THALES

ProtectToolkit 5.9.1
PTK-C

PROGRAMMING GUIDE

Document Information

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PREFACE: About the ProtectToolkit-C Programming Guide

This document provides instructions for using the ProtectToolkit-C Application Programming Interface. It contains the following chapters and appendices:

- "An Introduction to PKCS#11" on page 23 — Introduction to PKCS#11 programming
- "Environments" on page 27 — Application, development, and configuration environments
- "Object Classes" on page 31 — Supported object types
- "ProtectToolkit-C Mechanisms" on page 65 — Supported mechanism types
- "Sample Programs" on page 403 — Sample programs included with the SDK
- "Best Practice Guidelines" on page 411 — Development tips and techniques and best practice guidelines
- "ctbrowse - Token Browser" on page 426 — **ctbrowse** application
- "API Tutorial: Development of a Sample Application" on page 435 — Full tutorial with complete details on the **fcrypt** sample
- "PKCS#11 Logger Library" on page 448 — Reference on how to use the PKCS#11 logger library
- "PKCS#11 Command Reference" on page 452 — Full reference on the ProtectToolkit-C implementation of the PKCS#11 API
- "ctutil.h Functionality Reference" on page 494 — Reference for the **CTLUTIL** library
- "ctextra.h Library Reference" on page 574 — Reference for the **CTEXTRA** library
- "hex2bin.h Library Reference" on page 624 — Reference for the **HEX2BIN** library
- "hsmadmin.h Library Reference" on page 631 — Reference for the **HSMAdmin** library
- "Attribute Certificate" on page 640

This preface also includes the following information about this document:

- "Document Conventions" below
- "Support Contacts" on page 22

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

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 cross-references to other documents in this documentation set.
<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.

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Format	Convention
{**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 to this service is governed by the support plan arrangements made between Thales and your organization. Please consult this support plan for further information about 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. The Customer Support Portal is 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. You can also use the portal to create and manage support cases.

> **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: An Introduction to PKCS#11

The PKCS#11 Cryptographic Token Interface Standard, also known as Cryptoki, is one of the Public Key Cryptography Standards developed by RSA Security. PKCS#11 defines the interface between an application and a cryptographic device. This chapter gives a general outline of PKCS#11 and some of its basic concepts. If unfamiliar with PKCS#11, the reader is strongly advised to refer to *PKCS #11: Cryptographic Token Interface Standard*.

PKCS#11 is used as a low-level interface to perform cryptographic operations without the need for the application to directly interface a device through its driver. PKCS#11 represents cryptographic devices using a common model referred to simply as a token. An application can therefore perform cryptographic operations on any device or token, using the same independent command set.

ProtectToolkit-C is a cryptographic service provider using the PKCS #11 application programming interface (API) standard, as specified by RSA Labs. It includes a lightweight, proprietary Java API to access these PKCS #11 functions from Java.

The PKCS #11 API, also known as Cryptoki, includes a suite of cryptographic services for encryption, decryption, signature generation, signature verification, and permanent key storage. The software found on the installation DVD is compliant with PKCS #11 v. 2.20. The latest versions of the client software and HSM firmware can be found on the Thales Technical Support Customer Portal. See "Support Contacts" on page 22 for more information.

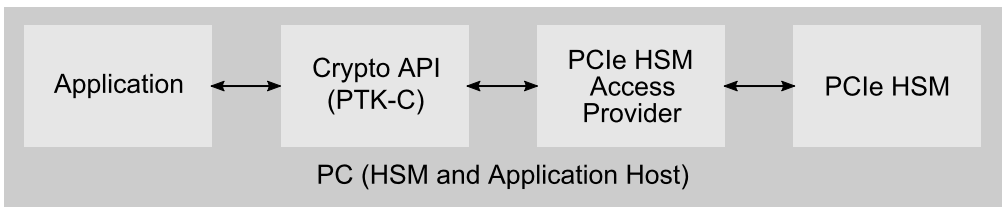
To provide the highest level of security, ProtectToolkit-C interfaces with SafeNet access provider software and the SafeNet range of hardware security modules (HSMs):

- ProtectServer Network HSM
- ProtectServer PCIe HSM

HSMs include high-speed DES and RSA hardware acceleration, as well as generic security processing. Secure, persistent, tamper-resistant CMOS key storage is included. Multiple adapters may be used in a single host computer to improve throughput or to provide redundancy. HSMs may be installed locally, on the same host system as ProtectToolkit-C or they may be located remotely across a network.

ProtectToolkit-C can be used in one of three *operating modes*. These are:

- **PCI mode** in conjunction with a locally-installed ProtectServer PCIe 2.



- **Network mode** over a TCP/IP network, in conjunction with a compatible product such as the ProtectServer External 2.

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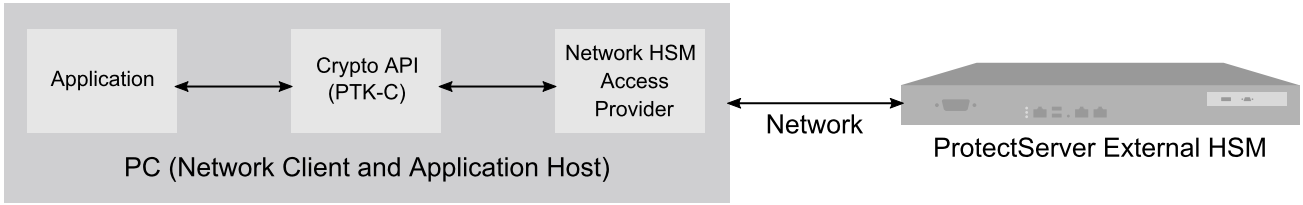
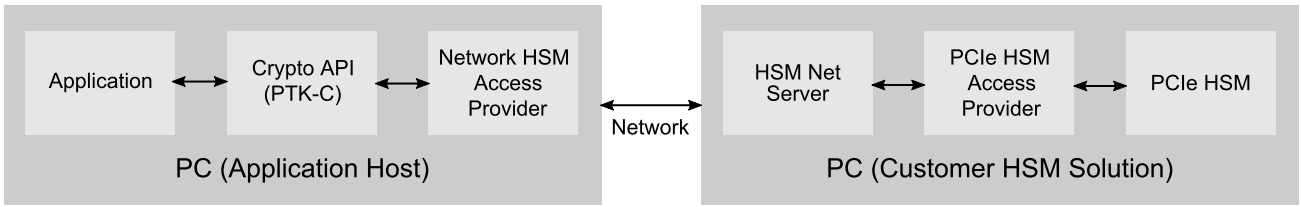


A machine with a ProtectServer PCIe 2 installed may also be used as a server in network mode.



> **Software-only mode** on a local machine without access to a hardware security module.

Within the client/server runtime environment, the server performs cryptographic processing at the request of the client. The server itself will only operate in one of the hardware runtime modes.

The software-only version is available for a variety of platforms, including Windows NT and Solaris, and is typically used as a development and testing environment for applications that will eventually use the hardware variant of ProtectToolkit-C.

Runtime Licensing

All of the runtime software, including all applications and the software-only ProtectToolkit-C runtime supplied with this SDK, are licensed for development and testing purposes only. NO RUNTIME LICENSES ARE INCLUDED. Therefore this software, or any component of it, must not be used for production systems. Separate runtime licenses must be purchased for production systems deployed using any ProtectToolkit-C support.

Please refer to the **readme.txt** file found in the install directory of the ProtectToolkit-C SDK for licensing requirement details.

The PKCS#11 Model

The model for PKCS#11 can be seen illustrated below, demonstrating how an application communicates its requests to a token via the PKCS#11 interface. The term slot represents a physical device interface. For example, a smart card reader would represent a slot and the smart card would represent the token. It is also possible that multiple slots may share the same token.

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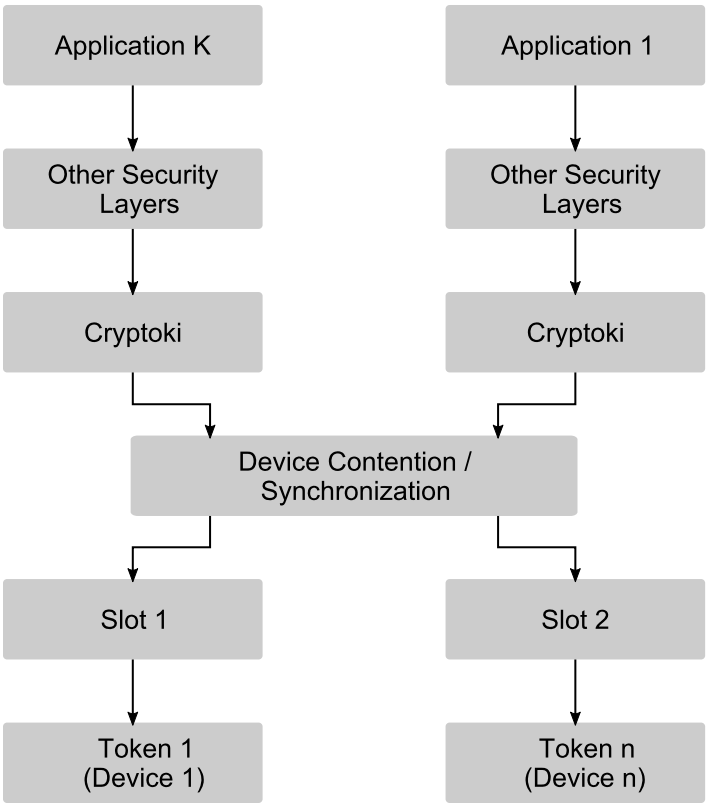
Figure 1: General PKCS#11 Model



Within PKCS#11, a token is viewed as a device that stores objects and can perform cryptographic functions. Objects are generally defined in one of four classes:

- Data objects, which are defined by an application
- Certificate objects, which are digital certificates such as X.509
- Key objects, which can be public, private or secret cryptographic keys
- Vendor-defined objects

Objects within PKCS#11 are further defined as either a token object or a session object. Token objects are visible by any application which has sufficient access permission and is connected to that token. An important attribute of a token object is that it remains on the token until a specific action is performed to remove it.

A connection between a token and an application is referred to as a session. Session objects are temporary and only remain in existence while the session is open. Session objects are only ever visible to the application that created them.

> **NOTE**
>
> - The ProtectServer HSM supports up to 65534 concurrent sessions.
> - ProtectToolkit-C allows an application to have concurrent sessions with more than one token. It is also possible for a token to have concurrent sessions with more than one application.

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Access to objects within PKCS#11 is defined by the object type. Public objects are visible to any user or application, whereas private objects require that the user must be logged into that token in order to view them. PKCS#11 recognizes two types of users, namely a security officer (SO) or normal user. The security officer's only role is to initialize a token and set the normal user's access PIN.

> **NOTE** The normal user, which manipulates objects and performs most operations, cannot log in until the security officer has set that user's PIN.

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CHAPTER 2: Environments

This chapter provides details of how ProtectToolkit-C is supplied in different environments. It contains the following sections:

> "Application Environment" below

> "Development Environment Guidelines" on the next page

> "Setup and Configuration" on page 30

Application Environment

Win32™/Win64™ Environment

ProtectToolkit-C is supplied as a Win32/64 Dynamic Link Library (**cryptoki.dll**) built with Microsoft development tools (MSVC). **cryptoki2.lib** is an import library that should be linked against applications to resolve function calls into **cryptoki.dll**.

UNIX Environments

This is supplied as shared libraries. The hardware based ProtectToolkit-C library is stored as the shared library **libcthsm.so** (**libcthsm.sl** for HP-UX on PA-RISC, **libcthsm.a** for AIX) and the software-only version as **libctsw.so** (**libctsw.sl** for HP-UX on PA-RISC, **libctsw.a** for AIX). The symbolic link **libcryptoki.so** (**libcryptoki.sl** for HP-UX on PA-RISC, **libcryptoki.a** for AIX) is setup in the **/opt/safenet/protecttoolkit5/ptk/lib** folder and should point to the appropriate library. Additionally these libraries must be included in the LD_LIBRARY_PATH (SHLIB_PATH for HP-UX on PA-RISC, or LIBPATH for AIX).

The **libcthsm** shared object requires the library **libethsm**.

For systems that support 32-bit and 64-bit, the 32-bit libraries and executables are the default.

Java™ Environments

A lightweight proprietary Java wrapper for PKCS#11 API, JCPROV, is provided to allow access to the ProtectToolkit-C functionality from Java, without the overhead of the JCA/JCE API. The aim of this API is to be as similar to the PKCS#11 as the Java language allows. This provides a high level of familiarity with the PKCS#11 environment and allows for faster implementation of Java programs.

The Java API is compatible with JDK 6, 7, and 8. The library is implemented in **jcprov.jar**, under the namespace **safenet_tech.jcprov**. An accompanying shared library "**jcprov**" (**jcprov.dll** in Win32/64 environments, and **libjcprov.so** in UNIX environments (**libjcprov.sl** for HP-UX on PA-RISC, **libjcprov.a** for AIX) provides the native methods used to access the appropriate PKCS#11 library.

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JCPROV Java JNI Support (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 the correct JNI library is selected for use with Java VM being used.

If using a 32-bit Java VM

- The **/opt/safenet/protecttoolkit5/ptk/lib/libjcprov.a** symbolic link must point to a 32-bit version of the library (**libjcprov_32.a**).

  For example: **/opt/safenet/protecttoolkit5/ptk/lib/libjcprov_32.a**
- The **/opt/safenet/protecttoolkit5/ptk/lib/libjcryptoki.a** symbolic link must point a 32-bit version of the library (**libjcryptoki_32.a**).

  For example: **/opt/safenet/protecttoolkit5/ptk/lib/libjcryptoki_32.a**

If using a 64-bit Java VM

- The **/opt/safenet/protecttoolkit5/ptk/lib/libjcprov.a** symbolic link must point to a 64-bit version of the library (**libjcprov_64.a**).

  For example: **/opt/safenet/protecttoolkit5/ptk/lib/libjcprov_64.a**
- The **/opt/safenet/protecttoolkit5/ptk/lib/libjcryptoki.a** symbolic link must point a 64-bit version of the library (**libjcryptoki_64.a**).

  For example: **/opt/safenet/protecttoolkit5/ptk/lib/libjcryptoki_64.a**

> **NOTE** When installing the ProtectToolkit-C Runtime package, the above links are automatically created to use the 32-bit versions of the JNI libraries.

Development Environment Guidelines

This manual gives a number of application development guidelines that can be of benefit for both novice and advanced developers using ProtectToolkit-C.

An API tutorial is provided in "API Tutorial: Development of a Sample Application" on page 435.

Further sample programs, for which source code has been provided, may be compiled and linked against the supplied libraries. Further details about the sample programs are covered in Chapter 5.

The additional libraries **ctextra**, **ctutil**, **hex2bin** and **LMlib** are static libraries that contain additional PKCS#11 support and helper functions that are not a part of the PKCS#11 standard. For full details on the content of these libraries please refer to:

- "ctextra.h Library Reference" on page 574
- "ctutil.h Functionality Reference" on page 494
- "hex2bin.h Library Reference" on page 624
- KMLIB Function Reference in the *ProtectToolkit-C Management Libraries Programming Guide*.

The library **HSMAdmin** calls services on the HSM that are not part of the PKCS#11 standard - see "hsmadmin.h Library Reference" on page 631 for details.

This development kit may be used to build applications for any variant of the ProtectToolkit-C runtimes.

> **NOTE** It is assumed that the Native C/C++ compiler is being used.

Compiling and Linking Applications on AIX

It is important that new applications link against libraries in the **/opt/safenet/protecttoolkit5/ptk/lib** directory *instead* of the libraries in the **/opt/safenet/protecttoolkit5/ptk/lib/legacy** directory. This can be achieved by using the **-L/opt/safenet/protecttoolkit5/ProtectToolkit/lib** argument to the compiler or linker. *Do not* specify the **/opt/safenet/protecttoolkit5/ptk/lib/legacy** library path, since the legacy shared libraries are deprecated, and support is to be removed in a future release.

You may also want to explicitly specify an embedded library path when linking your own applications and libraries, so that your applications automatically find the required libraries *without* requiring the **LIBPATH** environment variable to be set. Do this by using the **-blibpath:/usr/lib:/lib:/opt/safenet/protecttoolkit5/ptk/lib** option to the linker (**ld**), or alternatively (if using the compiler to link):

```
-Wl,-blibpath:/usr/lib:/lib:/opt/safenet/protecttoolkit5/ptk/lib
```

Compiling and Linking 64-bit Applications on AIX

To compile 64-bit applications for AIX specify the following compiler and linker flags:

```
-q64
```

Compiling and Linking 64-bit Applications for Solaris SPARC

To compile 64 bit applications for Solaris SPARC specify the following compiler flags:

```
-Xarch = v9
-DBITS64
```

The 64-bit libraries are to be found in the **/opt/safenet/protecttoolkit5/ptk/lib/sparcv9** directory. To link against them instead of the libraries in the directory **/opt/safenet/protecttoolkit5/ptk/lib**, add the following argument to the compiler or linker:

```
-L /opt/safenet/protecttoolkit5/ptk/lib/sparcv9
```

> **NOTE** It is assumed that the Sun C/C++ compiler is being used.

Compiling and Linking 64-bit Applications for HP-UX

To compile 64-bit applications for HP-UX, specify the following compiler flags:

```
+DD64
```

The 64 bit libraries are to be found in the **/opt/safenet/protecttoolkit5/ptk/lib/64** directory. To link against them instead of the libraries in the directory **/opt/safenet/protecttoolkit5/ptk/lib**, add the following argument to the compiler or linker:

```
-L /opt/safenet/protecttoolkit5/ptk/lib/64
```


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MSVC Project Settings

In order to remove link errors when linking to the additional libraries **ctextra** and **ctutil** etc, you need to set the MSVC project settings to **Multithreaded** under the C/C++ tab of the **Code generation** category, since this is what the libraries were compiled with.

Also add **"_WINDOWS**" to the **Preprocessor definitions** under the **C/C++** tab of the **General** category.

Modes of Operation

To switch the ProtectToolkit-C operational mode, you will need to ensure that you are linking to the correct **cryptoki.dll**. As of version 5.3, the **setmode** tool has been provided for this purpose. Refer to the *ProtectToolkit-C Administration Guide* for more information.

Setup and Configuration

For full details regarding setup and configuration of ProtectToolkit-C and/or ProtectServer hardware security modules (HSMs), please refer to:

- *ProtectServer HSM and ProtectToolkit Installation Guide*
- *ProtectToolkit-C Administration Guide*

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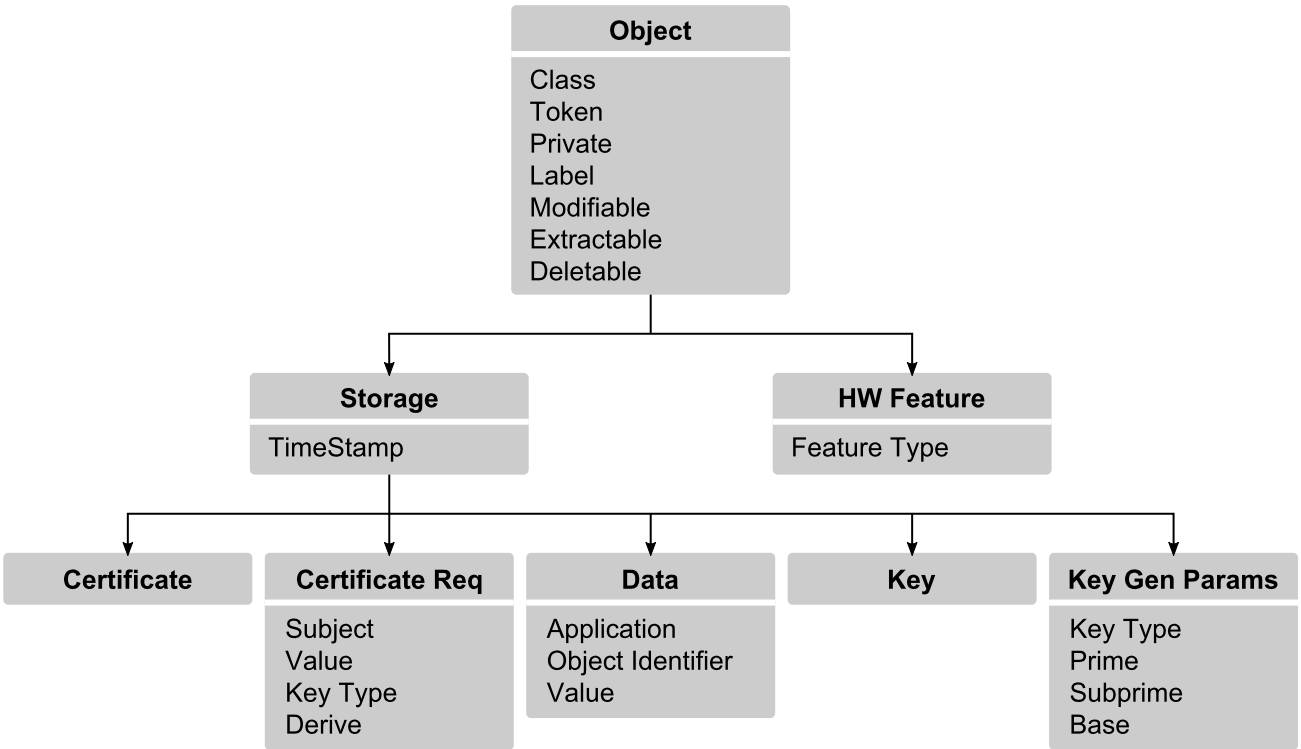
CHAPTER 3: Object Classes

Cryptoki recognizes a number of object classes, as defined in the `CK_OBJECT_CLASS` data type. An object consists of a set of attributes, each of which has a given value. Each object attribute has precisely one value. "Object Attribute Hierarchy" below illustrates the high-level hierarchy of the Cryptoki objects and some of the attributes they support:

Figure 2: Object Attribute Hierarchy



Cryptoki provides functions for creating, destroying, and copying objects and for obtaining or modifying their attribute values. Some of the cryptographic functions (for example, **C_GenerateKey**) also create key objects to hold their results.

Objects are always “well-formed” in Cryptoki—that is, an object always contains a minimum set of attributes for its proper operation, and the attributes are always consistent with one another from the time the object is created. It is possible, however, for an object to have one or more optional attributes missing.

A token can hold several identical objects. That is, it is permissible for two or more objects to have exactly the same values for all of their attributes.

Some object attributes possess default values, and need not be specified when creating an object. Some of these default values may even be the empty string (“”). Nevertheless, the object possesses these attributes. A given object has a single value for each attribute it possesses. Optional attributes are, by default, not created.

In addition to possessing Cryptoki attributes, objects may possess additional vendor-specific attributes. The meanings and values of the attributes not specified by Cryptoki are described below.

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This chapter contains the following sections:

- "Creating, Modifying, Copying, and Deleting Objects" below
- "Additional Attribute Types" on the next page
- "Common Attributes" on page 39
- "Hardware Feature Objects" on page 39
- "Clock Objects" on page 40
- "Monotonic Counter Objects" on page 40
- "Storage Objects" on page 41
- "Data Objects" on page 42
- "Certificate Objects" on page 42
- "Key Objects" on page 45
  - "Public Key Objects" on page 48
  - "Private Key Objects" on page 52
  - "Secret Key Objects" on page 56
  - "Key Parameter Objects" on page 61

Creating, Modifying, Copying, and Deleting Objects

Cryptoki functions that create, modify, or copy objects, take a template as one of their arguments, where the template specifies attribute values. Cryptographic functions that create objects may also contribute some additional attribute values themselves. Which attributes have values contributed by a cryptographic function call depends on which cryptographic mechanism is being performed.

In any case, all the required attributes supported by an object class that do not have default values must be specified when an object is created, either in the template or by the function itself.

Creating Objects

Objects may be created with the Cryptoki functions **C_CreateObject**, **C_GenerateKey**, **C_GenerateKeyPair**, **C_UnwrapKey**, and **C_DeriveKey**. In addition, copying an existing object, with the function **C_CopyObject** or **CT_CopyObject**, also creates a new object.

Attempting to create an object with any of these functions requires an appropriate template to be supplied.

- If the supplied template specifies a value for an unrecognized attribute, then the attribute is stored but ignored.
- If the supplied template specifies an inappropriate value for a valid attribute, then the attribute is stored, except when it is the value attribute for a key, in which case the length is checked. Checks are made on the validity of attributes when the object is used in later operations.
- When a token has the `CKF_LOGIN_REQUIRED` flag set in the flags field of the `CK_TOKEN_INFO` structure, the token is read-only until the user (or SO) has been authenticated to the token.

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- If the attribute values in the supplied template, any default attribute values, and any attribute values contributed by the object-creation function itself are insufficient to fully specify the object to be created, then the attempt will fail with the error code `CKR_TEMPLATE_INCOMPLETE`.
- If the supplied template specifies the same value for a particular attribute more than once (or the template specifies the same value for a particular attribute that the object-creation function itself contributes to the object), then the duplicate attribute is ignored.

Modifying Objects

If the “Increased Security” flag is set as part of the security policy, then **C_CopyObject** does not allow changing the `CKA_MODIFIABLE` flag from `FALSE` to `TRUE` (See *ProtectToolkit-C Administration Manual* for details on setting HSM security policy).

Apart from the above exception, all PKCS#11 version 2.20 rules for object modification are applied.

Copying Objects

All PKCS#11 version 2.20 rules for copying objects are applied.

Deleting Objects

In addition to standard object deletion rules, there is support for the `CKA_DELETABLE` attribute. This is an optional attribute that may be specified for token objects. For token objects with `CKA_DELETABLE` set to `FALSE`, the **C_DestroyObject** function will not delete the object and will instead return the error `CKR_OBJECT_READ_ONLY`.

Additional Attribute Types

This section describes additional vendor-defined attribute types.

CKA_KEY_SIZE

The key size for key type `CKK_EC` can be any arbitrary bit length. That is, not within the byte boundary (for example: the key size for a P-521 curve).

The `CKA_KEY_SIZE` attribute has the following additional properties:

- Size is in bits
- Read-only attribute
- Assigned at object creation time
- Applicable to both private and public keys

> **NOTE** This attribute is applicable only to `CKK_EC`.

CKA_TIME_STAMP

Every object created is assigned a value for the `CKA_TIME_STAMP` attribute. This value is always read-only and may not be included in a template for a new object. However, when an object is duplicated using the **C_CopyObject** function or the object is a key derived using the **C_DeriveKey**, the new object will inherit the same

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creation time as the original object.

The value of this attribute is a text string encoding of the time. The encoding format is "**YYYYMMDDHHMMSS00**".

CKA_TRUSTED

This attribute may be included in a template for the creation of a Certificate object. It indicates whether or not the certificate is *trusted* by the application. Once set, the value of this attribute may not be modified.

The following values are defined for this attribute:

CKA_TRUSTED	Description
TRUE (1)	The certificate is trusted.
FALSE (0)	The certificate is not trusted and must be verified.

The value of CKA_TRUSTED may be set to TRUE only when the Security Officer is logged in. That is, the state of the session must be CKS_RW_SO_FUNCTIONS. Once a Certificate object has the CKA_TRUSTED attribute equal to TRUE, the Certificate is considered a *trusted root certificate*. The certificate validation code will stop once it reaches a trusted root certificate.

The certificate validation algorithm will locate the certificate's issuer by searching for a Certificate object with the CKA_SUBJECT attribute equal to the issuer's distinguished name. If located, it will then verify the signature on the certificate. If the signature is invalid it will return false, otherwise it will check the CKA_TRUSTED attribute on the issuer's certificate. If not equal to TRUE it will search for the issuer of that certificate. The algorithm will continue until a trusted certificate is found, the signature verification fails or the certificate chain is broken. The chain is broken when a certificate for the issuer cannot be found.

Once a certificate is marked as trusted, the object's CKA_VALUE attribute may no longer be modified.

> **NOTE** The other attributes of the certificate will remain modifiable unless the CKA_MODIFIABLE attribute is set to FALSE.

CKA_USAGE_COUNT

The value of this attribute maintains a count of the number of times a key object is used for a cryptographic operation. It is possible to set the value of this attribute for a key. Afterwards it is automatically incremented each time the key is used in a Cryptoki initialization routine (that is, **C_SignInit**).

Also see description for CKA_USAGE_LIMIT.

When generating Certificate objects with the CKM_ENCODE_X_509 mechanism, the CKA_SERIAL_NUMBER attribute for the new certificate object is taken from the certificate signing key's CKA_USAGE_COUNT attribute. The usage count from the private key is used only if the serial number is not already included in the template for the new certificate.

CKA_USAGE_LIMIT

This attribute represents the highest possible CKA_USAGE_COUNT value allowed on this object - the maximum number of times the object can be used.

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This attribute may be specified when the object is created, or added to an object when CKA_MODIFIABLE is true. Once the attribute is added, it cannot be changed by the **C_SetAttributeValue** function.

Only the CKM_SET_ATTRIBUTES ticket mechanism can change this attribute. The Ticket can modify the attribute even if MODIFABLE=False.

CKA_START_DATE, CKA_END_DATE

These attributes control the period in which the object can be used.

These attributes may be specified when the object is created or added to an object when CKA_MODIFIABLE is true. Once the attribute is added it cannot be changed by the **C_SetAttributeValue** function.

Only the CKM_SET_ATTRIBUTES ticket mechanism can change these attributes. The Ticket can modify the attributes even if MODIFABLE=False.

Attribute validation is performed if these attributes are supplied during a **C_CreateObject** or **C_UnWrapkey** or **C_DeriveKey** operation. One or both of these attributes may be missing, or present but with an empty value. In this case the attribute is interpreted as "No restriction applies". For example if START_DATE is specified, but END_DATE is not, then the object will be usable from the start date onwards.

If the attribute is specified, it must have a valid data structure (year is between 1900 and 9999, month from 01 to 12 and day from 01 to 31).

CKA_ADMIN_CERT

The CKA_ADMIN_CERT is a new Vendor-defined Attribute.

This attribute is used to hold the certificate of an entity that can perform certain management operations on the object.

The value of the attribute is the DER encoding of an X509 v3 Public Key Certificate.

Rules for validation of the Certificate are:

- If it is self signed, it is implicitly trusted
- If it is signed by another entity, that entity's PKC must be present on the Token and be part of a chain terminating in a Cert marked CKA_TRUSTED=True
- It may be specified in the template when the Object is created, generated or imported.
- It may be added to an object with the **C_SetAttributeValue** command only if the CKA_MODIFIABLE is True and the attribute does not already exist i.e. once an object is created and made non-modifiable then the CKA_ADMIN_CERT cannot be added later.

The CKA_ADMIN_CERT is used with the CKM_SET_ATTRIBUTES Ticket Mechanism.

So if an object is not Modifiable and has no CKA_ADMIN_CERT then the CKM_SET_ATTRIBUTES Ticket Mechanism can never be applied to that object. Its attributes are forever locked.

CKA_ISSUER_STR, CKA_SUBJECT_STR, CKA_SERIAL_NUMBER_INT

These attributes mirror the standard attributes (without the _STR or _INT suffix) but present that attribute as a printable value rather than as a DER encoding.

