete the key

Authorizing/Rescinding Authorization on a Key *per Access*

Authorization data can be directly put into the access, but only to access unassigned keys.

This is achieved, using the same API call as above, when hObject is set to CK_INVALID_HANDLE.

The provided authorization data is not immediately used as a result of that command, since the command does not specify a key at that point. Instead, the hash of the authorization data is kept in the access and is available to all of the sessions sharing the same access.

The authorization in this case is a two-step process:

1. Authorization data only is sent in
2. A “keyed” command is sent in, and the authorization data stored in the access is validated against the individual key.

If, in a given session, authorization already exists for an individual key at the session level, that is checked first, if the OUID matches the key in the command.

Note that the overall authorization process remains per individual key, and each key is individually authorized for use.

As with the authorization in the previously described session, the same command also allows explicit authorization rescinding if the auth data length is 0 (object handle is set to CK_INVALID_HANDLE). Other rescinding methods include but are not limited to:

> Pull the power plug

> Decommission

> Delete the partition

> Logout

> Change auth data on the key (this will revoke any existing authorizations for that key in any sessions/accesses)

> Delete the key

Per-Key Authorization Failure Handling

Access to keys is blocked after a set amount of authorization failures in accordance with the authentication failure handling requirements of the PP, and the CO role has the ability to unblock blocked keys.

The authorization failure count is stored as an attribute (CKA_FAILED_KEY_AUTH_COUNT) directly in the object. Another new-to-firmware 7.7.0 attribute, CKA_KEY_STATUS, contains the max allowed failed key auth attempt count, along with the current status of the key - locked or not.

Once the max failed attempt count is reached, the key is marked as locked. The CO can then reset the count to 0 (through C_SetAttributeValue()) in the attribute to unblock the access to the key.

Template Handling in the Cryptoki Library

For the Luna use-case (partition is V0 and SKS and PKA are not available), the library masks the artifacts of per-key authorization.

The C_Login() call for CO/CU is overridden to include the additional action:

1. A normal C_Login() call with all the provided parameters, followed by
2. A CA_AuthorizeKey() call with the string “Luna” passed in as authorization data to the access

The following calls that create a secret/private key are overridden, and add a CKA_AUTH_DATA attribute with the value “Luna” is added to the input template:

- C_GenerateKey()
- C_GenerateKeyPair()
- C_UnwrapKey()
- C_DeriveKey()

These modifications in the library, along with the two-step per-key authorization functionality, allow operation through the regular Luna API with no modifications required to existing applications, while still providing the ability to make use of the extended per-key auth API should the customer choose to do so.

V0 vs V1 Partitions

To support legacy client installations, the V0 and V1 partition types were introduced in Luna HSM Firmware 7.7.0 and newer, where

- the V0 partition preserves compatibility with the “legacy” Luna use-case, or keys always in hardware (whether a partition is V0 due to firmware update, or V0 due to default choice at partition creation), while
- the V1 partition supports Per Key Authorization, Scalable Key Storage, and other eIDAS-use-case functions that cannot be compatible with the previous scheme. These are indicated and selected by a new policy: “Partition Version”, which is set to 0 (the state of any pre-existing partitions after upgrade from pre-version-7.7.0 firmware, or the default setting for any newly created partitions) regular, non-legacy partitions will be version 1), and will control both internal legacy functionality (such as old HA login and old STC support), as well as govern toggling of certain other policy bits (such as per-key auth and SKS policies).

V0 partitions are not compliant with the Protection Profile, as the key objects in these partitions do not have authorization data attribute at all. This configuration is intended for customers who cannot upgrade their host-side library.

If you decide to move on to a PP compatible library,you can change the partition policy bit to V1. The firmware will assign the default auth data that is in the access to all of the key objects in the partition (please see section "Import via V0 to V1 Partition Conversion" on page 156 for further considerations) . If using the:

- Luna use-case, there is nothing further to do, the objects already have the correct auth data assigned to be used
- eIDAS use-case, you can follow-up the conversion operation by a separate call to set the per-key auth data to the desired value.

Cryptoki API

This section highlights the changes at the Cryptoki API level.

CA_AuthorizeKey

```
CA_AuthorizeKey(
           CK_SESSION_HANDLE hSession,       // the session's handle
           CK_OBJECT_HANDLE  hObject,        // the object's handle
           CK_UTF8CHAR_PTR   pAuthData,      // the user's auth data
           CK_ULONG          ulAuthDataLen   // the length of the auth data
         )
```

This is a new command, as of firmware 7.7.0, to explicitly authorize a key (assigned or unassigned) by key handle in a given session. It can be used only in an already-authenticated session for any role.

CA_SetAuthorizationData

```
CA_SetAuthorizationData(
           CK_SESSION_HANDLE hSession,          // the session's handle
           CK_OBJECT_HANDLE  hObject,           // the object's handle
           CK_UTF8CHAR_PTR   pOldAuthData,      // the user's old/current auth data
           CK_ULONG          ulOldAuthDataLen   // the length of the old/current auth data
           CK_UTF8CHAR_PTR   pNewAuthData,      // the user's new auth data
           CK_ULONG          ulNewAuthDataLen   // the length of the new auth data
         )
```

This command modifies the authorization data for a key, and is available to all the roles without explicit requirement to have been authorized first with CA_AuthorizeKey(), since the call itself takes in the current authorization data as a parameter.

Old (current) auth data is an optional parameter. If not provided, this data is filled in by the library to the “Luna” value to accommodate the case of keys imported through the migration scenarios in section (which will have their auth data set initially from the access, hence “Luna” as well).

This case appears to the end-user as though they are setting the per-key auth of an imported key for the first time.

The following return codes are added, that can be returned by this command:

- CKR_AUTH_DATA_TOO_LARGE
- CKR_AUTH_DATA_TOO_SMALL

CA_ResetAuthorizationData

```
CA_ResetAuthorizationData(
           CK_SESSION_HANDLE hSession,       // the session's handle
           CK_OBJECT_HANDLE  hObject,        // the object's handle
           CK_UTF8CHAR_PTR   pAuthData,      // the user's auth data
           CK_ULONG          ulAuthDataLen   // the length of the auth data
         )
```

This command resets the authorization data for a key, and is available to the CO role only, and only for the unassigned keys.

This command also resets the authorization failure count (CKA_FAILED_KEY_AUTH_COUNT) for a locked out key and unlocks it.

Two new return codes can be returned by this command:

- CKR_AUTH_DATA_TOO_LARGE
- CKR_AUTH_DATA_TOO_SMALL

CA_AssignKey

```
CA_AssignKey(
          CK_SESSION_HANDLE hSession,       // the session's handle
          CK_OBJECT_HANDLE  hObject         // the object's handle
        )
```

This command flags a key as assigned by setting its CKA_ASSIGNED attribute to 1, and is available to the CO role only, and only for the unassigned keys.

The key has to satisfy the following conditions:

- It must have CKA_AUTH_DATA
- It must have CKA_EXTRACTABLE = false
- It must have CKA_SENSITIVE = true
- It must have CKA_MODIFIABLE = false

These new return codes can be returned by this command:

- CKR_ASSIGNED_KEY_REQUIRES_AUTH_DATA
- CKR_ROLE_CANNOT_MAKE_KEYS_ASSIGNED
- CKR_INVALID_ASSIGNED_ATTRIBUTE_TRANSITION
- CKR_ASSIGNED_KEY_FAILED_ATTRIBUTE_DEPENDENCIES

CA_IncrementFailedAuthCount

```
CA_IncrementFailedAuthCount(
          CK_SESSION_HANDLE hSession,       // the session's handle
          CK_OBJECT_HANDLE  hObject         // the object's handle
        )
```

This command increments the CKA_FAILED_KEY_AUTH_COUNT for a key.

It is intended to be used to keep members of an HA group in sync.

CKA_AUTH_DATA

This is a sensitive attribute on each symmetric/private key object, and holds the hashed authorization data. It is initialized through the regular means of passing in attribute values in templates during key generation, derivation, or unwrapping.

It can be modified only through the use of CA_SetAuthorizationData() (section "CA_SetAuthorizationData" on the previous page), and CA_ResetAuthorizationData() (section "CA_ResetAuthorizationData" on the previous page), and not through the regular C_SetAttributeValue() API, as the the current value of the auth data must be provided at the time of the modification. Having previously authenticated for per-key auth is not enough.

This is akin to the case of a user password modification/reset. Even when the user is logged in, the current password must be re-specified at the time of the password modification, with the exception of the administrator being able to reset the password.

CKA_ASSIGNED

This is an attribute on each symmetric/private key object, and indicates whether the key is an assigned key or a general key. The default value is false. It can be modified from false to true, but not the other way around.

The following are the new error codes that can be returned by an attempt to modify this attribute through C_SetAttribute() command:

- CKR_ASSIGNED_KEY_REQUIRES_AUTH_DATA
- CKR_ROLE_CANNOT_MAKE_KEYS_ASSIGNED
- CKR_INVALID_ASSIGNED_ATTRIBUTE_TRANSITION
- CKR_ASSIGNED_KEY_FAILED_ATTRIBUTE_DEPENDENCIES

CKA_KEY_STATUS
This is an attribute on each symmetric/private key object, and holds the key lock status flags and the failed per-key auth count limit. It is present only along with CKA_AUTH_DATA, otherwise never there, and never allowed.

```
typedef struct OH_KEY_STATUS_S {
            UInt8   flags1;
            UInt8   failedAuthLimt;
            UInt8   reserved1;
            UInt8   reserved2;
         } OH_KEY_STATUS;
```

Flags:

- CK_KEY_STATUS_F_AUTH_DATA_SET
- CK_KEY_STATUS_F_LOCKED_DUE_TO_FAILED_AUTH
- CK_KEY_STATUS_F_LOCKED_DUE_TO_DATE
- CK_KEY_STATUS_F_LOCKED_DUE_TO_DES3_BLOCK_COUNTER
- CK_KEY_STATUS_F_LOCKED_DUE_TO_USAGE_COUNTER

CKA_FAILED_KEY_AUTH_COUNT
This is an attribute on each symmetric/private key object, and holds the number for the failed per-key auth attempts. It will be present only along with CKA_AUTH_DATA, otherwise never there, and never allowed. The CO role can modify this attribute to lock/unlock the key through C_SetAttributeValue(). It is also reset upon auth data resetting by the CO through CA_ResetAuthorizationData().

Library/Tool Considerations

Tool Changes

LunaCM/LunaSH
LunaCM changes are highlighted below, LunaSH gets similar changes.

LunaCM supports an optional flag on partition creation that can be specified to tell the HSM that the partition should be a V0 partition (through partition version) to support Luna use-case and customers with legacy applications using older libraries, or V1 Partition, supporting the eIDAS use-case (SKS, PKA, etc.).

Ckdemo
Ckdemo has added support for CKA_AUTH_DATA and CKA_ASSIGNED attributes in all required commands for:

1. Key generation/derivation/unwrap
2. Attribute setting/modification

New commands are added, to:

- Authorize keys
- Assign general keys
- Set/Reset per-key auth data for general keys
- Increment failed auth count

The following is accomplished through existing commands:

- Query key status (locked/active) – Display Key
- Unlock locked keys – Set Attribute (failed auth count)

High Availability (HA)

Mixed modes, such as the following, are not supported:

- Pre-FW7.7.0 and Luna HSM Firmware 7.7.0 partitions
- V0 and V1 partitions

HA Group Migration

HA group migration from pre-FW7.7.0 will be done in two steps:

1. Updating the group to Luna HSM Firmware 7.7.0 (starting with non-primary members), which results in all partitions being flagged as V0 Partitions.
2. If desired, converting these V0 partitions to V1 partitions that are PP 419-221.5 compliant

To update an HA group to Luna HSM Firmware 7.7.0, all the non-primary partitions must be updated to Luna HSM Firmware 7.7.0 *first*, to ensure that the key objects from the pre-FW7.7.0 primary can still move to the non-primaries through key cloning. Then the primary can be updated to Luna HSM Firmware 7.7.0. At the conclusion of this step, all of the existing partitions on the upgraded HSMs are flagged as V0 Partition.

In the optional next step to convert these partitions to PP 419-221.5 compliant, V1 partitions, once again, all the non-primary partitions must be converted first, and only then the primary partition can be converted.

Migration Scenarios for Per-Key Auth

All of these migration scenarios imply key objects without per-key auth data being imported into a Luna HSM Firmware 7.7.0 partition that enforces per-key authentication.

To that end, we have to consider all paths from legacy devices such as FW4, FW6, and FW7, as well as legacy partitions on the FW7 that are converted to non-legacy.

There are several migration methods to be considered that are all detailed in the following sections:

1. Cloning
2. Pre-firmware-7.7.0 SKS (a.k.a. SIM)
3. Unwrapping
4. V0 to V1 Partition Conversion

Import via Cloning

When a key object is being imported via cloning from a legacy HSM/partition, the flattened object attributes within the incoming blob will not have a CKA_AUTH_DATA attribute present. Instead, the f/w will initialize the CKA_AUTH_DATA of the imported object to the value from the access.

- In the Luna use-case where the per-key auth is not visible to the end user, this is all that is needed.
- In the eIDAS use-case, the import via cloning should be followed by an explicit call to CA_SetAuthorizationData() to reset the per-key auth of the imported object to the desired value. Please note that imported keys cannot be assigned until their per-key auth is set.

Import via Legacy SKS

When a key object is being imported via legacy SKS from a legacy HSM/partition, the flattened object attributes within the incoming blob do not have a CKA_AUTH_DATA attribute present. Instead, the firmware initializes the CKA_AUTH_DATA of the imported object to the value from the access.

- In the Luna use-case where the per-key auth is not visible to the end user, this is all that is needed.
- In the eIDAS use-case, the import via legacy SKS should be followed by an explicit call to CA_SetAuthorizationData() to reset the per-key auth of the imported object to the desired value. Please note that imported keys cannot be assigned until their per-key auth is set.

Import via Unwrapping

When a key object is being imported via unwrapping, the unwrap template will have a CKA_AUTH_DATA attribute present:

- In the eIDAS use-case, the users will set the CKA_AUTH_DATA in the template explicitly.
- In the Luna use-case, the library fills the CKA_AUTH_DATA in the template (please refer to section "Template Handling in the Cryptoki Library" on page 150).

Import via V0 to V1 Partition Conversion

Existing keys will not have auth-data. Consider partition conversion as import (from outside into an eIDAS compliant environment), allowing for the setting of initial per-key auth values by the Administrator.

When the PSO or the PCO flip the partition version bit to convert the V0 partition to V1, the access auth-data (which was set upon login) is applied to all objects. The setting of this per-key auth is tracked (in case it was interrupted by a power failure or otherwise h/w reset), and the partition is mostly unusable until all the objects in the partition have been successfully converted.

Only in the eIDAS use-case (unlikely, as V0 or pre-firmware 7.7.0 devices/partitions would not have been involved in an eIDAS scenario), the conversion of the partition should be followed by an explicit call to CA_SetAuthorizationData() to reset the per-key auth of each key to the desired value. Please note that the keys on the converted partition cannot be assigned until their per-key auth is set.

Summary of New PKA Commands and Capabilities

This following table lists all of the new commands, HSM policies and APIs that are added by Luna HSM Firmware 7.7.0. It also provides a cross-reference to the section of the document with more details for the new item.

New Item	Description	Cross-reference
partition create -version	LunaCM command enhancement	"LunaCM/LunaSH" on page 154
CKA_AUTH_DATA	New object attribute	"New Authorization Data Attribute" on page 148 "CKA_AUTH_DATA" on page 153
CKA_ASSIGNED	New object attribute	"CKA_ASSIGNED" on page 153
CKA_KEY_STATUS	New object attribute	"CKA_KEY_STATUS" on page 154
CKA_FAILED_KEY_AUTH_COUNT	New object attribute	"CKA_FAILED_KEY_AUTH_COUNT" on page 154
CA_AuthorizeKey(CK_SESSION_HANDLE hSession, CK_OBJECT_HANDLE hObject, CK_UTF8CHAR_PTR pAuthData, CK_ULONG ulAuthDataLen)	New Cryptoki API	"CA_AuthorizeKey" on page 152
CA_SetAuthorizationData(CK_SESSION_HANDLE hSession, CK_OBJECT_HANDLE hObject, CK_UTF8CHAR_PTR pOldAuthData, CK_ULONG ulOldAuthDataLen CK_UTF8CHAR_PTR pNewAuthData, CK_ULONG ulNewAuthDataLen)	New Cryptoki API	"CA_SetAuthorizationData" on page 152
CA_ResetAuthorizationData(CK_SESSION_HANDLE hSession, CK_OBJECT_HANDLE hObject, CK_UTF8CHAR_PTR pAuthData, CK_ULONG ulAuthDataLen)	New Cryptoki API	"CA_ResetAuthorizationData" on page 152
CA_AssignKey(CK_SESSION_HANDLE hSession, CK_OBJECT_HANDLE hObject)	New Cryptoki API	"CA_AssignKey" on page 153

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New Item	Description	Cross-reference
CA_IncrementFailedAuthCOunt(CK_SESSION_HANDLE hSession, CK_OBJECT_HANDLE hObject)	New Cryptoki API	"CA_IncrementFailedAuthCount" on page 153
CKR_ASSIGNED_KEY_REQUIRES_AUTH_DATA	New return code	"CKA_ASSIGNED" on page 153
CKR_ROLE_CANNOT_MAKE_KEYS_ASSIGNED	New return code	"CKA_ASSIGNED" on page 153
CKR_INVALID_ASSIGNED_ATTRIBUTE_TRANSITION	New return code	"CKA_ASSIGNED" on page 153
CKR_ASSIGNED_KEY_FAILED_ATTRIBUTE_DEPENDENCIES	New return code	"CKA_ASSIGNED" on page 153
CKR_AUTH_DATA_TOO_LARGE	New return code	"CA_SetAuthorizationData" on page 152 "CA_ResetAuthorizationData" on page 152
CKR_AUTH_DATA_TOO_SMALL	New return code	"CA_SetAuthorizationData" on page 152 "CA_ResetAuthorizationData" on page 152
CK_KEY_STATUS_F_AUTH_DATA_SET	New flag	"CKA_KEY_STATUS" on page 154
CK_KEY_STATUS_F_LOCKED_DUE_TO_FAILED_AUTH	New flag	"CKA_KEY_STATUS" on page 154
CK_KEY_STATUS_F_LOCKED_DUE_TO_DATE	New flag	"CKA_KEY_STATUS" on page 154
CK_KEY_STATUS_F_LOCKED_DUE_TO_DES3_BLOCK_COUNTER	New flag	"CKA_KEY_STATUS" on page 154
CK_KEY_STATUS_F_LOCKED_DUE_TO_USAGE_COUNTER	New flag	"CKA_KEY_STATUS" on page 154

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V0 PARTITIONS

Version zero (V0) partitions are designed to support older clients. They can be created in two ways: through firmware update (all existing partitions will be marked as legacy) and directly during partition creation. They will be marked with a new policy: “Partition Version”, which will be set to 0. The regular, non-legacy partitions will be version 1.

Firmware Update

1. During firmware update from a pre-7.7.0 version, existing partitions are always converted to V0 partitions
2. Zeroizes old STC keys as Luna HSM Firmware 7.7.0 (and newer) will not support it at all.
3. Partition v0 to v1 transition is non-destructive (both across firmware update and through normal toggling):

Existing keys will not have auth-data. The first time the CO logs in, the access auth-data is set and can be applied to all objects. A partition on an HSM updated to firmware version 7.7.0 (or newer) becomes usable when a one-time CO login is performed.

The firmware update process, in this case, is considered equivalent to “import” because the existing keys are being imported in to the ecosystem of the new firmware.

For purposes of STC: to avoid breaking the clients’ access to the partition, old STC must be disabled before firmware update, then, post-update a partition updated to V0 allows new STC setup. So the appropriate order would be to update the client first, then setup new STC, then set the partition version to V1 if desired.

Neither V0 nor V1 partitions will support old STC

Partition Creation

1. An optional flag can be specified to tell the HSM that the partition should be Partition Version v0 (supported by LUSH and LunaCM)
   Normally, in the case of legacy client support, we’re talking about appliance, and partitions are created through Lush, which will be updated anyway.
2. Old clients (or old client apps + new client library) are unable to provide this, so partitions created with the old client will be v1.
   As mentioned above, this should only apply to PCI case, and we don’t have to support legacy client installations there.
3. If a partition is pre-created, and it is later determined that a partition version v0 is required, HSM SO has to delete the partition and re-create a partition v0
4. Identified by “Partition Version policy”.
   a. Partition Version 0 == new default or pre-existing upgraded to Luna HSM Firmware 7.7.0 (or newer), Partition Version 1 == eIDAS (SKS and PKA)
   b. Policy is always destructive for V1 to V0 transition (eIDAS use-case to Luna use-case), and cannot be changed by customer via PPT (Partition Policy Template)
   c. V0 to V1 (Luna use-case to eIDAS use-case), non-destructive by default, can be set to be destructive.
5. Other default partition policy settings that are forced on the legacy partition (either directly upon creation or through firmware update)

   a. SKS capability/policy = 1/0 (even in the case of insertion, since pre-firmware-7.7.0 does not have any SKS support)
   b. Cloning capability/policy = 1/1
   c. Per-key-auth capability/policy = 1/0
   d. If CKE (cloning-key-export), then remains as CKE with same SIM/Cloning settings as above.
6. For V0 partition:
   a. Does not allow partition policy changes that would require new clients
      i. Cannot turn SKS On (both masking and unmasking private/secret keys)
      ii. Cannot turn Per-key-auth On
   b. Allows user objects to be cloned off using CPV3
   c. HA Login
      i. v1.1 is supported on Secondary HSM
      ii. v1.0 is not supported on Secondary HSM
      iii. v1.0, v1.1 and v2.0 are all always supported on Primary HSMs
7. For V1 partition:
   a. Per-key-auth is turned On by default, but can be turned Off for performance
   b. Does not allow user objects to be cloned off
   c. HA Login
      i. v1.1 is not supported on Secondary HSM
      ii. v1.0 is not supported on Secondary HSM
      iii. Only v2.0 is supported on Secondary HSM
      iv. v1.0, v1.1 and v2.0 are all always supported on Primary HSMs

Converting from V0 to V1 (changing the policy)

1. Non-destructive to the partition by default (can be changed)
2. Leaves Cloning On (but V1 does not allow cloning out, only in for migration)
3. Turn SKS On
4. Turn Per-key-auth On

Converting from V1 to V0 (changing the policy)

1. Destructive to the partition (and can't be changed)
   a. Zeroize everything except for STC keys: SMKs, etc.
2. Turn SKS Off
3. Turn Per-key-auth Off

G5 Backup HSM and Cloning Protocol

1. V0 and V1 partitions are not distinguishable, they all have CPV3 and same migration rules.
2. When cloning out of CPV3 HSM, new things like DES3 usage counters are included
    i. FW7.7.0 brings updated features for FIPS compliance, so adjustment is needed to allow their backup -- FW7.7.0 update for G5 Backup HSM allows those counters to be stored in its header
3. Support for creating backup partitions with old client during **partition archive** command
    a. Backup partitions default to a “set on first use” value for CPVx and FM-enabled
    b. Then when used, (for example, CloneAsTargetInit) the CPVx (cloning protocol version) and FM-enabled values are set
    c. All backup partitions are created in this way (as “set on first use”). Partition attributes are visible in LunaCM.
4. Some new things like new key types (ed25519 etc) cannot be added to Luna Backup HSM G5. That still requires moving to blob-based-backup; consider Luna Backup HSM 7.

eIDAS partitions

1. New partitions can be V1 by selecting the option at partition creation time.
2. SKS is ON
3. Per-key-auth is ON
4. No key cloning (outbound)
    a. When high level CA_CloneObject() call is issued, the client library chooses cloning or SKS based on what is available at the source and target HSMs,
5. For full backward compatibility for old client applications that use the step-by-step cloning APIs, the solution is to employ cloning CPV3 APIs in the firmware to achieve key transport over SKS blobs:
    a. CloneAsTargetInit always performs the regular TargetInit operation, because it does not know
        i. if the source is V0 or not, or
        ii. if the requested operation is a command to clone the SMK, or
        iii. if the requested operation is will be an SKS extract/insert that needs to pose as cloning
        iv. this adds overhead for one part of the cloning exchange, an RSA operation, which can slow applications that don’t use new SKS APIs.
    b. CloneAsTarget, from V1 to V1
        i. This can receive SKS blob (for key objects) or cloning blob (only for SMK)
        ii. Both blobs start with SIM: [length|SIM-MECH|SMK ID], cloning: [length|legacy bit + cloning version|zSizeField]
        iii. New mechanism values are used to prevent collision with cloning version

Limited Crypto Officer (LCO) role

As the name suggests, this role is between the CO and CU. It is a subset of the CO role – that is, everything LCO can do, CO can do as well but not the other way around. The relationship between LCO and CU is somewhat more complicated. For the most part, LCO is a superset of CU; however, there are some nuances with cloning – LCO does not support cloning in any way, shape, or form while CU can clone public objects. This is why

- the CO role is common both for the traditional use-cases of the Luna HSM and for the eIDAS use-case
- the CU role is retained for traditional Luna use-cases without a real place in the eIDAS use-case (which uses SKS in place of cloning)
- the LCO role is suited to the eIDAS use-case

Below are the details:

1. LCO is created by CO.
2. LCO supports password authentication and multifactor quorum authentication. For multifactor quorum authentication:
   a. A new iKey can be separate from CO and CU keys;
   b. MofN is supported.
3. LCO is supported by HA_Login for primary and secondary nodes.
4. CO can reset LCO's primary credentials (password or iKey), for example lunacm **role resetpw**
   a. This can be done regardless of the Enable SO reset of a partition PIN HSM policy 15 (contrast this to PSO resetting CO's primary credentials).
5. CO can create LCO's challenge (multifactor quorum authentication)
   a. LCO is subject to activation (partition policy 22);
   b. LCO can be deactivated (e.g., lunacm **role deactivate**) by any role or even w/o a session.
6. CO can reset LCO's challenge (multifactor quorum authentication) e.g. lunacm **role createChallenge**
   a. This can be done regardless of the Enable SO reset of a partition PIN HSM policy 15 (contrast this to PSO resetting CO's challenge).
7. LCO, and only LCO, can change its own primary and/or secondary credentials (password or iKey and/or challenge secret); for example **role changepw**.
8. LCO is subject to the Enable forcing user PIN change HSM policy 21 with respect to either primary or secondary credentials (password or iKey and/or challenge secret).
9. LCO is subject to failed logins logic:
   a. The Max failed user logins allowed partition policy 20;
   b. Upon reaching the limit, LCO locks out; CO and CU remain operational;
   c. The Partition CO can unlock the Partition Limited Crypto Officer role by resetting its credentials;
   d. The Max failed challenge responses >partition policy 15;
   e. HA_Login is governed by the same logic (for primary credentials; that is, challenge excluding).
10. LCO is subject to the following partition policies:
    a. Minimum PIN length (25),

   b. Maximum PIN length (26).

11. Pre-firmware 7.7.0 partitions or V0 partitions:
   a. Luna HSM Client 10.2.0 or older: LCO role is not exposed (not visible through any tools).
   b. Luna HSM Client 10.3.0 or newer: LCO role is visible but any login attempt will always fail.
12. LCO can generate keys (assigned or unassigned)
   a. LCO cannot assign keys (but can generate them assigned).
13. LCO can delete keys:
   a. Unlike CO, LCO has to provide per-key authorization data,
   b. LCO needs to be able to delete keys to support the “single-use signing keys” scenario where a user generates a key, signs with that key, and deletes the key.
14. LCO can create and destroy private objects.
15. LCO can copy keys
   a. Like CO, LCO has to provide per-key authorization data
16. LCO can copy private objects
17. LCO can modify keys
   a. Like CO, LCO has to provide per-key authorization data for unassigned keys.
18. LCO can modify private objects.
19. LCO has the same rules with respect to Usage Counters as CU
   a. Can increment the counter but, unlike CO, cannot change/set the limit.
20. LCO can generate domain parameters
21. LCO can authorize PKA keys
   a. Same as CO, CU, SO, and AD.
22. LCO can set a new per-key authorization data (the old one must be provided)
   a. Same as CO, CU, SO, and AD.
23. Unlike SO and CO, LCO cannot reset (i.e. w/o providing the old auth data) the per-key authorization data
   a. SO and CO can do it for unassigned keys. Nobody can for assigned.
24. Unlike SO and CO, LCO cannot unblock blocked (due to per-key auth failures) PKA keys.
25. LCO can wrap/unwrap:
   a. PKA behaviour for wrap: has to provide the per-key auth data for both the wrapping and the wrapped keys.
   b. PKA behaviour for unwrap: has to provide the per-key auth data for unwrapping key and specify the per-key auth data for the unwrapped key in the template.
   c. For the unwrapped key, if auth data is not in the template, the library will insert the access level auth data.
26. LCO can derive keys:
   a. PKA behaviour: has to provide the per-key auth data for the key used for derivation and specify the per-key auth data for the key being derived in the template.
   b. For the derived key, if auth data is not in the template, the library will insert the access level auth data.

27. LCO can derive-and-wrap
    a. PKA behaviour: as per the wrap/unwrap and derive points above.
28. LCO can SIM extract/insert in all scenarios:
    a. Including SKS key migration (old SKS: SIM Insert; no SIM Extract),
    b. Including new SKS (SIM Extract and SIM Insert).
29. LCO cannot clone/replicate in any scenario:
    a. CPV1 user key migration – no.
    b. CPV3 user key migration from legacy partitions – no.
    c. SMK (SKS secret) cloning (including G5 backup/restore) – no.
        i. Among other things, this means that LCO is not self-sufficient to perform HA – CO is required to clone SMK(s).
    d. Note that CU can do some limited cloning but LCO cannot.
30. Unlike CO, LCO cannot perform SMK rollover.

Example: Creating a key with PKA to have AUTH data

This example uses CKDemo.

1. Login to the HSM partition (CO or LCO role).

```
(1) Open Session
(3) Login [Login as CO with partition CO password or challenge]
```

2. Generate an RSA Key Pair

```
(45) Simple Generate Key
Select type of key to generate [7] RSA
Enter Key Length in bits:2048 and set key attributes
```

3. Set the Authorization Data on the private key.

```
(211) Set Authorization Data

Sample Output

Using zero-length authorization data.
What format do you wish to enter the new authorization data in?
[0] No Authorization Data
[1] HEX (max 256 bytes)
[2] String (max 256 characters)
Choice: 2

Enter data in string format: lunakey

Status: Doing great, no errors (CKR_OK)
```

> **NOTE** NOTE: "lunakey" is the AuthData supplied as a password string used in the above step #3 to create the AuthData (Option 211) and then in step #4, below, to authenticate.

4. Authorize the private key before usage (e.g., for signing).

```
(210) Authorize Key
Sample Output
```

```
Enter your choice : 210
Do you wish to authorize a key in a session or authorize keys at the access level?
[0] Authorize A Key In A Session
[1] Authorize Keys At The Access Level
Choice: 0

Select the object to authorize (0 to list available objects) : 363

What format do you wish to enter the authorization data in?
[0] No Authorization Data
[1] HEX (max 256 bytes)
[2] String (max 256 characters)
Choice: 2

Enter data in string format: lunakey

Status: Doing great, no errors (CKR_OK)
```

5. Demonstrate Signing with the authorized key.

```
(42) Sign
Mechanism to use: [4] SHA256-RSA

Sample Output

Enter data to sign: WorldIsBeautiful

Enter key used for signature (0 to list available objects) : 363

The following data was saved to file SIGN.BIN
(hex)
9dbf5e1a9a3839cd4962c32e1598ca25b5fe38923e7d0c4c183c8ba0d2fdcee17eb39481aca0a454508f428081ef
1f9d985556d209108d7c0ea6cfa1391c0f331a3c6184f4ff9f8ceffa4c33a5dcadac809847985ea4d61bbc490bee
0be897b8c7ff60d0dfab60277a5a4b8c8d8d22ca59f30cf0026e1598c50f3375f00e3623c7a7413ebd37ec24bede
1621673b085e71e9d7d0cf677d88686e6fdd5f1ad0935720ad6d9ee8439230bf0e2afff3a2884f1f6a186660ed68
af5baa26f0147d10b335b56579e56798ba2425777e82a9cafe24cc34e1452a1424dfd520112fd9f6d364c8600181
e2dd87b395c4a1c80c5687e68bf7e2c2cca094a350bbac3ed146
Status: Doing great, no errors (CKR_OK)
```

Demonstrate failure if the key is not authorized.