For the distinguished name attributes the string is encoded in the form: **C=**Country code, **O=**Organization, **CN=**Common Name, **OU=**Organizational Unit, **L=**Locality name, **ST=**State name.

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These attributes may be supplied by an application in place of the DER-encoded form and the other form of the attribute shall be derived from the one supplied in the template.

> **NOTE** CKA_SERIAL_NUMBER_INT is a CK_ULONG value and is an intrinsic integer type.

CKA_PKI_ATTRIBUTE_BER_ENCODED

This attribute may be used to supply X.509 certificate extensions or PKCS#10 attribute values when creating these objects using the CKM_ENCODE_X509 or CKM_ENCODE_PKCS10 mechanisms, respectively. Please refer to the sections "CKM_DECODE_X_509" on page 123 and "CKM_ENCODE_PKCS_10" on page 205 for full descriptions of these mechanisms.

The value of the CKA_PKI_ATTRIBUTE_BER_ENCODED is the BER-encoded attribute.

CKA_EXPORT, CKA_EXPORTABLE

These attributes are similar to the standard CKA_WRAP and CKA_EXTRACTABLE attributes, as they determine if a given key can wrap other keys and be extracted from the token in an encrypted form. The important difference between these attributes and their standard counterparts is that there are special controls on who can set the CKA_EXPORT flag. This flag may be set to TRUE by the token's Security Officer, or by the User if certain conditions are met. Thus the normal user can specify that a key may be exported in an encrypted form (by specifying that the CKA_EXPORTABLE attribute is TRUE) but only by keys as determined by the SO (for example, a key that has the CKA_EXPORT attribute set to TRUE).

The user may also specify the CKA_EXPORT attribute for keys that are generated internally and cannot be extracted other than by another key marked with CKA_EXPORT. This class of key may be used for transport keys where a master key encryption key (KEK) exists. In this case, the Security Officer would create the KEK, and the user could then create transport keys that could be exported only under the master KEK.

All other key usage attributes that might allow such a key, or any key exported by it, to be known outside the adapter must be set to FALSE. Specifically the template must specify FALSE for CKA_EXTRACTABLE, CKA_DECRYPT, CKA_SIGN and CKA_MODIFIABLE, and TRUE for CKA_SENSITIVE. The template may also not specify TRUE for the CKA_DERIVE attribute.

CKA_DELETABLE

This attribute may be set on any token object (that is, where the CKA_TOKEN attribute is TRUE) to specify that the object is permanent and may not be deleted. Once created, an object with the CKA_DELETABLE attribute set to FALSE may be deleted only by re-initialization of the token (or during a hardware tamper process).

CKA_SIGN_LOCAL_CERT

This attribute must be set to TRUE on any private key that is used with the Proof of Origin mechanism (CKM_ENCODE_X_509_LOCAL_CERT). Signing keys that do not have this attribute may not be used with this mechanism. Refer to "CKM_WRAPKEY_DES3_ECB" on page 384 and "CKM_WRAPKEY_DES3_CBC" on page 381 for more information.

Keys with this attribute should have the CKA_SIGN and CKA_ENCRYPT attributes set to FALSE to ensure that the key cannot be used to sign arbitrary data. Special precautions should be taken to ensure that the key cannot leave the adapter - generally, CKA_EXTRACTABLE and CKA_EXPORTABLE should be FALSE and CKA_SENSITIVE should be TRUE.

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CKA_CHECK_VALUE

This attribute is a key check value that is calculated as follows:

- Take a buffer of the cipher block size of binary zeros (**0x00**).
- Encrypt this block in ECB mode.
- Take the first three bytes of cipher text as the check value.

This attribute is calculated on all keys of class `CKO_SECRET`, that is, all symmetric key types when they are created or generated. The attribute is generated by default if it is not supplied in the key template. If it is supplied in the template, the template value is used even if its value would conflict with the one calculated as shown above. This is applicable when a customer wants to use an alternative method to validate a key.

> **NOTE** The `CKA_ENCRYPT` attribute is not required to be set to `TRUE` on the key object for the CKA_CHECK_VALUE attribute to be generated. This attribute cannot be changed once it has been set.

CKA_IMPORT

This attribute is similar to the standard `CKA_UNWRAP` attribute, which determines if a given key can be used to unwrap encrypted key material. The important difference between this attribute and `CKA_UNWRAP` is that if `CKA_IMPORT` is set to `TRUE` and `CKA_UNWRAP` attribute is set to `FALSE`, the only available unwrap mechanism is `CKM_WRAPKEY_DES3_CBC`. The error code `CKR_MECHANISM_INVALID` is returned for all other mechanisms. `CKA_IMPORT` is set to `FALSE` by default.

CKA_CERTIFICATE_START_TIME; CKA_CERTIFICATE_END_TIME

These attributes are used to specify a user-defined validity period for X.509 certificates. Without these, the certificate validity period is 1 year from the date and time of creation. The format is **YYYYMMDDhhmmss00**, which is identical to that defined for **utcTime** in `CK_TOKEN_INFO`.

CKA_MECHANISM_LIST

These attributes hold an array of `CK_MECHANISM_TYPE` values.

The `CKA_MECHANISM_LIST` attribute restricts the operations that can be performed with any object containing it.

The following functions will check the object for the attribute, and if it is found, the `CK_MECHANISM_TYPE` being requested must be present in the attribute, or a `CKR_MECHANISM_INVALID` error is returned:

- **C_Wrapkey**
- **C_Unwrapkey**
- **C_EncryptInit**
- **C_DecryptInit**
- **C_DigestKey**
- **C_SignInit**
- **C_VerifyInit**
- **C_SignRecoverInit**

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> **C_VerifyRecoverInit**

CKA_ENUM_ATTRIBUTE

This attribute is used to enumerate all the attributes of an object.

The attribute can only be passed in as part of a **pTemplate** parameter to the **C_GetAttributeValue**. It is never stored on an object.

Each ProtectToolkit-C session can hold an index value that is just used to support attribute enumeration.

Each call to **C_GetAttributeValue** using `CKA_ENUM_ATTRIBUTE` will return the next object attribute.

The error `CKR_ATTRIBUTE_TYPE_INVALID` is returned to indicate that the object has no more attributes.

A call to **C_GetAttributeValue** with the **ulCount** parameter set to zero will reset the index to zero.

CKA_BIP32_CHAINCODE

This read-only attribute is a 32-bit numeric value produced during BIP32 key derivation, part of the extended key. Applicable to the CKK_BIP32 key type only.

CKA_BIP32_VERSION_BYTES

This attribute is a 32-bit numeric value used by client applications to determine the network the key should be used in. By default, it is set to the main-net values. Applicable to the CKK_BIP32 key type only.

CKA_BIP32_CHILD_INDEX

This read-only attribute is a 32-bit numeric value that defines the child number. Values over 0x80000000 are considered hardened keys. The Master key node value is always 0. Applicable to the CKK_BIP32 key type only.

CKA_BIP32_CHILD_DEPTH

This read-only attribute is an 8 bit numeric value that defines the depth of the child. The Master key node depth is always 0.Applicable to the CKK_BIP32 key type only.

CKA_BIP32_ID

This read-only attribute provides a unique identifier for the BIP32 key pair. This value is generated by calculating the HASH160 of the public key. Applicable to the CKK_BIP32 key type only.

CKA_BIP32_FINGERPRINT

This read-only attribute is defined by the first 32 bits of the `CKA_BIP32_ID`. Applicable to the CKK_BIP32 key type only.

CKA_BIP32_PARENT_FINGERPRINT

This read-only attribute is defined by the first 32 bits of the parent node's `CKA_BIP32_ID`. For master keys, the value is always 0. Applicable to the CKK_BIP32 key type only.

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Common Attributes

The following table defines the attributes common to all objects:

Table 1: Common Object Attributes

Attribute	Data Type	Meaning
CKA_CLASS[1]	CK_OBJECT_CLASS	Object class (type)

[1]This attribute must be specified when the object is created

ProtectToolkit-C supports the following Cryptoki version 2.20 values for CKA_CLASS (that is, the following classes (types) of objects):

- CKO_HW_FEATURE
- CKO_DATA, CKO_CERTIFICATE
- CKO_PUBLIC_KEY
- CKO_PRIVATE_KEY
- CKO_SECRET_KEY

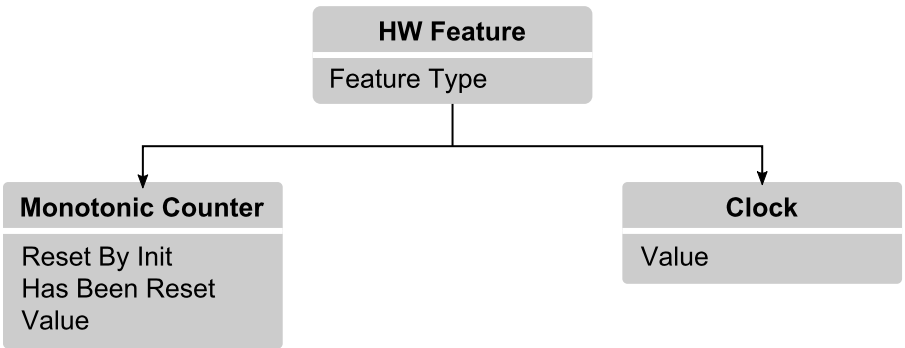
The following CKA_CLASS values are ProtectToolkit-C extensions:

- CKO_CERTIFICATE_REQUEST
- CKO_CRL

Hardware Feature Objects

Hardware feature objects (CKO_HW_FEATURE) represent features of the device. They are created by the firmware on boot-up. The following figure illustrates the hierarchy of hardware feature objects and the attributes they support:

Figure 3: Hardware Feature Object Attribute Hierarchy



Hardware feature objects act as an interface to a hardware feature, existing independent of the feature being represented. For example, creating two clock objects does not imply that there are two clocks, just two interfaces to the one clock. Further, deleting the clock object does not affect the clock device in any way. However

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hardware feature objects may contain information independent of the feature being represented, which may affect the behavior of the object. The slot in which the object is created and the state of the session may also affect the behavior of the object.

Table 1: Hardware Feature Common Attributes

Attribute	Data Type	Meaning
CKA_HW_FEATURE_TYPE	CK_HW_FEATURE	Hardware feature (type)

ProtectToolkit-C supports the following values for CKA_HW_FEATURE_TYPE:

- CKH_CLOCK
- CKH_MONOTONIC_COUNTER

Clock Objects

Clock objects represent real-time clocks that exist on the device. This represents the same clock source as the **utcTime** field in the CK_TOKEN_INFO structure.

Table 1: Clock Object Attributes

Attribute	Data Type	Meaning
CKA_VALUE	CK_CHAR[16]	Current time as a character-string of length 16, represented in the format **YYYYMMDDhhmmss00** (the last two reserved characters are set to 0).

The CKA_VALUE attribute may be set using the **C_SetAttributeValue** function if the object exists in the Admin Token and the session is in RW User Mode.

C_SetAttributeValue returns the error CKR_USER_NOT_LOGGED_IN to indicate that a different user type is required to set the value.

One object of this type is automatically created in the Admin token.

Monotonic Counter Objects

Monotonic counter objects represent hardware counters that exist on the device. Also:

- The value of the counter is guaranteed to increase by 1 each time it is read.
- The monotonic counter is supported only on soft (non-smart card based) tokens and the value of the counter on each different token is the same.
- There is only one monotonic counter per token.
- The monotonic counter is automatically created whenever a token is initialized and exists by default on the Admin Token.
- The value is interpreted as a 160-bit big-endian binary integer (MSB on left).
- The Token SO may change the count value by setting the CKA_VALUE attribute.

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Table 1: Monotonic Counter Attributes

Attribute	Data Type	Meaning
CKA_RESET_ON_INIT1	CK_BBOOL	The value of the counter will reset to a previously returned value if the token is initialized using **C_InitializeToken**.
CKA_HAS_RESET1	CK_BBOOL	The value of the counter has been reset at least once at some point in time.
CKA_VALUE	Byte Array	The current version of the monotonic counter. The value is returned in big endian order. This value must be 20 bytes in size. Any attempt to set a value less than 20 bytes will fail.

[1] Read Only. The CKA_VALUE attribute may not be set by the client.

Storage Objects

Table 1: Common Storage Object Attributes

Attribute	Data Type	Meaning
CKA_TOKEN	CK_BBOOL	TRUE if object is a token object. FALSE if object is a session object. Default is FALSE.
CKA_PRIVATE	CK_BBOOL	TRUE if object is a private object. FALSE if object is a public object. Default value is token-specific, and may depend on the values of other attributes of the object.
CKA_MODIFIABLE	CK_BBOOL	TRUE if object can be modified. FALSE if object can not be modified. Default is TRUE.
CKA_LABEL	RFC2279 string	Description of the object. Default is empty.

Only the CKA_LABEL attribute can be modified after the object is created. The CKA_TOKEN, CKA_PRIVATE, and CKA_MODIFIABLE attributes can be changed in the process of copying an object.

The CKA_TOKEN attribute identifies whether the object is a token object or a session object.

When the CKA_PRIVATE attribute is TRUE, a user may not access the object until the user has been authenticated to the token.

The value of the CKA_MODIFIABLE attribute determines whether or not an object is read-only.

ProtectToolkit-C unmodifiable objects can be deleted. Objects may, however, specify CKA_DELETABLE to FALSE, for token objects only, in which case the object may not be deleted using the **C_DestroyObject** function. Only by re-initializing the token can the object be destroyed.

The CKA_LABEL attribute is intended to assist users in browsing.

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Data Objects

Data objects (object class CKO_DATA) hold information defined by an application. Other than providing access to it, Cryptoki does not attach any special meaning to a data object. The following table lists the attributes supported by data objects, in addition to the common attributes listed in "Common Object Attributes" on page 39 and "Common Storage Object Attributes" on the previous page:

Table 1: Data Object Attributes

Attribute	Data Type	Meaning
CKA_APPLICATION	RFC2279 string	Description of the application that manages the object (default empty)
CKA_OBJECT_ID	Byte Array	DER-encoding of the object identifier indicating the data object type (default empty)
CKA_VALUE	Byte array	Value of the object (default empty)

Each of these attributes may be modified after the object is created.

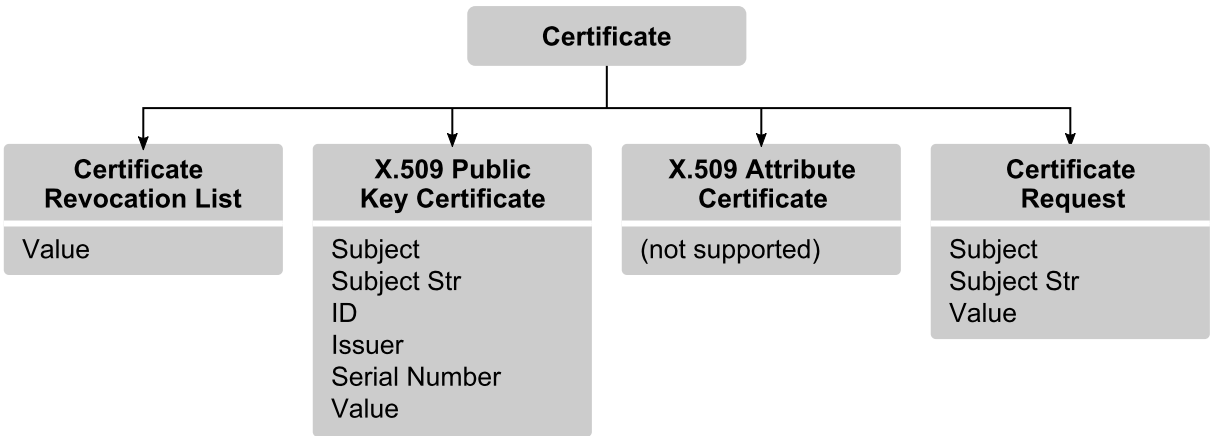
The CKA_APPLICATION attribute provides a means for applications to indicate ownership of the data objects they manage. However, Cryptoki does not provide a means of ensuring that only a particular application has access to a data object.

The CKA_OBJECT_ID attribute provides an independent and expandable way for an application to indicate the type of a data object. Cryptoki does not provide a means of ensuring that the data object identifier matches the data object type.

Certificate Objects

The following figure illustrates details of certificate objects:

Figure 4: Certificate Object Attribute



Hierarchy Certificate objects (object class CKO_CERTIFICATE) hold public-key or attribute certificates. Other than providing access to certificate objects, Cryptoki does not attach any special meaning to certificates. ProtectToolkit-C, however, does include a number of extensions to Cryptoki that allows for more sophisticated certificate processing.

In addition to a number of extension attributes, it is possible to use a certificate object in place of a public key object. It is also possible to generate certificates (or certification requests) from public keys. Finally, it is possible to introduce trusted certificates that allow for certificate path verification.

The following table defines the common certificate object attributes, in addition to the common attributes listed in "Common Object Attributes" on page 39 and "Common Storage Object Attributes" on page 41:

Table 1: Common Certificate Object Attributes

Attribute	Data Type	Meaning
CKA_CERTIFICATE_TYPE[1]	CK_CERTIFICATE_TYPE	Type of certificate
CKA_TRUSTED[2,3]	CK_BBOOL	Trust state of the object; see above description
CKA_DERIVE[2]	CK_BBOOL	Indicates if certificate can be used in derive mechanisms

[1] Must be specified when the object is created.
[2] SafeNet Extension
[3] May be specified as TRUE only by the Security Officer.

The CKA_CERTIFICATE_TYPE attribute may not be modified after an object is created.

X.509 Public Key Certificate Objects

X.509 certificate objects (certificate type CKC_X_509) hold X.509 public key certificates. The following table defines the X.509 certificate object attributes, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41 and "Common Certificate Object Attributes" above:

Table 2: X.509 Certificate Object Attributes

Attribute	Data Type	Meaning
CKA_SUBJECT[1]	Byte array	DER-encoding of the certificate subject name
CKA_SUBJECT_STR[2]	Byte array	Printable representation of CKA_SUBJECT attribute
CKA_ID	Byte array	Key identifier for public/private key pair (default empty)
CKA_ISSUER	Byte array	DER-encoding of the certificate issuer name (default empty)
CKA_ISSUER_STR[2]	Byte array	Printable representation of CKA_ISSUER attribute
CKA_SERIAL_NUMBER	Byte array	DER-encoding of the certificate serial number (default empty)

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Attribute	Data Type	Meaning
CKA_SERIAL_NUMBER_INT[2]	Big Integer	Certificate serial number as an integer (default empty)
CKA_VALUE[1]	Byte array	BER-encoding of the certificate

[1] Must be specified when the object is created.
[2] SafeNet Extension

Only the CKA_ID, CKA_ISSUER and CKA_SERIAL_NUMBER attributes may be modified after the object is created.

The CKA_ID attribute is intended to be a means of distinguishing multiple public/private key pairs held by the same subject (whether stored in the same token or not). Since subject names, as well as identifiers, distinguish keys, it is possible that keys that have different subjects may have the same CKA_ID value without introducing any ambiguity.

It is intended, in the interests of interoperability, that the subject name and key identifier for a certificate is to be the same as those for the corresponding public and private keys (though it is not required that all be stored in the same token). Cryptoki does not enforce this association or even the uniqueness of the key identifier for a given subject. In fact, an application may leave the key identifier empty.

The CKA_ISSUER and CKA_SERIAL_NUMBER attributes are for compatibility with PKCS #7 and Privacy Enhanced Mail (RFC1421).

> **NOTE** With the version 3 extensions to X.509 certificates, the key identifier may be carried in the certificate. It is intended that the CKA_ID value be identical to the key identifier in such a certificate extension, however Cryptoki will not enforce this.

Certificate Request Objects

Certificate request objects (object class CKO_CERTIFICATE_REQUEST) hold a PKCS#10 certificate request. There are mechanisms included to generate a Certificate Request object from an RSA public key (see "CKM_ENCODE_PKCS_10" on page 205) or generate a Certificate from a Certificate Request (see "CKM_ENCODE_X_509" on page 208). This object class is a vendor-defined extension class. The following table defines the Certificate request object attributes, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41 and "Common Certificate Object Attributes" on the previous page:

Table 3: Certificate Request Object Attributes

Attribute	Data Type	Meaning
CKA_SUBJECT	Byte array	DER-encoding of the certificate subject name
CKA_SUBJECT_STR[2]	Byte array	Printable representation of CKA_SUBJECT attribute
CKA_VALUE[1]	Byte array	BER-encoding of the certificate
KEY_TYPE	CK_KEY_TYPE	Type of public key in request

[1] Must be specified when the object is created.
[2] SafeNet Extension

Certificate Revocation List

Certificate Revocation List (CRL) objects (object class CKO_CRL) hold a certificate revocation list. This object class is a vendor defined extension class.

The following table defines the CRL object attributes, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41 and "Common Certificate Object Attributes" on page 43:

Table 4: Certificate Revocation Object Attributes

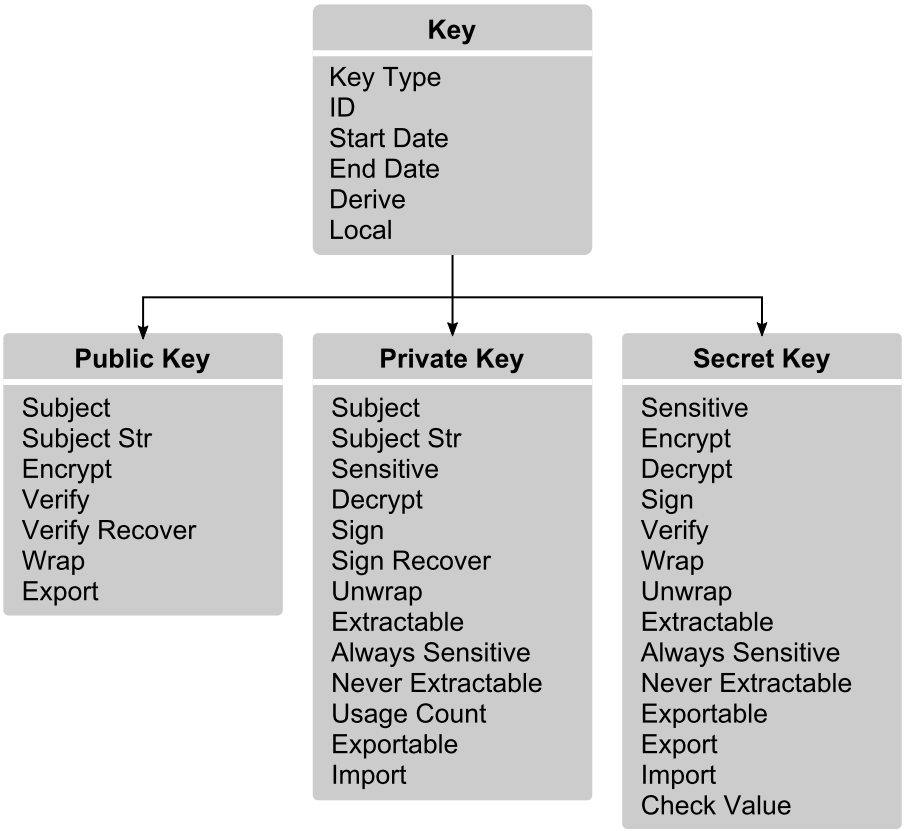
Attribute	Data Type	Meaning
CKA_SUBJECT	Byte array	DER-encoding of the certificate subject name
CKA_SUBJECT_STR[2]	Byte array	Printable representation of CKA_SUBJECT attribute
CKA_VALUE[1]	Byte array	BER-encoding of the certificate

[1] Must be specified when the object is created.
[2] SafeNet Extension

Key Objects

The following figure illustrates details of key objects:

Figure 5: Key Attribute Detail



Key objects hold encryption or authentication keys, which can be public keys, private keys, or secret keys. The HSM has a key storage capacity of 4 MB.

The following common footnotes apply to all the tables describing attributes of keys:

Table 1: Common footnotes for key attribute tables

[1] Must be specified when object is created with **C_CreateObject**.
[2] Must *not* be specified when object is created with **C_CreateObject**.
[3] Must be specified when object is generated with **C_GenerateKey** or **C_GenerateKeyPair**.
[4] Must *not* be specified when object is generated with **C_GenerateKey** or **C_GenerateKeyPair.**
[5] Must be specified when object is unwrapped with **C_UnwrapKey**.
[6] Must *not* be specified when object is unwrapped with **C_Unwrap**.
[7] Cannot be revealed if object has **CKA_SENSITIVE** attribute set to **TRUE** or its **CKA_EXTRACTABLE** attribute set to **FALSE**.

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[8] May be modified after object is created with a **C_SetAttributeValue** call, or in the process of copying object with a **C_CopyObject** call. As mentioned previously, however, it is possible that a particular token may not permit modification of the attribute.

[9] Default value is token-specific, and may depend on the values of other attributes.

[10] SafeNet Extension

The following table defines the attributes common to public key, private key and secret key classes, in addition to the common attributes listed in "Common Object Attributes" on page 39 and "Common Storage Object Attributes" on page 41

Table 2: Common Key Attributes

Attribute	Data Type	Meaning
CKA_KEY_TYPE[1,3,5]	CK_KEY_TYPE	Type of key
CKA_ID[8]	Byte array	Key identifier for key (default empty)
CKA_START_DATE[8]	CK_DATE	Start date for the key (default empty). If not empty then the attribute holds starting date for the key.
CKA_END_DATE[8]	CK_DATE	End date for the key (default empty). If not empty then the attribute holds expiry date for the key.
CKA_ADMIN_CERT[10]	Byte array	DER encoded certificate of the key administrator. See more details in the discussion on Key Usage Limits.
CKA_DERIVE[8]	CK_BBOOL	**TRUE** if key supports key derivation (that is, if other keys can be derived from this one (default **FALSE**)
CKA_LOCAL[2,4,6]	CK_BBOOL	**TRUE** only if key was either > generated locally (that is, on the token) with a **C_GenerateKey** or **C_GenerateKeyPair**call > created with a **C_CopyObject** call as a copy of a key which had its **CKA_LOCAL** attribute set to **TRUE**
CKA_MECHANISM_LIST[10]	CKA_MECHANISM_TYPE array	List of allowable mechanisms that can be used. For more information see the entry for this attribute in "Additional Attribute Types" on page 33.

"Common footnotes for key attribute tables" on the previous page

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Public Key Objects

Public key objects (object class **CKO_PUBLIC_KEY**) hold public keys. This version of Cryptoki recognizes four types of public keys: RSA, DSA, Diffie-Hellman and Elliptic Curve. The following table defines the attributes common to all public keys, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41, and "Common Key Attributes" on the previous page:

Table 1: Common Public Key Attributes

Attribute	Data Type	Meaning
CKA_SUBJECT[8]	Byte array	DER-encoding of the key subject name (default empty)
CKA_SUBJECT_STR[10]	Byte array	Printable version of CKA_SUBJECT
CKA_ENCRYPT[8]	CK_BBOOL	**TRUE** if key supports encryption 9
CKA_VERIFY[8]	CK_BBOOL	**TRUE** if key supports verification where the signature is an appendix to the data 9
CKA_VERIFY_RECOVER[8]	CK_BBOOL	**TRUE** if key supports verification where the data is recovered from the signature 9
CKA_WRAP[8]	CK_BBOOL	**TRUE** if key supports wrapping (that is, can be used to wrap other keys)9
CKA_EXPORT[10]	CK_BBOOL	**TRUE** if the key may be used to export Exportable keys.

"Common footnotes for key attribute tables" on page 46

In the interests of interoperability, it is intended that the subject name and key identifier for a public key is to be the same as those for the corresponding certificate and private key. However, this is not enforced, and it is not required that the certificate and private key be stored on the same token.

To map between ISO/IEC 9594-8 (X.509) key usage flags for public keys and the PKCS #11 attributes for public keys, use the following table. ProtectToolkit-C does not enforce these usage flags. When a certificate object is created, it may have any of the standard Cryptoki usage attributes, which is enforced.

Table 2: Mapping of X.509 key usage flags to Cryptoki attributes for public keys

Key Usage Flags for Public Keys in X.509 Public Key Certificates	Corresponding Cryptoki Attributes for Public Keys
dataEncipherment	CKA_ENCRYPT
digitalSignature, keyCertSign, cRLSign	CKA_VERIFY
digitalSignature, keyCertSign, cRLSign	CKA_VERIFY_RECOVER
keyAgreement	CKA_DERIVE

Key Usage Flags for Public Keys in X.509 Public Key Certificates	Corresponding Cryptoki Attributes for Public Keys
keyEncipherment	CKA_WRAP
nonRepudiation	CKA_VERIFY
nonRepudiation	CKA_VERIFY_RECOVER

RSA Public Key Objects

RSA public key objects (object class CKO_PUBLIC_KEY, key type CKK_RSA) hold RSA public keys. The following table defines the RSA public key object attributes, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41, "Common Key Attributes" on page 47, and "Common Public Key Attributes" on the previous page:

Table 3: RSA Public Key Object Attributes

Attribute	Data Type	Meaning
CKA_MODULUS[1,4,6]	Big integer	Modulus *n*
CKA_MODULUS_BITS[2,3,6]	CK_ULONG	Length in bits of modulus *n*
CKA_PUBLIC_EXPONENT[1,3,6]	Big integer	Public exponent e

"Common footnotes for key attribute tables" on page 46

Depending on the token, there may be limits on the length of key components. See PKCS #1 for more information on RSA keys.

DSA Public Key Objects

DSA public key objects (object class CKO_PUBLIC_KEY, key type CKK_DSA) hold DSA public keys. The following table defines the DSA public key object attributes, in addition to the common attributes listed in "Common Attributes" on page 39, "Storage Objects" on page 41, "Key Objects" on page 45, and "Common Public Key Attributes" on the previous page:

Table 4: DSA Public Key Attributes

Attribute	Data Type	Meaning
CKA_PRIME[1,3,6]	Big integer	Prime *p* (512 to 1024 bits, in steps of 64 bits)
CKA_SUBPRIME[1,3,6]	Big integer	Subprime *q* (160 bits)
CKA_BASE[1,3,6]	Big integer	Base *g*
CKA_VALUE[1,4,6]	Big integer	Public value y

"Common footnotes for key attribute tables" on page 46

The CKA_PRIME, CKA_SUBPRIME and CKA_BASE attribute values are, collectively, the “DSA parameters”.

Diffie-Hellman Public Key Objects

Diffie-Hellman public key objects (object class CKO_PUBLIC_KEY, key type CKK_DH) hold Diffie-Hellman public keys. The following table defines the Diffie-Hellman public key object attributes, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41, "Common Key Attributes" on page 47, and "Common Public Key Attributes" on page 48:

Table 5: Diffie-Hellman Public Key Object Attributes

Attribute	Data Type	Meaning
CKA_PRIME[1,3,6]	Big integer	Prime *p*
CKA_BASE[1,3,6]	Big integer	Base *g*
CKA_VALUE[1,4,6]	Big integer	Public value *y*

"Common footnotes for key attribute tables" on page 46

The CKA_PRIME and CKA_BASE attribute values are collectively the “Diffie-Hellman parameters”. Depending on the token, there may be limits on the length of the key components. See PKCS #3 for more information on Diffie-Hellman keys.