Since we have chosen to authorize the key as Authorize A Key In A Session , we can attempt to open a new session and use the key for signing which should fail with CKR_KEY_NOT_AUTHORIZED.

Sample Output

```
Enter your choice : 42

Sessions available:
session#1 - slot 0
session#2 - slot 0
Select a session: 2
Mechanism to use: [4] SHA256-RSA

Enter data to sign: SomeDataOrOther

Enter key used for signature (0 to list available objects) : 363

Status: C_Sign returned error. (CKR_KEY_NOT_AUTHORIZED)
```

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CHAPTER 5: Using the Luna SDK

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

> "Libraries and Applications" below
> Object handles and labels
> "Application IDs" on page 174
> "Named Curves and User-Defined Parameters" on page 178
> "ECDH with Key Derive Function" on page 189
> ECIES general
> ECIES for 5G
> "Supported ECC Curves" on page 185
> "Capability and Policy Configuration Control Using the Luna API" on page 194
> "Connection Timeout" on page 198

Libraries and Applications

This section explains how to make the Chrystoki library available to the other components of the Luna 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.

Luna SDK Applications General Information

All applications provided in Luna USB HSM 7 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 crystoki.ini (Windows) or crystoki.conf (UNIX) file.

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Compiler Tools

Tools used for Luna development are platform specific tools/development environments, where applicable (e.g., Visual C++ on Windows). Current version information is provided in the Customer Release Notes.

> **NOTE** Contact Thales for information about the availability of newer versions of compilers.

Using CKlog

Luna Software Development Kit provides a facility which can record all interactions between an application and the PKCS#11-compliant library. It allows a developer to debug an application by viewing what the library receives.

This tool is known as the Cryptoki Logging Facility or cklog. Cklog is a shim library that an application accesses when seeking our PKCS#11 library. When cklog receives a call it does not service the request. Instead, it logs the call to a file and passes the request to the originally intended library. Configuration consists of redirecting the LibNT (Windows) or LibUNIX (Linux/UNIX) library locations, and setting some additional configuration options as summarized after the examples, below.

Prior to client UC10.9.1, cklog exposed some sensitive information.

The default is now to mask such information in cklog unless you explicitly allow it. See "Configure cklog masking" on page 170, below, for more detail.

To configure CkLog:

Perform these steps:

1. Direct the application to use the cklog library instead of the regular Chrystoki library. Do this by modifying the configuration file to instruct CkBridge to load the Cklog library.

   Windows

   ```
   [Chrystoki2]
   LibNT=c:\Program Files\SafeNet\LunaClient\cklog201.dll
   ```

   Linux/UNIX

   ```
   Chrystoki2 =
   {
   LibUNIX=/usr/lib/libcklog2.so;
   ```

2. Instruct the cklog library where to access the regular cryptoki library.

   Windows

   ```
   [CkLog2]
   LibNT=c:\Program Files\SafeNet\LunaClient\cryptoki.dll
   ```

   Linux/UNIX

   ```
   CkLog2 =
   {
   LibUNIX=/usr/lib/libCryptoki2.so;
   }
   ```

3. Add appropriate entries to the CkLog2 section for the desired level of operation. See the examples and explanations of entries, below.

Windows Example

The following example shows a typical initialization file under Windows where cklog is in use:

```
[Chrystoki2]
LibNT=c:\Program Files\SafeNet\LunaClient\cklog201.dll
[CkLog2]
LibNT=c:\Program Files\SafeNet\LunaClient\cryptoki.dll
Enabled=1
File=c:\Program Files\SafeNet\LunaClient\cklog2.txt
Error=c:\Program Files\SafeNet\LunaClient\error2.txt
FileSize=100
NewFormat=1
LoggingMask=ALL_FUNC
```

UNIX Example

The following example shows a typical configuration file under UNIX where cklog is in use:

```
Chrystoki2 =
{
LibUNIX=/usr/lib/libcklog2.so;
}
CkLog2 =
{
LibUNIX=/usr/lib/libCryptoki2.so;
Enabled=1;
File=/tmp/cklog.txt;
FileSize=100
Error=/tmp/error.txt;
NewFormat=1;
LoggingMask=ALL_FUNC;
}
```

Here are descriptions of entries that might be applicable:

- LibNT - references to a Cryptoki library for Windows.
- LibUNIX - references to a Cryptoki library for UNIX.
- Enabled - 0 or 1. Allows turning the logging facility off or on.
- File - references the file to which the requests should be logged.
- FileSize - in MB is the size that triggers log-file rotation - when the file reaches the indicated value, it is renamed to indicate the current date and time (like cklog.txt-<YYMMDD-hhmmss>), and a new cklog.txt file begins accumulating log entries.
- Error - references a file where the logging facility can record fatal errors.
- NewFormat - affects the log output format. Possible values:
  - **0**: standard log output format
  - **1** (default): compact output format preferred by Thales Customer Support

    ```
    2023-06-27 15:38:48 07724--424540352:FINIInitialize CKR_OK(10ms) {}
    ```

  - **2**: compact output format, including the amount of real time that Luna HSM Client took to process the request (`operation latency`, in ms). This option requires Luna HSM Client 10.6.0 or newer.

    ```
    2023-06-27 15:38:48 07724--424540352:FINIInitialize CKR_OK(10ms) (operation latency:
    40ms) {}
    ```

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Selective Logging

When logging is turned on, all functions are logged, by default. If you wish to restrict logging to particular functions of interest only, you can edit the “LoggingMask=” parameter in the crystoki.ini [Windows] or Chrystoki.conf [UNIX] file to include flags for the desired logging.

LoggingMask= Flags

Here is the list of possible flags for cklog:

Flag	Description
GEN_FUNC	General functions
SLOT_TOKEN_FUNC	Slot/Token related functions
SESSION_FUNC	Session related functions
OBJ_MNGMNT_FUNC	Object Management functions
ENC_DEC_FUNC	Encrypt/Decrypt related functions
DIGEST_FUNC	Digest Related functions
SIGN_VERIFY_FUNC	Signing/Verifying related functions
KEY_MNGMNT_FUNC	Key Management related functions
MISC_FUNC	Misc functions
CHRYSALIS_FUNC	Luna Extensions functions
ALL_FUNC	All functions logged;

You can mix and match any or all of the flags, using the “|” operator. For example, the following:

LoggingMask=GEN_FUNC | SLOT_TOKEN_FUNC | ENC_DEC_FUNC | SIGN_VERIFY_FUNC;

would be valid.

> **NOTE** You can use the flags in any order. Using the ALL_FUNC flag overrides any other flag. If you have the “LoggingMask=” parameter, with NO flags set, then nothing is logged. If logging capability is enabled (cklog), but there is no “LoggingMask=” line, then default behavior prevails and *everything* is logged.

Configure cklog masking

For security reasons, beginning with UC 10.9.1, CKLog defaults to masking sensitive data. Previously, it was generally not masked in the log text file (except for passwords, which are always masked). To revert to the

previous behavior, you must add the **MaskedParams** entry under the Cklog2 heading in the Configuration file (Chrystoki.conf / crystoki.ini), either by manually editing or by using the configurator tool. The same applies if you wish to edit/change an existing entry.

The use of command vtl cklogsupport (enable option) launches cklogging, but does not perform this configuration, which must be done separately.

Example of Chrystoki.conf / crystoki.ini entry

```
Cklog2 = {
  Enabled = 1
  File = /tmp/cklog.txt;
  FileSize = 100
  Error = /tmp/error.txt
  LibUNIX = /usr/safenet/lunaclient/libCryptoki1.so;
  LibUNIX64 = /usr/safenet/lunaclient/lib/libCryptoki2_64.so;
  MaskedParams = 0;  <-- unmasked - this parameter does not appear in config file unless
explicitly added; instead, value 1 is assumed
```

What it means, how it works

Prior to client version UC 10.9.1, when performing crypto operations, sensitive information and byte strings, including file text could be visible in clear text in cklog. To prevent that, or make it optional, in UC 10.9.1 and newer, the `MaskedParams =` parameter was added. You can insert it by directly editing the Cklog2 section in the Chrystoki.conf (Linux) or Crystoki.ini (Windows) file; if that section does not already exist, create one. Or use the configurator tool to do the same; it creates the section, if needed, and adds the entry. Setting `MaskedParams =` does not enable logs (see above about "vtl cklog enable").
Parameters that were always masked previously remain masked.

Values of MaskedParams

Values of the parameter are:

0 - legacy no masking (except passwords and highly sensitive attributes CKA_primes, CKA_coefficients, AUXdata)

```
./configurator setValue -s CkLog2 -e MaskedParams -v 0
```

With no masking, values in log are depicted as "somestringofcharacters" where the value that was input or that was generated by a logged operation appears between quotation marks.

1 - (new default) masks log data that is identified as sensitive (encrypt/decrypt, API, attribute values like CKAvalue, pEncryptedData

either no value set, or

```
./configurator setValue -s CkLog2 -e MaskedParams -v 1
```

When a parameter masking level is set, affected (masked) values are depicted as "*" a single asterisk between quotation marks, or for attributes, the value is simply omitted from the log entirely with no asterisk.

2 - deeper masking (superset of level 1) like CKA_label for an object, and other attributes

```
./configurator setValue -s CkLog2 -e MaskedParams -v 2
```

When a masking level is set, affected (masked) values are depicted as "*" a single asterisk between quotation marks, or for attributes, the value is simply omitted from the log entirely with no asterisk.

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Sample log outputs of actions

The following sample operations show the result in log files when MaskedParams is set to the available options:

C_GetSlotList or Ckdemo Option: 14
C_GetFunctionList or by opening Ckdemo
C_DestroyObject or Ckdemo Option: 22
C_GetInfo or Ckdemo Option: 10
C_GetMechanismInfo or Ckdemo Option: 9
C_GetMechanismList or Ckdemo Option: 8

Logs of the foregoing actions remain unmasked when MaskedParams is set to 0, or 1, or 2.

C_Digest

Log of this action shows ByteString with data when MaskedParams is set to 0.
Log of this action shows ByteString with "*" when MaskedParams is set to 1 or 2.

C_DigestUpdate or Ckdemo Option: 44

Log of this action shows ByteString with data when MaskedParams is set to 0.
Log of this action shows ByteString with "*" when MaskedParams is set to 1 or 2.

C_DigestFinal
C_DigestInit
C_DigestKey or Ckdemo Option: 46

Logs of these actions show ByteString with data when MaskedParams is set to 0.
Logs of these actions show ByteString with "*" when MaskedParams is set to 1 or 2.

C_DeriveKey or Ckdemo Option: 63

Log of this action remains unmasked (shows cleartext) when MaskedParams is set to 0.
Appropriate attributes are omitted when MaskedParams is set to 1 or 2

C_CreateObject or Ckdemo Option: 20

Log of this action remains unmasked (shows cleartext) when MaskedParams is set to 0.
Appropriate attributes are omitted when MaskedParams is set to 1 or 2

C_CopyObject or Ckdemo Option: 21

Log of this action remains unmasked (shows cleartext) when MaskedParams is set to 0.
Appropriate attributes are omitted when MaskedParams is set to 1 or 2.

C_GetAttributeValue or Ckdemo Option: 38

Log of this action remains unmasked (shows cleartext) when MaskedParams is set to 0.
Appropriate attributes are omitted when MaskedParams is set to 1 or 2

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C_FindObjects or Ckdemo Option: 26
C_FindObjectsFinal
C_FindObjectsInit

Logs of these actions remain unmasked (shows cleartext) when MaskedParams is set to 0, or 1, or 2.

C_GetSessionInfo or Ckdemo Option: 13

Log of this action shows AppID masked when MaskedParams is set to 0, or 1, or 2.

C_GenerateRandom or Ckdemo Option: 62

Log of this action shows ByteString with data when MaskedParams is set to 0.
Log of this action shows ByteString with "*" when MaskedParams is set to 1 or 2.

C_SeedRandom or Ckdemo Option: 66

Log of this action shows ByteString with data when MaskedParams is set to 0.
Log of this action shows ByteString with "*" when MaskedParams is set to 1 or 2.

C_SignInit or Ckdemo Option: 42

Log of this action shows ByteString with data when MaskedParams is set to 0.
Log of this action shows ByteString with "*" when MaskedParams is set to 1 or 2.

C_GenerateKey/C_GenerateKeyPair or Ckdemo Option: 45

Log of this action remains unmasked (shows cleartext) when MaskedParams is set to 0.
Appropriate attributes are omitted when MaskedParams is set to 1 or 2

C_WrapKey / C_UnwrapKey or Ckdemo Option: 60/61

Log of this action shows ByteString with data when MaskedParams is set to 0.
Log of this action shows ByteString with "*" when MaskedParams is set to 1 or 2.

C_Encrypt/C_Decrypt
C_EncryptFinal
C_EncryptInit
C_EncryptUpdate
C_DecryptFinal
C_DecryptInit
C_DecryptUpdate or Ckdemo Option: 40/41

Logs of these actions show ByteString with data when MaskedParams is set to 0.
Logs of these actions show ByteString with "*" when MaskedParams is set to 1 or 2.

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Application IDs

Within Chrystoki, each application has an application ID that is generated when the application starts, but which can also be specified in the configuration file. An application ID was historically a 64-bit integer, normally specified in two 32-bit parts. As of Luna HSM Firmware 7.7.0, application IDs are 128 bits. 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.

NOTE From HSM firmware version 7.8.4 and newer, Application IDs (APPId) are *encrypted*, with the following effects:

- Whenever firmware is upgraded from a non-APPID encrypted version (before firmware 7.8.4) to an encrypted APPID firmware version, the access ID shown in the audit logs will change.
- The ID is encrypted for sending *to* the HSM, and when sent *back to* the crypto library, and is *unencrypted* and visible for the application (for example, LUNACM) but appears in *encrypted* form only, in audit logs.
- The access ID shown also changes after every reset/restart of firmware version 7.8.4 and newer because a new APPID encryption key (AEK) is created each time firmware starts up. The AEK is used by the crypto library of the APP to encrypt the access ID.
- Also whenever an Application is started it creates a new random access ID each time (unless fixed to a value [set AppId= under the Misc section] in the Configuration file).

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 Luna 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 Luna PED authentication across multiple applications, but this is not ideal for security reasons.

To change application IDs manually using the LunaCM **appid** command, see appid.

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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 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

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.

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Login State Sharing Functions

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

> **NOTE** The following login state sharing functions cannot be used with STC-enabled slots.

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.

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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()
```

Named Curves and User-Defined Parameters

Luna USB HSM 7 is a PKCS#11-oriented device. The HSM firmware statically defines NIST named curve OIDs and curve parameters by default. You can also define other non-NIST curve OIDS and parameters such as Brainpool. Luna USB HSM 7 can decode and use the ecParameters structure for key generation, signing, and verification.

Curve Validation Limitations

The HSM can validate the curve parameters, but 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 181.

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

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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     = 400000000000000000000000004A20E90C39067C893BBB9A5
```

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=AADD9DB8DBE9C48B3FD4E6AE33C9FC07CB308DB3B3C9D20ED6639CCA703308717D4D9B009BC66842AECDA12AE6A38
0E62881FF2F2D82C68528AA6056583A48F3

a=7830A3318B603B89E2327145AC234CC594CBDD8D3DF91610A83441CAEA9863BC2DED5D5AA8253AA10A2EF1C98B9AC
8B57F1117A72BF2C7B9E7C1AC4D77FC94CA

b=3DF91610A83441CAEA9863BC2DED5D5AA8253AA10A2EF1C98B9AC8B57F1117A72BF2C7B9E7C1AC4D77FC94CADC083
E67984050B75EBAE5DD2809BD638016F723

x=81AEE4BDD82ED9645A21322E9C4C6A9385ED9F70B5D916C1B43B62EEF4D0098EFF3B1F78E2D0D48D50D1687B93B97
D5F7C6D5047406A5E688B352209BCB9F822

y=7DDE385D566332ECC0EABFA9CF7822FDF209F70024A57B1AA000C55B881F8111B2DCDE494A5F485E5BCA4BD88A276
3AED1CA2B2FA8F0540678CD1E0F3AD80892

q=AADD9DB8DBE9C48B3FD4E6AE33C9FC07CB308DB3B3C9D20ED6639CCA70330870553E5C414CA92619418661197FAC1
0471DB1D381085DDADDB58796829CA90069
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    = 34545567685743523457
x    = 188DA80EB03090F67CBF20EB43A18800F4FF0AFD82FF1012
y    = 07192B95FFC8DA78631011ED6B24CDD573F977A11E794811
q    = FFFFFFFFFFFFFFFFFFFFFFFF99DEF836146BC9B1B4D22831
h    = 12323435765786
```

Supported ECC Curves

The following table lists all supported Elliptic Curve Cryptography (ECC) curves and their Object Identifiers (OID, expressed in dot notation and byte format).

> **NOTE** When **HSM policy 12:** Allow non-FIPS algorithms is disabled (FIPS mode):
> - curves with length 224-bits or greater can be used for all operations
> - curves >= 160-bits and < 224-bits can be used for signature verification only
> - curves less than 160-bits are not permitted
>
> These restrictions comply with the recommendations in NIST SP 800-131A Rev2.

Curve Name(s)	OID (dot)	OID (byte)	Security Strength (bits)
brainpoolP160r1	1.3.36.3.3.2.8.1.1.1	06 09 2B 24 03 03 02 08 01 01 01	80
brainpoolP160t1	1.3.36.3.3.2.8.1.1.2	06 09 2B 24 03 03 02 08 01 01 02	80
brainpoolP192r1	1.3.36.3.3.2.8.1.1.3	06 09 2B 24 03 03 02 08 01 01 03	96
brainpoolP192t1	1.3.36.3.3.2.8.1.1.4	06 09 2B 24 03 03 02 08 01 01 04	96
brainpoolP224r1	1.3.36.3.3.2.8.1.1.5	06 09 2B 24 03 03 02 08 01 01 05	112
brainpoolP224t1	1.3.36.3.3.2.8.1.1.6	06 09 2B 24 03 03 02 08 01 01 06	112
brainpoolP256r1	1.3.36.3.3.2.8.1.1.7	06 09 2B 24 03 03 02 08 01 01 07	128
brainpoolP256t1	1.3.36.3.3.2.8.1.1.8	06 09 2B 24 03 03 02 08 01 01 08	128

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Curve Name(s)	OID (dot)	OID (byte)	Security Strength (bits)
brainpoolP320r1	1.3.36.3.3.2.8.1.1.9	06 09 2B 24 03 03 02 08 01 01 09	160
brainpoolP320t1	1.3.36.3.3.2.8.1.1.10	06 09 2B 24 03 03 02 08 01 01 0a	160
brainpoolP384r1	1.3.36.3.3.2.8.1.1.11	06 09 2B 24 03 03 02 08 01 01 0b	192
brainpoolP384t1	1.3.36.3.3.2.8.1.1.12	06 09 2B 24 03 03 02 08 01 01 0c	192
brainpoolP512r1	1.3.36.3.3.2.8.1.1.13	06 09 2B 24 03 03 02 08 01 01 0d	256
brainpoolP512t1	1.3.36.3.3.2.8.1.1.14	06 09 2B 24 03 03 02 08 01 01 0e	256
c2pnb163v1 (X9.62 c2pnb163v1)	1.2.840.10045.3.0.1	06 08 2A 86 48 CE 3D 03 00 01	81
c2pnb163v2 (X9.62 c2pnb163v2)	1.2.840.10045.3.0.2	06 08 2A 86 48 CE 3D 03 00 02	81
c2pnb163v3 (X9.62 c2pnb163v3)	1.2.840.10045.3.0.3	06 08 2A 86 48 CE 3D 03 00 03	81
c2pnb176w1 (X9.62 c2pnb176w1) **c2pnb176v1** (X9.62 c2pnb176v1)	1.2.840.10045.3.0.4	06 08 2A 86 48 CE 3D 03 00 04	88
c2pnb208w1 (X9.62 c2pnb208w1)	1.2.840.10045.3.0.10	06 08 2A 86 48 CE 3D 03 00 0A	104
c2pnb272w1 (X9.62 c2pnb272w1)	1.2.840.10045.3.0.16	06 08 2A 86 48 CE 3D 03 00 10	136
c2pnb304w1 (X9.62 c2pnb304w1)	1.2.840.10045.3.0.17	06 08 2A 86 48 CE 3D 03 00 11	152
c2pnb368w1 (X9.62 c2pnb368w1)	1.2.840.10045.3.0.19	06 08 2A 86 48 CE 3D 03 00 13	184
c2tnb191v1 (X9.62 c2tnb191v1)	1.2.840.10045.3.0.5	06 08 2A 86 48 CE 3D 03 00 05	96
c2tnb191v2 (X9.62 c2tnb191v2)	1.2.840.10045.3.0.6	06 08 2A 86 48 CE 3D 03 00 06	96

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Curve Name(s)	OID (dot)	OID (byte)	Security Strength (bits)
c2tnb191v3 (X9.62 c2tnb191v3)	1.2.840.10045.3.0.7	06 08 2A 86 48 CE 3D 03 00 07	96
c2tnb239v1 (X9.62 c2tnb239v1)	1.2.840.10045.3.0.11	06 08 2A 86 48 CE 3D 03 00 0B	120
c2tnb239v2 (X9.62 c2tnb239v2)	1.2.840.10045.3.0.12	06 08 2A 86 48 CE 3D 03 00 0C	120
c2tnb239v3 (X9.62 c2tnb239v3)	1.2.840.10045.3.0.13	06 08 2A 86 48 CE 3D 03 00 0D	120
c2tnb359v1 (X9.62 c2tnb359v1)	1.2.840.10045.3.0.18	06 08 2A 86 48 CE 3D 03 00 12	180
c2tnb431r1 (X9.62 c2tnb431r1)	1.2.840.10045.3.0.20	06 08 2A 86 48 CE 3D 03 00 14	215
Ed25519 (edwards25519)	1.3.6.1.4.1.11591.15.1	06 09 2B 06 01 04 01 DA 47 0F 01	128
prime192v1 (X9.62 prime192v1, secp192r1)	1.2.840.10045.3.1.1	06 08 2A 86 48 CE 3D 03 01 01	96
prime192v2 (X9.62 prime192v2)	1.2.840.10045.3.1.2	06 08 2A 86 48 CE 3D 03 01 02	96
prime192v3 (X9.62 prime192v3)	1.2.840.10045.3.1.3	06 08 2A 86 48 CE 3D 03 01 03	96
prime239v1 (X9.62 prime239v1)	1.2.840.10045.3.1.4	06 08 2A 86 48 CE 3D 03 01 04	120
prime239v2 (X9.62 prime239v2)	1.2.840.10045.3.1.5	06 08 2A 86 48 CE 3D 03 01 05	120
prime239v3 (X9.62 prime239v3)	1.2.840.10045.3.1.6	06 08 2A 86 48 CE 3D 03 01 06	120
prime256v1 (X9.62 prime256v1, secp256r1)	1.2.840.10045.3.1.7	06 08 2A 86 48 CE 3D 03 01 07	128

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Curve Name(s)	OID (dot)	OID (byte)	Security Strength (bits)
secp112r1	1.3.132.0.6	06 05 2B 81 04 00 06	56
secp112r2	1.3.132.0.7	06 05 2B 81 04 00 07	56
secp128r1	1.3.132.0.28	06 05 2B 81 04 00 1C	64
secp128r2	1.3.132.0.29	06 05 2B 81 04 00 1D	64
secp160k1	1.3.132.0.9	06 05 2B 81 04 00 09	80
secp160r1	1.3.132.0.8	06 05 2B 81 04 00 08	80
secp160r2	1.3.132.0.30	06 05 2B 81 04 00 1E	80
secp192k1	1.3.132.0.31	06 05 2B 81 04 00 1F	96
secp224k1	1.3.132.0.32	06 05 2B 81 04 00 20	112
secp224r1	1.3.132.0.33	06 05 2B 81 04 00 21	112
secp256k1	1.3.132.0.10	06 05 2B 81 04 00 0A	128
secp384r1	1.3.132.0.34	06 05 2B 81 04 00 22	192
secp521r1	1.3.132.0.35	06 05 2B 81 04 00 23	260
sect113r1	1.3.132.0.4	06 05 2B 81 04 00 04	56
sect113r2	1.3.132.0.5	06 05 2B 81 04 00 05	56
sect131r1	1.3.132.0.22	06 05 2B 81 04 00 16	64
sect131r2	1.3.132.0.23	06 05 2B 81 04 00 17	64
sect163k1	1.3.132.0.1	06 05 2B 81 04 00 01	80
sect163r1	1.3.132.0.2	06 05 2B 81 04 00 02	80
sect163r2	1.3.132.0.15	06 05 2B 81 04 00 0F	80
sect193r1	1.3.132.0.24	06 05 2B 81 04 00 18	96
sect193r2	1.3.132.0.25	06 05 2B 81 04 00 19	96

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Curve Name(s)	OID (dot)	OID (byte)	Security Strength (bits)
sect233k1	1.3.132.0.26	06 05 2B 81 04 00 1A	112
sect233r1	1.3.132.0.27	06 05 2B 81 04 00 1B	112
sect239k1	1.3.132.0.3	06 05 2B 81 04 00 03	115
sect283k1	1.3.132.0.16	06 05 2B 81 04 00 10	128
sect283r1	1.3.132.0.17	06 05 2B 81 04 00 11	128
sect409k1	1.3.132.0.36	06 05 2B 81 04 00 24	192
sect409r1	1.3.132.0.37	06 05 2B 81 04 00 25	192
sect571k1	1.3.132.0.38	06 05 2B 81 04 00 26	256
sect571r1	1.3.132.0.39	06 05 2B 81 04 00 27	256
X25519 (curve25519)	1.3.6.1.4.1.3029.1.5.1	06 0a 2b 06 01 04 01 97 55 01 05 01	128

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

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

ECDH with Key Derive Function

HSM mechanisms supporting key derivation include DH, ECDH, ECIES.

For the concatenation KDF the X9 and NIST variants differ. For example, the X9 variant is not compliant with KDFs defined in SP800-56.

You will need to determine with which standard your solution should comply.

The mechanism parameter for CKM_ECDH1_DERIVE (in most cases, probably CKM_ECDH1_COFACTOR_DERIVE) has a “kdf” parameter that defines the type of KDF to use.

At the PKCS#11 level, both variants are supported by the Luna HSMs and the Luna Cloud HSM; for example CKD_SHA256_KDF versus CKD_SHA256_NIST_KDF.

PKCS#11 standard KDFs supported in Luna HSM

PKCS#11		Available since
#define CKD_NULL	0x00000001UL	Luna HSM Firmware 7.0.1

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PKCS#11		Available since
#define CKD_SHA1_KDF	0x00000002UL	Luna HSM Firmware 7.0.1
#define CKD_SHA1_KDF_ASN1	0x00000003UL	Luna HSM Firmware 7.0.1
#define CKD_SHA1_KDF_CONCATENATE	0x00000004UL	Luna HSM Firmware 7.0.1
#define CKD_SHA224_KDF	0x00000005UL	Luna HSM Firmware 7.0.1
#define CKD_SHA256_KDF	0x00000006UL	Luna HSM Firmware 7.0.1
#define CKD_SHA384_KDF	0x00000007UL	Luna HSM Firmware 7.0.1
#define CKD_SHA512_KDF	0x00000008UL	Luna HSM Firmware 7.0.1
#define CKD_SHA3_224_KDF	0x0000000AUL	Luna HSM Firmware 7.4.2
#define CKD_SHA3_256_KDF	0x0000000BUL	Luna HSM Firmware 7.4.2
#define CKD_SHA3_384_KDF	0x0000000CUL	Luna HSM Firmware 7.4.2
#define CKD_SHA3_512_KDF	0x0000000DUL	Luna HSM Firmware 7.4.2
#define CKD_SHA1_KDF_SP800	0x0000000EUL	Luna HSM Client 10.5.0
#define CKD_SHA224_KDF_SP800	0x0000000FUL	Luna HSM Client 10.5.0
#define CKD_SHA256_KDF_SP800	0x00000010UL	Luna HSM Client 10.5.0
#define CKD_SHA384_KDF_SP800	0x00000011UL	Luna HSM Client 10.5.0
#define CKD_SHA512_KDF_SP800	0x00000012UL	Luna HSM Client 10.5.0
#define CKD_SHA3_224_KDF_SP800	0x00000013UL	Luna HSM Client 10.5.0
#define CKD_SHA3_256_KDF_SP800	0x00000014UL	Luna HSM Client 10.5.0
#define CKD_SHA3_384_KDF_SP800	0x00000015UL	Luna HSM Client 10.5.0
#define CKD_SHA3_512_KDF_SP800	0x00000016UL	Luna HSM Client 10.5.0

Vendor defined KDFs

The "_NIST_" KDFs map to the SP800 KDFs above.

The "_OLD" KDFs map to their non-"_OLD" equivalents above.

Vendor Defined	Value
#define CKD_SHA224_KDF_OLD	0x80000003
#define CKD_SHA256_KDF_OLD	0x80000004
#define CKD_SHA384_KDF_OLD	0x80000005
#define CKD_SHA512_KDF_OLD	0x80000006
#define CKD_RIPEMD160_KDF	0x80000007
#define CKD_SHA1_NIST_KDF	0x00000012
#define CKD_SHA224_NIST_KDF	0x80000013
#define CKD_SHA256_NIST_KDF	0x80000014
#define CKD_SHA384_NIST_KDF	0x80000015
#define CKD_SHA512_NIST_KDF	0x80000016
#define CKD_RIPEMD160_NIST_KDF	0x80000017
#define CKD_SHA3_224_NIST_KDF	0x8000001A
#define CKD_SHA3_256_NIST_KDF	0x8000001B
#define CKD_SHA3_384_NIST_KDF	0x8000001C
#define CKD_SHA3_512_NIST_KDF	0x8000001D
#define CKD_SHA1_SES_KDF	0x82000000
#define CKD_SHA224_SES_KDF	0x83000000
#define CKD_SHA256_SES_KDF	0x84000000
#define CKD_SHA384_SES_KDF	0x85000000
#define CKD_SHA512_SES_KDF	0x86000000
#define CKD_RIPEMD160_SES_KDF	0x87000000

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Vendor Defined	Value
#define CKD_SHA3_224_SES_KDF	0x8A000000
#define CKD_SHA3_256_SES_KDF	0x8B000000
#define CKD_SHA3_384_SES_KDF	0x8C000000
#define CKD_SHA3_512_SES_KDF	0x8D000000
#define CKD_SHA1_KDF_CONCATENATE_X9_42 CKD_SHA1_KDF_CONCATENATE	
#define CKD_SHA1_KDF_CONCATENATE_NIST	0x80000001

JCPROV	Value	Equivalent Available in JSP
public static final long CKD_NULL =	0x00000001	Yes
public static final long CKD_SHA1_KDF =	0x00000002	Yes
public static final long CKD_SHA224_KDF =	0x00000005	Yes
public static final long CKD_SHA256_KDF =	0x00000006	Yes
public static final long CKD_SHA384_KDF =	0x00000007	Yes
public static final long CKD_SHA512_KDF =	0x00000008	Yes
public static final long CKD_RIPEMD160_KDF =	0x80000007	No
public static final long CKD_SHA1_NIST_KDF =	0x80000012	No
public static final long CKD_SHA224_NIST_KDF =	0x80000013	No
public static final long CKD_SHA256_NIST_KDF =	0x80000014	Yes
public static final long CKD_SHA384_NIST_KDF =	0x80000015	No
public static final long CKD_SHA512_NIST_KDF =	0x80000016	No

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JCPROV	Value	Equivalent Available in JSP
public static final long CKD_RIPEMD160_NIST_KDF=	0x80000017	No
public static final long CKD_SHA1_SES_KDF =	0x82000000	No
public static final long CKD_SHA224_SES_KDF =	0x83000000	No
public static final long CKD_SHA256_SES_KDF =	0x84000000	No
public static final long CKD_SHA384_SES_KDF =	0x85000000	No
public static final long CKD_SHA512_SES_KDF =	0x86000000	No
public static final long CKD_RIPEMD160_SES_KDF=	0x87000000	No
/* counter values for TR-03111 session keys */		
public static final long CKD_SES_ENC_CTR =	0x00000001	No
public static final long CKD_SES_AUTH_CTR =	0x00000002	No
public static final long CKD_SES_ALT_ENC_CTR =	0x00000003	No
public static final long CKD_SES_ALT_AUTH_CTR =	0x00000004	No
public static final long CKD_SES_MAX_CTR =	0x0000FFFF	No
public static final long CKD_SHA3_224_KDF	0x0000000A	No
public static final long CKD_SHA3_256_KDF	0x0000000B	No
public static final long CKD_SHA3_384_KDF	0x0000000C	No
public static final long CKD_SHA3_512_KDF	0x0000000D	No
public static final long CKD_SHA1_KDF_SP800 =	0x0000000E	No
public static final long CKD_SHA224_KDF_SP800 =	0x0000000F	No
public static final long CKD_SHA256_KDF_SP800 =	0x00000010	No
public static final long CKD_SHA384_KDF_SP800 =	0x00000011	No

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JCPROV	Value	Equivalent Available in JSP
public static final long CKD_SHA512_KDF_SP800 =	0x00000012	No
public static final long CKD_SHA3_224_KDF_SP800 =	0x00000013	No
public static final long CKD_SHA3_256_KDF_SP800 =	0x00000014	No
public static final long CKD_SHA3_384_KDF_SP800 =	0x00000015	No
public static final long CKD_SHA3_512_KDF_SP800 =	0x00000016	No
public static final long CKD_RIPEMD160_KDF =	0x80000007	No

Capability and Policy Configuration Control Using the Luna API

The configuration and control of the Luna USB HSM 7 is provided by a set of capabilities and policies which you can query and set using the Luna 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 behavior of the HSM.

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

HSM Partition Capabilities and Policies

Each HSM can support one-or-more virtual HSMs called application 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 application partition has a set of capabilities. An application partition's capability set defines and controls the behavior of the partition.

application partition behavior can be further modified through changing policies. The HSM SO can refine the behavior of an application partition by changing the policy settings. Different partitions can have different values for the configuration elements which apply to specific application partitions – in other words, if a policy is set to a given value for one partition, the policy can be set to a different value for another partition 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 SO, 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 SO, 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 SO can set the policy to a value less than or equal to 10.

In general, the HSM SO may modify policy set elements to make the HSM or partition policy more restrictive than that imposed by the capability set elements. The HSM SO can not make the HSM or application 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 SO. 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,

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```
> 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 application 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.

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The CA_Set...() Functions
The various **CA_Set...()** functions allow you to set individual HSM and 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 Luna USB HSM 7 is unavailable.

Windows Connection Timeout

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

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CHAPTER 6: Design Considerations

This chapter provides guidance for creating applications that use specific Luna USB HSM 7 configurations or features. It contains the following topics:

> "High Availability Implementations" on page 201
> "Key Attribute Defaults" on page 203
> "Object Usage Count" on page 206
> "Migrating Keys From Software to a Luna USB HSM 7" on page 208
> "Audit Logging" on page 232

Multifactor Quorum-Authenticated HSMs

In normal use, Luna 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 Luna PED: the HSM Security Officer, and an application partition user (Partition SO, Crypto Officer/User). The person handling new HSMs and using Luna 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 Luna PED may be required to present the HSM Partition Owner's iKey or iKeys (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 iKey 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 iKey holders.

About CKDemo with iKey

As its name suggests, CKDemo (CryptoKi Demonstration) is a demonstration program, allowing you to explore the capabilities and functions of several Luna products. The demo program breaks out a number of PKCS 11 functions, as well as the Luna 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 Luna USB HSM 7 with multifactor quorum authentication, and iKey, 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 Luna PED keypad. In fact, the option is dictated by the Luna USB HSM 7, 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 Luna USB HSM 7 (password or multifactor quorum-authenticated), but you cannot make one type behave like the other.

Security and design requirements, enforced by the multifactor quorum-authenticated Luna USB HSM 7, dictate that use of Luna 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 iKeys 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 iKey. Alternatively, the secret can be accepted from a iKey (previously imprinted by another HSM) and imprinted on the current HSM. This is mandatory for the cloning domain, when HSMs (or application 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 iKey holder) or more than one application partition to be administered by a single Crypto Officer/User.

iKeys that have never been imprinted are completely interchangeable. They can be used with any modern Luna USB HSM 7, 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 iKey, 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 Luna PED can be used with any Luna USB HSM 7 - the PED itself contains no secrets; it simply provides the interface between you and your HSM(s). The exception is that only some Luna PEDs have the capability to be used remotely from the HSM. Any Remote-capable Luna PED is interchangeable with any other Remote-capable Luna PED, and any Luna PED (remote-capable or not) is interchangeable with any other when locally connected to a Luna USB HSM 7.

Application partitions and Backup Tokens and iKeys can be “re-cycled” for use in different combinations, but this reuse requires re-initializing the HSM(s) and re-imprinting the iKeys with new secrets or security parameters. Re-initializing a token or HSM wipes previous information from it. Re-imprinting a iKey overwrites any previous information it carried (PIN, domain, etc.).

Startup

Luna PED expects to be connected to a multifactor quorum-authenticated Luna USB HSM 7. At power-up, it presents a message showing its firmware version. After a few seconds, the message changes to "Awaiting command..." The Luna PED is waiting for a command from the token/HSM.

The Luna 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. 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. An orderly shutdown of your application should include logging out any users and closing all sessions on HSMs.

Cloning of Tokens

To securely copy the contents of an application partition to another application partition, you must perform a backup to a Luna Backup HSM from the source partition followed by a restore operation from the Backup HSM to the new destination partition. This is done via LunaCM command line, and cannot be accomplished via CKDemo.

High Availability Implementations

If you use the Luna USB HSM 7 HA feature then the calls to the Luna USB HSM 7s 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 AutoRecovery, bringing a failed/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 AutoRecovery function works, in practice.

For every PKCS#11 call, the HA recover logic will check to see if we need to perform auto 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 PKCS#11 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 LunaCM.

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 commands hagroup retry and hagroup interval.

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 auto recovery design runs within a PKCS#11 call. The responsiveness of recovering a disconnected member is greatly influenced by the frequency of PKCS#11 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 PKCS#11 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

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 ---
```