Elliptic Curve Public Key Objects

EC (also related to ECDSA) public key objects (object class CKO_PUBLIC_KEY, key type CKK_EC or CKK_EDWARDS in PKCS#11 v2.20) hold EC public keys. The following table defines the EC public key object attributes, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41, "Common Key Attributes" on page 47, and "Common Public Key Attributes" on page 48:

Table 6: Elliptic Curve Public Key Object Attributes

Attribute	Data Type	Meaning
CKA_EC_PARAMS[1,3] (CKA_ECDSA_PARAMS)	Byte Array	DER-encoding of an ANSI X9.62 Parameters value
CKA_POINT[1,4]	Byte Array	DER-encoding of an ANSI X9.62 ECPoint value Q

"Common footnotes for key attribute tables" on page 46

The CKA_EC_PARAMS (CKA_ECDSA_PARAMS) attribute value is known as the “EC domain parameters” and is defined in ANSI X9.62 as a choice of three parameter representation methods with the following syntax:

```
Parameters ::= CHOICE {
ecParameters ECParameters,
namedCurve CURVES.&id({CurveNames}),
implicitlyCA NULL
}
```


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This allows detailed specification of all required values using choice **ecParameters**, the use of a **namedCurve** as an object identifier substitute for a particular set of elliptic curve domain parameters, or **implicitlyCA** to indicate that the domain parameters are explicitly defined elsewhere. The use of a **namedCurve** is recommended over **ecParameters**. The choice **implicitlyCA** must not be used in Cryptoki.

Both the **namedCurve** and **ecParameters** methods are supported in ProtectToolkit-C. See "CKM_EC_KEY_PAIR_GEN" on page 181 for details.

BIP32 Public Key Objects

BIP32 public key objects (object class `CKO_PUBLIC_KEY`, key type `CKK_BIP32`) hold EC public keys with a set of additional attributes. The following table defines the BIP32 public key attributes, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41, "Common Key Attributes" on page 47, "Common Public Key Attributes" on page 48, and "Elliptic Curve Public Key Object Attributes" on the previous page:

Table 7: BIP32 Public Key Object Attributes

Attribute	Data Type	Meaning
`CKA_BIP32_CHAINCODE`	Byte Array	32 byte numeric value produced during key derivation. Part of the extended key. Read-only.
`CKA_BIP32_VERSION_BYTES`	`CK_ULONG`	32 bit numeric value that is used by client applications to determine the network the key should be used in. By default, it is set to the main-net values.
`CKA_BIP32_CHILD_INDEX`	`CK_ULONG`	32 bit numeric value that defines the child number. Values over 0x80000000 are considered hardened keys. The Master key node value is always 0. Read-only.
`CKA_BIP32_CHILD_DEPTH`	`CK_ULONG`	8 bit numeric value that defines the depth of the child. The Master key node depth is always 0. Read-only.
`CKA_BIP32_ID`	Byte Array	Unique identifier for the key pair. Generated by calculating the HASH160 of the public key. Read-only.
`CKA_BIP32_FINGERPRINT`	Byte Array	The first 32 bits of the `CKA_BIP32_ID`. Read-only.
`CKA_BIP32_PARENT_FINGERPRINT`	Byte Array	The first 32 bits of the parent node's `CKA_BIP32_ID`. For master keys the value is always 0. Read-only.

"Common footnotes for key attribute tables" on page 46

The chain code and index play an important role in the key derivation mechanism, so they need to be stored alongside the key value. The other fields (version bytes, child depth, ID and fingerprints) are generated during derivation and are kept as a courtesy for the client applications, which might have a use for them.

See "CKM_BIP32_MASTER_DERIVE" on page 107 and "CKM_BIP32_CHILD_DERIVE" on page 104 for details on the mechanisms used to create BIP32 objects.

Private Key Objects

Private key objects (object class CKO_PRIVATE_KEY) hold private keys. This version of ProtectToolkit-C recognizes four types of private key: RSA, DSA, Diffie-Hellman and Elliptic Curve. The following table defines the attributes common to all private keys, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41, and "Common Key Attributes" on page 47:

Table 1: Common Private Key Attributes

Attribute	Data Type	Meaning
CKA_SUBJECT[8]	Byte array	DER-encoding of certificate subject name (default empty)
CKA_SUBJECT_STR[10]	Byte array	Printable version of CKA_SUBJECT (default empty)
CKA_SENSITIVE[8] (see below)	CK_BBOOL	TRUE if key is sensitive[9]
CKA_SECONDARY_AUTH	CK_BBOOL	This is not supported.
CKA_AUTH_PIN_FLAGS[2,4,6]	CK_FLAGS	This is not supported.
CKA_DECRYPT[8]	CK_BBOOL	TRUE if key supports decryption[9]
CKA_SIGN[8]	CK_BBOOL	TRUE if key supports signatures where the signature is an appendix to the data[9]
CKA_SIGN_RECOVER[8]	CK_BBOOL	TRUE if key supports signatures where the data can be recovered from the signature[9]
CKA_UNWRAP[8]	CK_BBOOL	TRUE if key supports unwrapping (that is, can be used to unwrap other keys)[9]
CKA_EXTRACTABLE[8] (see below)	CK_BBOOL	TRUE if key is extractable[9]
CKA_ALWAYS_SENSITIVE[2,4,6]	CK_BBOOL	TRUE if key has always had the CKA_SENSITIVE attribute set to TRUE
CKA_NEVER_EXTRACTABLE[2,4,6]	CK_BBOOL	TRUE if key has never had the CKA_EXTRACTABLE attribute set to TRUE
CKA_USAGE_COUNT[10]	CK_ULONG	This optional field will hold a usage counter. The numeric value is incremented each time the key is used.
CKA_EXPORTABLE[10]	CK_BBOOL	TRUE if key may be wrapped with a key that has the CKA_EXPORT attribute set.

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Attribute	Data Type	Meaning
CKA_IMPORT[10]	CK_BBOOL	If TRUE and CKA_UNWRAP is FALSE supports unwrapping only using CKM_WRAPKEY_DES3_CBC.

"Common footnotes for key attribute tables" on page 46

RSA Private Key Objects

RSA private key objects (object class CKO_PRIVATE_KEY, key type CKK_RSA) hold RSA private keys. The following table defines the RSA private key object attributes, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41, "Common Key Attributes" on page 47, and "Common Private Key Attributes" on the previous page:

Table 2: RSA Private Key Object Attributes

Attribute	Data Type	Meaning
CKA_MODULUS[1,4,6]	Big integer	Modulus *n*
CKA_PUBLIC_EXPONENT[4,6]	Big integer	Public exponent *e*
CKA_PRIVATE_EXPONENT[1,4,6,7]	Big integer	Private exponent *d*
CKA_PRIME_1[4,6,7]	Big integer	Prime *p*
CKA_PRIME_2[4,6,7]	Big integer	Prime *q*
CKA_EXPONENT_1[4,6,7]	Big integer	Private exponent *d* modulo *p*-1
CKA_EXPONENT_2[4,6,7]	Big integer	Private exponent *d* modulo *q*-1
CKA_COEFFICIENT[4,6,7]	Big integer	CRT coefficient *q*-1 mod *p*

"Common footnotes for key attribute tables" on page 46

RSA modulus size may range from 512 to 4096 bits. RSA private keys can include all CRT components or just the modulus and exponent. Performance is greatly enhanced by providing all CRT components so this is advised. Any RSA keys generated locally will always include all components.

> **NOTE** When generating an RSA private key, there is no CKA_MODULUS_BITS attribute specified. This is because RSA private keys are only generated as part of an RSA key *pair*, and the CKA_MODULUS_BITS attribute for the pair is specified in the template for the public key.

DSA Private Key Objects

DSA private key objects (object class CKO_PRIVATE_KEY, key type CKK_DSA) hold DSA private keys. The following table defines the DSA private key object attributes, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41, "Common Key Attributes" on

page 47, and "Common Private Key Attributes" on page 52:

Table 3: DSA Private Key Object Attributes

Attribute	Data Type	Meaning
CKA_PRIME[1,4,6]	Big integer	Prime *p* (512 to 1024 bits, in steps of 64 bits)
CKA_SUBPRIME[1,4,6]	Big integer	Subprime *q* (160 bits)
CKA_BASE[1,4,6]	Big integer	Base *g*
CKA_VALUE[1,4,6,7]	Big integer	Private value *x*

"Common footnotes for key attribute tables" on page 46

The CKA_PRIME, CKA_SUBPRIME and CKA_BASE attribute values are collectively the “DSA parameters”. See *FIPS PUB 186* for more information on DSA keys.

> **NOTE** When generating a DSA private key, the DSA parameters are *not* specified in the key’s template. This is because DSA private keys are only generated as part of a DSA key *pair*, and the DSA parameters for the pair are specified in the template for the public key. If they are present in the private key template they are ignored.

Diffie-Hellman Private Key Objects

Diffie-Hellman private key objects (object class CKO_PRIVATE_KEY, key type CKK_DH) hold Diffie-Hellman private keys. The following table defines the Diffie-Hellman private key object attributes, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41, "Common Key Attributes" on page 47, and "Common Private Key Attributes" on page 52:

Table 4: Diffie-Hellman Private Key Object Attributes

Attribute	Data Type	Meaning
CKA_PRIME[1,4,6]	Big integer	Prime p
CKA_BASE[1,4,6]	Big integer	Base g
CKA_VALUE[1,4,6,7]	Big integer	Private value x
CKA_VALUE_BITS[2,6]	CK_ULONG	Length in bits of private value x

"Common footnotes for key attribute tables" on page 46

The CKA_PRIME and CKA_BASE attribute values are collectively the “Diffie-Hellman parameters”. Depending on the token, there may be limits on the length of the key components. See *PKCS #3* for more information on Diffie-Hellman keys.

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> **NOTE** When generating a Diffie-Hellman private key, the Diffie-Hellman parameters are *not* specified in the key's template. This is because Diffie-Hellman private keys are only generated as part of a Diffie-Hellman key *pair*, and the Diffie-Hellman parameters for the pair are specified in the template for the public key. If they are present in the private key template, they are ignored.

Elliptic Curve Private Key Objects

EC (also related to ECDSA) private key objects (object class `CKO_PRIVATE_KEY`, key type `CKK_EC` or `CKK_EDWARDS` in PKCS#11 v2.20) hold EC private keys. The following table defines the EC private key object attributes, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41, "Common Key Attributes" on page 47, and "Common Private Key Attributes" on page 52:

Table 5: Elliptic Curve Private Key Object Attributes

Attribute	Data Type	Meaning
`CKA_EC_PARAMS`[1,4,6] (`CKA_ECDSA_PARAMS`)	Byte Array	DER-encoding of an ANSI X9.62 Parameters value
`CKA_POINT`[1,4,6,7]	Byte Array	ANSI X9.62 private value *d*

"Common footnotes for key attribute tables" on page 46

The `CKA_EC_PARAMS` (`CKA_ECDSA_PARAMS`) attribute value is known as the "EC domain parameters" and is defined in ANSI X9.62 as a choice of three parameter representation methods with the following syntax:

```
Parameters ::= CHOICE {
ecParameters ECParameters,
namedCurve CURVES.&id({CurveNames}),
implicitlyCA NULL
}
```

This allows detailed specification of all required values using choice **ecParameters**, the use of a **namedCurve** as an object identifier substitute for a particular set of elliptic curve domain parameters, or **implicitlyCA** to indicate that the domain parameters are explicitly defined elsewhere. The use of a **namedCurve** is recommended over the choice **ecParameters**. The choice **implicitlyCA** *must not* be used in Cryptoki.

Both the **ecParameters** and the **namedCurve** method are supported in ProtectToolkit-C. See "CKM_EC_KEY_PAIR_GEN" on page 181 for details.

> **NOTE** When generating an EC private key, the EC domain parameters are not specified in the key's template. This is because EC private keys are generated only as part of an EC key pair, and the EC domain parameters for the pair are specified in the template for the public key.

BIP32 Private Key Objects

BIP32 private key objects (object class `CKO_PRIVATE_KEY`, key type `CKK_BIP32`) hold EC private keys with a set of additional attributes. The following table defines the BIP32 private key attributes, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41, "Common Key Attributes" on page 47, "Common Private Key Attributes" on page 52, and "Elliptic Curve Private Key Object Attributes" above:

Table 6: BIP32 Private Key Object Attributes

Attribute	Data Type	Meaning
CKA_BIP32_CHAINCODE	Byte Array	32 byte numeric value produced during key derivation. Part of the extended key. Read-only.
CKA_BIP32_VERSION_BYTES	CK_ULONG	32 bit numeric value that is used by client applications to determine the network the key should be used in. By default, it is set to the main-net values.
CKA_BIP32_CHILD_INDEX	CK_ULONG	32 bit numeric value that defines the child number. Values over 0x80000000 are considered hardened keys. The Master key node value is always 0. Read-only.
CKA_BIP32_CHILD_DEPTH	CK_ULONG	8 bit numeric value that defines the depth of the child. The Master key node depth is always 0. Read-only.
CKA_BIP32_ID	Byte Array	Unique identifier for the key pair. Generated by calculating the HASH160 of the public key. Read-only.
CKA_BIP32_FINGERPRINT	Byte Array	The first 32 bits of the CKA_BIP32_ID. Read-only.
CKA_BIP32_PARENT_FINGERPRINT	Byte Array	The first 32 bits of the parent node's CKA_BIP32_ID. For master keys the value is always 0. Read-only.

"Common footnotes for key attribute tables" on page 46

The chain code and index play an important role in the key derivation mechanism, so they need to be stored alongside the key value. The other fields (version bytes, child depth, ID and fingerprints) are generated during derivation and are kept as a courtesy for the client applications, which might have a use for them.

See "CKM_BIP32_MASTER_DERIVE" on page 107 and "CKM_BIP32_CHILD_DERIVE" on page 104 for details on the mechanisms used to create BIP32 objects.

Secret Key Objects

Secret key objects (object class CKO_SECRET_KEY) hold secret keys. This version of Cryptoki recognizes the following types of secret key: **generic**, **RC2**, **RC4**, **DES**, **DES2**, **DES3**, **CAST128** (also known as **CAST5**), **IDEA**, and **AES**. The following table defines the attributes common to all secret keys, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41, "Common Key Attributes" on page 47

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Table 1: Common Secret Key Attributes

Attribute	Data Type	Meaning
CKA_SENSITIVE[8] (see below)	CK_BBOOL	TRUE, if object is sensitive (default FALSE)
CKA_ENCRYPT[8]	CK_BBOOL	TRUE, if key supports encryption[9]
CKA_DECRYPT[8]	CK_BBOOL	TRUE, if key supports decryption[9]
CKA_SIGN[8]	CK_BBOOL	TRUE, if key supports signatures (that is, authentication codes) where the signature is an appendix to the data[9]
CKA_VERIFY[8]	CK_BBOOL	TRUE, if key supports verification (that is, of authentication codes) where the signature is an appendix to the data[9]
CKA_WRAP[8]	CK_BBOOL	TRUE, if key supports wrapping (that is, can be used to wrap other keys)[9]
CKA_UNWRAP[8]	CK_BBOOL	TRUE, if key supports unwrapping (that is, can be used to unwrap other keys)[9]
CKA_EXTRACTABLE[8] (see below)	CK_BBOOL	TRUE, if key is extractable[9]
CKA_ALWAYS_SENSITIVE[2,4,6]	CK_BBOOL	TRUE if key has always had the CKA_SENSITIVE attribute set to TRUE
CKA_NEVER_EXTRACTABLE[2,4,6]	CK_BBOOL	TRUE, if key has never had the CKA_EXTRACTABLE attribute set to TRUE
CKA_SUBJECT[8]	Byte array	DER-encoding of certificate subject name (default empty)
CKA_EXPORT[10]	CK_BBOOL	TRUE, if the key may be used to wrap Exportable keys. Restrictions apply on who can set this attribute to TRUE.
CKA_EXPORTABLE[10]	CK_BBOOL	TRUE, if key may be wrapped with a key attribute set with CKA_EXPORT.
CKA_IMPORT[10]	CK_BBOOL	If TRUE and CKA_UNWRAP is FALSE supports unwrapping only using CKM_WRAPKEY_DES3_CBC.
CKA_CHECK_VALUE	Byte Array	A calculated key check value. Fixed size of 3 bytes.

"Common footnotes for key attribute tables" on page 46

After an object is created, the CKA_SENSITIVE attribute may be changed, but only to the value TRUE. Similarly, after an object is created, the CKA_EXTRACTABLE attribute may be changed, but only to the value FALSE. Attempts to make other changes to the values of these attributes should return the error code CKR_ATTRIBUTE_READ_ONLY.

If the CKA_SENSITIVE attribute is TRUE, or if the CKA_EXTRACTABLE attribute is FALSE, then certain attributes of the secret key cannot be revealed in plain text outside the token. The attributes that are affected by the sensitive and extractable attributes are specified by the 7-superscript in the attribute table, in the section describing that type of key.

If the CKA_EXTRACTABLE and CKA_EXPORTABLE attribute is FALSE, then the key cannot be wrapped.

Generic Secret Key Objects

Generic secret key objects (object class CKO_SECRET_KEY, key type CKK_GENERIC_SECRET) hold generic secret keys. These keys do not support encryption, decryption, signatures or verification (other than HMAC algorithms); however, other keys can be derived from them. The following table defines attributes of generic secret key objects, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41, "Common Key Attributes" on page 47, and "Common Secret Key Attributes" on the previous page:

Table 2: Generic Secret Key Object Attributes

Attribute	Data Type	Meaning
CKA_VALUE[1,4,6,7]	Byte array	Key value (arbitrary length)
CKA_VALUE_LEN[2,3,6]	CK_ULONG	Length in bytes of key value

"Common footnotes for key attribute tables" on page 46

RC2 Secret Key Objects

RC2 secret key objects (object class CKO_SECRET_KEY, key type CKK_RC2) hold RC2 keys. The following table defines the RC2 secret key object attributes, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41, "Common Key Attributes" on page 47, and "Common Secret Key Attributes" on the previous page:

Table 3: RC2 Secret Key Object Attributes

Attribute	Data Type	Meaning
CKA_VALUE[1,4,6,7]	Byte array	Key value (1 to 128 bytes)
CKA_VALUE_LEN[2,3,6]	CK_ULONG	Length in bytes of key value

"Common footnotes for key attribute tables" on page 46

RC4 Secret Key Objects

RC4 secret key objects (object class CKO_SECRET_KEY, key type CKK_RC4) hold RC4 keys. The following table defines the RC4 secret key object attributes, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41, "Common Key Attributes" on page 47,

and "Common Secret Key Attributes" on page 57:

Table 4: RC4 Secret Key Object Attributes

Attribute	Data Type	Meaning
CKA_VALUE[1,4,6,7]	Byte array	Key value (1 to 256 bytes)
CKA_VALUE_LEN[2,3,6]	CK_ULONG	Length in bytes of key value

"Common footnotes for key attribute tables" on page 46

AES Secret Key Objects

AES secret key objects (object class CKO_SECRET_KEY, key type CKK_AES) hold AES keys. The following table defines the AES secret key object attributes, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Key Attributes" on page 47, and "Common Secret Key Attributes" on page 57:

Table 5: AES Secret Key Object Attributes

Attribute	Data Type	Meaning
CKA_VALUE[1,4,6,7]	Byte array	Key value (16 to 32 bytes)
CKA_VALUE_LEN[2,3,6]	CK_ULONG	Length in bytes of key value

"Common footnotes for key attribute tables" on page 46

DES Secret Key Objects

DES secret key objects (object class CKO_SECRET_KEY, key type CKK_DES) hold single-length DES keys. The following table defines the DES secret key object attributes, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41, "Common Key Attributes" on page 47, and "Common Secret Key Attributes" on page 57:

Table 6: DES Secret Key Object

Attribute	Data Type	Meaning
CKA_VALUE[1,4,6,7]	Byte array	Key value (always 8 bytes long)

"Common footnotes for key attribute tables" on page 46

DES keys should always have their parity bits properly set as described in *FIPS PUB 46-2*. However, attempting to create or unwrap a DES key with incorrect parity will not return an error as the key will still function correctly.

DES2 Secret Key Objects

DES2 secret key objects (object class CKO_SECRET_KEY, key type CKK_DES2) hold double-length DES keys. The following table defines the DES2 secret key object attributes, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41, "Common Key Attributes" on page 47, and "Common Secret Key Attributes" on page 57:

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Table 7: DES2 Secret Key Object Attributes

Attribute	Data Type	Meaning
CKA_VALUE[1,4,6,7]	Byte array	Key value (always 16 bytes long)

"Common footnotes for key attribute tables" on page 46

DES2 keys should have their parity bits properly set as described in *FIPS PUB 46-2* (that is, each of the DES keys comprising a DES2 key should have its parity bits properly set). However, attempting to create or unwrap a DES2 key with incorrect parity will not return an error as the key will still function correctly.

DES3 Secret Key Objects

DES3 secret key objects (object class CKO_SECRET_KEY, key type CKK_DES3) hold triple-length DES keys. The following table defines the DES3 secret key object attributes, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41, "Common Key Attributes" on page 47, and "Common Secret Key Attributes" on page 57:

Table 8: DES3 Secret Key Object Attributes

Attribute	Data Type	Meaning
CKA_VALUE[1,4,6,7]	Byte array	Key value (always 24 bytes long)

"Common footnotes for key attribute tables" on page 46

DES3 keys should always have their parity bits properly set as described in *FIPS PUB 46-2* (that is, each of the DES keys comprising a DES3 key should have its parity bits properly set). However, attempting to create or unwrap a DES3 key with incorrect parity will not return an error as the key will still function correctly.

CAST128 (CAST5) Secret Key Objects

CAST128 (also known as CAST5) secret key objects (object class CKO_SECRET_KEY, key type CKK_CAST128 or CKK_CAST5) hold CAST128 keys. The following table defines the CAST128 secret key object attributes, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41, "Common Key Attributes" on page 47, and "Common Secret Key Attributes" on page 57:

Table 9: CAST128 (CAST5) Secret Key Object Attributes

Attribute	Data Type	Meaning
CKA_VALUE[1,4,6,7]	Byte array	Key value (1 to 16 bytes)
CKA_VALUE_LEN[2,3,6]	CK_ULONG	Length in bytes of key value

"Common footnotes for key attribute tables" on page 46

IDEA Secret Key Objects

IDEA secret key objects (object class `CKO_SECRET_KEY`, key type `CKK_IDEA`) hold IDEA keys. The following table defines the IDEA secret key object attributes, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41, "Common Key Attributes" on page 47, and "Common Secret Key Attributes" on page 57:

Table 10: IDEA Secret Key Object

Attribute	Data Type	Meaning
`CKA_VALUE`[1,4,6,7]	Byte array	Key value (always 16 bytes long)

"Common footnotes for key attribute tables" on page 46

SEED Secret Key Objects

SEED secret key objects (object class `CKO_SECRET_KEY`, key type `CKK_SEED`) hold SEED keys. The following table defines the SEED secret key object attributes, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41, "Common Key Attributes" on page 47, and "Common Secret Key Attributes" on page 57:

Table 11: SEED Secret Key Object

Attribute	Data type	Meaning
`CKA_VALUE`[1,4,6,7,10]	Byte array	Key value (always 16 bytes long)

"Common footnotes for key attribute tables" on page 46

Key Parameter Objects

ProtectToolkit-C includes support for key parameter objects (as specified in *PKCS#11 2.11 draft 3*). These objects are used to store parameters associated with DSA or DH keys. It is possible to generate new objects of this type using the **C_GenerateKey** function.

Key parameter objects (object class `CKO_DOMAIN_PARAMETERS`) hold public key generation parameters. This version of Cryptoki recognizes the following types of key parameters: **DSA** and **Diffie-Hellman**. The following table defines the footnotes that apply to each of the following attribute tables:

Table 1: Common footnotes for key parameter attribute tables

[1] Must be specified when object is created with **C_CreateObject**.
[2] Must *not* be specified when object is created with **C_CreateObject**.
[3] Must be specified when object is generated with **C_GenerateKey** or **C_GenerateKeyPair**.
[4] Must *not* be specified when object is generated with **C_GenerateKey** or **C_GenerateKeyPair**.

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The following table defines the attributes common to key attribute objects in addition to the common attributes listed in "Common Object Attributes" on page 39 and "Common Storage Object Attributes" on page 41:

Table 2: Common Key Parameter Attributes

Attribute	Data Type	Meaning
CKA_KEY_TYPE[1]	CK_KEY_TYPE	Type of key the parameters can be used to generate.
CKA_LOCAL[2,4]	CK_BBOOL	TRUE only if key parameters were either: > generated locally (that is, on the token) with a **C_GenerateKey** > created with a **C_CopyObject** call as a copy of key parameters which had its CKA_LOCAL attribute set to TRUE

"Common footnotes for key parameter attribute tables" on the previous page

The rules applying to the CKA_LOCAL mean that this attribute has the value TRUE if and only if the key was originally generated on the token by a **C_GenerateKey** call.

DSA Public Key Parameter Objects

DSA public key parameter objects (object class CKO_DOMAIN_PARAMETERS, key type CKK_DSA) hold DSA public key parameters. The following table defines the DSA public key parameter object attributes, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41, and "Common footnotes for key parameter attribute tables" on the previous page:

Table 3: DSA Public Key Parameter Object Attributes

Attribute	Data Type	Meaning
CKA_PRIME[1,4]	Big integer	Prime *p* (512 to 1024 bits, in steps of 64 bits)
CKA_SUBPRIME[1,4]	Big integer	Subprime *q* (160 bits)
CKA_BASE[1,4]	Big integer	Base *g*
CKA_PRIME_BITS[2,3]	CK_ULONG	Length of the prime value

"Common footnotes for key parameter attribute tables" on the previous page

The CKA_PRIME, CKA_SUBPRIME and CKA_BASE attribute values are collectively the “DSA parameters”. See *FIPS PUB 186* for more information on DSA key parameters.

Objects of this type may be generated by using the **C_GenerateKey** with the CKM_DSA_PARAMETER_GEN mechanism.

Diffie-Hellman Public Key Parameter Objects

Diffie-Hellman public key parameter objects (object class CKO_DOMAIN_PARAMETERS, key type CKK_DH) hold Diffie-Hellman public key parameters. The following table defines the Diffie-Hellman public key parameter object attributes, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41, and "Common footnotes for key parameter attribute tables" on page 61:

Table 4: Diffie-Hellman Public Key Parameter Object Attributes

Attribute	Data Type	Meaning
CKA_PRIME[1,4]	Big integer	Prime *p*
CKA_BASE[1,4]	Big integer	Base *g*
CKA_PRIME_BITS[2,3]	CK_ULONG	Length of the prime value

"Common footnotes for key parameter attribute tables" on page 61

The CKA_PRIME and CKA_BASE attribute values are collectively the “Diffie-Hellman parameters”. Depending on the token, there may be limits on the length of the key components. See PKCS #3 for more information on Diffie-Hellman key parameters.

Objects of this type may be generated by using the **C_GenerateKey** with the CKM_DH_PKCS_PARAMETER_GEN mechanism.

Elliptic Curve Public Key Parameter Objects

Elliptic Curve public key parameter objects (object class CKO_DOMAIN_PARAMETERS, key type CKK_EC or CKK_EC_EDWARDS) hold Elliptic Curve public key parameters.

The following table defines the Elliptic Curve public key parameter object attributes, in addition to the common attributes listed in "Common Object Attributes" on page 39, "Common Storage Object Attributes" on page 41, and "Common footnotes for key parameter attribute tables" on page 61:

Table 5: Elliptic Curve Public Key Parameter Object Attributes

Attribute	Data Type	Meaning
CKA_EC_PARAMS[1,3,6]	Byte Array	DER encoding of *ANSI X9.62* Parameters value. Applies to CKK_EC keys.

"Common footnotes for key parameter attribute tables" on page 61

The CKA_EC_PARAMS attribute values is the “Elliptic Curve parameters”. Depending on the token, there may be limits on the length of the key components.

ProtectToolkit-C does not support generation of this type of object.

When objects of this type are stored using the **C_CreateObject** then the domain parameters are verified.

Key Generation Parameter Objects

This object type is used to hold DSA or DH key generation parameters.

The CKA_KEY_TYPE attribute indicates which type of parameters it is holding.

Where the key type is CKK_DSA the attributes should be as follows:

Attribute	Data Type	Meaning
CKA_KEY_TYPE	CK_KEY_TYPE	Type of key. Must be CKK_DSA.
CKA_PRIME	Big integer	Prime
CKA_SUBPRIME	Big integer	Prime
CKA_BASE	Big integer	Prime

Where the key type is **CKK_DH** the attributes should be as follows:

Attribute	Data Type	Meaning
CKA_KEY_TYPE	CK_KEY_TYPE	Type of key. Must be CKK_DH.
CKA_PRIME	Big integer	Prime
CKA_BASE	Big integer	Prime

See "CKM_EC_KEY_PAIR_GEN" on page 181 for more details on the Parameter value.

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CHAPTER 4: ProtectToolkit-C Mechanisms

Characteristics of all ProtectToolkit-C mechanisms are summarized in the pages that follow. Both PKCS #11 standard mechanisms and Thales-proprietary mechanisms are included.

"Available Mechanisms" below contains a full list of available mechanisms and a secondary list of mechanisms that are available in FIPS Mode. Continue to the individual mechanism pages for full descriptions.

> **NOTE** Functions in bold are Thales-proprietary. See also "PTK-C Vendor-Defined Error Codes" on page 397.