Key Attribute Defaults

The following default attribute settings are applied to generated keys/keypairs, and to unwrapped private/secret keys, unless your application specifies different values.

Management Attributes

Attribute	Default Value			
	Generated Public Keys	**Generated Private Keys**	**Unwrapped Private/Secret Keys**	**Derived Secret Keys**
CKA_TOKEN	**0** (FALSE)	**0** (FALSE)	**0** (FALSE)	**0** (FALSE)

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Attribute	Default Value			
	Generated Public Keys	**Generated Private Keys**	**Unwrapped Private/Secret Keys**	**Derived Secret Keys**
CKA_PRIVATE	**1** (TRUE) if Crypto Officer logged in **0** (FALSE) if Crypto Officer not logged in	**1** (TRUE) if Crypto Officer logged in **0** (FALSE) if Crypto Officer not logged in	**1** (TRUE) if Crypto Officer logged in **0** (FALSE) if Crypto Officer not logged in	**1** (TRUE) if Crypto Officer logged in **0** (FALSE) if Crypto Officer not logged in
CKA_SENSITIVE	N/A	**1** (TRUE)	**1** (TRUE)	**0** (FALSE)
CKA_MODIFIABLE	**1** (TRUE)	**1** (TRUE)	**1** (TRUE)	**1** (TRUE)
CKA_ EXTRACTABLE	N/A	**0** (FALSE)	**0** (FALSE)	**0** (FALSE)
CKA_ALWAYS_ SENSITIVE	N/A	Always the same value as CKA_ SENSITIVE	Always **0** (FALSE)	Inherited from base key(s) depending on CKA_SENSITIVE history*
CKA_NEVER_ EXTRACTABLE	N/A	Always the opposite value of CKA_ EXTRACTABLE	Always **0** (FALSE)	Inherited from base key(s) depending on CKA_ EXTRACTABLE history**

NOTE If using a Luna Cloud HSM service you must specify both CKA_PRIVATE=1 and CKA_ SENSITIVE=1 Key Attributes for all Generated, Derived and Unwrapped keys.

* CKA_ALWAYS_SENSITIVE=1 assures that the key and the key(s) from which it was derived have always been sensitive (CKA_SENSITIVE=1). If a newly-derived key has CKA_ALWAYS_SENSITIVE=0, it means the key(s) from which it derives has had CKA_SENSITIVE=0 at some point.

** CKA_NEVER_EXTRACTABLE=1 assures that the key and the key(s) from which it was derived have never been extractable (CKA_EXTRACTABLE has always been set to 0). If a newly-derived key has CKA_NEVER_ EXTRACTABLE=0, it means the key(s) from which it derives has had CKA_EXTRACTABLE=1 at some point.

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Key Usage Attributes

Attribute	Default Value			
	Generated Public Keys	**Generated Private Keys**	**Unwrapped Private/Secret Keys**	**Derived Secret Keys**
CKA_ENCRYPT	**0** (FALSE)	N/A	**0** (FALSE)	**0** (FALSE)
CKA_DECRYPT	N/A	**0** (FALSE)	**0** (FALSE)	**0** (FALSE)
CKA_WRAP	**0** (FALSE)	N/A	**0** (FALSE)	**0** (FALSE)
CKA_UNWRAP	N/A	**0** (FALSE)	**0** (FALSE)	**0** (FALSE)
CKA_SIGN	N/A	**0** (FALSE)	**0** (FALSE)	**0** (FALSE)
CKA_VERIFY	**0** (FALSE)	N/A	**0** (FALSE)	**0** (FALSE)
CKA_DERIVE	**0** (FALSE)	N/A	**0** (FALSE)	**0** (FALSE)

Vendor-defined key attributes

KEY ATTRIBUTE	DESCRIPTION
CKA_CCM_PRIVATE	Not used by current Luna HSMs; it does not affect any of the HSM functionality.
CKA_OUID	This is a 12-byte unique identifier for the object, unique across all Luna HSMs. It can be used to identify the object across multiple HSM.
CKA_EKM_UID	This is not used by the Luna HSM, it does not affect any of the HSM functionality. It is intended to be used by our EKM Key Manager SHIM to store a KEY ID, so that the key manager can track keys efficiently. Customer applications should not use this (they should use the CKA_GENERIC_1/2/3 attributes defined below).
CKA_GENERIC_1/2/3	These are not used by the Luna HSM, and do not affect any of the HSM functionality. They are variable length attributes that store an array of CK_BYTE and are provided for customer applications to make use of, to store whatever data they want.

New Attributes in Luna Firmware Version 7.7.0

KEY ATTRIBUTE	DESCRIPTION	DEFAULT
CKA_ASSIGNED	Flags a key as assigned when value is set to **1** (TRUE).	**0** (FALSE)

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KEY ATTRIBUTE	DESCRIPTION	DEFAULT
CKA_KEY_STATUS	Holds the key lock status flags and the failed per key count limit.	Flags: 0x00 Failed Key Authorization Limit: 3
CKA_FAILED_KEY_AUTH_COUNT	Stores the key authorization failure count.	00000000 (0)

New Attributes in Luna Firmware Version 7.7.2

KEY ATTRIBUTE	DESCRIPTION	DEFAULT
CKA_KEYRING	Supports keyring authorization object (KR-AUTH) when set to **1** (TRUE)	**0** (FALSE)
CKA_KEYRING_OUID	Identifies a key with the OUID of the keyring authorization object (KR-AUTH).	CKA_KEYRING_OUID=

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. will 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 Luna HSM Client 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)
```

Using this key to perform cryptographic operations will now increment 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 will 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 Luna HSM Client 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 will be 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)
```

Migrating Keys From Software to a Luna USB HSM 7

Luna USB HSM 7s 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,
```

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```
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 Luna USB HSM 7.

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Sample Program

The sample program below encrypts a known RSA private key, then unwraps the key pair onto the Luna USB HSM 7 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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*
* All rights reserved. This file contains information that
 is
* proprietary to SafeNet, Inc. and may not be
* distributed or copied without written consent from
* 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
       myuserpin
 = (CK_CHAR_PTR)"default";
   CK_USHORT
         lenmyuserpin
  = 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;
```

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```
      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,
```

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```
 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,
```

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```
 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)
 },
```

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```
        {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;
```

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```
      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;
```

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```
        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.";
```

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```
}
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;
}
```

Audit Logging

By default, the HSM logs select events. See Audit Logging for more information.

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.

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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

Offset	Length (Chars)	Description
28	1	Comma
29	256	Message text, interpreted from raw data and consisting of: > the HSM SN > the Access ID fields > `external message follows:` > the user message (limited to 100 characters by the HSM firmware) > padded space characters up to the 256-character maximum
285	1	Comma
286	64	HMAC of previous record as ASCII-HEX
350	1	Comma
351	104	Data for this record as ASCII-HEX (raw data). The total raw data is broken up into 3 log records (**1:** bytes 0-14, **2:** bytes 15-61, **3:** bytes 62-99), and only the first part of the raw data is included here. All of the message data is included in the HMAC calculation, including sequence number, time, etc. The raw data fields byte sizes, in order, are: **1.** Sequence number: 4 bytes **2.** Category: 2 bytes **3.** Operation: 2 bytes **4.** Time: 4 bytes **5.** Return code: 4 bytes **6.** Access ID: 8 bytes **7.** HSM serial number: 8 bytes **8.** Session handle: 4 bytes **9.** Data: 16 bytes All fields are little-endian format except Access ID and data.
455	1	Newline '\n'

Log External

An important element of the security audit logging feature is the Log External function. This Luna 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
- **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 lunacm:> **audit logmsg** within a startup script to insert a text record at the time the application is started.

When a user logs in to the Luna USB HSM 7 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.

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CHAPTER 7: Java Interfaces

This chapter describes the Java interfaces to the PKCS#11 API. It contains the following topics:

> "Luna JSP Overview and Installation" below
> "Luna JSP Configuration" on page 242
> "The JCPROV PKCS#11 Java Wrapper" on page 246
> "Java or JSP Errors" on page 252
> "Re-Establishing a Connection Between Your Java Application and Luna USB HSM 7" on page 253
> "Recovering From the Loss of All HA Members" on page 254
> "Using Java Keytool with Luna USB HSM 7" on page 256
> "LunaKeyStore Reference" on page 261

Luna JSP Overview and Installation

The Luna JSP is part of an application program interface (API) that allows Java applications to make use of certain Luna products.

As with other APIs, some existing Java-based applications might have generic requirements and calls that can already work with Luna 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 Luna 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 Luna Java API usage notes for developers, as well as development support by Thales. A standard Java development environment is required, in addition to the API provided by Thales.

Please refer to the current-version Luna USB HSM 7 Customer Release Notes (CRN) for the most up-to-date list of supported platforms and APIs.

> **NOTE** **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.

TIP

Post Quantum Crypto (PQC) with Java
Java support for ML-KEM and ML-DSA with Luna HSM requires that you install one of:

- OpenJDK 24/25 LTS onward

  or

- Oracle JDK 24/25 LTS onward

Refer to Java jsp standard documentation to use ML-KEM and ML-DSA with java.

Java PQC samples in Luna Client UC 10.9.1 onward are available in the samples folder (e.g C:\Program Files\SafeNet\LunaClient\JSP\samples), and include:

- LunaMLKEMDemo.java
- SignatureMLDSADemo.java

Availability of specific ML-KEM and ML-DSA related features or compatibility depends on the version of firmware installed in the HSM being accessed by your client.

This following sections describe the tasks required to set up the JSP API:

- "Installation" below
- "JSP Registration" on page 239
- "Post-Installation Tasks" on page 240

Installation

To use the Luna JavaSP service providers three main components are needed:

- The Java SDK
- The Java Cryptographic JCE Policy files (optional)
- The Luna JavaSP artifacts in the Luna HSM Client

Java SDK Installation

Acquire and install the JDK or JRE (available from the Java site, not included with the Luna software). Refer to the Customer Release Notes for supported Java versions.

Java Cryptographic JCE Policy Files Installation (optional)

If you intend to generate large key sizes, you might need to apply the unlimited strength ciphers policy. You will need two cryptographic JCE Policy files v 7/8/9/10/11 (available from the Oracle Java web site): local_policy.jar and US_export_policy.jar.

Copy these files to JAVA_HOME/jre/lib/security (or the equivalent directory that applies to your setup).