Table 1: Available Mechanisms

All Mechanisms	FIPS Mode Mechanisms
CKM_AES_CBC	CKM_AES_CBC
CKM_AES_CBC_ENCRYPT_DATA	Not available
CKM_AES_CBC_PAD	CKM_AES_CBC_PAD
CKM_AES_CCM	CKM_AES_CCM
CKM_AES_CMAC	CKM_AES_CMAC
CKM_AES_CMAC_GENERAL	CKM_AES_CMAC_GENERAL
CKM_AES_ECB	CKM_AES_ECB
CKM_AES_ECB_ENCRYPT_DATA	Not available
CKM_AES_GCM	CKM_AES_GCM
CKM_AES_KEY_GEN	CKM_AES_KEY_GEN
CKM_AES_KEY_WRAP	CKM_AES_KEY_WRAP
CKM_AES_KEY_WRAP_PAD	CKM_AES_KEY_WRAP_PAD
CKM_AES_KW	CKM_AES_KW
CKM_AES_KWP	CKM_AES_KWP
CKM_AES_MAC	Not available

All Mechanisms	FIPS Mode Mechanisms
CKM_AES_MAC_GENERAL	Not available
CKM_AES_OFB	CKM_AES_OFB
CKM_ARDFP	Not available
CKM_ARIA_CBC	Not available
CKM_ARIA_CBC_PAD	Not available
CKM_ARIA_ECB	Not available
CKM_ARIA_KEY_GEN	Not available
CKM_ARIA_MAC	Not available
CKM_ARIA_MAC_GENERAL	Not available
CKM_BIP32_CHILD_DERIVE	Not available
CKM_BIP32_MASTER_DERIVE	Not available
CKM_CAST128_CBC (CKM_CAST5_CBC)	Not available
CKM_CAST128_CBC_PAD (CKM_CAST5_CBC_PAD)	Not available
CKM_CAST128_ECB (CKM_CAST5_ECB)	Not available
CKM_CAST128_ECB_PAD	Not available
CKM_CAST128_KEY_GEN (CKM_CAST5_KEY_GEN)	Not available
CKM_CAST128_MAC (CKM_CAST5_MAC)	Not available
CKM_CAST128_MAC_GENERAL (CKM_CAST5_MAC_GENERAL)	Not available
CKM_CONCATENATE_BASE_AND_DATA	Not available
CKM_CONCATENATE_BASE_AND_KEY	Not available
CKM_CONCATENATE_DATA_AND_BASE	Not available

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All Mechanisms	FIPS Mode Mechanisms
CKM_DECODE_PKCS_7	**CKM_DECODE_PKCS_7**
CKM_DECODE_X_509	**CKM_DECODE_X_509**
CKM_DES_BCF	Not available
CKM_DES_CBC	Not available
CKM_DES_CBC_ENCRYPT_DATA	Not available
CKM_DES_CBC_PAD	Not available
CKM_DES_DERIVE_CBC_DEPRECATED	Not available
CKM_DES_DERIVE_ECB_DEPRECATED	Not available
CKM_DES_ECB	Not available
CKM_DES_ECB_ENCRYPT_DATA	Not available
CKM_DES_ECB_PAD	Not available
CKM_DES_KEY_GEN	Not available
CKM_DES_MAC	Not available
CKM_DES_MAC_GENERAL	Not available
CKM_DES_MDC_2_PAD1	Not available
CKM_DES_OFB64	Not available
CKM_DES2_KEY_GEN	Not available
CKM_DES3_BCF	Not available
CKM_DES3_CBC	CKM_DES3_CBC
CKM_DES3_CBC_ENCRYPT_DATA	Not available
CKM_DES3_CBC_PAD	CKM_DES3_CBC_PAD
CKM_DES3_CMAC	CKM_DES3_CMAC
CKM_DES3_CMAC_GENERAL	CKM_DES3_CMAC_GENERAL
CKM_DES3_DDD_CBC	Not available

All Mechanisms	FIPS Mode Mechanisms
CKM_DES3_DERIVE_CBC_DEPRECATED	Not available
CKM_DES3_DERIVE_ECB_DEPRECATED	Not available
CKM_DES3_ECB	CKM_DES3_ECB
CKM_DES3_ECB_ENCRYPT_DATA	Not available
CKM_DES3_ECB_PAD	**CKM_DES3_ECB_PAD**
CKM_DES3_KEY_GEN	CKM_DES3_KEY_GEN
CKM_DES3_MAC	CKM_DES3_MAC
CKM_DES3_MAC_GENERAL	CKM_DES3_MAC_GENERAL
CKM_DES3_OFB64	CKM_DES3_OFB64
CKM_DES3_RETAIL_CFB_MAC	**CKM_DES3_RETAIL_CFB_MAC**
CKM_DES3_X919_MAC	**CKM_DES3_X919_MAC**
CKM_DES3_X919_MAC_GENERAL	**CKM_DES3_X919_MAC_GENERAL**
CKM_DH_PKCS_DERIVE	CKM_DH_PKCS_DERIVE
CKM_DH_PKCS_KEY_PAIR_GEN	CKM_DH_PKCS_KEY_PAIR_GEN
CKM_DH_PKCS_PARAMETER_GEN	CKM_DH_PKCS_PARAMETER_GEN
CKM_DSA	CKM_DSA
CKM_DSA_KEY_PAIR_GEN	CKM_DSA_KEY_PAIR_GEN
CKM_DSA_PARAMETER_GEN	CKM_DSA_PARAMETER_GEN
CKM_DSA_SHA1	CKM_DSA_SHA1
CKM_DSA_SHA1_PKCS	**CKM_DSA_SHA1_PKCS**
CKM_DSA_SHA224	**CKM_DSA_SHA224**
CKM_DSA_SHA224_PKCS	**CKM_DSA_SHA224_PKCS**
CKM_DSA_SHA256	**CKM_DSA_SHA256**
CKM_DSA_SHA256_PKCS	**CKM_DSA_SHA256_PKCS**

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All Mechanisms	FIPS Mode Mechanisms
CKM_DSA_SHA384	**CKM_DSA_SHA384**
CKM_DSA_SHA384_PKCS	**CKM_DSA_SHA384_PKCS**
CKM_DSA_SHA512	**CKM_DSA_SHA512**
CKM_DSA_SHA512_PKCS	**CKM_DSA_SHA512_PKCS**
CKM_EC_EDWARDS_KEY_PAIR_GEN	Not available
CKM_EC_KEY_PAIR_GEN	CKM_EC_KEY_PAIR_GEN
CKM_ECDH1_DERIVE	CKM_ECDH1_DERIVE
CKM_ECDSA	CKM_ECDSA
CKM_ECDSA_GBCS_SHA256	CKM_ECDSA_GBCS_SHA256
CKM_ECDSA_SHA1	CKM_ECDSA_SHA1
CKM_ECDSA_SHA3_224	CKM_ECDSA_SHA3_224
CKM_ECDSA_SHA3_256	CKM_ECDSA_SHA3_256
CKM_ECDSA_SHA3_384	CKM_ECDSA_SHA3_384
CKM_ECDSA_SHA3_512	CKM_ECDSA_SHA3_512
CKM_ECDSA_SHA224	CKM_ECDSA_SHA224
CKM_ECDSA_SHA256	CKM_ECDSA_SHA256
CKM_ECDSA_SHA384	CKM_ECDSA_SHA384
CKM_ECDSA_SHA512	CKM_ECDSA_SHA512
CKM_ECIES	Not available
CKM_EDDSA	Not available
CKM_ENCODE_ATTRIBUTES	**CKM_ENCODE_ATTRIBUTES**
CKM_ENCODE_PKCS_10	**CKM_ENCODE_PKCS_10**
CKM_ENCODE_PUBLIC_KEY	**CKM_ENCODE_PUBLIC_KEY**
CKM_ENCODE_X_509	**CKM_ENCODE_X_509**

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All Mechanisms	FIPS Mode Mechanisms
CKM_ENCODE_X_509_LOCAL_CERT	**CKM_ENCODE_X_509_LOCAL_CERT**
CKM_EXTRACT_KEY_FROM_KEY	Not available
CKM_GENERIC_SECRET_KEY_GEN	CKM_GENERIC_SECRET_KEY_GEN
CKM_IDEA_CBC	Not available
CKM_IDEA_CBC_PAD	Not available
CKM_IDEA_ECB	Not available
CKM_IDEA_ECB_PAD	Not available
CKM_IDEA_KEY_GEN	Not available
CKM_IDEA_MAC	Not available
CKM_IDEA_MAC_GENERAL	Not available
CKM_KECCAK_1600	CKM_KECCAK_1600
CKM_KEY_TRANSLATION	Not available
CKM_KEY_WRAP_SET_OAEP	CKM_KEY_WRAP_SET_OAEP
CKM_MD2	Not available
CKM_MD2_HMAC	Not available
CKM_MD2_HMAC_GENERAL	Not available
CKM_MD2_KEY_DERIVATION	Not available
CKM_MD2_RSA_PKCS	Not available
CKM_MD5	Not available
CKM_MD5_HMAC	Not available
CKM_MD5_HMAC_GENERAL	Not available
CKM_MD5_KEY_DERIVATION	Not available
CKM_MD5_RSA_PKCS	Not available
CKM_MILENAGE_DERIVE	Not available

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All Mechanisms	FIPS Mode Mechanisms
CKM_MILENAGE_SIGN	Not available
CKM_NVB	Not available
CKM_PBA_SHA1_WITH_SHA1_HMAC	Not available
CKM_PBE_MD2_DES_CBC	Not available
CKM_PBE_MD5_CAST128_CBC (CKM_PBE_MD5_CAST5_CBC)	Not available
CKM_PBE_MD5_DES_CBC	Not available
CKM_PBE_SHA1_CAST128_CBC (CKM_PBE_SHA1_CAST5_CBC)	Not available
CKM_PBE_SHA1_DES2_EDE_CBC	Not available
CKM_PBE_SHA1_DES3_EDE_CBC	Not available
CKM_PBE_SHA1_RC2_40_CBC	Not available
CKM_PBE_SHA1_RC2_128_CBC	Not available
CKM_PBE_SHA1_RC4_40	Not available
CKM_PBE_SHA1_RC4_128	Not available
CKM_PKCS12_PBE_EXPORT	Not available
CKM_PKCS12_PBE_IMPORT	Not available
CKM_PP_LOAD_SECRET	**CKM_PP_LOAD_SECRET**
CKM_PP_LOAD_SECRET_2	**CKM_PP_LOAD_SECRET_2**
CKM_RC2_CBC	Not available
CKM_RC2_CBC_PAD	Not available
CKM_RC2_ECB	Not available
CKM_RC2_ECB_PAD	Not available
CKM_RC2_KEY_GEN	Not available
CKM_RC2_MAC	Not available

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All Mechanisms	FIPS Mode Mechanisms
CKM_RC2_MAC_GENERAL	Not available
CKM_RC4	Not available
CKM_RC4_KEY_GEN	Not available
CKM_REPLICATE_TOKEN_RSA_AES	**CKM_REPLICATE_TOKEN_RSA_AES**
CKM_RIPEMD128	Not available
CKM_RIPEMD128_HMAC	Not available
CKM_RIPEMD128_HMAC_GENERAL	Not available
CKM_RIPEMD128_RSA_PKCS	Not available
CKM_RIPEMD160	Not available
CKM_RIPEMD160_HMAC	Not available
CKM_RIPEMD160_HMAC_GENERAL	Not available
CKM_RIPEMD160_RSA_PKCS	Not available
CKM_RSA_9796	Not available
CKM_RSA_FIPS_186_4_PRIME_KEY_PAIR_GEN	CKM_RSA_FIPS_186_4_PRIME_KEY_PAIR_GEN
CKM_RSA_PKCS	CKM_RSA_PKCS
CKM_RSA_PKCS_KEY_PAIR_GEN	CKM_RSA_PKCS_KEY_PAIR_GEN
CKM_RSA_PKCS_OAEP	CKM_RSA_PKCS_OAEP
CKM_RSA_PKCS_PSS	CKM_RSA_PKCS_PSS
CKM_RSA_X_509	Not available
CKM_RSA_X9_31_KEY_PAIR_GEN	CKM_RSA_X9_31_KEY_PAIR_GEN
CKM_SECRET_RECOVER_WITH_ATTRIBUTES	**CKM_SECRET_RECOVER_WITH_ATTRIBUTES**
CKM_SECRET_SHARE_WITH_ATTRIBUTES	**CKM_SECRET_SHARE_WITH_ATTRIBUTES**
CKM_SEED_CBC	Not available
CKM_SEED_CBC_PAD	Not available

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All Mechanisms	FIPS Mode Mechanisms
CKM_SEED_ECB	Not available
CKM_SEED_ECB_PAD	Not available
CKM_SEED_KEY_GEN	Not available
CKM_SEED_MAC	Not available
CKM_SEED_MAC_GENERAL	Not available
CKM_SET_ATTRIBUTES	**CKM_SET_ATTRIBUTES**
CKM_SHA1	CKM_SHA1
CKM_SHA1_HMAC	CKM_SHA1_HMAC
CKM_SHA1_HMAC_GENERAL	CKM_SHA1_HMAC_GENERAL
CKM_SHA1_EDDSA	Not available
CKM_SHA1_KEY_DERIVATION	Not available
CKM_SHA1_RSA_PKCS	CKM_SHA1_RSA_PKCS
CKM_SHA1_RSA_PKCS_PSS	CKM_SHA1_RSA_PKCS_PSS
CKM_SHA1_RSA_PKCS_TIMESTAMP	Not available
CKM_SHA3_224	CKM_SHA3_224
CKM_SHA3_224_EDDSA	Not available
CKM_SHA3_224_HMAC	CKM_SHA3_224_HMAC
CKM_SHA3_224_HMAC_GENERAL	CKM_SHA3_224_HMAC_GENERAL
CKM_SHA3_224_KEY_DERIVE	Not available
CKM_SHA3_224_RSA_PKCS	CKM_SHA3_224_RSA_PKCS
CKM_SHA3_224_RSA_PKCS_PSS	CKM_SHA3_224_RSA_PKCS_PSS
CKM_SHA3_256	CKM_SHA3_256
CKM_SHA3_256_EDDSA	Not available
CKM_SHA3_256_HMAC	CKM_SHA3_256_HMAC

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All Mechanisms	FIPS Mode Mechanisms
CKM_SHA3_256_HMAC_GENERAL	CKM_SHA3_256_HMAC_GENERAL
CKM_SHA3_256_KEY_DERIVE	Not available
CKM_SHA3_256_RSA_PKCS	CKM_SHA3_256_RSA_PKCS
CKM_SHA3_256_RSA_PKCS_PSS	CKM_SHA3_256_RSA_PKCS_PSS
CKM_SHA3_384	CKM_SHA3_384
CKM_SHA3_384_EDDSA	Not available
CKM_SHA3_384_HMAC	CKM_SHA3_384_HMAC
CKM_SHA3_384_HMAC_GENERAL	CKM_SHA3_384_HMAC_GENERAL
CKM_SHA3_384_KEY_DERIVE	Not available
CKM_SHA3_384_RSA_PKCS	CKM_SHA3_384_RSA_PKCS
CKM_SHA3_384_RSA_PKCS_PSS	CKM_SHA3_384_RSA_PKCS_PSS
CKM_SHA3_512	CKM_SHA3_512
CKM_SHA3_512_EDDSA	Not available
CKM_SHA3_512_HMAC	CKM_SHA3_512_HMAC
CKM_SHA3_512_HMAC_GENERAL	CKM_SHA3_512_HMAC_GENERAL
CKM_SHA3_512_KEY_DERIVE	Not available
CKM_SHA3_512_RSA_PKCS	CKM_SHA3_512_RSA_PKCS
CKM_SHA3_512_RSA_PKCS_PSS	CKM_SHA3_512_RSA_PKCS_PSS
CKM_SHA224	CKM_SHA224
CKM_SHA224_EDDSA	Not available
CKM_SHA224_HMAC	CKM_SHA224_HMAC
CKM_SHA224_HMAC_GENERAL	CKM_SHA224_HMAC_GENERAL
CKM_SHA224_KEY_DERIVATION	Not available

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All Mechanisms	FIPS Mode Mechanisms
CKM_SHA224_RSA_PKCS	CKM_SHA224_RSA_PKCS
CKM_SHA224_RSA_PKCS_PSS	CKM_SHA224_RSA_PKCS_PSS
CKM_SHA256	CKM_SHA256
CKM_SHA256_EDDSA	Not available
CKM_SHA256_HMAC	CKM_SHA256_HMAC
CKM_SHA256_HMAC_GENERAL	CKM_SHA256_HMAC_GENERAL
CKM_SHA256_KEY_DERIVATION	Not available
CKM_SHA256_RSA_PKCS	CKM_SHA256_RSA_PKCS
CKM_SHA256_RSA_PKCS_PSS	CKM_SHA256_RSA_PKCS_PSS
CKM_SHA384	CKM_SHA384
CKM_SHA384_EDDSA	Not available
CKM_SHA384_HMAC	CKM_SHA384_HMAC
CKM_SHA384_HMAC_GENERAL	CKM_SHA384_HMAC_GENERAL
CKM_SHA384_KEY_DERIVATION	Not available
CKM_SHA384_RSA_PKCS	CKM_SHA384_RSA_PKCS
CKM_SHA384_RSA_PKCS_PSS	CKM_SHA384_RSA_PKCS_PSS
CKM_SHA512	CKM_SHA512
CKM_SHA512_EDDSA	Not available
CKM_SHA512_HMAC	CKM_SHA512_HMAC
CKM_SHA512_HMAC_GENERAL	CKM_SHA512_HMAC_GENERAL
CKM_SHA512_KEY_DERIVATION	Not available
CKM_SHA512_RSA_PKCS	CKM_SHA512_RSA_PKCS
CKM_SHA512_RSA_PKCS_PSS	CKM_SHA512_RSA_PKCS_PSS
CKM_SSL3_KEY_AND_MAC_DERIVE	Not available

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All Mechanisms	FIPS Mode Mechanisms
CKM_SSL3_MASTER_KEY_DERIVE	Not available
CKM_SSL3_MD5_MAC	Not available
CKM_SSL3_PRE_MASTER_KEY_GEN	CKM_SSL3_PRE_MASTER_KEY_GEN
CKM_SSL3_SHA1_MAC	Not available
CKM_TDEA_TKW	CKM_TDEA_TKW
CKM_TUAK_DERIVE	CKM_TUAK_DERIVE
CKM_TUAK_SIGN	CKM_TUAK_SIGN
CKM_VISA_CVV	Not available
CKM_WRAPKEY_AES_CBC	**CKM_WRAPKEY_AES_CBC**
CKM_WRAPKEY_AES_KWP	CKM_WRAPKEY_AES_KWP
CKM_WRAPKEY_DES3_CBC	**CKM_WRAPKEY_DES3_CBC**
CKM_WRAPKEY_DES3_ECB	**CKM_WRAPKEY_DES3_ECB**
CKM_WRAPKEYBLOB_AES_CBC	**CKM_WRAPKEYBLOB_AES_CBC**
CKM_WRAPKEYBLOB_DES3_CBC	**CKM_WRAPKEYBLOB_DES3_CBC**
CKM_X9_42_DH_DERIVE	CKM_X9_42_DH_DERIVE
CKM_X9_42_DH_KEY_PAIR_GEN	CKM_X9_42_DH_KEY_PAIR_GEN
CKM_X9_42_DH_PARAMETER_GEN	CKM_X9_42_DH_PARAMETER_GEN
CKM_XOR_BASE_AND_DATA	Not available
CKM_XOR_BASE_AND_KEY	Not available
CKM_ZKA_MDC_2_KEY_DERIVATION	Not available

NOTE Key size limitations specified above may be further limited, depending on the specific operation being performed. For example: CKM_DES3_CBC specifies a 16-byte key as a lower limit, but in FIPS mode, such keys are only allowed for legacy decryption operations and not new encryptions. See the section detailing the relevant mechanism for more information.

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CKM_AES_CBC

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	Yes
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	No Wrapping

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	32
Parameter	16 bytes

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

CKM_AES_CBC_ENCRYPT_DATA

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No

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SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	32
Parameter	`CK_AES_CBC_ENCRYPT_DATA_PARAMS`

Description

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CKM_AES_CBC_PAD

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	No Wrapping

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	32
Parameter	16 bytes

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_AES_CCM

Supported Operations

Encrypt and Decrypt	Yes (Single-part operation only)
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	32
Parameter	`CK_CCM_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.30* documentation from RSA Laboratories.

AES CCM is a single part encrypt/decrypt operation; the following sequence of PKCS#11 function calls may be used in applications:

```
C_EncryptInit(...)
C_Encrypt(...)
...
C_DecryptInit(...)
C_Decrypt(...)
```

PTK's implementation of AES CCM assumes the following limitations:

> maximum plain text size is 130032 octets, tested under the following conditions:

- Key size: 16 octets

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- Nonce size: 7-13 octets
- AAD size: 32 octets
- Tag length: 8 octets
- MAC length: 4, 6, 8, 10, 12, 14, or 16 octets

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CKM_AES_CMAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	32
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.30* documentation from RSA Laboratories.

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CKM_AES_CMAC_GENERAL

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	32
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.30* documentation from RSA Laboratories.

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CKM_AES_ECB

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	No Wrapping

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	32
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_AES_ECB_ENCRYPT_DATA

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	32
Parameter	Data to be encrypted

Description

This mechanism functions as described in the *PKCS#11 version 2.20* documentation from RSA Laboratories, with the following exception:

> **CAUTION!** *PKCS#11 version 2.20* points to a CK_KEY_DERIVATION_STRING_DATA structure. If this structure is passed as a parameter, it contains pointers to the data located in host memory, and the HSM will crash during execution.

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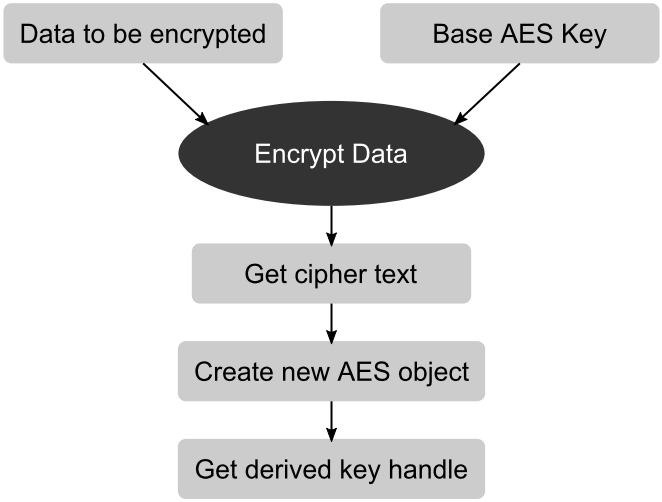
Figure 6: CKM_AES_ECB_ENCRYPT_DATA mechanism



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CKM_AES_GCM

Supported Operations

Encrypt and Decrypt	Yes (Single-part operation only)
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	32
Parameter	`CK_GCM_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.30* documentation from RSA Laboratories.

AES GCM is a single part encrypt/decrypt operation; the following sequence of PKCS#11 function calls may be used in applications:

```
C_EncryptInit(...)
C_Encrypt(...)
...
C_DecryptInit(...)
C_Decrypt(...)
```

C_Encrypt() returns the cipher text, followed by the IV. With FIPS Mode enabled, the IV is randomly generated.

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The caller must pass an initialized buffer of length specified in the IV field of `CK_GCM_PARAMS`. Passing NULL as the IV returns an error.

PTK's implementation of AES GCM assumes the following limitations:

- IV maximum length is 128 octets (max value from NIST test vectors),
- AAD maximum length is 90 octets(max value from NIST test vectors),
- message maximum length is 126K (129024) octets.

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CKM_AES_KEY_GEN

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	32
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_AES_KEY_WRAP

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	32
Parameter	Multiple of 8 bytes (optional)

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.30* documentation from RSA Laboratories.

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CKM_AES_KEY_WRAP_PAD

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	32
Parameter	Multiple of 8 bytes (optional)

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.30* documentation from RSA Laboratories.

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CKM_AES_KW

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bits) and Parameters

Minimum	128
FIPS Minimum	128
Maximum	256
Parameter	None

Description

For a full description of this mechanism, refer to *NIST Special Publication 800-38F*.

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CKM_AES_KWP

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bits) and Parameters

Minimum	128
FIPS Minimum	128
Maximum	256
Parameter	None

Description

For a full description of this mechanism, refer to *NIST Special Publication 800-38F*.

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CKM_AES_MAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	32
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_AES_MAC_GENERAL

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	32
Parameter	`CK_MAC_GENERAL_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.30* documentation from RSA Laboratories.

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CKM_AES_OFB

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	Yes
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	No Wrapping

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	32
Parameter	16 bytes

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_ARDFP

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	Yes
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	None

Description

Available in Software Emulation mode only.

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CKM_ARIA_CBC

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	32
Parameter	16 bytes

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_ARIA_CBC_PAD

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	32
Parameter	16 bytes

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_ARIA_ECB

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	32
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_ARIA_KEY_GEN

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	32
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_ARIA_MAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	32
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_ARIA_MAC_GENERAL

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	32
Parameter	`CK_MAC_GENERAL_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_BIP32_CHILD_DERIVE

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	Yes
SignRecover and VerifyRecover	Yes
Digest	Yes
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	Yes
Available in FIPS Mode	No

Key Size Range (bits) and Parameters

Minimum	64
Maximum	571
Parameter	`CKM_BIP32_CHILD_DERIVE_PARAMS`

Description

Generates a BIP32 Child node key pair from a BIP32 key.

The child derived keys need a BIP32 key as the base key to be effective. Private and hardened keys can only be derived using private keys.

When generating the child key, you need to specify the depth of the derived key with respect to the base key, as well as the index value at each level. The base key must have the following characteristics:

- **CKK_BIP32** -- using any other key type as a base key will result in an error (`CKR_KEY_TYPE_INCONSISTENT`)
- **128-512 bits of data** -- using a seed outside of this range will result in an error (`CKR_BIP32_MASTER_SEED_LEN_INVALID`)

This mechanism has a parameter, a CKM_BIP32_CHILD_DERIVE_PARAMS structure, defined as follows:

```
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;
    CK_OBJECT_HANDLE hPrivateKey;
    CK_ULONG ulPathErrorIndex;
} CK_BIP32_CHILD_DERIVE_PARAMS;
```

The fields of this structure are defined as follows:

pPublicKeyTemplate	Points to the key attributes for the public key.
ulPublicKeyAttributeCount	States the number of attributes in the public key template.
pPrivateKeyTemplate	Points to the key attributes for the private key.
ulPrivateKeyAttributeCount	States the number of key attributes in the private key template.
pulPath	
ulPathLen	
hPublicKey	Returns the public object handle after a successful key derivation.
hPrivateKey	Returns the private object handle after a successful key derivation.

If the attribute count is set to zero or the template is set to NULL, the public or private key will not be generated.

If both attribute count properties are set to zero and/or both key templates are set to NULL, an error will result (`CKR_MECHANISM_PARAM_INVALID`).

If ulPathLen is set to zero and/or pulPath is set to NULL, an error will result (`CKR_MECHANISM_PARAM_INVALID`).

The following restrictions apply to both templates:

- The CKA_KEY_TYPE value must be **CKK_BIP32**. Using any other key type will result in an error (`CKR_TEMPLATE_INCONSISTENT`).
- The only allowable curve for BIP32 is **secp256k1**. Setting an ECC curve will result in an error (`CKR_TEMPLATE_INCONSISTENT`).

If a step fails during the derivation, the depth at which the failure occurred will be stored in the ulPathErrorIndex parameter.

If a private key cannot be produced due to passing an invalid index, an error will result (`CKR_BIP32_CHILD_INDEX_INVALID`).

If a base public key is used to derive a private key, an error will result (`CKR_ARGUMENTS_BAD`).

If a base public key is used to derive a hardened key, an error will result (`CKR_BIP32_INVALID_HARDENED_DERIVATION`).

> **NOTE** For leaf children nodes, both the public and private keys must have the **CKA_DERIVE** attribute disabled to prevent further key derivations.

Sample

```
CK_RV generateChildKeyPair(
      CK_SESSION_HANDLE hPrivateSession
```

```
    , CK_OBJECT_HANDLE hParent
    , CK_OBJECT_HANDLE& hPubKey
    , CK_OBJECT_HANDLE& hPriKey
    )
{
    CK_RV retCode = CKR_OK;
    CK_BYTE no = 0;
    CK_BYTE yes = 1;
    CK_ULONG indexPath[] = {0,1,4};

    CK_NUMERIC kt = CKK_BIP32;
    CK_OBJECT_HANDLE tmpHandle;

    CK_ATTRIBUTE pubKeyTemplate[] = {
        {CKA_DERIVE,      &yes,         sizeof(yes)},
        {CKA_KEY_TYPE, &kt,sizeof(kt)  }
    };

    CK_ATTRIBUTE priKeyTemplate[] = {
        {CKA_DERIVE,      &yes,         sizeof(yes)},
        {CKA_KEY_TYPE, &kt,sizeof(kt)  }
    };

    CK_MECHANISM     deriveMech = { CKM_BIP32_CHILD_DERIVE, NULL_PTR, 0 };
    CK_BIP32_CHILD_DERIVE_PARAMS BIP32_Params;

    BIP32_Params.pPrivateKeyTemplate = priKeyTemplate;
    BIP32_Params.ulPrivateKeyAttributeCount = (sizeof(priKeyTemplate) / sizeof(CK_ATTRIBUTE));
    BIP32_Params.pPublicKeyTemplate = pubKeyTemplate;
    BIP32_Params.ulPublicKeyAttributeCount = (sizeof(pubKeyTemplate) / sizeof(CK_ATTRIBUTE));
    BIP32_Params.pulPath = indexPath;
    BIP32_Params.ulPathLen = 3;

    deriveMech.pParameter = &BIP32_Params;
    deriveMech.usParameterLen = sizeof(BIP32_Params);

    retCode = C_DeriveKey(hPrivateSession, (CK_MECHANISM_PTR)&deriveMech, hParent,
        (CK_ATTRIBUTE_PTR)priKeyTemplate, (sizeof(priKeyTemplate) / sizeof(CK_ATTRIBUTE)),
        &tmpHandle);
    hPubKey = BIP32_Params.hPublicKey;
    hPriKey = BIP32_Params.hPrivateKey;
    return retCode;
}
```


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CKM_BIP32_MASTER_DERIVE

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range (bits) and Parameters

Minimum	64
Maximum	571
Parameter	`CKM_BIP32_MASTER_DERIVE_PARAMS`

Description

Generates a BIP32 Master node key pair from a generic secret.

The BIP algorithm requires a random input for the key generation mechanism. This is provided by the C_DeriveKey's base key, which must have the following characteristics:

- **CKK_GENERIC_SECRET** -- using any other base key will result in an error (CKR_KEY_TYPE_INCONSISTENT)
- **128-512 bits of random data** -- using a seed outside of this range will result in an error (CKR_BIP32_MASTER_SEED_LEN_INVALID)

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> **CAUTION!** To keep the BIP32 master key pair secure, restrict the generic secret key to CKM_BIP32_MASTER_DERIVE operations or immediately delete it after the master key pair is derived. Restrict operations by including **--mech-list=**BIP32_MASTER_DERIVE in the **ctkmu** command that is used to generate the key. For example, run the following **ctkmu** command:
>
> **ctkmu c -t**gs **-z**128 **--mech-list=**BIP32_MASTER_DERIVE **-n**bip32seed **-a**PTR
>
> Refer to "Samples" on the next page for a code example of creating a known seed.

This mechanism has a parameter, a CKM_BIP32_MASTER_DERIVE_PARAMS structure, defined as follows:

```
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;
    CK_OBJECT_HANDLE hPrivateKey;
} CK_BIP32_MASTER_DERIVE_PARAMS;
```

The fields of this structure are defined as follows:

pPublicKeyTemplate	Points to the key attributes for the public key.
ulPublicKeyAttributeCount	States the number of attributes in the public key template.
pPrivateKeyTemplate	Points to the key attributes for the private key.
ulPrivateKeyAttributeCount	States the number of key attributes in the private key template.
hPublicKey	Returns the public object handle after a successful key derivation.
hPrivateKey	Returns the private object handle after a successful key derivation.

If the attribute count is set to zero or the template is set to NULL, the public or private key will not be generated.

If both attribute count properties are set to zero and/or both key templates are set to NULL, an error will result (CKR_MECHANISM_PARAM_INVALID).