```
[root@my-client]# echo $JAVA_HOME
/usr/java/default
[root@my-client]# cp -p local_policy.jar /usr/java/default/jre/lib/security/
[root@my-sclient]# cp -p US_export_policy.jar /usr/java/default/jre/lib/security/
```

If you see errors like "Invalid Key size", that is usually an indication that the JCE is not properly installed.

Luna JavaSP included in the Luna HSM Client

Follow the installation procedure for the Luna HSM Client as described in the *Installation Guide*. When installing the Luna HSM Client software, choose the option to install Luna JSP. There are two SafeNet files: the **LunaProvider.jar** file, and the Java library file (**libLunaAPI.so** in Unix based systems or **LunaAPI.dll** in Windows systems). To ensure that the Java Environment can find these files, follow the instructions for either Java 7/8 or Java 9+.

Operating System	JSP Install directory
Linux	**/usr/safenet/lunaclient/jsp/lib**
Windows	**C:\Program Files\LunaClient\JSP\lib**

To configure Java 7/8 for Luna JSP

To ensure that Luna USB HSM 7 and Luna JSP can work with the JRE, copy the JSP files from the default installation location to the Java environment. The exact destination directory might differ depending on where you obtained your Java system, the version, and any choices that you made while installing and configuring it.

Operating System	Destination directory example
Linux	**/usr/jre/lib/ext**
Windows	<java_install_dir>**\bin** **C:\Program Files\Java\jdk1.8.0_121\bin** **NOTE** Java 7/8/9 for Windows has removed the **<java_install_dir>\lib\ext** directory from the Java library path.

IBM Java 7/8 has a .jar authentication issue that requires a patch from IBM. See APAR IJ25459 for details.

To configure Java 9+ for Luna JSP

Add **LunaProvider.jar** to the Java classpath and specify the Luna Java library location (**libLunaAPI.so** in Unix based systems or **LunaAPI.dll** in Windows systems) in the Java library path.

For example:

> **java -cp /**<directory_location>**/LunaProvider.jar -Djava.library.path=**<Luna_Java_library_location> <class name>

TIP In Windows, you can also put **LunaAPI.dll** in an arbitrary folder and add that folder to the system path. Java will search the system path for **LunaAPI.dll**.

The exact directory might differ depending on where you obtained your Java system, the version, and any choices that you made while installing and configuring it.

JSP Registration

Before Java can use Luna JSP, you must register it with the Java Runtime Enviroment. You can choose either a static registration or a dynamic registration. A static registration defaults all Java applications to default to the Luna provider, while a dynamic registration allows you to set the provider for Java applications individually.

JSP Static Registration

> **NOTE** This section applies to JSP, not to JCPROV.

You would choose static registration of providers if you want all applications to default to the Luna provider.

Once your client has externally logged in using **salogin** or your own HSM-aware utility, any application would be able to use Luna product without being designed to log in to the HSM Partition.

Edit the **java.security** file located in the **/jre/lib/security** directory of your Java SDK/JRE installation to read as follows:

```
security.provider.1=sun.security.provider.Sun
security.provider.2=com.sun.net.ssl.internal.ssl.Provider
security.provider.3=com.safenetinc.luna.provider.LunaProvider
security.provider.4=com.sun.rsajca.Provider
security.provider.5=com.sun.crypto.provider.SunJCE
security.provider.6=sun.security.jgss.SunProvider
```

You can set our provider in first position for efficiency if Luna HSM operations are your primary mode. However, if your application needs to perform operations not supported by the LunaProvider (secure random generation or random publickey verification, for example) then it would receive error messages from the HSM and would need to handle those gracefully before resorting to providers further down the list. We have found that having our provider in third position works well for most applications.

The modifications in the **java.security** file are global, and they might result in the breaking of another application that uses the default KeyPairGenerator without logging into the Luna Network HSM first. This consideration might argue for using dynamic registration, instead.

JSP Dynamic Registration

You might prefer to employ dynamic registration of Providers, in order to avoid possible negative impacts on other applications running on the same machine. As well, the use of dynamic registration allows you to keep installation as straightforward as possible for your customers.

This sample code shows an example of dynamic registration with the Luna provider. The Luna provider is registered in position 2, ensuring that the "SUN" provider is still the default. If you want the Luna provider to be used when no provider is explicitly specified, it should be registered at position 1.

```
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());
```

Post-Installation Tasks

Making Private and Secret Keys Extractable

By default, all generated private and secret keys have their CKA_EXTRACTABLE attribute set to **0** (see "Key Attribute Defaults" on page 203). These keys are stored in the HSM hardware and cannot be extracted, only cloned to a partition on another HSM. This attribute cannot be modified later. If you want the ability to wrap private and/or secret keys and export them off the HSM, you must use one of the following two methods to set CKA_EXTRACTABLE to **1** (TRUE) when the key is created:

Global configuration:

Configure **java.security** as follows to have JSP create all future private/secret keys with CKA_EXTRACTABLE=1:

> To make all private keys extractable, add the following line to **java.security**:

com.safenetinc.luna.provider.createExtractablePrivateKeys=true

> To make all secret keys extractable, add the following line to **java.security**:

com.safenetinc.luna.provider.createExtractableSecretKeys=true

Local configuration:

Configure CKA_EXTRACTABLE on a key-by-key basis by using the following methods in your Java application:

> To make the next generated private key extractable using the **LunaSlotManager.setPrivateKeysExtractable()** method:

```
LunaSlotManager.getInstance().setPrivateKeysExtractable(true); // Set CKA_EXTRACTABLE=1 on
upcoming private keys
kpg = KeyPairGenerator.getInstance("RSA", "LunaProvider");
kpg.initialize(2048);
myPair = kpg.generateKeyPair();
LunaSlotManager.getInstance().setPrivateKeysExtractable(false); // Set CKA_EXTRACTABLE=0 on
upcoming private keys
```

> **NOTE** To wrap and export private keys, the partition must have **partition policy 1:** Allow private key wrapping set to 1 (ON). See Configuring the Partition for Cloning or Export of Private Keys.

> To make the next generated secret key extractable using the **LunaSlotManager.setSecretKeysExtractable()** method:

```
LunaSlotManager.getInstance().setSecretKeysExtractable(true); // Set CKA_EXTRACTABLE=1 on
upcoming secret keys
kg = KeyGenerator.getInstance("AES");
kg.init(256);
aesKey = kg.generateKey();
LunaSlotManager.getInstance().setPrivateKeysExtractable(false); // Set CKA_EXTRACTABLE=0 on
upcoming secret keys
```

Using Luna JCE/JCA with 64-bit Libraries

If you are using Luna JCE/JCA with the 64-bit libraries for Luna Network HSM, you must include the **-d64** switch in the Java command-line.

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.

> **NOTE** Luna HSM Client 10.1.0 and newer includes libraries for 64-bit operating systems only.

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.

Managing Security for Java Developers

The Luna JSP is a Java API that is intended to be used as an interface between customer-written or third-party Java applications and the Luna USB HSM 7. 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 Luna 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 Mapping

The Luna 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".

Notes about thread safe, session safe, and multi-threading

PKCS#11 (the standard, and Thales's implementation) requires that a session can be used only by a single thread at a time. That is, multiple threads cannot access the same session simultaneously. Threads can share a session; however the application must ensure that only one thread accesses the session at a time. It is simpler for an application to assign a unique session for each thread, but applications do not need to follow that pattern.

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Our LunaProvider endeavors to be thread safe in the way it uses our PKCS#11 library. But customer Java applications must follow the threading model defined by Java. For example, Java Cipher objects (essentially all crypto-related objects) are not thread safe according to the JSP specification. Similar to PKCS#11 sessions, only one thread should use a cipher object at a time. Our LunaProvider requires that the Java application follows that JSP approach.

Therefore, it is very possible, and expected, to see sessions being used by multiple threads, all in legitimate and thread-safe ways according to both JSP and PKCS#11.

Luna JSP Configuration

Luna JSP consists of a single JCA/JCE service provider, that allows a Java-based application to use Luna USB HSM 7 products for secure cryptographic operations. Please refer to the Javadocs accompanying the toolkit, for the most current information regarding the Luna JSP packages and LunaProvider functionality.

To install JSP, refer to "Luna JSP Overview and Installation" on page 236.

Luna Java Security Provider

In general, you should use the standard JCA/JCE classes and methods to work with Luna USB HSM 7. The following sections provide examples of when you may wish to use the special Luna methods.

Class Hierarchy

All public classes in the Luna 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. Luna 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 Luna 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 Luna hardware.

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> **NOTE** Sensitive attributes cannot be retrieved from keys stored on Luna 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 Luna hardware.

Signature Verification in Software

Using Luna HSM Client 10.7.0 or newer, you can enable the following settings in the java.Security file to allow some algorithms to perform signature verification in software:

- com.safenetinc.luna.provider.verifyInSoftware=<setting>

  When <setting> is **true**, signature verification is performed in software. When <setting> is **false** (default), it is performed using the HSM.

- com.safenetinc.luna.provider.verifyInSoftwareProvider=<provider>

  In this setting, <provider> specifies the provider to be used for the signature verification (default: **SunRsaSign**).

> **NOTE** This default setting requires minimum Java JDK 1.8.0-251.

Examples

The Luna 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 <Luna USB HSM 7 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)
```

> **NOTE** The Luna Keystore is not a physical file like a regular JKS. It is a virtual interface to the HSM and contains only handles for the private key objects.

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.

NOTE

> Thales strongly recommends that you *use the application partition's label* as the identifier for the cryptographic slot on the HSM. That designator never changes, unless you explicitly change label. The slot number, on the other hand, might change, and therefore should not be used in your code.

> If you are using OpenJDK 9 or newer, you can configure the KeyStore file to allow the Crypto User to log in to the HSM. This is useful in circumstances where you would like the user to be able to use the Java Keytool utility without the risk of wiping, modifying, or adding cryptographic objects. For more information about this utility, refer to "Keytool" below.

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 Luna 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 behavior.

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 Luna JSP may be used in combination with the Java keytool utility to store and use keys on a Luna USB HSM 7, see "Using Java Keytool with Luna USB HSM 7" on page 256.

> **NOTE** Add the following to the java.security file when generating AES keys using keytool:
>
> ```
> jdk.security.provider.preferred=KeyGenerator.AES:LunaProvider
> ```
>
> This entry ensures that AES keys are generated within the HSM.

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 and objects that persist after they are no longer needed in the HSM contribute to unnecessary burden during find/lookup operations, possibly slowing responses enough to trigger timeout, which can affect high-availability (HA) among other operations. This can exacerbate the effects of network latency and other factors. Always have your code clean up after itself.

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 Luna PKCS#11 API can be used with the Luna 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 Luna 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 Luna KeyStore key entry or a Luna 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 Luna 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 248
- "JCPROV Sample Classes" on page 248
- "JCPROV API Documentation" on page 252

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.

AES-GMAC and AES-GCM are supported in JCPROV. Use CK_AES_GCM_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 **com.safenetinc.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 (64 bit)	jcprov.dll
Linux	libjcprov.so

Installing JCPROV

Use the Luna HSM 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

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.

> **NOTE** Luna HSM Client 10.1.0 and newer includes libraries for 64-bit operating systems only.

> **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 **com.safenetinc.jcprov.sample** namespace. This is required since all of the applications are registered under this namespace.

To compile the JCPROV sample programs on 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 com.safenetinc.jcprov.sample.GetInfo -info -slot 0**

JCPROV Sample Classes

JCPROV provides sample classes in the <jcprov_installation_directory>/**samples** directory. These include:

- "DeleteKey" on the next page

> "EncDec" below
> "GenerateKey" on the next page
> "GetInfo" on page 251
> "Threading" on page 251

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 Luna USB HSM 7" on page 256

Usage

java com.safenetinc.jcprov.sample.DeleteKey -keyType <keytype> **-keyName** <keyname> [**-slot** <slotId>] [**-password** <your_unique_password_for_co_of_indicated_slot>]

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" on the next page or refer to "Using Java Keytool with Luna USB HSM 7" on page 256

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Usage

java com.safenetinc.jcprov.sample.EncDec -keyType <keytype> **-keyName** <keyname> [**-slot** <slotId>] [**-password** <your_unique_password_for_co_of_indicated_slot>]

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 com.safenetinc.jcprov.sample.GenerateKey -keyType <keytype> **-keyName** <keyname> [**-slot** <slotId>] [**-password** <your_unique_password_for_co_of_indicated_slot>]

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 > **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 com.safenetinc.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 page 250 or refer to "Using Java Keytool with Luna USB HSM 7" on page 256

Usage

java com.safenetinc.jcprov.sample.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 Luna appliance and its HSM cryptographic module 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 Luna 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 for a summary of error codes and their meanings, which includes the Luna 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 Luna 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 Luna USB HSM 7

Thales provides Java code samples for performing various application functions. For the proper method for performing a reconnect between a Java application and the Luna USB HSM 7 in the event of a disconnect, see **MiscReconnectDemo.java** in the Samples folder.

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-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 Luna Network HSM 7 appliances, so that you can safely recover an entire HA group.

When to Use the reinitialize Method

When using the high-availability (HA) features of Luna USB HSM 7, the 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.

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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 Luna USB HSM 7

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.
- .Keytool behaves differently with respect to generating Asymmetric keys or generating Symmetric keys.

The example below uses a KeyStore file containing only the line “slot:0”. This tells the Luna KeyStore to use the token in slot 0.

> **NOTE** The Luna Keystore is not a physical file like a regular JKS. It is a virtual interface to the HSM and contains only handles for the private key objects.

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]:  Thales
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=Thales, 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-lunaclient:~/luna-keystores$ keytool -list -v -storetype Luna -keystore bylabel.keystore
```

The system requests the Crypto Officer password of the partition and shows its contents.

> **NOTE** To log in to the partition with a different role, you must add a line to the keystore file to specify that role:
>
> - Crypto User:
>
>   `usertype:CKU_CRYPTO_USER`
> - Limited Crypto Officer:
>
>   `usertype:CKU_LIMITED_CRYPTO_OFFICER`
>
> See also "LunaKeyStore Reference" on page 261.

Symmetric keys with keytool

> **NOTE** Add the following to the java.security file when generating AES keys using keytool:
>
> `jdk.security.provider.preferred=KeyGenerator.AES:LunaProvider`
>
> This entry ensures that AES keys are generated within the HSM.

Examples

Here is a sample command to create an RSA 2048 bit key with SHA256withRSA self-signed certificate. This example uses java 6, other versions might be slightly different.