The following restrictions apply to both templates:

- The CKA_KEY_TYPE value must be **CKK_BIP32**. Using any other key type will result in an error (CKR_TEMPLATE_INCONSISTENT).
- The only allowable curve for BIP32 is **secp256k1**. Setting an ECC curve will result in an error (CKR_TEMPLATE_INCONSISTENT).
- If the public key generated from the specified seed is invalid, an error will result (CKR_BIP32_MASTER_SEED_INVALID).

> **NOTE** Both the public and private keys must have the **CKA_DERIVE** attribute enabled, or the generated key pair cannot be used for key derivation.

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Samples

Seed Generation

The code sample below demonstrates the creation of a known seed.

```
static CK_RV createSeed(CK_SESSION_HANDLE hSession, CK_OBJECT_HANDLE *hSeed)
{
    CK_RV             rv         = CKR_OK;
    CK_BBOOL          yes        = TRUE;
    CK_NUMERIC        kt         = CKK_GENERIC_SECRET;
    CK_OBJECT_CLASS   objClass   = CKO_SECRET_KEY;
    CK_MECHANISM_TYPE mechlist[] = {CKM_BIP32_MASTER_DERIVE};
    CK_BYTE           seed[]     = {
        0x00, 0x01, 0x02, 0x03, 0x04, 0x05, 0x06, 0x07,
        0x08, 0x09, 0x0a, 0x0b, 0x0c, 0x0d, 0x0e, 0x0f
    };
    CK_ULONG sLen = sizeof(seed);

    CK_ATTRIBUTE keyTemplate[] = {
        {CKA_KEY_TYPE,          &kt, sizeof(kt)},
        {CKA_CLASS,             &objClass, sizeof(objClass)},
        {CKA_TOKEN,             &yes, sizeof(yes)},
        {CKA_SENSITIVE,         &yes, sizeof(yes)},
        {CKA_DERIVE,            &yes, sizeof(yes)},
        {CKA_MECHANISM_LIST,    mechlist, sizeof(mechlist)},
        {CKA_VALUE,             seed, sizeof(seed)},
        {CKA_VALUE_LEN,         &sLen, sizeof(sLen)},
    };
    CK_COUNT nattr = (sizeof(keyTemplate) / sizeof(CK_ATTRIBUTE));

    rv = C_CreateObject(hSession, keyTemplate, nattr, hSeed);
    return rv;
}

CK_RV generateMasterKeyPair(
    CK_SESSION_HANDLE hPrivateSession, CK_OBJECT_HANDLE hSeed,
    CK_OBJECT_HANDLE &hPubKey, CK_OBJECT_HANDLE &hPriKey)
{
    CK_RV        retCode    = CKR_OK;
    CK_BYTE      yes        = TRUE;
    CK_NUMERIC   kt         = CKK_BIP32;
    CK_MECHANISM deriveMech = {CKM_BIP32_MASTER_DERIVE, NULL_PTR, 0};

    CK_OBJECT_HANDLE              tmpHandle;
    CK_BIP32_MASTER_DERIVE_PARAMS BIP32_Params;

    CK_ATTRIBUTE pubKeyTemplate[] = {
        {CKA_DERIVE, &yes, sizeof(yes)},
        {CKA_KEY_TYPE, &kt, sizeof(kt)},
    };

    CK_ATTRIBUTE priKeyTemplate[] = {
        {CKA_DERIVE, &yes, sizeof(yes)},
        {CKA_KEY_TYPE, &kt, sizeof(kt)},
    };

    BIP32_Params.pPrivateKeyTemplate        = priKeyTemplate;
```

```
    BIP32_Params.ulPrivateKeyAttributeCount = (sizeof(priKeyTemplate) / sizeof(CK_ATTRIBUTE));
    BIP32_Params.pPublicKeyTemplate         = pubKeyTemplate;
    BIP32_Params.ulPublicKeyAttributeCount  = (sizeof(pubKeyTemplate) / sizeof(CK_ATTRIBUTE));

    deriveMech.pParameter     = &BIP32_Params;
    deriveMech.usParameterLen = sizeof(BIP32_Params);

    retCode = C_DeriveKey(hPrivateSession, &deriveMech, hSeed,
                          priKeyTemplate, (sizeof(priKeyTemplate) / sizeof(CK_ATTRIBUTE)),
                          &tmpHandle);
    hPubKey = BIP32_Params.hPublicKey;
    hPriKey = BIP32_Params.hPrivateKey;
    return retCode;
}
```

BIP32 Master Key Derivation

The code sample below demonstrates the derivation of a BIP32 master key pair.

```
CK_RV generateMasterKeyPair(
      CK_SESSION_HANDLE hPrivateSession
    , CK_OBJECT_HANDLE hSeed
    , CK_OBJECT_HANDLE& hPubKey
    , CK_OBJECT_HANDLE& hPriKey
    )
{
    CK_RV retCode = CKR_OK;
    CK_BYTE no = 0;
    CK_BYTE yes = 1;

    CK_NUMERIC kt = CKK_BIP32;
    CK_OBJECT_HANDLE tmpHandle;

    CK_ATTRIBUTE pubKeyTemplate[] = {
        {CKA_DERIVE,      &yes,         sizeof(yes)},
        {CKA_KEY_TYPE, &kt,sizeof(kt)  }
    };

    CK_ATTRIBUTE priKeyTemplate[] = {
        {CKA_DERIVE,      &yes,         sizeof(yes)},
        {CKA_KEY_TYPE, &kt,sizeof(kt)  }
    };

    CK_MECHANISM     deriveMech = { CKM_BIP32_MASTER_DERIVE , NULL_PTR, 0 };
    CK_BIP32_MASTER_DERIVE_PARAMS BIP32_Params;

    BIP32_Params.pPrivateKeyTemplate = priKeyTemplate;
    BIP32_Params.ulPrivateKeyAttributeCount = (sizeof(priKeyTemplate) / sizeof(CK_ATTRIBUTE));
    BIP32_Params.pPublicKeyTemplate = pubKeyTemplate;
    BIP32_Params.ulPublicKeyAttributeCount = (sizeof(pubKeyTemplate) / sizeof(CK_ATTRIBUTE));

    deriveMech.pParameter = &BIP32_Params;
    deriveMech.usParameterLen = sizeof(BIP32_Params);

    retCode = C_DeriveKey(hPrivateSession, (CK_MECHANISM_PTR)&deriveMech, hSeed,
        (CK_ATTRIBUTE_PTR)priKeyTemplate, (sizeof(priKeyTemplate) / sizeof(CK_ATTRIBUTE)),
        &tmpHandle);
    hPubKey = BIP32_Params.hPublicKey;
    hPriKey = BIP32_Params.hPrivateKey;
    return retCode;
}
```


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CKM_CAST128_CBC

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	1
Maximum	16
Parameter	8 bytes

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_CAST128_CBC_PAD

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	1
Maximum	16
Parameter	8 bytes

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_CAST128_ECB

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	1
Maximum	16
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_CAST128_ECB_PAD

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	1
Maximum	16
Parameter	None

Description

This is a padding mechanism. Implemented padding mechanisms are:

- `CKM_CAST128_ECB_PAD`
- `CKM_DES_ECB_PAD`
- `CKM_DES3_ECB_PAD`
- `CKM_IDEA_ECB_PAD`
- `CKM_RC2_ECB_PAD`

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

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

PKCS#11 version 2.20 specifies mechanisms for Chain Block Cipher algorithms with and without padding and ECB algorithms without padding, but not ECB with padding. These mechanisms fill this gap. The mechanisms may be used for general data encryption and decryption and also for key wrapping and unwrapping (provided all the access conditions of the relevant keys are satisfied).

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CKM_CAST128_KEY_GEN

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	1
Maximum	16
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_CAST128_MAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	1
Maximum	16
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_CAST128_MAC_GENERAL

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	1
Maximum	16
Parameter	`CK_MAC_GENERAL_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_CONCATENATE_BASE_AND_DATA

> ****WARNING**** **This mechanism contains vulnerabilities that could compromise security. It has been disabled in the factory settings for new HSMs. To enable it, the *Weak PKCS#11 Mechanisms* flag must be set. See Weak PKCS#11 Mechanisms in the "Security Policies and User Roles" section of the *ProtectToolkit-C Administration Guide* for more information.**

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	`CK_KEY_DERIVATION_STRING_DATA`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_CONCATENATE_BASE_AND_KEY

> ****WARNING**** **This mechanism contains vulnerabilities that could compromise security. It has been disabled in the factory settings for new HSMs. To enable it, the *Weak PKCS#11 Mechanisms* flag must be set. See Weak PKCS#11 Mechanisms in the "Security Policies and User Roles" section of the *ProtectToolkit-C Administration Guide* for more information.**

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	`CK_OBJECT_HANDLE`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_CONCATENATE_DATA_AND_BASE

> ****WARNING** This mechanism contains vulnerabilities that could compromise security. It has been disabled in the factory settings for new HSMs. To enable it, the *Weak PKCS#11 Mechanisms* flag must be set. See Weak PKCS#11 Mechanisms in the "Security Policies and User Roles" section of the *ProtectToolkit-C Administration Guide* for more information.**

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	`CK_KEY_DERIVATION_STRING_DATA`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_DECODE_PKCS_7

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range and Parameters

Minimum	0
FIPS Minimum	0
Maximum	None
Parameter	None

Description

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

One of the functions of PKCS#7 is a mechanism for distributing certificates and CRLs in a single encoded package. In this case the PKCS#7 message content is usually empty. This mechanism is provided to split certificates and CRLs from such a PKCS7 encoding so that those certificates and CRLs may be further processed.

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This mechanism will decode a PKCS#7 encoding and create PKCS#11 objects for all certificates (object class `CKO_CERTIFICATE`) and CRLs (object class `CKO_CRL`) that it finds in the encoding. The signature on the PKCS#7 content is not verified. The parameter containing the newly derived key is the last Certificate or CRL that is extracted from the PKCS#7 encoding. The attribute template is applied to all objects extracted from the encoding.

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CKM_DECODE_X_509

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range and Parameters

Minimum	0
FIPS Minimum	0
Maximum	None
Parameter	None

Description

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

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

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CKM_DES_BCF

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	8
Maximum	8
Parameter	8 bytes

Description

Available in Software Emulation mode only.

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CKM_DES_CBC

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	8
Maximum	8
Parameter	8 bytes

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_DES_CBC_ENCRYPT_DATA

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	8
Maximum	8
Parameter	`CK_DES_CBC_ENCRYPT_DATA_PARAMS`

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CKM_DES_CBC_PAD

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	8
Maximum	8
Parameter	8 bytes

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_DES_DERIVE_CBC_DEPRECATED

> **NOTE** The **CKM_DES_DERIVE_CBC** mechanism is deprecated in this release. Use of **CKM_DES_DERIVE_CBC** is no longer recommended.

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	8
Maximum	8
Parameter	`CK_DES_CBC_PARAMS`

Description

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

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

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

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

The following rules apply to the provided attribute template:

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

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

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

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

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CKM_DES_DERIVE_ECB_DEPRECATED

> **NOTE** The **CKM_DES_DERIVE_ECB** mechanism is deprecated in this release. Use of **CKM_DES_DERIVE_ECB** is no longer recommended.

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	8
Maximum	8
Parameter	Multiple of 8 bytes

Description

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

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

The following rules apply to the provided attribute template:

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

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

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

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

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

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CKM_DES_ECB

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	8
Maximum	8
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_DES_ECB_ENCRYPT_DATA

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	8
Maximum	8
Parameter	`CK_KEY_DERIVATION_STRING_DATA`

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CKM_DES_ECB_PAD

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	8
Maximum	8
Parameter	None

Description

This is a padding mechanism. Implemented padding mechanisms are:

- CKM_CAST128_ECB_PAD
- CKM_DES_ECB_PAD
- CKM_DES3_ECB_PAD
- CKM_IDEA_ECB_PAD
- CKM_RC2_ECB_PAD

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

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

PKCS#11 version 2.20 specifies mechanisms for Chain Block Cipher algorithms with and without padding and ECB algorithms without padding, but not ECB with padding. These mechanisms fill this gap. The mechanisms may be used for general data encryption and decryption and also for key wrapping and unwrapping (provided all the access conditions of the relevant keys are satisfied).

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CKM_DES_KEY_GEN

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	8
Maximum	8
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_DES_MAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	8
Maximum	8
Parameter	`CK_MAC_GENERAL_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_DES_MAC_GENERAL

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	8
Maximum	8
Parameter	`CK_MAC_GENERAL_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_DES_MDC_2_PAD1

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	Yes
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	0
Parameter	None

Description

This mechanism is a hash function as defined in ISO/IEC DIS 10118-2 using DES as block algorithm.

This mechanism implements padding in accordance with ISO 10118-1 Method 1. Basically, zeros are used to pad the input data to a multiple of 8 if required. If the input data is already a multiple of 8, then no padding is added.

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CKM_DES_OFB64

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	8
Maximum	8
Parameter	8 bytes

Description

Single DES-OFB64 denoted `CKM_DES_OFB64` is a mechanism for single and multiple part encryption and decryption; based on DES Output Feedback Mode.

It has a parameter, an 8-byte initialization vector.

This mechanism does not require either clear text or cipher text to be presented in multiple block lengths. There is no padding required. The mechanism will always return a reply equal in length to the request.

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CKM_DES2_KEY_GEN

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	16
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_DES3_BCF

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
FIPS-approved	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	24
Parameter	8 bytes

Description

Available in Software Emulation mode only.

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CKM_DES3_CBC

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	No Wrapping Encrypt: A maximum limit of 2^{28} 64-bit packets can be processed by a single key. Once this limit is reached, an error (CKR_KEY_NOT_ACTIVE) occurs.

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	24
Parameter	8 bytes

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_DES3_CBC_ENCRYPT_DATA

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	24
Parameter	`CK_DES_CBC_ENCRYPT_DATA_PARAMS`

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CKM_DES3_CBC_PAD

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	No Wrapping Encrypt: A maximum limit of 2^{28} 64-bit packets can be processed by a single key. Once this limit is reached, an error (CKR_KEY_NOT_ACTIVE) occurs.

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	24
Parameter	8 bytes

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_DES3_CMAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Sign/Verify: A maximum limit of 2^{28} 64-bit packets can be processed by a single key. Once this limit is reached, an error (CKR_KEY_NOT_ACTIVE) occurs.

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	24
Parameter	8 bytes

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.30* documentation from RSA Laboratories.

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CKM_DES3_CMAC_GENERAL

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Sign/Verify: A maximum limit of 2^{28} 64-bit packets can be processed by a single key. Once this limit is reached, an error (CKR_KEY_NOT_ACTIVE) occurs.

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	24
Parameter	8 bytes

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_DES3_DDD_CBC

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	24
Parameter	8 bytes

Description

`CKM_DES3_DDD_CBC` is a mechanism for single- and multiple-part encryption and decryption, key wrapping and key unwrapping, based on the DES block cipher and cipher-block chaining mode as defined in *FIPS PUB 81*.

The DES3-DDD cipher encrypts an 8 byte block by `D(KL, D(KR, D(KL, data)))` and decrypts with `E(KL, E(KR, E(KL, cipher)))`; where `Key = KL || KR`, and `E(KL, data)` is a single DES encryption using key `KL` and `D(KL, cipher)` is a single DES decryption.

It has a parameter, an initialization vector for cipher block chaining mode. The initialization vector has the same length as the block size, which is 8 bytes.

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

Table 1: DES3-DDD Block Cipher CBC: Key and Data Length

Function	Key Type	Input Length	Output Length	Comments
C_Encrypt	`CKK_DES2`	Any	input length rounded up to multiple of block size	no final part

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Function	Key Type	Input Length	Output Length	Comments
C_Decrypt	CKK_DES2	Multiple of block size	same as input length	no final part
C_WrapKey	CKK_DES2	Any	input length rounded up to multiple of block size	
C_UnwrapKey	CKK_DES2	Any	Determined by type of key being unwrapped or CKA_VALUE_LEN	

For the encrypt and wrap operations, the mechanism performs zero-padding when the input data or wrapped key's length is not a multiple of 8. That is, the value 0x00 is appended to the last block until its length is 8 (for example, plaintext 0x01 would be padded to become 0x010x000x000x000x000x000x000x00).

With the exception of the algorithm specified in this section, the use of this mechanism is identical to the use of other secret key mechanisms. Therefore, for further details on aspects not covered here (for example, access control, or error codes) refer to the PKCS#11 standard.

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CKM_DES3_DERIVE_CBC_DEPRECATED

> **NOTE** The **CKM_DES3_DERIVE_CBC** mechanism is deprecated in this release. Use of **CKM_DES3_DERIVE_CBC** is no longer recommended.

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	24
Parameter	`CK_DES2_CBC_PARAMS` `CK_DES3_CBC_PARAMS`

Description

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

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

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

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

The following rules apply to the provided attribute template:

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

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

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

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

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CKM_DES3_DERIVE_ECB_DEPRECATED

> **NOTE** The **CKM_DES3_DERIVE_ECB** mechanism is deprecated in this release. Use of **CKM_DES3_DERIVE_ECB** is no longer recommended.

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	24
Parameter	Multiple of 8 bytes

Description

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

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

The following rules apply to the provided attribute template:

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

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

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

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

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

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CKM_DES3_ECB

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	No Wrapping Encrypt: A maximum limit of 2^{28} 64-bit packets can be processed by a single key. Once this limit is reached, an error (CKR_KEY_NOT_ACTIVE) occurs.

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	24
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_DES3_ECB_ENCRYPT_DATA

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
FIPS-approved	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	24
Parameter	`CK_KEY_DERIVATION_STRING_DATA`

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CKM_DES3_ECB_PAD

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	No Wrapping Encrypt: A maximum limit of 2^{28} 64-bit packets can be processed by a single key. Once this limit is reached, an error (CKR_KEY_NOT_ACTIVE) occurs.

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	24
Parameter	None

Description

This is a padding mechanism. Implemented padding mechanisms are:

- CKM_CAST128_ECB_PAD
- CKM_DES_ECB_PAD
- CKM_DES3_ECB_PAD
- CKM_IDEA_ECB_PAD
- CKM_RC2_ECB_PAD

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

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

PKCS#11 version 2.20 specifies mechanisms for Chain Block Cipher algorithms with and without padding and ECB algorithms without padding, but not ECB with padding. These mechanisms fill this gap. The mechanisms may be used for general data encryption and decryption and also for key wrapping and unwrapping (provided all the access conditions of the relevant keys are satisfied).

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CKM_DES3_KEY_GEN

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	24
FIPS Minimum	24
Maximum	24
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_DES3_MAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	No MAC generation

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	24
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_DES3_MAC_GENERAL

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	No MAC generation

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	24
Parameter	`CK_MAC_GENERAL_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_DES3_OFB64

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Encrypt: A maximum limit of 2^{28} 64-bit packets can be processed by a single key. Once this limit is reached, an error (CKR_KEY_NOT_ACTIVE) occurs.

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	24
Parameter	8 bytes

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_DES3_RETAIL_CFB_MAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	No MAC generation

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	24
Parameter	8 bytes (IV)

Description

This is a signature generation and verification mechanism. The produced MAC is 8 bytes in length. It is an extension of the single length key MAC mechanisms. It takes an 8 byte IV as a parameter, which is encrypted (ECB mode) with the left most key value before the first data block is MAC'ed.

The data, which must be a multiple of 8 bytes, is MAC’ed with the left most key value in the normal manner, but the final cipher block is then decrypted (ECB mode) with the middle key value and encrypted (ECB mode) with the Right most key part.

For double length DES keys, the Right key component is the same as the Left key component.

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CKM_DES3_X919_MAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	No MAC generation

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	24
Parameter	`CK_MAC_GENERAL_PARAMS`

Description

`CKM_DES3_X919_MAC` and `CKM_DES3_X919_MAC_GENERAL` are signature generation and verification mechanisms, as defined by ANSI X9.19. They are an extension of the single length key MAC mechanisms. The data is MAC'ed with the left most key value in the normal manner, but the final cipher block is then decrypted (ECB mode) with the middle key value and encrypted (ECB mode) with the Right most key part.

For double length keys, the Right key component is the same as the Left key component.

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CKM_DES3_X919_MAC_GENERAL

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	No MAC generation

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	24
Parameter	`CK_MAC_GENERAL_PARAMS`

Description

`CKM_DES3_X919_MAC` and `CKM_DES3_X919_MAC_GENERAL` are signature generation and verification mechanisms, as defined by ANSI X9.19. They are an extension of the single length key MAC mechanisms. The data is MAC'ed with the left most key value in the normal manner, but the final cipher block is then decrypted (ECB mode) with the middle key value and encrypted (ECB mode) with the Right most key part.

For double length keys, the Right key component is the same as the Left key component.

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CKM_DH_PKCS_DERIVE

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for all operations Cannot be used for existing Diffie-Hellman keys smaller than 2048 bits

Key Size Range (bits) and Parameters

Minimum	512
FIPS Minimum	2048
Maximum	4096
Parameter	Bytes (Big Integer)

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_DH_PKCS_KEY_PAIR_GEN

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for all operations

Key Size Range (bits) and Parameters

Minimum	512
FIPS Minimum	2048
Maximum	4096
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_DH_PKCS_PARAMETER_GEN

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for all operations

Key Size Range (bits) and Parameters

Minimum	512
FIPS Minimum	2048
Maximum	4096
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_DSA

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes (Single-part operation only)
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for all operations

Key Size Range (bytes) and Parameters

Minimum	512
FIPS Minimum	2048
Maximum	3072
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_DSA_KEY_PAIR_GEN

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for all operations

Key Size Range (bits) and Parameters

Minimum	512
FIPS Minimum	2048
Maximum	3072
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_DSA_PARAMETER_GEN

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for all operations

Key Size Range (bits) and Parameters

Minimum	512
FIPS Minimum	2048
Maximum	3072
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_DSA_SHA1

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	No Signing Minimum 2048-bit modulus for all operations

Key Size Range (bits) and Parameters

Minimum	512
FIPS Minimum	2048
Maximum	3072
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_DSA_SHA1_PKCS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	No Signing Minimum 2048-bit modulus for all operations

Key Size Range (bits) and Parameters

Minimum	512
FIPS Minimum	2048
Maximum	3072
Parameter	None

Description

The PKCS #1 DSA signature with SHA-1 mechanism, denoted `CKM_DSA_SHA1_PKCS`, performs single and multiple-part digital signature and verification operations without message recovery. The operations performed are as described in PKCS #1 with the object identifier `sha1WithDSAEncryption`.

It is similar to the PKCS#11 mechanism `CKM_RSA_SHA1_PKCS` except DSA is used instead of RSA. This mechanism has no parameter.

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CKM_DSA_SHA224

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for all operations

Key Size Range (bits) and Parameters

Minimum	1024
FIPS Minimum	2048
Maximum	3072
Parameter	None

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CKM_DSA_SHA224_PKCS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for all operations

Key Size Range (bits) and Parameters

Minimum	1024
FIPS Minimum	2048
Maximum	3072
Parameter	None

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CKM_DSA_SHA256

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for all operations

Key Size Range (bits) and Parameters

Minimum	1024
FIPS Minimum	2048
Maximum	3072
Parameter	None

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CKM_DSA_SHA256_PKCS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for all operations

Key Size Range (bits) and Parameters

Minimum	1024
FIPS Minimum	2048
Maximum	3072
Parameter	None

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CKM_DSA_SHA384

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for all operations

Key Size Range (bits) and Parameters

Minimum	1024
FIPS Minimum	2048
Maximum	3072
Parameter	None

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CKM_DSA_SHA384_PKCS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for all operations

Key Size Range (bits) and Parameters

Minimum	1024
FIPS Minimum	2048
Maximum	3072
Parameter	None

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CKM_DSA_SHA512

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for all operations

Key Size Range (bits) and Parameters

Minimum	1024
FIPS Minimum	2048
Maximum	3072
Parameter	None

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CKM_DSA_SHA512_PKCS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for all operations

Key Size Range (bits) and Parameters

Minimum	1024
FIPS Minimum	2048
Maximum	3072
Parameter	None

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CKM_EC_EDWARDS_KEY_PAIR_GEN

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bits) and Parameters

Minimum	64
Maximum	571
Parameter	None

Description

The elliptic curve key pair generation mechanism, denoted `CKM_EC_EDWARDS_KEY_PAIR_GEN`, is a key pair generation mechanism for EC Operation.

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CKM_EC_KEY_PAIR_GEN

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bits) and Parameters

Minimum	64
FIPS Minimum	224
Maximum	571
Parameter	None

Description

The elliptic curve key pair generation mechanism, denoted `CKM_EC_KEY_PAIR_GEN`, is a key pair generation mechanism for EC Operation.

This mechanism operates as specified in PKCS#11, with the following adjustments.

The `CKA_EC_PARAMS` or `CKA_ECDSA_PARAMS` attribute value must be supplied in the Public Key Template. This attribute is known as the “EC domain parameters” and is defined in ANSI X9.62 as a choice of three parameter representation methods with the following syntax:

```
Parameters ::= CHOICE {
ecParameters ECParameters,
namedCurve CURVES.&id({CurveNames}),
implicitlyCA NULL
}
```


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If the CKA_EC_PARAMS attribute contains a namedCurve then it must be the of DER OID-encoding of one of the following supported curves:

- { iso(1) member-body(2) US(840) x9-62(10045) curves(3) characteristicTwo(0) c2tnb191v1(5) }
- { iso(1) member-body(2) US(840) x9-62(10045) curves(3) prime(1) prime192v1(1) }
- { iso(1) identified-organization(3) Certicom(132) certicom_ellipticCurve(0) secp224r1(33) }
- { iso(1) member-body(2) US(840) x9-62(10045) curves(3) prime(1) prime256v1(7) }
- { iso(1) identified-organization(3) Certicom(132) certicom_ellipticCurve(0) secp384r1(34) }
- { iso(1) identified-organization(3) Certicom(132) certicom_ellipticCurve(0) secp521r1(35) }

Plus the custom curve with unofficial OID:

- { iso(1) member-body(2) US(840) x9-62(10045) curves(3) characteristicTwo(0) c2tnb191v1e (15) }

Refer to the **CT_DerEncodeNamedCurve** function in the **CTUTIL** library for a convenient way to obtain the encodings of supported namedCurve OIDs.

If the CKA_EC_PARAMS attribute is in the form of the ECParameters sequence then the domain parameters may be described explicitly. In this way the developer is able to specify the curve parameters for curves that the firmware has no prior knowledge of.

Support for ECParameters sequence is disabled unless the Security Configuration “User Specified ECC Domain Parameters Allowed” is enabled (see **ctconf -fE**).

Refer to the **CT_GetECCDomainParameters** function in the **CTUTILS** library and the **KM_EncodeECParamsP** and **KM_EncodeECParams2M** functions from the **KMLIB** library for convenient methods to obtain ECParameters encodings.

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CKM_ECDH1_DERIVE

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bits) and Parameters

Minimum	64
FIPS Minimum	224
Maximum	571
Parameter	`CK_ECDH1_DERIVE_PARAMS`

Description

The elliptic curve Diffie-Hellman (ECDH) key derivation mechanism, denoted `CKM_ECDH1_DERIVE`, is a mechanism for key derivation based on the Diffie- Hellman version of the elliptic curve key agreement scheme, as defined in ANSI X9.63, where each party contributes one key pair all using the same EC domain parameters.

This mechanism has a parameter, a `CK_ECDH1_DERIVE_PARAMS` structure.

```
typedef struct CK_ECDH1_DERIVE_PARAMS {
    CK_EC_KDF_TYPE kdf;/* key derivation function */
    CK_ULONG  ulSharedDataLen;/* optional extra shared data */
    CK_BYTE_PTR pSharedData;
    CK_ULONG   ulPublicDataLen;/* other party public key value */
    CK_BYTE_PTR  pPublicData;
} CK_ECDH1_DERIVE_PARAMS;
typedef struct CK_ECDH1_DERIVE_PARAMS * CK_ECDH1_DERIVE_PARAMS_PTR;
```


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The fields of the structure have the following meanings:

kdf	This is the Key Derive Function (see below for the description of the possible values of this field).
ulSharedDataLen	This is the length of the optional shared data used by some of the key derive functions. This may be zero if there is no shared data.
pSharedData	This is the address of the optional shared data or NULL if there is no shared data.
ulPublicDataLen	This is the length of the other party public key.
pPublicData	This is the pointer to the other party public key. Only uncompressed format is accepted.

The mechanism calculates an agreed value using the EC Private key referenced by the base object handle and the EC Public key passed to the mechanism through the **pPublicData** field of the mechanism parameter.

The length of the agreed value is equal to the 'q' value of the underlying EC curve.

The agreed value is then processed by the Key Derive Function (kdf) to produce the `CKA_VALUE` of the new Secret Key object.

Four main types of KDFs are supported:

- The NULL KDF performs no additional processing and can be used to obtain the raw agreed value. Basically: Key = Z
- The CKF_<hash>_KDF algorithms are based on the algorithm described in section 5.6.3 of ANSI X9.63 2001. Basically: Key = H(Z || *counter* || *OtherInfo*)
- The CKF_<hash>_SES_KDF algorithms are based on the variant of the x9.63 algorithm specified in *Technical Guideline TR-03111 - Elliptic Curve Cryptography (ECC) based on ISO 15946 Version 1.0*, Bundesamt Fur Sicherheit in der Informationstechnik (BSI)

  Basically: Key = H(Z || *counter*) where *counter* is a user specified parameter
- The CKF_<hash>_NIST_KDF algorithms are based on the algorithm described in *NIST 800-56A Concatenisation Algorithm*

  Basically: Key = H(*counter* || Z || *OtherInfo*)

The CKF_SES_<hash>_KDF algorithms require the value of the counter to be specified. This is done by arithmetically adding the counter value to the CKF value.

The following Counter values are defined in TR-03111:

Counter Name	Value	Description
`CKD_SES_ENC_CTR`	0x00000001	Default encryption Key
`CKD_SES_AUTH_CTR`	0x00000002	Default authentication Key
`CKD_SES_ALT_ENC_CTR`	0x00000003	Alternate encryption Key

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Counter Name	Value	Description
CKD_SES_ALT_AUTH_CTR	0x00000004	alternate Authentication Key
CKD_SES_MAX_CTR	0x0000FFFF	Maximum counter value

For example:
To derive a session key to be used as an Alternate key for Encryption the counter must equal 0x00000003. If the SHA-1 hash algorithm is required then the kdf value would be set like this:

```
CK_ECDH1_DERIVE_PARAMS Params;
Params.kdf = CKD_SHA1_SES_KDF + CKD_SES_ALT_ENC_CTR;
```

The table below describes the supported KDFs.