```
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]:  Thales
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=Thales, 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-lunaclient:~/luna-keystores$ keytool -importcert -storetype Luna -keystore bylabel.keystore
-alias root-mikeca -file mike_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 those in the CA certificate.

```
my-lunaclient:~/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-lunaclient:~/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-mikeca
Creation date: Oct 4, 2012
Entry type: trustedCertEntry
Owner: EMAILADDRESS=username@thales.com, CN=mike CA, OU=SE, O=SFNT, L=bgy, ST=bg, C=IT
Issuer: EMAILADDRESS=username@thales.com, CN=mike CA, OU=SE, O=SFNT, L=bgy, ST=bg, C=IT
```

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```
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-lunaclient:~/luna-keystores$ keytool -certreq -alias java-client2-key -file client2-
mikeca.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-lunaclient $ 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-mikeca
Creation date: Oct 4, 2012
```

```
Entry type: trustedCertEntry
Owner: EMAILADDRESS=username@thales.com, CN=mike CA, OU=SE, O=SFNT, L=bgy, ST=bg, C=IT
Issuer: EMAILADDRESS=username@thales.com, CN=mike 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=username@thales.com, CN=mike 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=username@thales.com, CN=mike CA, OU=SE, O=SFNT, L=bgy, ST=bg, C=IT
Issuer: EMAILADDRESS=username@thales.com, CN=mike 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 first insert 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-sa $ openssl crl2pkcs7 -nocrl -certfile HSM_Luna-manual-chain.crt -out HSM_Luna-manual-chain.p7b -certfile root_CA.crt
```

4. 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-mikeca -file /home/mike/luna-keystores/mike_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 mike_CA.p7b -out mike_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 mike_CA.crt
```

LunaKeyStore Reference

This page reproduces information found in the Luna JSP javadocs.

```
java.lang.Object
    java.security.KeyStoreSpi
        com.safenetinc.luna.provider.LunaKeyStore
public class LunaKeyStore
extends java.security.KeyStoreSpi
```

This is the preferred means of managing Luna HSM access via the LunaProvider. This is the KeyStore engine class for storing objects on Luna hardware. The data in a Luna KeyStore corresponds to the objects in a hardware token. Like a JKS KeyStore, a Luna KeyStore must be loaded before being used. Unlike a JKS KeyStore, setting a key/certificate entry causes the key/certificate to be immediately written to the HSM as a token (permanent) object with the specified alias; the Luna provider does not wait until store() is called.

When no InputStream is specified, the KeyStore acts essentially as a front- end to the default HSM slot.

```
KeyStore ks = KeyStore.getInstance("Luna"); ks.load(null, "mypasswd".toCharArray());
```

The code above is the bare minimum necessary to get a Luna KeyStore up and running. This KeyStore is backed by the HSM partition that is at the currently specified default slot in LunaSlotManager. If no password is supplied in load, the user must log in via LunaSlotManager before using the keystore.

When the InputStream is backed by a file, the file should specify the slot to use in one of two formats. Using the string "tokenlabel:label" will attempt to open the KeyStore against the token with the provided label. Using "slot:<slotNum>" will attempt to open the KeyStore against the token at the provided slot. It is recommended that the token label be used, as the slot number of a given token may change but the label will not.

As well, the user type can be specified by adding a line with "usertype:<user type>" with possible values of CKU_CRYPTO_USER or CKU_CRYPTO_OFFICER.

Object Caching can be enabled for the LunaKeyStore by adding a line with "caching:true". If Caching is enabled the number of loading threads can be specified by adding a line with "loadingthreads:<number of threads>". If caching is enabled, adding a line with "cachingstrict:true" will prevent the LunaKeystore from accessing the HSM to search for the object if the object isn't found in the cache. If caching is enabled, adding a line with "clearcache:false" will prevent the object cache from being cleared when the LunaKeyStore is loaded. If caching is enabled, adding a line with "loadcache:false" will prevent the object cache from being loaded when the LunaKeyStore is loaded.

Using a file to back the InputStream in the load() method is optional. If there is no existing KeyStore file, a new KeyStore can be loaded by creating an InputStream backed by a String in one of the two formats above.

```
ByteArrayInputStream slot = new ByteArrayInputStream("slot:2".getBytes()); KeyStore ks =
KeyStore.getInstance("Luna"); ks.load(slot, "mypasswd".toCharArray());
```

The code above will attempt to open a KeyStore on slot 2 with the partition password "mypasswd". Multiple KeyStores can be opened on the same slot, but they are not guaranteed to be thread-safe. External synchronization is recommended.

If an InputStream is provided that contains anything other than a string in one of the two formats above, the KeyStore will attempt to use the default slot.

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CHAPTER 8: Microsoft Interfaces

This chapter describes the Microsoft interfaces to the PKCS#11 API. It contains the following topics:

> "Luna CSP Registration Utilities" below
> "Luna KSP for CNG Registration Utilities" on page 268
> "Run a Windows CNG application as Crypto Officer limited to key handling ability at Crypto User level" on page 274
> "Luna CSP Calls and Functions" on page 277

Luna CSP Registration Utilities

This section describes how to use the Luna CSP registration tool and related utilities to configure the Luna HSM client to use a Luna USB HSM 7 with Microsoft Certificate Services. You must be the client Administrator or a member of the Administrators group to run the Luna CSP tools.

The Luna CSP can be used by any application that acquires the context of the Luna CSP. All users who log in and use the applications that acquired the context have access to the Luna CSP. After you register the Luna USB HSM 7 partitions with Luna CSP, your CSP and KSP code should work the same whether the Luna USB HSM 7 (crypto provider) or the default provider is selected.

The Luna CSP is an optional client feature. During client installation, select **CSP (CAPI) / KSPCNG)** to install it. To install the feature later, run the client installer again, select the option, and click **Modify**.

By default, the Luna CSP utilities are installed in <client_install_dir>/**CSP**. The installation includes **LunaCSP.dll**, the library used by CSP to interact with **Cryptoki.dll**, and the following utilities:

> **"register" below**
  - "Registering Partitions/HA Groups to CSP" on page 265
  - "Registering Cryptographic Algorithms to be Used in Software" on page 266
  - "Enabling Key Counting" on page 266
> **"ms2Luna" on page 266** — Used to migrate Microsoft CSP keys to a Luna USB HSM 7 partition
> **"keymap" on page 267** — Used to manage keys on the partition for use with Microsoft CSP

register

You can use the CSP registration tool (<client_install_dir>/**CSP**/**register.exe**) to perform the following functions:

> Register application partitions/HA groups and their passwords/challenge secrets for use with the Luna CSP (see "Registering Partitions/HA Groups to CSP" on page 265).
> Register which non-RSA cryptographic algorithms you want performed in software only (see "Registering Cryptographic Algorithms to be Used in Software" on page 266).
> Enable key counting in KSP/CSP (see "Enabling Key Counting" on page 266).

> Register the provider library with the Windows OS to make it available for applications.

NOTE CSP or KSP registration includes a step that verifies the DLLs are signed by our certificate that chains back to the DigiCert root of trust G4 (in compliance with industry security standards).

This step can fail if your Windows operating system does not have the required certificate. If you have been keeping your Windows OS updated, you should already have that certificate.

If your Luna HSM Client host is connected to the internet, use the following commands to update the certificate manually:

certutil -urlcache -f http://cacerts.digicert.com/DigiCertTrustedRootG4.crt

certutil -addstore -f root DigiCertTrustedRootG4.crt

To manually update a non-connected host

1. Download the DigiCert Trusted Root G4 (http://cacerts.digicert.com/DigiCertTrustedRootG4.crt) to a separate internet-connected computer.
2. Transport the certificate, using your approved means, to the Luna HSM Client host into a <downloaded cert path> location of your choice
3. Add the certificate to the certificate store using the command:

   certutil -addstore -f root <downloaded cert path>

Syntax

register.exe [**/partition** | **/algorithms** | **/library** | **/usagelimit**] [**/password**] [**/highavail**] [**/strongprotect**] [**/cryptouser**] [**/?**]

Argument	Shortcut	Description
/algorithms	**/a**	Register algorithms that will be used in software by Microsoft CSP (i.e. not on the HSM). Only non-RSA algorithms can be configured to run in software; RSA algorithms will always run on the HSM hardware.
/cryptouser	**/c**	Register the password/challenge for the Crypto User (read-only crypto role). If this option is not specified, the Crypto Officer password/challenge is registered.
/highavail	**/h**	Register the virtual partition of a high-availability (HA) group.

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Argument	Shortcut	Description
/library	**/l**	Register the library and associated provider names for use with CSP. The following providers are registered: > Luna enhanced RSA and AES provider for Microsoft Windows > Luna Cryptographic Services for Microsoft Windows > Luna SChannel Cryptography Services for Microsoft Windows **NOTE** This operation is required only for 32-bit client libraries, which have been discontinued in Luna HSM Client 10.1.0 and newer.
/partition	**/p**	Register a partition and its password/challenge. You are prompted to select which available partitions to register to the CSP. This is the default option. If you type **register** with no additional parameters, then **/partition** is assumed. For example, **register /strongprotect** is the same as **register /partition /strongprotect**.
/password		Specify the user password or challenge for the desired role. By default, this is the Crypto Officer. This option requires minimum Luna HSM Client 10.5.1.
/strongprotect	**/s**	Strongly protect the challenge for registered partitions. This option ensures that only existing client users can access the CSP partitions. After running **register /strongprotect**, new users are not allowed to use CSP.
/usagelimit	**/u**	Set the maximum usage limit for RSA keys using CSP. Enter **0** to register unlimited uses.

Registering Partitions/HA Groups to CSP

Use the **"register" on page 263** utility to register application partitions or HA virtual slots to the CSP. The Crypto Officer or Crypto User must complete this procedure, depending on which role you wish to use.

> **NOTE** You cannot register a combination of HA groups and application partitions; either physical or virtual slots may be registered to the CSP at one time.

To register an application partition or HA group to the CSP

1. In a command prompt, navigate to the Luna CSP install directory and register the desired application partition (s) or HA group(s). Specify **/cryptouser** to register the CU role. Otherwise, the CO role will be registered. If you want to register both roles, you can run the command twice, once with **/cryptouser** and once without.

   "register" on page 263 [**/highavail**] [**/cryptouser**]

   You are prompted (**y**/**n**) to decide whether to register each available partition or HA virtual slot.
2. Install and/or configure your application(s).
3. Run each of your applications once to use Luna CSP.
4. Ensure the security of the registered role passwords/challenges by specifying **/strongprotect**.

"register" on page 263 /strongprotect

5. If you are using a 32-bit CSP provider, register the library. If you are using a 64-bit CSP provider, this is done automatically.

   "register" on page 263 /library

   You can now run all applications as usual.

Registering Cryptographic Algorithms to be Used in Software

Certain symmetric operations such as hashing may be completed faster in software than on the Luna USB HSM 7. The **register /algorithms** command allows you to choose which algorithms to de-register from the Luna USB HSM 7. This may improve performance for operations that use these algorithms, but there is a security cost (exposing the operation in software). Signing and other asymmetric operations are always done on the HSM.

To register algorithms for software-only use

1. In a command prompt, navigate to the Luna CSP install directory and register the desired algorithms to be used in software.

   "register" on page 263 /algorithms

   You are prompted (**y**/**n**) to decide whether each available algorithm should be used in software.

Enabling Key Counting

Key counting allows you to specify the maximum number of times that a key can be used.

To enable key counting

1. In a command prompt, navigate to the Luna CSP install directory and register the key usage limit.

   "register" on page 263 /usagelimit

   You are prompted to enter a key usage limit. You can turn the feature off (unlimited uses) by entering **0**.

ms2Luna

Use the **ms2Luna** utility (<client_install_dir>/**CSP**/**ms2Luna.exe**) to migrate existing Microsoft CSP keys held in software to a registered partition/HA group on the Luna USB HSM 7. It requires the thumbprint of a certificate held in the client's keystore.

Prerequisites

> You must already have registered a partition/HA group using the **"register" on page 263** utility.

> Private keys must be exportable to be migrated to the HSM.

To migrate Microsoft CSP keys to the Luna USB HSM 7

1. In a command prompt, navigate to the Luna CSP install directory and migrate your existing keys to the HSM.

   ms2Luna

   You are prompted for the CSP certificate thumbprint.

keymap

Use the **keymap** utility (<client_install_dir>/**CSP**/**keymap.exe**) to manage keys for use with CSP. CSP needs three objects for a certificate to work:

- Private key
- Public key
- A container: data object containing the certificate's association with the keys

A container is automatically created for all keypairs created using the CSP. For existing keypairs that were created outside the CSP, you must create a container and associate it with each keypair to make them available to the CSP.

When you run the **keymap** utility and select an available slot, the following options are available:

Option	Name	Description
1	**Browse Objects**	List the objects on the slot (public keys, private keys, and containers) that can be used by the CSP.
2	**Create Key Container**	Create a key container that can be used by the CSP.
3	**View Key Container**	Display information about a key container and the keys associated with it.
4	**Associate Keys With Container**	Map a keypair to an existing container. There are two possible algorithm mappings, depending on the intended purpose of the keypair: - **Signature**: keypair will be used for signing operations - **Exchange**: keypair will be used for key exchange
5	**Do Nothing**	Take no action.
99	**Destroy Key Container**	Destroy a key container object. This has no effect on the keys associated with a container.
0	**Exit**	Exit the **keymap** utility.

Luna KSP for CNG Registration Utilities

CNG (Cryptography Next Generation) is Microsoft's cryptographic application programming interface (API), replacing the older Windows cryptoAPI (CAPI). CNG adds new algorithms along with additional flexibility and functionality. Thales provides Luna CSP for applications running in older Windows crypto environments (running CAPI), and Luna KSP for newer Windows clients (running CNG). Consult Microsoft documentation to determine which one is appropriate for your client operating system.

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 Luna cryptoki with CNG and to use the newer functions and algorithms in Microsoft IIS.

After you register the Luna USB HSM 7 partitions with Luna KSP, your KSP code should work the same whether a Luna HSM (crypto provider) or the default provider is selected.

> **NOTE** Be aware when working in a mixed environment or updating applications that previously used CAPI and the Luna 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 and certificate installation will fail.

The Luna KSP is an optional client feature. During client installation, select **CSP (CAPI) / KSP (CNG)** to install it. To install the feature later, run the client installer again, select the option, and click **Modify**.

By default, the Luna KSP utilities are installed in <client_install_dir>/**KSP**. The installation includes the following utilities:

> **"kspcmd" on the next page**
  - "Configuring the KSP Using the Command Line" on page 270

> **"KspConfig" on page 270**
  - "Configuring the KSP Using the GUI" on page 271

> **"ms2Luna" on page 272** — Used to migrate Microsoft CSP keys to a Luna USB HSM 7 partition

> **"ksputil" on page 273** — Used to display and manage partition keys that are visible to the KSP

> **NOTE** *KSP works with Crypto Officer only*.
>
> For management and security and compliance reasons, you might prefer to limit your applications to read-only usage of keys such as the Crypto User role provides. However, since KSP cannot function as CU, you can simulate the CO/CU role separation - see "Run a Windows CNG application as Crypto Officer limited to key handling ability at Crypto User level" on page 274.
>
> This allows you to use the full capability of Crypto Officer for partition and object management tasks, whenever necessary, and then resume running your CNG/KSP-using application as CO, but with reduced, read-only permissions.

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kspcmd

You can use this utility (<client_install_dir>**/KSP/kspcmd.exe**) to register the KSP library and partitions via the Windows command line.

> **NOTE** To register the library and partitions using a GUI, use **"KspConfig" on the next page**. It is unnecessary to use both utilities.

Syntax

kspcmd.exe

library <path**cryptoki.dll**>
nonAdminuser
password /s <slot_label> [**/u** <username>] [**/c** <co_password/challenge>] [**/d** <domain>]
usagelimit
viewslots

Argument	Shortcut	Description
library <path**cryptoki.dll**>	**l**	Register the library and associated provider names with KSP.
nonAdminUser	**n**	Enable non-administrator users on the client to use Luna KSP. This feature requires minimum Luna HSM Client 10.4.0.
password	**p**	Register the designated slot and its Crypto Officer password/challenge to the KSP. You can specify the following options: > **/s** <slot_label> [Mandatory] The label of the partition being registered to the KSP. > **/u** <username> [Optional] The username to register for this partition. If this is not specified, the currently logged-in user is registered. > **/c** <co_password/challenge> [Optional] The Crypto Officer password/challenge. You require minimum Luna HSM Client 10.4.0 to specify this option. > **/d** <domain> [Optional] The domain to register for this partition.
usagelimit	**u**	Set the maximum usage limit for RSA keys using KSP. Enter **0** to register unlimited uses.
viewslots	**v**	Display the registered slots by user/domain.

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Configuring the KSP Using the Command Line

You can use the **"kspcmd" on the previous page** command-line tool to configure the KSP for use with your partitions. The Crypto Officer must complete this procedure using Administrator privileges on the client.

You can register the following user/domain combinations with the KSP:

> **Administrator** user with the domain specific to the client. Default Windows domains are in the format **WIN-XXXXXXXXXXX**.

> **SYSTEM** user with the **NT AUTHORITY** domain

The configuration tool registers a Crypto Officer password/challenge to a specific user, so that only that user can unlock the partition.

To configure the KSP using the command line

1. In a command line, navigate to the Luna KSP install directory and register the **cryptoki.dll** library to the KSP.

   "kspcmd" on the previous page library /s <path**cryptoki.dll**> [**/u** <username>] [**/d** <domain>]

2. Register the designated slot and its Crypto Officer password/challenge to the KSP.

   "kspcmd" on the previous page password /s <slot_label> [**/u** <username>] [**/c** <co_password/challenge>] [**/d** <domain>]

   You are prompted to enter the CO password/challenge for the slot, unless you specified it using the **/c** option (minimum Luna HSM Client 10.4.0 required).

3. [Optional] Display the registered slots to ensure that registration is complete.

   "kspcmd" on the previous page viewslots

4. [Optional] Set the maximum usage limit for RSA keys using KSP.

   "kspcmd" on the previous page usagelimit

   You are prompted to enter a usage limit. Enter **0** to register unlimited uses.

5. [Optional] Enable non-administrator users on the client to use Luna KSP. This feature requires minimum Luna HSM Client 10.4.0.

   "kspcmd" on the previous page nonAdminUser

   You are prompted to confirm this action. When the action succeeds, the following entry is added to the Windows registry with a value of **1**:

   HKEY_LOCAL_MACHINE\SOFTWARE\Safenet\SafeNetKSP\CurrentConfig\NAUaccess

   To restrict non-admin users from Luna KSP in the future, set the value of this entry to **0**, or delete the key from the registry.

KspConfig

You can use this tool (<client_install_dir>**\KSP\KspConfig.exe**) to register the KSP library and partitions using a GUI.

> **NOTE** To register the library and partitions using the command line, use **"kspcmd" on the previous page**. It is unnecessary to use both utilities.

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NOTE CSP or KSP registration includes a step that verifies the DLLs are signed by our certificate that chains back to the DigiCert root of trust G4 (in compliance with industry security standards).

This step can fail if your Windows operating system does not have the required certificate. If you have been keeping your Windows OS updated, you should already have that certificate.

If your Luna HSM Client host is connected to the internet, use the following commands to update the certificate manually:

certutil -urlcache -f http://cacerts.digicert.com/DigiCertTrustedRootG4.crt

certutil -addstore -f root DigiCertTrustedRootG4.crt

To manually update a non-connected host

1. Download the DigiCert Trusted Root G4 (http://cacerts.digicert.com/DigiCertTrustedRootG4.crt) to a separate internet-connected computer.
2. Transport the certificate, using your approved means, to the Luna HSM Client host into a <downloaded cert path> location of your choice
3. Add the certificate to the certificate store using the command:

   certutil -addstore -f root <downloaded cert path>

Configuring the KSP Using the GUI

You can use the **"KspConfig" on the previous page** utility to configure the KSP for use with your partitions. The Crypto Officer must complete this procedure using Administrator privileges on the client.

You can register the following user/domain combinations with the KSP:

> **Administrator** user with the domain specific to the client. Default Windows domains are in the format **WIN-XXXXXXXXXXX**.

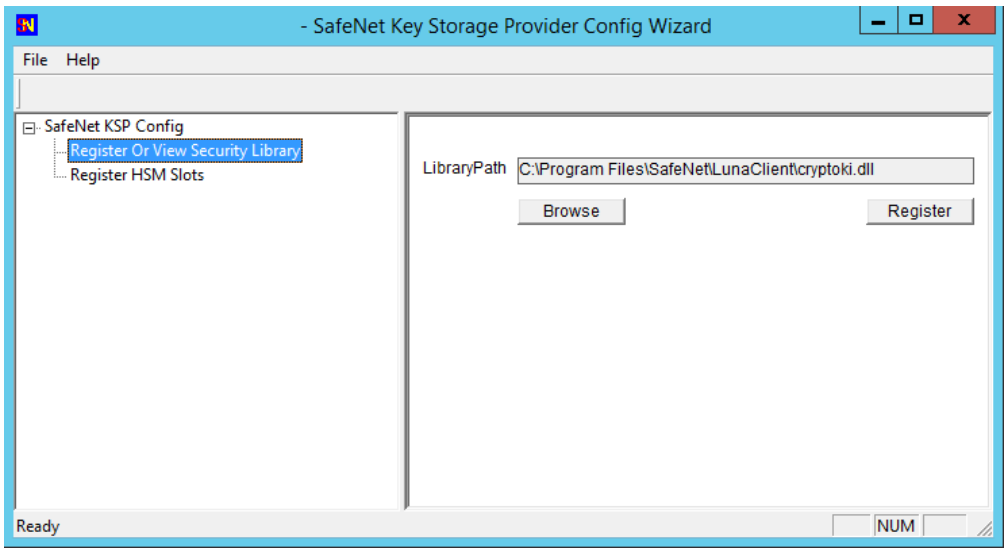
> **SYSTEM** user with the **NT-AUTHORITY** domain

The configuration tool registers a Crypto Officer password/challenge to a specific user, so that only that user can unlock the partition.

To configure the KSP using the GUI

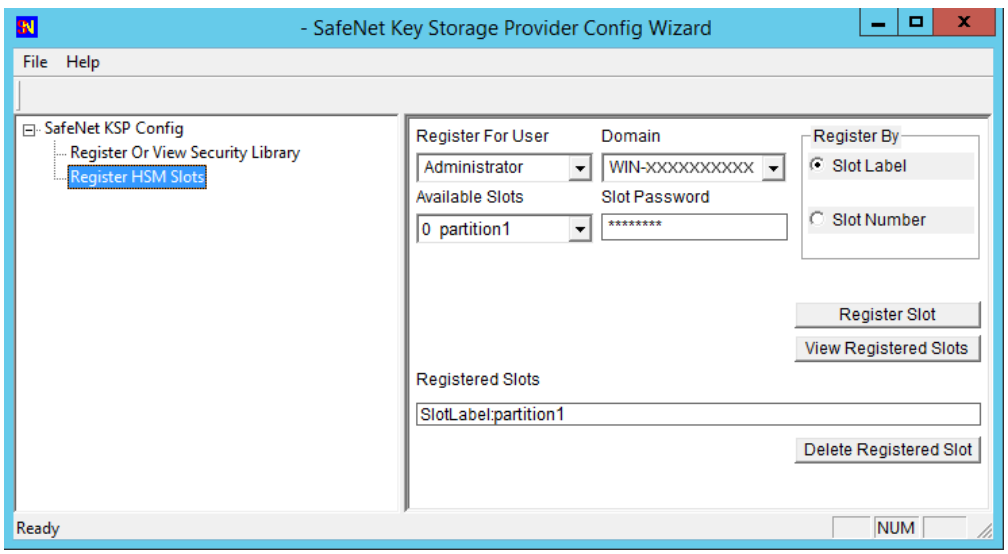
1. In Windows Explorer, navigate to the Luna KSP install directory and launch **"KspConfig" on the previous page** as the **Administrator** user.
2. In the left panel, double-click **Register or View Security Library**. Enter the filepath to **cryptoki.dll** or click Browse to locate it.

   <client_install_dir>**\cryptoki.dll**



Click **Register** to complete the registration.

3. In the left panel, double-click **Register HSM Slots**. Select the **Administrator** user, client domain, and an available slot to register. Enter the CO password/challenge and click **Register Slot**.



4. Select the **SYSTEM** user and **NT-AUTHORITY** domain and register for the slot.
5. Repeat steps 3-4 for any other available slots you want to register with the KSP.

   You can now begin using your applications to perform crypto operations on the registered slots.

ms2Luna

Use the **ms2Luna** utility (<client_install_dir>/**KSP**/**ms2Luna.exe**) to migrate existing Microsoft KSP keys held in software to a registered partition/HA group on the Luna USB HSM 7. It requires the thumbprint of a certificate held in the client's keystore.

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Prerequisites

> You must already have registered a partition/HA group using the **"kspcmd" on page 269** or **"KspConfig" on page 270** utility.

> Private keys must be exportable to be migrated to the HSM.

To migrate Microsoft KSP keys to the Luna USB HSM 7

1. In a command prompt, navigate to the Luna KSP install directory and migrate your existing keys to the HSM.

   ms2Luna

   You are prompted for the KSP certificate thumbprint.

ksputil

KSP binds machine keys to the hostname of the crypto server that created the keys. You can use the **"ksputil" above** utility to display and manage keys that are visible to the KSP.

Syntax

ksputil

clusterkeys /s <slotnum> **/n** <keyname> **/t** <target>
listkeys /s <slotnum> [**/user**]

Argument	Shortcut	Description
clusterkeys	**c**	Bind a specified keypair to a different server domain. Note that this does not change the bindings of existing keys; it creates a copy of the original keypair that is bound to the new domain. Available options: **/s** <slotnum> [Mandatory] The slot number of the partition where the key(s) are located. **/n** <keyname> [Mandatory] The name of the key(s) to bind to the new domain. **/d** <domain> [Mandatory] The domain to which keys will be bound.
listkeys	**l**	DIsplay a list of KSP-visible keys. Available options: **/s** <slotnum> [Mandatory] The slot number of the partition where the key(s) are located. **/user** [Optional] List keys bound to the currently logged-in user/hostname.

Algorithms Supported

Here, for comparison, are the algorithms supported by our CSP and KSP APIs.

Algorithms supported by the Luna 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 Luna 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

Run a Windows CNG application as Crypto Officer limited to key handling ability at Crypto User level

> **NOTE** KSP works with Crypto Officer only.

You might wish to implement the following scenario:

- create keys (requires the CO to have read/write capability on the partition, meaning that Partition Policy 28 - Allow Key Management Functions is set to ON)
- but also permit an application or service to make ongoing use of those keys, *without* an ability to change/create/delete them, (meaning that Partition Policy 28 - Allow Key Management Functions is set to OFF)
- from time to time, create new keys or delete old ones, etc. (requires the CO to have read/write capability on the partition, meaning that Partition Policy 28 - Allow Key Management Functions is set to ON again)
- then resume using your application, still as CO, *without* an ability to change/create/delete keys, (meaning that Partition Policy 28 - Allow Key Management Functions is set to OFF again)
- but Partition Policy 28 is destructive when set from OFF (0) to ON (1)

It is possible to implement such a scheme by initializing the partition using a Partition Policy Template file (see Setting Partition Policies Using a Template) which allows you to override the destructiveness setting, as follows:

Prerequisites

- The partition is created (see partition create for Luna PCIe HSM 7 or for Luna USB HSM 7.

To restrict Crypto Officer power for KSP-using application, while temporarily enabling full capability for partition management

1. Create a basic default policy template file.

   lunacm:> **partition showpolicies -slot** <slotnum> **-verbose -exporttemplate** <filename.policy>

2. In that file, edit policy 28,

   FROM its default value of

   28:"Allow Key Management Functions":1:**1**:0

   (This means that setting KeyManagement OFF to ON will zeroize the partition.)

   TO a new value of

   28:"Allow Key Management Functions":1:**0**:0

   (This removes destructiveness.)

   > **TIP** In the file, you can delete any of the other entries where you intend to use the default values.

3. Initialize a partition with the newly created template

   lunacm:> **partition init -label** <label string> **-password** <password> **-domain** <domainstring if PW-auth> **-applytemplate** <filename.policy> -force

   Complete the mandatory steps of creating new roles and changing the initial password.

4. Log in as Partition Security Officer.

   lunacm:> **role login -name** PO

5. Initialize the Crypto Officer role.

   lunacm:> **role init -name** CO

6. Log in as Crypto Officer.

   lunacm:> **role logout**

   lunacm:> **role login -name** CO

7. Partition policy 28 should currently be ON (from partition initialization with the template file). Generate keys by whatever means you normally employ.

8. Log in as Partition Security Officer.

   lunacm:> **role logout**

   lunacm:> **role login -name** PO

9. Switch policy 28 to OFF, to *disallow* key management.

   lunacm:> **partition changepolicy -policy** 28 -value 0

   In this state, the CO (or an application authenticated with CO credential) can now use any key that is currently in the partition, but cannot delete them or add new ones. This permits the CO, when logged in, to facilitate application access via KSP/CNG but with key-use capability at read-only Crypto User level.

10. Log in as Crypto Officer.

    lunacm:> **role logout**

    lunacm:> **role login -name** CO

    Run your KSP/CNG-using application that needs CO credentials (but not full CO read-write capability) to make use of existing keys.

11. Whenever it is necessary to manage keys in the partition (delete existing ones or create new ones, etc.), first shut down the application or service (for example code-signing) and then switch Partition Policy 28 to ON.

    lunacm:> **role logout**

    lunacm:> **role login -name** PO

    lunacm:> **partition changepolicy -policy** 28 **-value** 1

    lunacm:> **role logout**

    lunacm:> **role login -name** CO

    In this state, CO has full ability to add, delete, change objects in the partition, and the application is paused so that it does not make use of the expanded powers.

12. Generate a new keypair or perform other management function in the partition.

13. When key management action is done, switch Partition Policy 28 back to OFF.

    lunacm:> **role logout**

    lunacm:> **role login -name** PO

    lunacm:> **partition changepolicy -policy** 28 **-value** 0

    lunacm:> **role logout**

    lunacm:> **role login -name** CO

14. Resume operation of your application or service, via KSP/CNG, as the CO role, but with CU role limitations.

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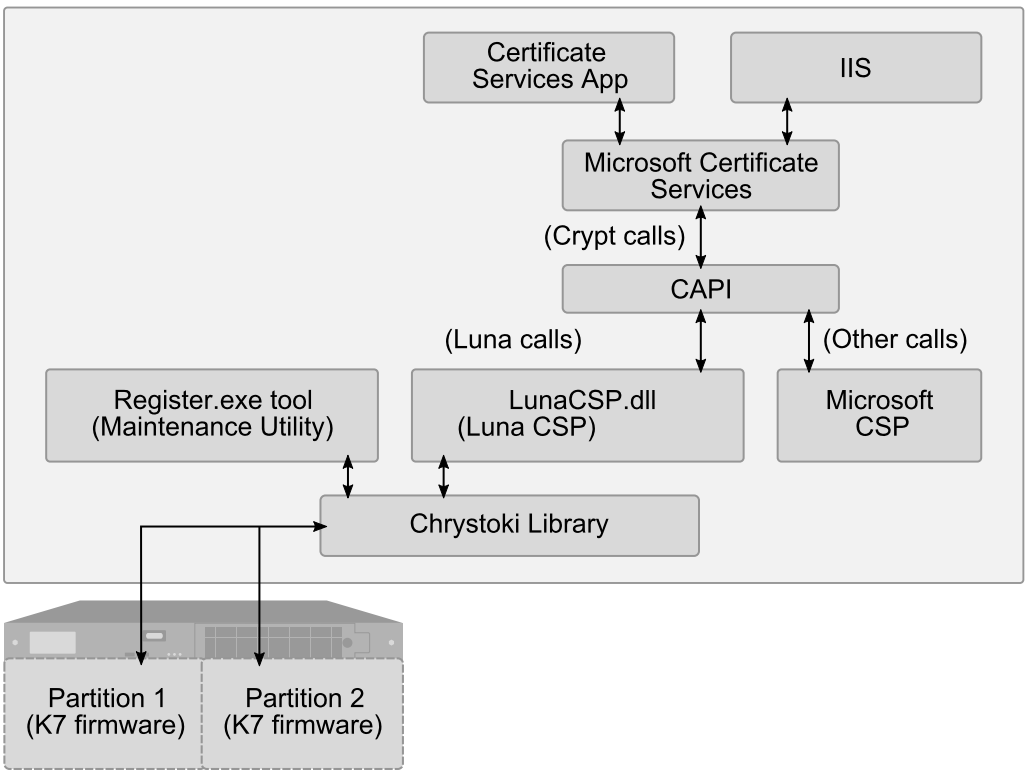
Luna CSP Calls and Functions

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 Luna USB HSM 7.

The diagram below depicts the relationship of the Luna components to the other layers in the certificate system.

Figure 1: Luna CSP architecture



Note, in the diagram, that the Luna 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 Luna CSP supported functions (see next section) – are passed to the Microsoft CSP.

Programming for Luna USB HSM 7 with Luna CSP

The Luna 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.

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

Luna 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).

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- 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 Luna 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.

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