KDF Type	Description
CKD_NULL	The null transformation. The derived key value is produced by taking bytes from the left of the agreed value. The new key size is limited to the size of the agreed value. The Shared Data is not used by this KDF and pSharedData should be NULL.
CKD_SHA1_KDF	This KDF generates secret keys of virtually any length using the algorithm described in X9.63 with the SHA-1 hash algorithm. Shared data may be provided.
CKD_SHA224_KDF	This KDF generates secret keys of virtually any length using the algorithm described in X9.63 with the SHA-224 hash algorithm. Shared data may be provided.
CKD_SHA256_KDF	This KDF generates secret keys of virtually any length using the algorithm described in X9.63 with the SHA-256 hash algorithm. Shared data may be provided.
CKD_SHA384_KDF	This KDF generates secret keys of virtually any length using the algorithm described in X9.63 with the SHA-384 hash algorithm. Shared data may be provided.
CKD_SHA512_KDF	This KDF generates secret keys of virtually any length using the algorithm described in X9.63 with the SHA-512 hash algorithm. Shared data may be provided.
CKD_RIPEMD160_KDF	This KDF generates secret keys of virtually any length using the algorithm described in X9.63 with the RIPE MD 160 hash algorithm. Shared data may be provided. This KDF is not available if the HSM is configured for “Only allow Fips Approved Algorithms”.

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KDF Type	Description
CKD_SHA1_SES_KDF	This KDF generates session keys. It uses the algorithm described in TR-03111 with the SHA-1 hash algorithm. Shared data may be provided but typically it is not used. The counter value that is a parameter to this KDF must be added to this constant.
CKD_SHA224_SES_KDF	This KDF generates single, double and triple length DES keys that are intended for Encryption operations. It uses the algorithm described in TR-03111 with the SHA-224 hash algorithm. Shared data may be provided but typically it is not used. The counter value that is a parameter to this KDF must be added to this constant.
CKD_SHA256_SES_KDF	This KDF generates single, double and triple length DES keys that are intended for Encryption operations. It uses the algorithm described in TR-03111 with the SHA-256 hash algorithm. Shared data may be provided but typically it is not used. The counter value that is a parameter to this KDF must be added to this constant.
CKD_SHA384_SES_KDF	This KDF generates single, double and triple length DES keys that are intended for Encryption operations. It uses the algorithm described in TR-03111 with the SHA-384 hash algorithm. Shared data may be provided but typically it is not used. The counter value that is a parameter to this KDF must be added to this constant.
CKD_SHA512_SES_KDF	This KDF generates single, double and triple length DES keys that are intended for Encryption operations. It uses the algorithm described in TR-03111 with the SHA-512 hash algorithm. Shared data may be provided but typically it is not used. The counter value that is a parameter to this KDF must be added to this constant.
CKD_RIPEMD160_SES_KDF	This KDF generates single, double and triple length DES keys that are intended for Encryption operations. It uses the algorithm described in TR-03111 with the Ripe MD 160 hash algorithm. Shared data may be provided but typically it is not used. The counter value that is a parameter to this KDF must be added to this constant. This KDF is not available if the HSM is configured for “Only allow Fips Approved Algorithms”.
CKD_SHA1_NIST_KDF	This KDF generates secret keys of virtually any length using the algorithm described in NIST 800-56A with the SHA-1 hash algorithm. Shared data should be formatted according to the standard.

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KDF Type	Description
CKD_SHA224_NIST_KDF	This KDF generates secret keys of virtually any length using the algorithm described in NIST 800-56A with the SHA-224 hash algorithm. Shared data should be formatted according to the standard.
CKD_SHA256_NIST_KDF	This KDF generates secret keys of virtually any length using the algorithm described in NIST 800-56A with the SHA-256 hash algorithm. Shared data should be formatted according to the standard.
CKD_SHA384_NIST_KDF	This KDF generates secret keys of virtually any length using the algorithm described in NIST 800-56A with the SHA-384 hash algorithm. Shared data should be formatted according to the standard.
CKD_SHA512_NIST_KDF	This KDF generates secret keys of virtually any length using the algorithm described in NIST 800-56A with the SHA-512 hash algorithm. Shared data should be formatted according to the standard.
CKD_RIPEMD160_NIST_KDF	This KDF generates secret keys of virtually any length using the algorithm described in NIST 800-56A with the RIPE MD 160 hash algorithm. Shared data should be formatted according to the standard. This KDF is not available if the HSM is configured for “Only allow Fips Approved Algorithms”.

This mechanism derives a secret value, and truncates the result according to the CKA_KEY_TYPE attribute of the template and, if it has one and the key type supports it, the CKA_VALUE_LEN attribute of the template. (The truncation removes bytes from the leading end of the secret value.) The mechanism contributes the result as the CKA_VALUE attribute of the new key; other attributes required by the key type must be specified in the template.

The following rules apply to the provided attribute template:

- A key type must be provided in the template or else a Template Error is returned.
- If no length is provided in the template then that key type must have a well-defined length. If it doesn’t, an error is returned.
- If both a key type and a length are provided in the template, the length must be compatible with that key type.
- If a DES key is derived with these mechanisms, the parity bits of the key are set properly.
- If the requested type of key requires more bytes than the Key Derive Function can provide, an error is generated.

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

- The CKA_SENSITIVE, CKA_EXTRACTABLE and CKA_EXPORTABLE attributes in the template for the new key can both be specified to be either CK_TRUE or CK_FALSE. If omitted, these attributes all take on the default value TRUE.
- If the base key has its CKA_ALWAYS_SENSITIVE attribute set to CK_FALSE, then the derived key will as well. If the base key has its CKA_ALWAYS_SENSITIVE attribute set to CK_TRUE, then the derived key has its CKA_ALWAYS_SENSITIVE attribute set to the same value as its CKA_SENSITIVE attribute.

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> Similarly, if the base key has its `CKA_NEVER_EXTRACTABLE` attribute set to `CK_FALSE`, then the derived key will, too. If the base key has its `CKA_NEVER_EXTRACTABLE` attribute set to `CK_TRUE`, then the derived key has its `CKA_NEVER_EXTRACTABLE` attribute set to the opposite value from its `CKA_EXTRACTABLE` attribute.

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CKM_ECDSA

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bits) and Parameters

Minimum	64
FIPS Minimum	224
Maximum	571
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_ECDSA_GBCS_SHA256

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bits) and Parameters

Minimum	64
FIPS Minimum	224
Maximum	571
Parameter	None

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CKM_ECDSA_SHA1

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	No Signing

Key Size Range (bits) and Parameters

Minimum	64
FIPS Minimum	224
Maximum	571
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_ECDSA_SHA224

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bits) and Parameters

Minimum	64
FIPS Minimum	224
Maximum	571
Parameter	None

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CKM_ECDSA_SHA256

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bits) and Parameters

Minimum	64
FIPS Minimum	224
Maximum	571
Parameter	None

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CKM_ECDSA_SHA384

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bits) and Parameters

Minimum	64
FIPS Minimum	224
Maximum	571
Parameter	None

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CKM_ECDSA_SHA512

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bits) and Parameters

Minimum	64
FIPS Minimum	224
Maximum	571
Parameter	None

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CKM_ECDSA_SHA3_224

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bits) and Parameters

Minimum	64
FIPS Minimum	224
Maximum	571
Parameter	None

Description

For a full description of this mechanism, refer to the ECDSA SHA-3 documentation from OASIS (https://www.oasis-open.org).

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CKM_ECDSA_SHA3_256

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bits) and Parameters

Minimum	64
FIPS Minimum	224
Maximum	571
Parameter	None

Description

For a full description of this mechanism, refer to the ECDSA SHA-3 documentation from OASIS (https://www.oasis-open.org).

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CKM_ECDSA_SHA3_384

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bits) and Parameters

Minimum	64
FIPS Minimum	224
Maximum	571
Parameter	None

Description

For a full description of this mechanism, refer to the ECDSA SHA-3 documentation from OASIS (https://www.oasis-open.org).

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CKM_ECDSA_SHA3_512

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bits) and Parameters

Minimum	64
FIPS Minimum	224
Maximum	571
Parameter	None

Description

For a full description of this mechanism, refer to the ECDSA SHA-3 documentation from OASIS (https://www.oasis-open.org).

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CKM_ECIES

Supported Operations

Encrypt and Decrypt	Yes (Single-part operation only)
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bits) and Parameters

Minimum	64
Maximum	571
Parameter	`CK_ECIES_PARAM`

Description

The Elliptic Curve Integrated Encryption Scheme (ECIES) mechanism, denoted CKM_ECIES, performs single-part encryption and decryption operations. The operations performed are as described in ANSI X9.63-2001.

This mechanism has a parameter, a CK_ECIES_PARAMS structure. This structure is defined as follows:

```
typedef struct CK_ECIES_PARAMS
{
CK_EC_DH_PRIMITIVE dhPrimitive;
    CK_EC_KDF_TYPE kdf;
    CK_ULONG ulSharedDataLen1;
    CK_BYTE_PTR pSharedData1;
    CK_EC_ENC_SCHEME encScheme;
    CK_ULONG ulEncKeyLenInBits;
    CK_EC_MAC_SCHEME macScheme;
    CK_ULONG ulMacKeyLenInBits;
    CK_ULONG ulMacLenInBits;
    CK_ULONG ulSharedDataLen2;
    CK_BYTE_PTR pSharedData2;
} CK_ECIES_PARAMS;
```


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The fields of this structure have the following meanings:

dhPrimitive	This is the Diffie-Hellman primitive used to derive the shared secret value. Valid value: `CKDHP_STANDARD`
kdf	This is the key derivation function used on the shared secret value. Valid value: `CKD_SHA1_KDF`
ulSharedDataLen1	This is the length in bytes of the key derivation shared data.
pSharedData1	This is the key derivation padding data shared between the two parties.
encScheme	This is the encryption scheme used to transform the input data. Valid value: `CKES_XOR`
ulEncKeyLenInBits	This is the bit length of the key to use for the encryption scheme.
macScheme	This is the MAC scheme used for MAC generation or validation. Valid values: `CKMS_HMAC_SHA1CKMS_SHA1` **NOTE** The MAC scheme `CKMS_SHA1`, should only be used for compatability with RSA BSAFE® Crypto-C, which uses a NON-STANDARD MAC scheme, which was defined in the 10/97 X9.63 Draft, but was removed from the released ANSI X9.63-2001 specification.
ulMacKeyLenInBits	This is the bit length of the key to use for the MAC scheme.
ulMacLenInBits	This is the bit length of the MAC scheme output.
ulSharedDataLen2	This is the length in bytes of the MAC shared data.
pSharedData2	This is the MAC padding data shared between the two parties.

The **pSharedData1** and **pSharedData2** parameters are optional, and if not supplied then they must be NULL and the **ulSharedDataLen1** and **ulSharedDataLen2** parameters must be zero. With the MAC scheme `CKMS_SHA1`, any supplied shared data is ignored.

With the encryption scheme `CKES_XOR`, the **ulEncKeyLenInBits** parameter MUST be zero. With any other encryption scheme, the **ulEncKeyLenInBits** parameter must be set to the applicable key length in bits.

With the MAC scheme `CKMS_SHA1`, the **ulMacKeyLenInBits** parameter must be 0. With any other MAC scheme, the **ulMacKeyLenInBits** parameter must be a minimum of 80 bits, and a multiple of 8 bits.

The **ulMacLenInBits** parameter must be a minimum of 80 bits, a multiple of 8 bits, and not greater than the maximum output length for the specified Hash.

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

Table 1: ECIES: Key and Data Length

Function	Key Type	Input Length	Output Length
C_Encrypt	EC public key	any	1 + 2modLen + any + macLen

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Function	Key Type	Input Length	Output Length
C_Decrypt	EC private key	1 + 2modLen + any + macLen	any

Where:

- modLen is the curve modulus length
- macLen is the length of the produced MAC

The encrypted data is in the format QE||EncData||MAC, where:

- QE is the uncompressed bit string of the ephemeral EC public key
- EncData is the encrypted data
- MAC is the generated MAC

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CKM_EDDSA

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bits) and Parameters

Minimum	64
Maximum	571
Parameter	None

Description

For a full description of this mechanism, refer to the EDDSA documentation from OASIS (https://www.oasis-open.org).

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CKM_ENCODE_ATTRIBUTES

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range and Parameters

Minimum	0
FIPS Minimum	0
Maximum	None
Parameter	None

Description

This wrapping mechanism takes the attributes of an object and encodes them. The encoding is not encrypted therefore the wrapping key object handle parameter is ignored.

If the object is sensitive then only non-sensitive attributes of the object are encoded. The encoding format is a simple proprietary encoding with the attribute type, length, a value presence indicator (Boolean) and the attribute value. This simple encoding format is used wherever BER or DER is not required.

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CKM_ENCODE_PKCS_10

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range and Parameters

Minimum	0
FIPS Minimum	0
Maximum	None
Parameter	None

Description

This mechanism is used with the **C_DeriveKey** function to create a PKCS#10 certification request from a public key. Either an RSA or DSA public key may be used with this function. The PKCS#10 certificate request could then be sent to a Certificate authority for signing.

From PKCS#10

A certification request consists of a distinguished name, a public key and optionally a set of attributes that are collectively signed by the entity requesting certification. Certification requests are sent to a certification authority, which will transform the request to an X.509 public-key certificate.

Usage

> Use `CKM_RSA_PKCS_KEY_PAIR_GEN` to generate a key.

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- Add a `CKA_SUBJECT` attribute to the public key, containing the subject's distinguished name.
- Initialize the signature mechanism to sign the request. Note that a digest/sign mechanism must be chosen. For example, `CKM_SHA1_RSA_PKCS`
- Call **C_DeriveKey** with the `CKM_ENCODE_PKCS_10` mechanism to perform the generation.
- On success, an object handle for the certificate request is returned.
- The object's `CKA_VALUE` attribute contains the PKCS#10 request.

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CKM_ENCODE_PUBLIC_KEY

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range and Parameters

Minimum	0
FIPS Minimum	0
Maximum	None
Parameter	None

Description

This wrapping mechanism performs a DER encoding of a Public Key object. The encoding is not encrypted therefore the wrapping key object handle parameter is ignored.

Public keys of type `CKK_RSA`, `CKK_DSA` and `CKK_DH` may be encoded with this mechanism. The encoding format is defined in PKCS#1. This mechanism has no parameter.

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CKM_ENCODE_X_509

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range and Parameters

Minimum	0
FIPS Minimum	0
Maximum	None
Parameter	`CK_MECH_TYPE_AND_OBJECT`

Description

This mechanism is used with the **C_DeriveKey** function to derive an X.509 certificate from a public key or a PKCS#10 certification request. This mechanism creates a new X.509 certificate based on the provided public key or certification request signed with a CA key. This mechanism takes no parameter.

The new certificate validity period is based on the `CKA_START_DATE` and `CKA_END_DATE` attributes on the base object. If the start date is missing the current time is used. If the end date is missing the certificate is valid for one year. These dates may be specified as relative values by adding the + character at the start of the date value. The start date is relative to 'now' and the end date is relative to the start date if relative times are specified. Negative relative times are not allowed. If the start or end date is invalid then the error `CKR_TEMPLATE_INCONSISTENT` is returned.

The certificate's serial number is taken from the template's `CKA_SERIAL_NUMBER`, `CKA_SERIAL_NUMBER_INT` or the signing key's `CKA_USAGE_COUNT` in that order. If none of these values is available `CKR_WRAPPING_KEY_HANDLE_INVALID` error is returned.

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To determine the Subject distinguished name for the new certificate if the base object is a public key the algorithm will use the CKA_SUBJECT_STR, CKA_SUBJECT from the template or the base key (in that order). If none of these values is available CKR_KEY_HANDLE_INVALID is returned.

It is also possible to include arbitrary X.509 extensions in the certificate. These are not verified for validity nor parsed for correctness. Rather they are included verbatim in the newly generated certificate. In order to specify an extension use the CKA_PKI_ATTRIBUTE_BER_ENCODED attribute with the value specified as a BER encoding of the attribute. If the base object is a Certification request or a self-signed certificate the subject is taken from the objects encoded subject name.

Currently this mechanism supports generation of RSA or DSA certificates. On success, a handle to a new CKO_CERTIFICATE object is returned. The certificate will include the CKA_ISSUER, CKA_SERIAL_NUMBER and CKA_SUBJECT attributes as well as a CKA_VALUE attribute which will contain the DER encoded certificate.

To create a X.509 certificate that uses EC keys, either provide a PKCS#10 certificate request that was created with EC keys, or provide an EC public key for the hBaseKey parameter to the function. To sign the certificate as a CA using EC keys, use the CKM_ECDSA_SHA1 mechanism to initialize the sign operation before calling **C_DeriveKey().**

Usage:

- Create a key-pair using the CKM_RSA_PKCS mechanism (this is the key-pair for the new certificate), or
- Create a CKO_CERTIFICATE_REQUEST object (with the object's CKA_VALUE attribute set to the PKCS#10 data)
- This object is the "base-key" used in the **C_DeriveKey** function
- Initialize the signature mechanism to sign the request using C_SignInit. Note that a digest / sign mechanism must be chosen. For example, CKM_SHA1_RSA_PKCS
- Call **C_DeriveKey** with CKM_ENCODE_X_509 to perform the generation

The new certificate's template may contain:

CKA_ISSUER_STR CKA_ISSUER	The distinguished name of the issuer of the new certificate. If this attribute is not included the issuer is taken from the signing key's CKA_SUBJECT attribute. CKA_ISSUER is the encoded version of this attribute.
CKA_SERIAL_NUMBER_INT CKA_SERIAL_NUMBER	The serial number of the new certificate. If this attribute is not included the serial number is set to the value of the CKA_USAGE_COUNT attribute of the signing key. CKA_SERIAL_NUMBER is the encoded version of this attribute.
CKA_SUBJECT_STR CKA_SUBJECT	If the base key (i.e. the input object) is a public key then either the template must contain this attribute or the public key must have a CKA_SUBJECT attribute. This attribute contains the distinguished name of the subject. When the base key is a PKCS#10 certification request the CKA_SUBJECT information is taken from there. CKA_SUBJECT is the encoded version of this attribute.
CKA_START_DATE CKA_END_DATE	These attributes are used to determine the new certificate's validity period. If the start date is missing the current date is used. If the end date is missing the date is set to one year from the start date. Relative values may be specified (see above).
CKA_PKI_ATTRIBUTE_BER _ ENCODED	These attributes are used to determine the new certificate's extended attributes.

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CKM_ENCODE_X_509_LOCAL_CERT

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range and Parameters

Minimum	0
FIPS Minimum	0
Maximum	None
Parameter	None

Description

This mechanism is similar to the `CKM_ENCODE_X_509` mechanism in that it is used to create an X 509 public key certificate. The basic difference is that this mechanism has additional usage controls.

This mechanism will only create certificates for public keys locally generated on the adapter. That is, the base key must have a `CKA_CLASS` attribute of `CKO_PUBLIC_KEY`and have the `CKA_LOCAL` attribute set to `TRUE`.

In addition, the signing key specified in the mechanism parameter (see below) must have the `CKA_SIGN_LOCAL_CERT` attribute set to `TRUE`. It is used with the **C_KeyDerive** function only, (that is, it is a derive mechanism).

It takes a parameter that is a pointer to a `CK_MECH_TYPE_AND_OBJECT` structure.

```
typedef struct CK_MECH_TYPE_AND_OBJECT {
CK_MECHANISM_TYPE mechanism;
CK_OBJECT_HANDLE obj;
} CK_MECH_TYPE_AND_OBJECT;
```


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The above mechanism field specifies the actual signature mechanism to use in generation of the certificate signature. This must be one of the multipart digest RSA or DSA algorithms. The **obj** field above specifies the signature generation key. That is, it should specify a RSA or DSA private key as appropriate for the chosen signature mechanism.

To create a X.509 local certificate that uses EC keys, either provide a PKCS#10 certificate request that was created with EC keys, or provide an EC public key for the **hBaseKey** parameter to the function. To sign the certificate as a CA using EC keys, use the `CKM_ECDSA_SHA1` mechanism to initialize the sign operation before calling **C_DeriveKey()**. The `CKM_ECDSA_SHA1` mechanism and EC key must also be specified in the mechanism parameter.

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CKM_EXTRACT_KEY_FROM_KEY

> ****WARNING**** **This mechanism contains vulnerabilities that could compromise security. It has been disabled in the factory settings for new HSMs. To enable it, the *Weak PKCS#11 Mechanisms* flag must be set. See Weak PKCS#11 Mechanisms in the "Security Policies and User Roles" section of the *ProtectToolkit-C Administration Guide* for more information.**

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	`CK_EXTRACT_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_GENERIC_SECRET_KEY_GEN

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range and Parameters

Minimum	0
FIPS Minimum	0
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_IDEA_CBC

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	16
Parameter	8 bytes

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_IDEA_CBC_PAD

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	16
Parameter	8 bytes

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_IDEA_ECB

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	16
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_IDEA_ECB_PAD

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	16
Parameter	None

Description

This is a padding mechanism. Implemented padding mechanisms are:

- `CKM_CAST128_ECB_PAD`
- `CKM_DES_ECB_PAD`
- `CKM_DES3_ECB_PAD`
- `CKM_IDEA_ECB_PAD`
- `CKM_RC2_ECB_PAD`

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

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

PKCS#11 version 2.20 specifies mechanisms for Chain Block Cipher algorithms with and without padding and ECB algorithms without padding, but not ECB with padding. These mechanisms fill this gap. The mechanisms may be used for general data encryption and decryption and also for key wrapping and unwrapping (provided all the access conditions of the relevant keys are satisfied).

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CKM_IDEA_KEY_GEN

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	16
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_IDEA_MAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	16
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_IDEA_MAC_GENERAL

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	16
Parameter	`CK_MAC_GENERAL_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_KECCAK_1600

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	Yes
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range and Parameters

Minimum	0
FIPS Minimum	0
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the KECCAK documentation at http://keccak.noekeon.org/Keccak-reference-3.0.pdf and http://keccak.noekeon.org/Keccakimplementation-3.2.pdf.

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CKM_KEY_TRANSLATION

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bits) and Parameters

Minimum	512
Maximum	4096
Parameter	None

Description

This is a key wrapping mechanisms as used by Entrust compliant applications. This mechanism is only visible when the `CKF_ENTRUST_READY` flag is set in the Security Mode attribute of the Adapter Configuration object in the Admin Token of the adapter.

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CKM_KEY_WRAP_SET_OAEP

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bits) and Parameters

Minimum	512
FIPS Minimum	1024
Maximum	4096
Parameter	`CK_KEY_WRAP_SET_OAEP_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_MD2

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	Yes
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_MD2_HMAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_MD2_HMAC_GENERAL

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	`CK_MAC_GENERAL_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_MD2_KEY_DERIVATION

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_MD2_RSA_PKCS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bits) and Parameters

Minimum	512
Maximum	4096
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_MD5

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	Yes
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_MD5_HMAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_MD5_HMAC_GENERAL

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	`CK_MAC_GENERAL_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_MD5_KEY_DERIVATION

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_MD5_RSA_PKCS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bits) and Parameters

Minimum	512
Maximum	4096
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_MILENAGE_DERIVE

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	16
Parameter	`CK_MILENAGE_DERIVE_PARAMS`

Description

This mechanism is used to perform key derivation for MILENAGE functions F3, F4, F5 and F5* as per the specification available at http://www.3gpp.org/specifications/60-confidentiality-algorithms using the PKCS function **C_DeriveKey()**. .

The mechanism requires the 16-byte milenage key 'K' to be initialized as an AES key on the HSM slot. The key should have the CKA_DERIVE attribute set to TRUE. The 16-byte Operator Variant key should be stored on the HSM slot as a Generic Secret key (CKK_GENERIC_SECRET).

The mechanism takes a parameter, CK_MILENAGE_DERIVE_PARAMS. See ctvdef.h for description.

The resultant derived key(s) are of the type "CKK_GENERIC_SECRET" using the supplied user template. Attempts to create any other type of key will result in an error.

> **NOTE** Only a 16-byte AES key and a 16-byte Operator Variant are supported with this mechanism.

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CKM_MILENAGE_SIGN

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes (Single-part sign only)
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	16
Parameter	`CK_MILENAGE_SIGN_PARAMS`

Description

This mechanism is used to perform MAC calculation for MILENAGE functions F1, F1* and F2 as per the specification available at http://www.3gpp.org/specifications/60-confidentiality-algorithms, using the PKCS functions **C_SignInit()** and **C_Sign()**.

The mechanism requires the 16-byte milenage key 'K' to be initialized as an AES key on the HSM slot. The key should have the CKA_SIGN attribute set to TRUE. The 16-byte Operator Variant key should be stored on the HSM slot as a Generic Secret key (CKK_GENERIC_SECRET).

The mechanism takes a parameter, CK_MILENAGE_SIGN_PARAMS. See ctvdef.h for description.

> **NOTE** Only a 16-byte AES key and a 16-byte Operator Variant are supported with this mechanism.

CKM_NVB

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	Yes
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	None

Description

This is a message digest mechanism. It is an implementation of the NVB (Nederlandse Vereiniging van Banken) Dutch hash standard. This hash algorithm is also known as the BGC hash, version 7.1. This mechanism is only available in Software Emulation mode.

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CKM_PBA_SHA1_WITH_SHA1_HMAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	20
Maximum	20
Parameter	`CK_PBE_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_PBE_MD2_DES_CBC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	8
Maximum	8
Parameter	`CK_PBE_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_PBE_MD5_CAST128_CBC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	16
Parameter	`CK_PBE_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_PBE_MD5_DES_CBC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	8
Maximum	8
Parameter	`CK_PBE_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_PBE_SHA1_CAST128_CBC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	16
Parameter	`CK_PBE_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_PBE_SHA1_DES2_EDE_CBC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	16
Parameter	`CK_PBE_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_PBE_SHA1_DES3_EDE_CBC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	24
Maximum	24
Parameter	`CK_PBE_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_PBE_SHA1_RC2_40_CBC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	5
Maximum	5
Parameter	`CK_PBE_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_PBE_SHA1_RC2_128_CBC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	16
Parameter	`CK_PBE_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_PBE_SHA1_RC4_40

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	5
Maximum	5
Parameter	`CK_PBE_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_PBE_SHA1_RC4_128

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	16
Parameter	`CK_PBE_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_PKCS12_PBE_EXPORT

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Wrap only
Derive	No
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	`CKM_PKCS12_PBE_EXPORT_PARAMS`

Description

The PKCS#12 export mechanism, denoted CKM_PKCS12_PBE_EXPORT is a mechanism for wrapping a private key and a certificate. The outcome of the wrapping operation is a PKCS#12 byte buffer.

This mechanism has a parameter, a CK_PKCS12_PBE_EXPORT_PARAMS structure.

This mechanism will enforce a password length based on the token. If the PIN is too short, then `CKR_PIN_LEN_RANGE` is returned.

This mechanism does not require a wrapping key and it only support RSA, ECDSA and DSA private keys and certificates.

During the wrapping operation, this mechanism performs a sign and verify test on the supplied key/certificate pair. Should this test fail, the wrapping operation will abort.

If the exported key is marked `CKA_EXPORTABLE=TRUE` and `CKA_EXTRACTABLE=FALSE` this mechanism forces the export to be performed under the Security Officer session. In this case, the user must ensure that the private key is either visible to the Security Ofiicer or made available to the Security Officer by performing a copy.

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Note that the user performing the private key export is asked to supply two (2) passwords. These passwords must be identical if MS Windows is to be used to later extract the created PKCS#12 file. For other 3rd party tools such as OpenSSL these two passwords do not have to be the same.

CK_PKCS12_PBE_EXPORT_PARAMS is a structure that provides parameter to the `CKM_PKCS12_PBE_EXPORT` mechanism. This structure is defined as follows:

```
typedef struct CK_PKCS12_PBE_EXPORT_PARAMS
{
CK_OBJECT_HANDLE keyCert;
CK_CHAR_PTR passwordAuthSafe;
CK_SIZE passwordAuthSafeLen;
CK_CHAR_PTR passwordHMAC;
CK_SIZE passwordHMACLen;
CK_MECHANISM_TYPE safeBagKgMech;
CK_MECHANISM_TYPE safeContentKgMech;
CK_MECHANISM_TYPE hmacKgMech;
}
```

The fields of the structure have the following meanings:

keyCert	This is the certificate handle for the associated private key.
passwordAuthSafe	This is the password for the PBE keys.
passwordAuthSafeLen	This is the length of the password.
passwordHMAC	This is the password for the PBA keys.
passwordHMACLen	This is the length of the password.
safeBagKgMech	This is the key generation mechanism for SafeBag encryption. It is only applicable to **pkcs8ShroudedKeyBag**. Valid options are: > `CKM_PBE_SHA1_RC4_128` > `CKM_PBE_SHA1_RC4_40` > `CKM_PBE_SHA1_DES3_EDE_CBC` > `CKM_PBE_SHA1_DES2_EDE_CBC` > `CKM_PBE_SHA1_RC2_128_CBC` > `CKM_PBE_SHA1_RC2_40_CBC`
safeContentKgMech	This is the key generation mechanism for SafeContent encryption. It is only applicable to **EncryptedData**. Valid options are: > `CKM_PBE_SHA1_RC4_128` > `CKM_PBE_SHA1_RC4_40` > `CKM_PBE_SHA1_DES3_EDE_CBC` > `CKM_PBE_SHA1_DES2_EDE_CBC` > `CKM_PBE_SHA1_RC2_128_CBC` > `CKM_PBE_SHA1_RC2_40_CBC`

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hmacKgMech	This is the key generation mechanism for generating PFX MAC. Valid option is: > `CKM_PBA_SHA1_WITH_SHA1_HMAC`

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CKM_PKCS12_PBE_IMPORT

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Unwrap only
Derive	No
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	`CK_PBE_PARAMS`

Description

The PKCS#12 import mechanism, denoted `CKM_PKCS12_PBE_IMPORT` is a mechanism for unwrapping a private key and certificate(s). This mechanism shall return the user a handle to a private key and handle(s) to certificate (s). Note that multiple certificate handles could be returned depending on the contents of the PKCS#12 file.

> **NOTE** This mechanism does *not* import optional PKCS#12 bag attributes and PKCS#8 private-key attributes. These components are discarded during import.

The mechanism has a parameter, a **CK_PKCS12_PBE_IMPORT_PARAMS** structure. This mechanism does *not* require an unwrapping key and supports RSA, DH, DSA and EC Private Keys and certificates.

CK_PKCS12_PBE_IMPORT_PARAMS is a structure that provides parameters to the `CKM_PKCS12_PBE_IMPORT` mechanism. This structure is defined as follows:

```
typedef struct CK_PKCS12_PBE_IMPORT_PARAMS
{
/** AuthenticatedSafe password */
CK_CHAR_PTR passwordAuthSafe;
/** Size of AuthenticatedSafe password */
CK_SIZE passwordAuthSafeLen;
```


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```
/** HMAC password */
CK_CHAR_PTR passwordHMAC;
/** Size of HMAC password */
CK_SIZE passwordHMACLen;
/** Certificate attributes */
CK_ATTRIBUTE_PTR certAttr;
/** Number of certificate attributes */
CK_COUNT certAttrCount;
/** Handle to returned certificate(s) */
CK_OBJECT_HANDLE_PTR hCert;
/** Number of returned certificate handle(s) */
CK_COUNT_PTR hCertCount;
}CK_PKCS12_PBE_IMPORT_PARAMS;
```

The fields of the structure have the following meanings:

passwordAuthSafe	This is the password to the authenticated safe container.
passwordAuthSafeLen	This is the length of password.
passwordHMAC	This is the password to HMAC.
certAttr	These are the attributes assigned to certificate.
certAttrCount	This is the number of entries in certAttr.
hCert	This is the returned certificate handle(s).
hCertCount	This is the number of handles allocated for hCert or the number of certificates found in PKCS#12 file. See below.

Length Prediction

The PKCS#12 file may contain more than one certificate, as such, the user would need to allocate sufficient buffer to hold the returned handles. The user needs to specify **NULL** as a parameter to the returned certificate handle (**hCert**), the import mechanism shall then return a count (**hCertCount**) of the certificate found the in the PKCS#12 file. Using the value of **hCertCount**, the user then allocates the required buffer to hold the returned certificate handles for the next **C_UnwrapKey** function call.

Returning Multiple Ceritificates

Assuming the user has allocated sufficient buffer to hold the certificate handles and there is multiple certificate in the PKCS#12 files, the import mechanism shall populate buffer hCert with the allocated certificate handles. The returned hCertCount shall match the specified value.

Reporting Remaining Certificates

In the event of the user not reserving sufficient buffer in hCert and there are more certificates to be unwrapped, the import mechanism shall unwrap up to a maximum of cerficate handles allocated by the user and return the total count of the certificates found in the PKCS#12 file. For example, if the user initially allocated one handle

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(**hCertCount=1**) and the PKCS#12 contains 2 certificates, the import mechanism shall extract the first certificate it encounters and return **hCertCount=2**. In this case, the returned **hCertCount** shall always be *larger* than the specified value.

PKCS#12 Import Return Code

The following vendor specific return code may be returned in the event of errors:

`CKR_PKCS12_DECODE`	This error code is returned when there is an error decoding the PKCS#12 file.
`CKR_PKCS12_ UNSUPPORTED_ SAFEBAG_TYPE`	This error code is returned when unsupported SafeBag is found. The import mechanism for this release only supports keyBag, pkcs8ShroudedKeyBag, and certBag.
`CKR_PKCS12_ UNSUPPORTED_ PRIVACY_MODE`	This error code is returned when a PKCS#12 file with unsupported privacy mode is encountered. The import mechanism for this release only supports password privacy mode.
`CKR_PKCS12_ UNSUPPORTED_ INTEGRITY_MODE`	This error code is returned when a PKCS#12 file with unsupported integrity mode is encountered. The import mechanism for this release only supports password integrity mode.

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CKM_PP_LOAD_SECRET

> **NOTE** This mechanism has been deprecated and will be removed in a future release. It is replaced by "CKM_PP_LOAD_SECRET_2" on page 256.

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	1
FIPS Minimum	1
Maximum	None
Parameter	`CK_PP_LOAD_SECRET_PARAMS`

Description

This is a key generate mechanism to provide the capability to load a clear key component from a directly-attached PIN pad device.

It has a parameter, a **CK_PP_LOAD_SECRET_PARAMS**, which holds the operational details for the mechanism.

```
struct CK_PP_LOAD_SECRET_PARAMS
{
/** Entered characters should be masked with '*' or similar to hide the
* value being entered. An error is returned if this is TRUE
* and the device does not support this feature. */
 CK_BBOOL bMaskInput;
```

```
/** Entered characters should be converted from the ASCII representation
* to binary before being stored, according to the conversion type
* supplied. If the device does not support the specified type of input
* (e.g. hex input on a decimal keyboard), an error is returned.
* The octal and decimal representations will expect 3 digits per byte,
* whereas the hexadecimal representations will expect 2 digits per byte.
* An error is returned if the data contains invalid encoding (such
* as 351 for decimal conversion).

*/
 CK_PP_CONVERT_TYPE cConvert;
/** The time to wait for operator response - in seconds. An error is
* returned if the operation does not complete in the specified time.
* This field may be ignored if the device does not support a configurable
* timeout. */
 CK_CHAR cTimeout;

/** Reserved for future extensions. Must be set to zero. */
 CK_CHAR reserved;
/** The prompt to be displayed on the device. If the prompt cannot fit on
* the device display, the output is clipped. If the device does not
* have any display, the operation will continue without any prompt, or
* error.
*
* The following special characters are recognized on the display:
* - Newline (0x0a): Continue the display on the next line.
*/

 CK_CHAR_PTR prompt;
};
```

The template supplied with the call to the **C_GenerateKey** function determines the type of object generated by the operation. **CKA_CLASS** may be **CKO_SECRETKEY** only, and the only key type supported is **CKK_GENERIC_SECRET**. (This restriction applies because only key components are to be entered by this mechanism).

The normal rules for template consistencies apply. In particular the `CKA_ALWAYS_SENSITIVE` must be set `FALSE` and the `CKA_NEVER_EXTRACTABLE` must be `FALSE`.

The expected size of the object value created by this operation is supplied in the **CKA_VALUE_LEN** parameter in the template.

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CKM_PP_LOAD_SECRET_2

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	1
FIPS Minimum	1
Maximum	None
Parameter	CK_PP_LOAD_SECRET_PARAMS

Description

This is a key generate mechanism to provide the capability to load a clear key component from a directly attached PIN pad device.

It has a parameter, a **CK_PP_LOAD_SECRET_PARAMS**, which holds the operational details for the mechanism.

```
struct CK_PP_LOAD_SECRET_PARAMS
{
/** Entered characters should be masked with '*' or similar to hide the
* value being entered. An error is returned if this is TRUE
* and the device does not support this feature. */
 CK_BBOOL bMaskInput;

/** Entered characters should be converted from the ASCII representation
* to binary before being stored, according to the conversion type
```

```
* supplied. If the device does not support the specified type of input
* (e.g. hex input on a decimal keyboard), an error is returned.
* The octal and decimal representations will expect 3 digits per byte,
* whereas the hexadecimal representations will expect 2 digits per byte.
* An error is returned if the data contains invalid encoding (such
* as 351 for decimal conversion).

*/
 CK_PP_CONVERT_TYPE cConvert;
/** The time to wait for operator response - in seconds. An error is
* returned if the operation does not complete in the specified time.
* This field may be ignored if the device does not support a configurable
* timeout. */
 CK_CHAR cTimeout;

/** Reserved for future extensions. Must be set to zero. */
 CK_CHAR reserved;
/** The prompt to be displayed on the device. If the prompt cannot fit on
* the device display, the output is clipped. If the device does not
* have any display, the operation will continue without any prompt, or
* error.
*
* The following special characters are recognized on the display:
* - Newline (0x0a): Continue the display on the next line.
*/

 CK_CHAR_PTR prompt;
};
```

An optional object handler parameter, **xorWith**, can be specified to XOR the value of the created component with the value of this object. The key size of the **xorWith** object must be the same as the component. Important attributes like `CKA_EXTRACTABLE` and `CKA_SENSITIVE` are inherited from the **xorWith** object.

The template supplied with the call to the **C_GenerateKey** function determines the type of object generated by the operation. **CKA_CLASS** may be **CKO_SECRETKEY** only. All key types are supported, as this mechanism is able to aggregate a complete key. Key creation via PIN-pad-entered components is supported in FIPS mode.

The normal rules for template consistencies apply. In particular the `CKA_ALWAYS_SENSITIVE` must be set `FALSE` and the `CKA_NEVER_EXTRACTABLE` must be `FALSE`.

The expected size of the object value created by this operation is supplied in the **CKA_VALUE_LEN** parameter in the template.

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CKM_RC2_CBC

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	1
Maximum	128
Parameter	`CK_RC2_CBC_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_RC2_CBC_PAD

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	1
Maximum	128
Parameter	`CK_RC2_CBC_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_RC2_ECB

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	1
Maximum	128
Parameter	`CK_RC2_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_RC2_ECB_PAD

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	1
Maximum	128
Parameter	`CK_RC2_PARAMS`

Description

This is a padding mechanism. Implemented padding mechanisms are:

- `CKM_CAST128_ECB_PAD`
- `CKM_DES_ECB_PAD`
- `CKM_DES3_ECB_PAD`
- `CKM_IDEA_ECB_PAD`
- `CKM_RC2_ECB_PAD`

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

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

PKCS#11 version 2.20 specifies mechanisms for Chain Block Cipher algorithms with and without padding and ECB algorithms without padding, but not ECB with padding. These mechanisms fill this gap. The mechanisms may be used for general data encryption and decryption and also for key wrapping and unwrapping (provided all the access conditions of the relevant keys are satisfied).

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CKM_RC2_KEY_GEN

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	1
Maximum	128
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_RC2_MAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	1
Maximum	128
Parameter	`CK_RC2_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_RC2_MAC_GENERAL

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	1
Maximum	128
Parameter	`CK_RC2_MAC_GENERAL_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_RC4

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	0
Maximum	256
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_RC4_KEY_GEN

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	0
Maximum	256
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_REPLICATE_TOKEN_RSA_AES

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bits) and Parameters

Minimum	2048
FIPS Minimum	2048
Maximum	4096
Parameter	`CK_REPLICATE_TOKEN_PARAMS`

Description

CKM_REPLICATE_TOKEN_RSA_AES is a Thales vendor-defined mechanism.

This mechanism is used to clone a token from one HSM to another (peer) HSM by creating a duplicate of the token on the peer HSM. This capability is useful if you are using the ProtectServer HSM's load balancing (Work Load Distribution) and redundancy (High Availability) capabilities, which *require* token consistency. For more information, refer to Token Replication. and Work Load Distribution Model (WLD) and High Availability (HA).

This mechanism is used to implement the wrapping and unwrapping operations that are required for cloning.

> **NOTE** Before attempting cloning operations, create identity keys for the HSMs with the **ctident** tool . For more information, refer to ctident.

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Wrapping Tokens

The mechanism wraps the token associated with the **hSession** parameter to **C_WrapKey()** into a protected format. When the mechanism is used to wrap a token it has a required parameter, a **CK_REPLICATE_TOKEN_PARAMS_PTR**.

The **CK_REPLICATE_TOKEN_PARAMS** structure is defined as follows:

```
typedef struct CK_REPLICATE_TOKEN_PARAMS {
CK_CHAR peerId[CK_SERIAL_NUMBER_SIZE];
} CK_REPLICATE_TOKEN_PARAMS;
```

The **peerId** field identifies the peer public key on the administrative token. The public key is used to wrap the token encryption key and therefore must identify the public key of the destination HSM.

CK_REPLICATE_TOKEN_PARAMS_PTR is a pointer to a **CK_REPLICATE_TOKEN_PARAMS**.

The following conditions must be satisfied:

- The token being wrapped which is associated with the **hSession** parameter to the **C_WrapKey()** must be a regular user token (i.e. NOT the administrative token or a smart-card token).
- The session state for **hSession** must be one of `CKS_RO_USER_FUNCTIONS` or `CKS_RW_USER_FUNCTIONS`.
- The **hWrappingKey** parameter to **C_WrapKey()** must specify `CK_INVALID_HANDLE`.
- The **hKey** parameter to **C_WrapKey()** must specify `CK_INVALID_HANDLE`.

Unwrapping Tokens

This mechanism unwraps the protected token information, replacing the entire token contents of the token associated with the **hSession** parameter to **C_UnwrapKey()**.When the mechanism is used for unwrapping a token, a mechanism parameter must not be specified.

The following conditions must be satisfied:

- The token being unwrapped which is associated with the **hSession** parameter to **C_UnwrapKey()** must be a regular user token. That is, NOT the administrative token or a smart card token.
- The session state for **hSession** must be `CKS_RW_USER_FUNCTIONS`.
- The **hUnwrappingKey** parameter to **C_UnwrapKey()** must specify `CK_INVALID_HANDLE`.
- The **pTemplate** parameter to **C_UnwrapKey()** must specify `NULL`.
- The **ulAttributeCount** parameter to **C_UnwrapKey()** must specify zero.
- The **phKey** parameter to **C_UnwrapKey()** must specify `NULL`.
- Any new sessions must be deferred until the operation has finished.
- The current session must be the only session in existence for the token.
- The application should call **C_Finalize()** upon completion.

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CKM_RIPEMD128

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	Yes
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_RIPEMD128_HMAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_RIPEMD128_HMAC_GENERAL

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	`CK_MAC_GENERAL_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_RIPEMD128_RSA_PKCS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bits) and Parameters

Minimum	512
Maximum	4096
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_RIPEMD160

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	Yes
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_RIPEMD160_HMAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_RIPEMD160_HMAC_GENERAL

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	`CK_MAC_GENERAL_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_RIPEMD160_RSA_PKCS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bits) and Parameters

Minimum	512
Maximum	4096
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_RSA_9796

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes (Single-part operation only)
SignRecover and VerifyRecover	Yes
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bits) and Parameters

Minimum	512
Maximum	4096
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_RSA_FIPS_186_4_PRIME_KEY_PAIR_GEN

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bits) and Parameters

Minimum	2048
FIPS Minimum	2048
Maximum	4096
Parameter	`CK_ULONG` (optional)

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CKM_RSA_PKCS

Supported Operations

Encrypt and Decrypt	Yes (Single-part operation only)
Sign and Verify	Yes (Single-part operation only)
SignRecover and VerifyRecover	Yes
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for signing

Key Size Range (bits) and Parameters

Minimum	512
FIPS Minimum	1024
Maximum	4096
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_RSA_PKCS_KEY_PAIR_GEN

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bits) and Parameters

Minimum	512
FIPS Minimum	2048
Maximum	4096
Parameter	`CK_ULONG` (optional)

Description

The mechanism denoted `CKM_RSA_PKCS_KEY_PAIR_GEN` is a Key Pair Generation mechanism to create a new RSA key pair of objects using the method described in PKCS#1. It behaves as described in the *PKCS#11 version 2.20* documentation, with the following exception:

This ProtectToolkit-C mechanism has an optional parameter of type `CK_ULONG` which, if provided, will specify the size in bits of the random public exponent.

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CKM_RSA_PKCS_OAEP

Supported Operations

Encrypt and Decrypt	Yes (Single-part operation only)
Sign and Verify	No
SignRecover and VerifyRecover	Yes
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for signing

Key Size Range (bits) and Parameters

Minimum	512
FIPS Minimum	1024
Maximum	4096
Parameter	`CK_RSA_PKCS_OAEP_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_RSA_PKCS_PSS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for signing

Key Size Range (bits) and Parameters

Minimum	512
FIPS Minimum	1024
Maximum	4096
Parameter	`CK_RSA_PKCS_PSS_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_RSA_X_509

Supported Operations

Encrypt and Decrypt	Yes (Single-part operation only)
Sign and Verify	Yes (Single-part operation only)
SignRecover and VerifyRecover	Yes
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bits) and Parameters

Minimum	512
Maximum	4096
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_RSA_X9_31_KEY_PAIR_GEN

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bits) and Parameters

Minimum	1024
FIPS Minimum	2048
Maximum	4096
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SECRET_RECOVER_WITH_ATTRIBUTES

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range and Parameters

Minimum	0
FIPS Minimum	None
Maximum	None
Parameter	`CK_SECRET_SHARE_PARAMS`

Description

The Secret Recovery Mechanism denoted `CKM_SECRET_RECOVER_WITH_ATTRIBUTES` is a derive mechanism to create a new key object by combining two or more shares.

The mechanism has no parameter.

The **C_DeriveKey** parameter **hBaseKey** is the handle of one of the share objects. The mechanism will obtain the **CKA_LABEL** value from **hBaseKey** and then treat all data objects with the same label as shares.

A template is not required as all the attributes of the object are also recovered from the secret.

Usage Note

To avoid shares getting mixed up between different uses of this mechanism the developer should ensure that data objects with the same label are all from the same secret share batch.

For further information about secure key backup and restoration see Secure Key Backup and Restoration in the *ProtectToolkit-C Administration Guide*.

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CKM_SECRET_SHARE_WITH_ATTRIBUTES

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range and Parameters

Minimum	0
FIPS Minimum	0
Maximum	None
Parameter	None

Description

The Secret Share Mechanism denoted `CKM_SECRET_SHARE_WITH_ATTRIBUTES` is a derive mechanism to create M shares of a key such that N shares are required to recover the secret, where N is less than or equal to M.

The mechanism creates a secret value by combining all the attributes of the base key and then shares that secret into M shares.

The algorithm used is according to A. Shamir - How to Share a Secret, Communications of the ACM vol. 22, no. 11, November 1979, pp. 612-613

It has a parameter, a `CK_SECRET_SHARE_PARAMS`, which specifies the number of shares M and the recovery threshold N. See below for the definition.

The mechanism will create M data objects and return the object handle of one of them. It is expected that the data objects would be copied to a smart card token for storage.

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The template supplied is used to specify the CKA_LABEL attribute of each new data object. If the CKA_LABEL attribute is not provided in the template then a CKR_TEMPLATE_INCOMPLETE error is returned.

The mechanism contributes the CKA_VALUE attribute of each data object. Any attempt to specify a CKA_VALUE attribute in the template will cause the mechanism to return the error: CKR_TEMPLATE_INCONSISTENT.

The default value of the CKA_TOKEN, CKA_PRIVATE attribute of the new objects is false. The new data objects will have a CKA_SENSITIVE attribute. If the CKA_SENSITIVE attribute of the base key is true then the data objects is sensitive. If the base key is not sensitive then the data objects take the value of CKA_SENSITIVE from the template or it is defaulted to false.

Usage Note

To avoid shares getting mixed up between different uses of this mechanism the developer should ensure that there are no data objects with the same label already on the token before attempting to use this mechanism. If objects are found then these objects should be deleted or a different label chosen.

Security Note

The key to be exported with this mechanism requires the **CKA_DERIVE** attribute to be true. This has the effect of enabling other key derive mechanisms to be performed with the key. If this is not desired then the CKA_MECHANISM_LIST attribute may be used with the key to restrict its derive operations to this mechanism.

For further information about secure key backup and restoration see Secure Key Backup and Restoration in the *ProtectToolkit-C Administration Guide*.

Secret Share Mechanism Parameter

CK_SECRET_SHARE_PARAMS is used to specify the number of shares M and the recovery threshold N for secret sharing mechanisms. It is defined as follows:

```
typedef struct CK_SECRET_SHARE_PARAMS {
CK_ULONG n;
CK_ULONG m;} CK_SECRET_SHARE_PARAMS;
```

The fields of the structure have the following meanings:

- N=Number of shares required to recover the secret. Must be at least 2 and not greater than the number of shares
- M=Total number of shares. Must be at least 2 and not greater than 64.

CK_SECRET_SHARE_PARAMS_PTR is a pointer to a CK_SECRET_SHARE_PARAMS.

CKM_SEED_CBC

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	16
Parameter	16 bytes

Description

SEED-CBC, denoted `CKM_SEED_CBC`, is a mechanism for single and multiple part encryption and decryption, key wrapping and key unwrapping, based on the KISA (Korean Information Security Agency) SEED specification and cipher-block chaining mode.

It has a single parameter; a 16-byte initialization vector.

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

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

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

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Table 1: SEED-CBC: Key and Data Length

Function	Key Type	Input Length	Output Length	Comments
C_Encrypt	CKK_SEED	Multiple of block size	Same as input length	No final part
C_Decrypt	CKK_SEED	Multiple of block size	Same as input length	No final part
C_WrapKey	CKK_SEED	Any	Input length rounded up to multiple of the block size	
C_UnwrapKey	CKK_SEED	Multiple of block size	Determined by type of key being unwrapped or CKA_VALUE_LEN	

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CKM_SEED_CBC_PAD

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	16
Parameter	16 bytes

Description

SEED-CBC with PKCS padding, denoted `CKM_SEED_CBC_PAD`, is a mechanism for single and multiple part encryption and decryption; key wrapping; and key unwrapping, based on the KISA (Korean Information Security Agency) SEED specification, cipher-block chaining mode and the block cipher padding method detailed in PKCS #7.

It has a single parameter; a 16-byte initialization vector.

The PKCS padding in this mechanism allows the length of the plaintext value to be recovered from the ciphertext value. Therefore, when unwrapping keys with this mechanism, no value should be specified for the `CKA_VALUE_LEN` attribute.

In addition to being able to wrap and unwrap secret keys, this mechanism can wrap and unwrap RSA, Diffie-Hellman, X9.42 Diffie-Hellman, and DSA private keys.

Constraints on key types and the length of data are summarized in the following table. The data length constraints do not apply to the wrapping and unwrapping of private keys.

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Table 1: SEED-CBC with PKCS Padding: Key and Data Length

Function	Key Type	Input Length	Output Length
C_Encrypt	CKK_SEED	Any	This is the input length plus one, rounded up to a multiple of the block size.
C_Decrypt	CKK_SEED	Multiple of block size	Between 1 and block size bytes shorter than input length.
C_WrapKey	CKK_SEED	Any	This is the input length plus one, rounded up to a multiple of the block size.
C_UnwrapKey	CKK_SEED	Multiple of block size	Between 1 and block length bytes shorter than input length.

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CKM_SEED_ECB

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	16
Parameter	None

Description

SEED-ECB, denoted `CKM_SEED_ECB`, is a mechanism for single- and multiple-part encryption and decryption; key wrapping; and key unwrapping, based on the KISA (Korean Information Security Agency) SEED specification and electronic codebook mode. It does not have a parameter

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

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

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

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Table 1: SEED-ECB: Key and Data Length

Function	Key Type	Input Length	Output Length	Comments
C_Encrypt	CKK_SEED	Multiple of block size	Same as input length	No final part
C_Decrypt	CKK_SEED	Multiple of block size	Same as input length	No final part
C_WrapKey	CKK_SEED	Any	Input length rounded up to multiple of block size	
C_UnwrapKey	CKK_SEED	Multiple of block size	Determined by type of key being unwrapped or CKA_VALUE_LEN	

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CKM_SEED_ECB_PAD

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	16
Parameter	None

Description

SEED-ECB with PKCS padding, denoted `CKM_SEED_ECB_PAD`, is a mechanism for single- and multiple-part encryption and decryption, key wrapping and key unwrapping, based on the KISA (Korean Information Security Agency) SEED specification, electronic code book mode and the block cipher padding method detailed in PKCS #7. It does not have a parameter.

The PKCS padding in this mechanism allows the length of the plaintext value to be recovered from the ciphertext value. Therefore, when unwrapping keys with this mechanism, no value should be specified for the `CKA_VALUE_LEN` attribute.

In addition to being able to wrap and unwrap secret keys, this mechanism can wrap and unwrap RSA, Diffie-Hellman, X9.42 Diffie-Hellman, and DSA private keys. The entries in "SEED-ECB with PKCS Padding: Key and Data Length" on the next page for data length constraints when wrapping and unwrapping keys do not apply to wrapping and unwrapping private keys. Constraints on key types and the length of data are summarized in the following table.

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Table 1: SEED-ECB with PKCS Padding: Key and Data Length

Function	Key Type	Input Length	Output Length
C_Encrypt	CKK_SEED	Any	This is the input length plus one, rounded up to a multiple of the block size.
C_Decrypt	CKK_SEED	Multiple of block size	Between 1 and block size bytes shorter than input length.
C_WrapKey	CKK_SEED	Any	This is the input length plus one, rounded up to a multiple of the block size.
C_UnwrapKey	CKK_SEED	Multiple of block size	Between 1 and block length bytes shorter than input length.

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CKM_SEED_KEY_GEN

Supported Operations

Encrypt and Decrypt	Yes
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	16
Parameter	None

Description

The SEED key generation mechanism, denoted `CKM_SEED_KEY_GEN`, is a key generation mechanism for the Korean Information Security Agency's SEED algorithm.

The mechanism does not have a parameter, and it generates SEED keys 16 bytes in length.

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

For this mechanism, the `ulMinKeySize` and `ulMaxKeySize` fields of the `CK_MECHANISM_INFO` structure specify the supported range of SEED key sizes, in bytes, which is 16.

The algorithm block size is 16 bytes.

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CKM_SEED_MAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	16
Parameter	None

Description

SEED-MAC, denoted by `CKM_SEED_MAC`, is a special case of the general-length SEED-MAC mechanism. SEED-MAC always produces and verifies MACs that are eight bytes in length. It does not have a parameter.

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

Table 1: SEED-MAC: Key and Data Length

Function	Key Type	Data Length	Signature Length
C_Sign	`CKK_SEED`	any	½ block size (8 bytes)
C_Verify	`CKK_SEED`	any	½ block size (8 bytes)

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CKM_SEED_MAC_GENERAL

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	16
Parameter	`CK_MAC_GENERAL_PARAMS`

Description

General-length SEED-MAC, denoted `CKM_SEED_MAC_GENERAL`, is a mechanism for single and multiple part signatures and verification, based on the KISA (Korean Information Security Agency) SEED specification.

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

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

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

Table 1: General-length SEED-MAC: Key and Data Length

Function	Key Type	Data Length	Signature Length
C_Sign	`CKK_SEED`	Any	0-block size, as specified in parameters
C_Verify	`CKK_SEED`	Any	0-block size, as specified in parameters

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CKM_SET_ATTRIBUTES

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bits) and Parameters

Minimum	1024
FIPS Minimum	1024
Maximum	4096
Parameter	None

Description

The Set Object Attribute Mechanism denoted **CKM_SET_ATTRIBUTES** is a **TICKET** mechanism used to modify the attributes of a key. It does not take a parameter.

The ticket specifies the Digest of the key/object to modify and the new attribute values. The ticket is digitally signed and the certificate used to verify the signature must be contained in the **CKA_ADMIN_CERT** attribute of the key object being modified.

This mechanism is only used with the **CT_PresentTicket** command.

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CKM_SHA1

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	Yes
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range and Parameters

Minimum	0
FIPS Minimum	0
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA1_EDDSA

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bits) and Parameters

Minimum	64
Maximum	571
Parameter	None

Description

For a full description of this mechanism, refer to the EDDSA documentation from OASIS (https://www.oasis-open.org).

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CKM_SHA1_HMAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	0
FIPS Minimum	10
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA1_HMAC_GENERAL

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	Yes
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	0
FIPS Minimum	10
Maximum	None
Parameter	`CK_MAC_GENERAL_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA1_KEY_DERIVATION

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA1_RSA_PKCS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Verify only

Key Size Range (bits) and Parameters

Minimum	512
FIPS Minimum	1024
Maximum	4096
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA1_RSA_PKCS_PSS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bits) and Parameters

Minimum	512
FIPS Minimum	1024
Maximum	4096
Parameter	`CK_RSA_PKCS_PSS_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA1_RSA_PKCS_TIMESTAMP

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Sign only
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bits) and Parameters

Minimum	512
Maximum	4096
Parameter	`CK_TIMESTAMP_PARAMS`

Description

The PKCS#11 mechanism **CKM_SHA1_RSA_PKCS_TIMESTAMP** provides time stamping functionality. The supported signing functions are **C_Sign_Init** and **C_Sign**. This mechanism supports single and multiple-part digital signatures and verification with message recovery. The mechanism uses the SHA1 hash function to generate the message digest. The mechanism only supports one second granularity in the timestamp although the timestamp format will provide for future sub-second granularity.

A monotonic counter object is used to generate the unique serial number that forms part of the timestamp. The monotonic counter object is automatically created when a token is initialized and exists by default in the Admin Token.

The following structure is used to provide the optional mechanism parameters in the **CK_MECHANISM** structure. The **CK_MECHANISM** structure is defined in the *PKCS #11 v2.10: Cryptographic Token Interface Standard, RSA Laboratories December 1999*.

```
typedef struct CK_TIMESTAMP_PARAMS {
CK_BBOOL useMilliseconds;
  CK_TIMESTAMP_FORMAT timestampFormat;
} CK_TIMESTAMP_PARAMS;
```

The **useMilleseconds** parameter specifies whether the timestamp should include millisecond granularity. The default value for this parameter is `FALSE`. If the mechanism parameters are specified then the useMilliseconds parameter must be set to `FALSE` as only one-second granularity is provided in the first release of the mechanism's implementation.

The "timeStampFormat" parameter specifies the input/output format of the data to be timestamped. This provides the ability to introduce future support for timestamping protocols such as those defined in RFC3161. The default value for this parameter is `CK_TIMESTAMP_FORMAT_PTKC`. If the mechanism parameters are specified then the timeStampType parameter must be set to `CK_TIMESTAMP_FORMAT_PTKC` as only this format is supported in the first release.

For `CK_TIMESTAMP_FORMAT_PTKC` the mechanism expects the input data to be a stream of bytes for which a message digest must be computed and a timestamp generated according to the format defined below. If mechanism parameters are passed and the two parameters are not set as defined above, the **C_SignInit** function returns `CKR_MECHANISM_PARAM_INVALID`.

C_Sign is defined in the PKCS #11 standard as:

```
CK_DEFINE_FUNCTION(CK_RV, C_Sign)(
CK_SESSION_HANDLE hSession,
CK_BYTE_PTR pData,
CK_ULONG ulDataLen,
CK_BYTE_PTR pSignature,
CK_ULONG_PTR pulSignatureLen );
```

The parameter formats are defined in the following tables.

Table 1: Input format (=pData in C_Sign)

C-Definition	Description
unsigned char Data	Transaction data (variable length), maximum of 3k

Table 2: Output format (=pSignature in C_Sign)

C-Definition	Contents on Output
Unsigned char serialnumber [20]	This is a unique number for each timestamp, padded with zeroes in a Big Endian 20 byte array. The number is read from the **CKH_MONOTONIC_COUNTER** hardware feature object on the same token as the signing key. By this read action the value contained by the object is automatically increased by 1.
Unsigned char timestamp[15]	This is the timestamp in the format of GeneralizedTime specified in RFC3161. The syntax is: **YYYYMMDDhhmmss[.s...]Z** The sub-second component is optional and not supported in the intial release but still defined to ensure backward compatibility in the future.
Unsigned char sign[128]	RSA Signature

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> **NOTE** Please see the *PKCS #11 v2.10: Cryptographic Token Interface Standard, RSA Laboratories December 1999* for a definition of types.

> **NOTE** It is highly recommended that the RFC3161 format timestamp provided by the HSM be stored on the host to allow future independent third party timestamp verification.

The mechanism will perform the following:

- Input data that is provided by the calling host.
- Obtain the time from within the ProtectHost.
- Calculate a signature across the merged input data and time data using PKCS#1 type 01 padding as follows:

  Signature = Sign(SHA1(Data || serialnumber || timestamp)
- Output part of the input data, the time data and the signature.

Verification of the signature can be performed using the **CKM_SHA1_RSA_PKCS_TIMESTAMP** mechanism with **C_Verify** or **C_VerifyRecover**. The difference between the two functions is that C_Verify calculates the hash but does not return it to the caller where as **C_VerifyRecover()** returns the hash. The following is passed as input data: `<data><serialnumber><timestamp>`

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CKM_SHA3_224

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	Yes
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range and Parameters

Minimum	0
FIPS Minimum	0
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the SHA-3 documentation from OASIS (https://www.oasis-open.org).

This mechanism uses the Secure Hash Algorithm-3 (SHA-3) standard, as described in NIST publication *FIPS PUB 202*.

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CKM_SHA3_224_EDDSA

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bits) and Parameters

Minimum	64
Maximum	571
Parameter	None

Description

This mechanism uses the Secure Hash Algorithm-3 (SHA-3) standard, as described in NIST publication *FIPS PUB 202*.

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CKM_SHA3_224_HMAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	0
FIPS Minimum	14
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the SHA-3 documentation from OASIS (https://www.oasis-open.org).

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CKM_SHA3_224_HMAC_GENERAL

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	0
FIPS Minimum	14
Maximum	None
Parameter	`CK_MAC_GENERAL_PARAMS`

Description

For a full description of this mechanism, refer to the SHA-3 documentation from OASIS (https://www.oasis-open.org).

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CKM_SHA3_224_KEY_DERIVE

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the SHA-3 documentation from OASIS (https://www.oasis-open.org).

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CKM_SHA3_224_RSA_PKCS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for signing

Key Size Range (bits) and Parameters

Minimum	512
FIPS Minimum	1024
Maximum	4096
Parameter	None

Description

For a full description of this mechanism, refer to the SHA-3 documentation from OASIS (https://www.oasis-open.org).

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CKM_SHA3_224_RSA_PKCS_PSS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for signing

Key Size Range (bits) and Parameters

Minimum	512
FIPS Minimum	1024
Maximum	4096
Parameter	`CK_RSA_PKCS_PSS_PARAMS`

Description

For a full description of this mechanism, refer to the SHA-3 documentation from OASIS (https://www.oasis-open.org).

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CKM_SHA3_256

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	Yes
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range and Parameters

Minimum	0
FIPS Minimum	0
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the SHA-3 documentation from OASIS (https://www.oasis-open.org).

This mechanism uses the Secure Hash Algorithm-3 (SHA-3) standard, as described in NIST publication *FIPS PUB 202*.

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CKM_SHA3_256_EDDSA

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bits) and Parameters

Minimum	64
Maximum	571
Parameter	None

Description

This mechanism uses the Secure Hash Algorithm-3 (SHA-3) standard, as described in NIST publication *FIPS PUB 202*.

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CKM_SHA3_256_HMAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	0
FIPS Minimum	16
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the SHA-3 documentation from OASIS (https://www.oasis-open.org).

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CKM_SHA3_256_HMAC_GENERAL

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	0
FIPS Minimum	16
Maximum	None
Parameter	`CK_MAC_GENERAL_PARAMS`

Description

For a full description of this mechanism, refer to the SHA-3 documentation from OASIS (https://www.oasis-open.org).

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CKM_SHA3_256_KEY_DERIVE

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the SHA-3 documentation from OASIS (https://www.oasis-open.org).

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CKM_SHA3_256_RSA_PKCS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for signing

Key Size Range (bits) and Parameters

Minimum	512
FIPS Minimum	1024
Maximum	4096
Parameter	None

Description

For a full description of this mechanism, refer to the SHA-3 documentation from OASIS (https://www.oasis-open.org).

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CKM_SHA3_256_RSA_PKCS_PSS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for signing

Key Size Range (bits) and Parameters

Minimum	512
FIPS Minimum	1024
Maximum	4096
Parameter	`CK_RSA_PKCS_PSS_PARAMS`

Description

For a full description of this mechanism, refer to the SHA-3 documentation from OASIS (https://www.oasis-open.org).

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CKM_SHA3_384

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	Yes
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range and Parameters

Minimum	0
FIPS Minimum	0
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the SHA-3 documentation from OASIS (https://www.oasis-open.org).

This mechanism uses the Secure Hash Algorithm-3 (SHA-3) standard, as described in NIST publication *FIPS PUB 202*.

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CKM_SHA3_384_EDDSA

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bits) and Parameters

Minimum	64
Maximum	571
Parameter	None

Description

This mechanism uses the Secure Hash Algorithm-3 (SHA-3) standard, as described in NIST publication *FIPS PUB 202*.

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CKM_SHA3_384_HMAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	0
FIPS Minimum	24
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the SHA-3 documentation from OASIS (https://www.oasis-open.org).

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CKM_SHA3_384_HMAC_GENERAL

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	0
FIPS Minimum	24
Maximum	None
Parameter	`CK_MAC_GENERAL_PARAMS`

Description

For a full description of this mechanism, refer to the SHA-3 documentation from OASIS (https://www.oasis-open.org).

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CKM_SHA3_384_KEY_DERIVE

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	0
Parameter	None

Description

For a full description of this mechanism, refer to the SHA-3 documentation from OASIS (https://www.oasis-open.org).

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CKM_SHA3_384_RSA_PKCS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for signing

Key Size Range (bits) and Parameters

Minimum	640
FIPS Minimum	1024
Maximum	4096
Parameter	None

Description

For a full description of this mechanism, refer to the SHA-3 documentation from OASIS (https://www.oasis-open.org).

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CKM_SHA3_384_RSA_PKCS_PSS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for signing

Key Size Range (bits) and Parameters

Minimum	640
FIPS Minimum	1024
Maximum	4096
Parameter	`CK_RSA_PKCS_PSS_PARAMS`

Description

For a full description of this mechanism, refer to the SHA-3 documentation from OASIS (https://www.oasis-open.org).

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CKM_SHA3_512

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	Yes
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range and Parameters

Minimum	0
FIPS Minimum	0
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the SHA-3 documentation from OASIS (https://www.oasis-open.org).

This mechanism uses the Secure Hash Algorithm-3 (SHA-3) standard, as described in NIST publication *FIPS PUB 202*.

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CKM_SHA3_512_EDDSA

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bits) and Parameters

Minimum	64
Maximum	571
Parameter	None

Description

This mechanism uses the Secure Hash Algorithm-3 (SHA-3) standard, as described in NIST publication *FIPS PUB 202*.

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CKM_SHA3_512_HMAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	0
FIPS Minimum	32
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the SHA-3 documentation from OASIS (https://www.oasis-open.org).

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CKM_SHA3_512_HMAC_GENERAL

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	0
FIPS Minimum	32
Maximum	None
Parameter	`CK_MAC_GENERAL_PARAMS`

Description

For a full description of this mechanism, refer to the SHA-3 documentation from OASIS (https://www.oasis-open.org).

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CKM_SHA3_512_KEY_DERIVE

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the SHA-3 documentation from OASIS (https://www.oasis-open.org).

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CKM_SHA3_512_RSA_PKCS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for signing

Key Size Range (bits) and Parameters

Minimum	768
FIPS Minimum	1024
Maximum	4096
Parameter	None

Description

For a full description of this mechanism, refer to the SHA-3 documentation from OASIS (https://www.oasis-open.org).

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CKM_SHA3_512_RSA_PKCS_PSS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for signing

Key Size Range (bits) and Parameters

Minimum	768
FIPS Minimum	1024
Maximum	4096
Parameter	`CK_RSA_PKCS_PSS_PARAMS`

Description

For a full description of this mechanism, refer to the SHA-3 documentation from OASIS (https://www.oasis-open.org).

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CKM_SHA224

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	Yes
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range and Parameters

Minimum	0
FIPS Minimum	0
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA224_EDDSA

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bits) and Parameters

Minimum	64
Maximum	571
Parameter	None

Description

For a full description of this mechanism, refer to the EDDSA documentation from OASIS (https://www.oasis-open.org).

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CKM_SHA224_HMAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	0
FIPS Minimum	14
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA224_HMAC_GENERAL

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	0
FIPS Minimum	14
Maximum	None
Parameter	`CK_MAC_GENERAL_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA224_KEY_DERIVATION

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
FIPS-approved	No

Key Size Range and Parameters

Minimum	0
Maximum	0
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA224_RSA_PKCS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for signing

Key Size Range (bits) and Parameters

Minimum	512
FIPS Minimum	2048
Maximum	4096
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA224_RSA_PKCS_PSS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for signing

Key Size Range (bits) and Parameters

Minimum	512
FIPS Minimum	2048
Maximum	4096
Parameter	`CK_RSA_PKCS_PSS_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA256

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	Yes
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range and Parameters

Minimum	0
FIPS Minimum	0
Maximum	0
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA256_EDDSA

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bits) and Parameters

Minimum	64
Maximum	571
Parameter	None

Description

For a full description of this mechanism, refer to the EDDSA documentation from OASIS (https://www.oasis-open.org).

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CKM_SHA256_HMAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	0
FIPS Minimum	16
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA256_HMAC_GENERAL

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	0
FIPS Minimum	16
Maximum	None
Parameter	`CK_MAC_GENERAL_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA256_KEY_DERIVATION

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
FIPS-approved	No

Key Size Range and Parameters

Minimum	0
Maximum	0
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA256_RSA_PKCS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for signing

Key Size Range (bits) and Parameters

Minimum	512
FIPS Minimum	2048
Maximum	4096
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA256_RSA_PKCS_PSS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for signing

Key Size Range (bits) and Parameters

Minimum	512
FIPS Minimum	2048
Maximum	4096
Parameter	`CK_RSA_PKCS_PSS_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA384

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	Yes
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range and Parameters

Minimum	0
FIPS Minimum	0
Maximum	0
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA384_EDDSA

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bits) and Parameters

Minimum	64
Maximum	571
Parameter	None

Description

For a full description of this mechanism, refer to the EDDSA documentation from OASIS (https://www.oasis-open.org).

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CKM_SHA384_HMAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	0
FIPS Minimum	24
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA384_HMAC_GENERAL

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	0
FIPS Minimum	24
Maximum	None
Parameter	`CK_MAC_GENERAL_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA384_KEY_DERIVATION

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
FIPS-approved	No

Key Size Range and Parameters

Minimum	0
Maximum	0
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA384_RSA_PKCS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for signing

Key Size Range (bits) and Parameters

Minimum	640
FIPS Minimum	1024
Maximum	4096
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA384_RSA_PKCS_PSS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for signing

Key Size Range (bits) and Parameters

Minimum	640
FIPS Minimum	1024
Maximum	4096
Parameter	`CK_RSA_PKCS_PSS_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA512

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	Yes
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range and Parameters

Minimum	0
FIPS Minimum	0
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA512_EDDSA

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bits) and Parameters

Minimum	64
Maximum	571
Parameter	None

Description

For a full description of this mechanism, refer to the EDDSA documentation from OASIS (https://www.oasis-open.org).

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CKM_SHA512_HMAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	0
FIPS Minimum	32
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA512_HMAC_GENERAL

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	0
FIPS Minimum	32
Maximum	None
Parameter	`CK_MAC_GENERAL_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA512_KEY_DERIVATION

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA512_RSA_PKCS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for signing

Key Size Range (bits) and Parameters

Minimum	768
FIPS Minimum	1024
Maximum	4096
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SHA512_RSA_PKCS_PSS

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	Minimum 2048-bit modulus for signing

Key Size Range (bits) and Parameters

Minimum	768
FIPS Minimum	1024
Maximum	4096
Parameter	`CK_RSA_PKCS_PSS_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SSL3_KEY_AND_MAC_DERIVE

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	48
Maximum	48
Parameter	`CK_SSL3_KEY_MAT_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SSL3_MASTER_KEY_DERIVE

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	48
Maximum	48
Parameter	`CK_SSL3_MASTER_KEY_DERIVE_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SSL3_MD5_MAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes

Key Size Range and Parameters

Minimum	0
FIPS Minimum	0
Maximum	None
Parameter	`CK_MAC_GENERAL_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SSL3_PRE_MASTER_KEY_GEN

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	48
FIPS Minimum	48
Maximum	48
Parameter	`CK_VERSION`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_SSL3_SHA1_MAC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	`CK_MAC_GENERAL_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_TDEA_TKW

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	64
Parameter	None

Description

For a full description of this mechanism, refer to *NIST Special Publication 800-38F*.

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CKM_TUAK_DERIVE

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	32
Parameter	`CK_TUAK_DERIVE_PARAMS`

Description

This mechanism is used to perform key derivation for TUAK functions F1, F1* and F2 as per the specification TS-35.231, available at http://www.3gpp.org, using the PKCS functions **C_DeriveKey()**.

The mechanism requires the 16- or 32-byte TUAK key 'K' to be initialized as an AES key on the HSM slot. The key should have the CKA_DERIVE attribute set to TRUE. The 16- or 32-byte Operator Variant key should be stored on the HSM slot as a Generic Secret key (CKK_GENERIC_SECRET).

The mechanism takes a parameter, CK_TUAK_DERIVE_PARAMS. See ctvdef.h for description.

The resultant derived key(s) are of the type "CKK_GENERIC_SECRET" using the supplied user template. Attempts to create any other type of key will result in an error.

NOTE Only a 16- or 32-byte AES key and a 16- or 32-byte Operator Variant are supported with this mechanism.

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CKM_TUAK_SIGN

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes (Single-part sign only)
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	32
Parameter	`CK_TUAK_SIGN_PARAMS`

Description

This mechanism is used to perform MAC calculation for TUAK functions F1, F1* and F2 as per the specification TS-35.231, available at http://www.3gpp.org, using the PKCS functions **C_SignInit()** and **C_Sign()**.

The mechanism requires the 16- or 32-byte TUAK key 'K' to be initialized as an AES key on the HSM slot. The key should have the CKA_SIGN attribute set to TRUE. The 16- or 32-byte Operator Variant key should be stored on the HSM slot as a Generic Secret key (CKK_GENERIC_SECRET).

The mechanism takes a parameter, CK_TUAK_SIGN_PARAMS. See ctvdef.h for description.

> **NOTE** Only a 16- or 32-byte AES key and a 16- or 32-byte Operator Variant are supported with this mechanism.

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CKM_VISA_CVV

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	No

Key Size Range (bytes) and Parameters

Minimum	16
Maximum	16
Parameter	None

Description

This is a signature generation and verification method. The Card Verification Value signature is generated as specified by VISA. The mechanism does not have a parameter. Constraints on key types and the length of data are summarized in the following table:

Table 1: Output format (=pSignature in C_Sign)

Function	Key Type	Input Length	Output Length
C_Sign	`CKK_DES2`	16	2
C_Verify	`CKK_DES2`	16, 2[2]	N/A

[2] Data length, signature length.

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CKM_WRAPKEY_AES_CBC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	No Wrapping

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	32
Parameter	None

Description

The CKM_WRAPKEY_AES_CBC mechanism is used to wrap a key value plus all of its attributes so that the entire key can be reconstructed without a template at the destination.

This mechanism is the same as the CKM_WRAPKEY_DES3_CBC mechanism but uses only NIST approved cryptographic algorithms and key sizes.

The following fields in the encoding are computed differently to those in "CKM_WRAPKEY_DES3_CBC" on page 381 mechanism.

mK	This is a randomly generated 256-bit MAC key using CKM_GENERIC_SECRET_KEY_GEN. This key is used with Mx.

E x	This is encryption using CKM_AES_CBC_PAD with key 'x'.
M x	This is MAC generation using CKM_SHA512_HMAC_GENERAL (16 byte MAC result) with key 'x'.

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CKM_WRAPKEY_AES_KWP

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	32
Parameter	None

Description

The **CKM_WRAPKEY_AES_KWP** mechanism is used to wrap a key value plus all of its attributes so that the entire key can be reconstructed without a template at the destination. This mechanism is the same as "CKM_WRAPKEY_DES3_CBC" on page 381, but uses only NIST-approved cryptographic algorithms and key sizes.

Encoding Format

The encoding is a proprietary encoding where fields are identified by their position (no tags). All fields are preceded by an encoding of the length of the content. The length may be zero indicating an empty field but must always be present. Where the length is zero the content is not present (zero bytes). Where the length is non zero the content has the number of bytes equal to the value of the encoded length. The length is encoded as a 32-bit big-endian binary value and can thus take values from 0 to (2^{32} -1) i.e. around 4 gigabytes.

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Definitions

wK	This is the wrapping key under which the subject key is to be wrapped. This key must be valid for the operation Ex.
mK	This is a randomly generated 256-bit MAC key using **CKM_GENERIC_SECRET_KEY_GEN**. This key is used with Mx.
cK	This is clear encoding of the subject key. For single-part symmetric keys, this is just the key value. For compound (e.g., RSA) keys, it is a BER encoding as per PKCS#1.
a	This is the encoded non-sensitive subject key attributes. The attributes are encoded with an attribute header, which is the number of attributes (4 byte), followed by a list of sub encodings which contain the attribute type (4 byte), content length (4 byte), a content presence indicator (1 byte), and the content bytes. The presence indicator allows the content length value to be non-zero, but, where presence indicator = 0, no content bytes are included. If the presence indicator is 1 then the content length must be the number of bytes indicated by the content length field. All numeric values are encoded as big-endian. Note that the sensitive attributes are contained in cK.
E x	This is encryption using **CKM_AES_KWP** with key 'x'.
M x	This is MAC generation using **CKM_SHA512_HMAC_GENERAL** (16 byte MAC result) with key 'x'.

A wrapped key using **CKM_WRAPKEY_AES_KWP** is made up of the following fields:

- ecK the encrypted key value, ecK = EwK(cK).
- a the encoded non-sensitive subject key attributes.
- m a MAC of the key value and attributes, m = MmK(cK + a).
- emK the encrypted MAC key value, emK = EwK(mK).

These fields are then encoded as described above.

For a full description of this mechanism, refer to *NIST Special Publication 800-38F*.

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CKM_WRAPKEY_DES3_CBC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	No Wrapping

Key Size Range and Parameters

Minimum	0
FIPS Minimum	0
Maximum	None
Parameter	None

Description

The **CKM_WRAPKEY_DES3_CBC** and **CKM_WRAPKEY_DES3_ECB** mechanisms are used to wrap a key value plus all of its attributes so that the entire key can be reconstructed without a template at the destination. The key value is encoded and encrypted using **CKM_DES3_CBC_PAD** and then combined with all other object attributes. The result are then MACed. The wrapping key is supplied as normal to the **C_Wrap** and **C_Unwrap** Cryptoki functions.

The **C_Unwrap** operation will fail with `CKR_SIGNATURE_INVALID` if any of the key's attributes have been tampered with while the key was in transit.

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Encoding Format

The encoding is a proprietary encoding where fields are identified by their position (no tags). All fields are preceded by an encoding of the length of the content. The length may be zero indicating an empty field but must always be present. Where the length is zero the content is not present (zero bytes). Where the length is non zero the content has the number of bytes equal to the value of the encoded length. The length is encoded as a 32-bit big-endian binary value and can thus take values from 0 to (2^{32} -1) i.e. around 4 gigabytes.

Definitions

wK	This is the wrapping key under which the subject key is to be wrapped. This key must be valid for the operation Ex.
mK	This is a randomly generated MAC key using **CKM_DES2_KEY_GEN**. This key is used with Mx.
cK	This is clear encoding of the subject key. For single-part symmetric keys, this is just the key value. For compound (e.g., RSA) keys, it is a BER encoding as per PKCS#1.
a	This is the encoded non-sensitive subject key attributes. The attributes are encoded with an attribute header, which is the number of attributes (4 byte), followed by a list of sub encodings which contain the attribute type (4 byte), content length (4 byte), a content presence indicator (1 byte), and the content bytes. The presence indicator allows the content length value to be non-zero, but, where presence indicator = 0, no content bytes are included. If the presence indicator is 1 then the content length must be the number of bytes indicated by the content length field. All numeric values are encoded as big-endian. Note that the sensitive attributes are contained in cK.
E x	This is encryption using **CKM_DES3_(ECB/CBC)_PAD** with key 'x'.
M x	This is MAC generation using **CKM_DES3_MAC_GENERAL** (8 byte MAC result) with key 'x'.

A wrapped key using **CKM_WRAPKEY_DES3_ECB** or **CKM_WRAPKEY_DES3_CBC** is made up of the following fields:

- ecK the encrypted key value, ecK = EwK(cK).
- a the encoded non-sensitive subject key attributes.
- m a MAC of the key value and attributes, m = MmK(cK + a).
- emK the encrypted MAC key value, emK = EwK(mK).

These fields are then encoded as described above.

E.g. Using **CKM_WRAPKEY_DES3_CBC** on a Single length DES key, with a Triple DES Wrapping key, produces the encoding:

```
|length | ecK - encrypted key value
00000010 2B847CF929FA2148A0A59BB6D44BBD74
|length | a - encoded non-sensitive attributes
00000120
      0000001900000001000000010101000000020000000101000000000300000
      0501746573740000000106000000010100800001280000000101000000107
      0000000101010000016200000001010180000129000000010101000001700
      0000010101000001040000000101010000010500000001010100000108000
      000101010000010A0000000101010000010300000001010000000163000000
      0101010000000000000040100000004000001000000000401000000130000
```

```
      0161000000040100000008800001020000001001323030313131303131323 4
      3530333030000001 0C0000001010000000102000000000000000110000000
      0000000011100000000000000016500000001010000000164000000010100
      000000000000000000
|length | m - MAC of key value and attributes
00000008 6256751248BFA515
|length | emK - encrypted MAC key value
00000018 2B847CF929FA214837ACF80D3AA9D1470082249D71E053DA
```


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CKM_WRAPKEY_DES3_ECB

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	No Wrapping

Key Size Range and Parameters

Minimum	0
FIPS Minimum	0
Maximum	None
Parameter	None

Description

The **CKM_WRAPKEY_DES3_CBC** and **CKM_WRAPKEY_DES3_ECB** mechanisms are used to wrap a key value plus all of its attributes so that the entire key can be reconstructed without a template at the destination. The key value is encoded and encrypted using **CKM_DES3_CBC_PAD** and then combined with all other object attributes. The result are then MACed. The wrapping key is supplied as normal to the **C_Wrap** and **C_Unwrap** Cryptoki functions.

The **C_Unwrap** operation will fail with `CKR_SIGNATURE_INVALID` if any of the key's attributes have been tampered with while the key was in transit.

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Encoding Format

The encoding is a proprietary encoding where fields are identified by their position (no tags). All fields are preceded by an encoding of the length of the content. The length may be zero indicating an empty field but must always be present. Where the length is zero the content is not present (zero bytes). Where the length is non zero the content has the number of bytes equal to the value of the encoded length. The length is encoded as a 32-bit big-endian binary value and can thus take values from 0 to (2^{32} -1) i.e. around 4 gigabytes.

Definitions

wK	This is the wrapping key under which the subject key is to be wrapped. This key must be valid for the operation Ex.
mK	This is a randomly generated MAC key using **CKM_DES2_KEY_GEN**. This key is used with Mx.
cK	This is clear encoding of the subject key. For single-part symmetric keys, this is just the key value. For compound (e.g., RSA) keys, it is a BER encoding as per PKCS#1.
a	This is the encoded non-sensitive subject key attributes. The attributes are encoded with an attribute header, which is the number of attributes (4 byte), followed by a list of sub encodings which contain the attribute type (4 byte), content length (4 byte), a content presence indicator (1 byte), and the content bytes. The presence indicator allows the content length value to be non-zero, but, where presence indicator = 0, no content bytes are included. If the presence indicator is 1 then the content length must be the number of bytes indicated by the content length field. All numeric values are encoded as big-endian. Note that the sensitive attributes are contained in cK.
E x	This is encryption using **CKM_DES3_(ECB/CBC)_PAD** with key 'x'.
M x	This is MAC generation using **CKM_DES3_MAC_GENERAL** (8 byte MAC result) with key 'x'.

A wrapped key using **CKM_WRAPKEY_DES3_ECB** or **CKM_WRAPKEY_DES3_CBC** is made up of the following fields:

- ecK the encrypted key value, ecK = EwK(cK).
- a the encoded non-sensitive subject key attributes.
- m a MAC of the key value and attributes, m = MmK(cK + a).
- emK the encrypted MAC key value, emK = EwK(mK).

These fields are then encoded as described above.

E.g. Using **CKM_WRAPKEY_DES3_CBC** on a Single length DES key, with a Triple DES Wrapping key, produces the encoding:

```
|length | ecK - encrypted key value
00000010 2B847CF929FA2148A0A59BB6D44BBD74
|length | a - encoded non-sensitive attributes
00000120
      0000001900000001000000010101000000020000000101000000000300000
      0501746573740000000106000000010100800001280000000101000000107
      0000000101010000016200000001010180000129000000010101000001700
      0000010101000001040000000101010000010500000001010100000108000
      000101010000010A0000000101010000010300000001010000000163000000
      0101010000000000000040100000004000001000000000401000000130000
```

```
      0161000000040100000008800001020000001001323030313131303131323 4
      3530333030000010C0000000101000000010200000000000000110000000
      0000000011100000000000000016500000001010000000164000000010100
      00000000000000000
|length | m - MAC of key value and attributes
00000008 6256751248BFA515
|length | emK - encrypted MAC key value
00000018 2B847CF929FA214837ACF80D3AA9D1470082249D71E053DA
```

CKM_WRAPKEYBLOB_AES_CBC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	No Wrapping

Key Size Range (bytes) and Parameters

Minimum	16
FIPS Minimum	16
Maximum	32
Parameter	None

Description

The CKM_WRAPKEYBLOB_AES_CBC and CKM_WRAPKEYBLOB_DES3_CBC mechanism is used to wrap a private key value using the Microsoft PRIVATEKEYBLOB format.

http://msdn.microsoft.com/en-us/library/cc250013(PROT.13).aspx

The RSA private key is formatted as shown below and then the result is encrypted by CKM_AES_CBC_PAD or CKM_DES3_CBC_PAD:

Header 12 bytes long = 07 02 00 00 00 A4 00 00 52 53 41 32
Bit Length (32 bit LE)
PubExp (32 bit LE)
Modulus (BitLength/8 bytes long LE)
P (BitLength/8 bytes long LE)
Q (BitLength/8 bytes long LE)
Dp (BitLength/8 bytes long LE)
Dq (BitLength/8 bytes long LE)
Iq (BitLength/8 bytes long LE)
D (BitLength/8 bytes long LE)

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CKM_WRAPKEYBLOB_DES3_CBC

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	No Wrapping

Key Size Range and Parameters

Minimum	0
FIPS Minimum	0
Maximum	None
Parameter	None

Description

The CKM_WRAPKEYBLOB_AES_CBC and CKM_WRAPKEYBLOB_DES3_CBC mechanism is used to wrap a private key value using the Microsoft PRIVATEKEYBLOB format.

http://msdn.microsoft.com/en-us/library/cc250013(PROT.13).aspx

The RSA private key is formatted as shown below and then the result is encrypted by CKM_AES_CBC_PAD or CKM_DES3_CBC_PAD:

Header 12 bytes long = 07 02 00 00 00 A4 00 00 52 53 41 32
Bit Length (32 bit LE)

PubExp (32 bit LE)
Modulus (BitLength/8 bytes long LE)
P (BitLength/8 bytes long LE)
Q (BitLength/8 bytes long LE)
Dp (BitLength/8 bytes long LE)
Dq (BitLength/8 bytes long LE)
Iq (BitLength/8 bytes long LE)
D (BitLength/8 bytes long LE)

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CKM_X9_42_DH_DERIVE

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	Yes
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bits) and Parameters

Minimum	1024
FIPS Minimum	2048
Maximum	4096
Parameter	`CK_X9_42_DH1_DERIVE_PARAMS`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_X9_42_DH_KEY_PAIR_GEN

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bits) and Parameters

Minimum	1024
FIPS Minimum	2048
Maximum	4096
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_X9_42_DH_PARAMETER_GEN

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	No
Available in FIPS Mode	Yes
Restrictions in FIPS Mode	None

Key Size Range (bits) and Parameters

Minimum	1024
FIPS Minimum	2048
Maximum	4096
Parameter	None

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_XOR_BASE_AND_DATA

> ****WARNING**** **This mechanism contains vulnerabilities that could compromise security. It has been disabled in the factory settings for new HSMs. To enable it, the *Weak PKCS#11 Mechanisms* flag must be set. See Weak PKCS#11 Mechanisms in the "Security Policies and User Roles" section of the *ProtectToolkit-C Administration Guide* for more information.**

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	`CK_KEY_DERIVATION_STRING_DATA`

Description

For a full description of this mechanism, refer to the *PKCS#11 version 2.20* documentation from RSA Laboratories.

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CKM_XOR_BASE_AND_KEY

> ****WARNING** This mechanism contains vulnerabilities that could compromise security. It has been disabled in the factory settings for new HSMs. To enable it, the *Weak PKCS#11 Mechanisms* flag must be set. See Weak PKCS#11 Mechanisms in the "Security Policies and User Roles" section of the *ProtectToolkit-C Administration Guide* for more information.**

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	`CK_OBJECT_HANDLE`

Description

XORing key derivation, denoted **CKM_XOR_BASE_AND_KEY**, is a mechanism which provides the capability of deriving a secret key by performing a bit XORing of two existing secret keys. The two keys are specified by handles; the values of the keys specified are XORed together in a buffer to create the value of the new key.

This mechanism takes a parameter, a **CK_OBJECT_HANDLE**. This handle produces the key value information that is XORed with the base key's value information (the base key is the key whose handle is supplied as an argument to **C_DeriveKey**).

For example, if the value of the base key is `0x01234567`, and the value of the other key is `0x89ABCDEF`, then the value of the derived key is taken from a buffer containing the string `0x88888888`.

- If no length or key type is provided in the template, then the key produced by this mechanism is a generic secret key. Its length is equal to the minimum of the lengths of the data and the value of the original key.
- If no key type is provided in the template, but a length is, then the key produced by this mechanism is a generic secret key of the specified length.
- If no length is provided in the template, but a key type is, then that key type must have a well-defined length. If it does, then the key produced by this mechanism is of the type specified in the template. If it doesn't, an error is returned.
- If both a key type and a length are provided in the template, the length must be compatible with that key type. The key produced by this mechanism is of the specified type and length.
- If a key type is provided in the template the behavior depends on whether the type is identical to the type of the base key. If the base key is of type **CKK_GENERIC_SECRET** then you can change the type of the new key. Otherwise you can change the type only if the "Pure PKCS11" configuration flag has been set.

If a DES, DES2, DES3, or CDMF key is derived with this mechanism, the parity bits of the key are set properly.

If the requested type of key requires more bytes than are available by taking the shorter of the two keys' value, an error is generated.

This mechanism has the following rules about key sensitivity and extractability:

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

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CKM_ZKA_MDC_2_KEY_DERIVATION

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	No
Wrap and Unwrap	No
Derive	Yes
Available in FIPS Mode	No

Key Size Range and Parameters

Minimum	0
Maximum	None
Parameter	Arbitrary byte length

Description

This is the ZKA MDC-2 and DES based key derivation mechanism. The algorithm implemented by this mechanism is defined in the ZKA technical appendix, "*Technischer Anhang zum Vertrag über die Zulassung als Netzbetreiber im electronic-cash-System der deutschen Kreditwirtschaft" V5.2, section 1.9.2.3, "Generierung kartenindividueller Schlüssel"*.

It has a parameter, the *derivation data*, which is an arbitrary-length byte array.

This mechanism only operates with the **C_DeriveKey( )**function.

The *derivation data* is digested using the CKM_DES_MDC_2_PAD1 mechanism, and the result is ECB decrypted with the base key. The result is used to make the value of a derived secret key. Only keys of type CKK_DES, CKK_DES2 and CKK_DES3 can be used as the base key for this mechanism. The derived key can have any *key type* with *key length* less than or equal to 16 bytes.

> If No*key type* and No*length* is provided in the template, then the key produced by this mechanism is a generic secret key. Its length is 16 bytes (the output size of MDC2).

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- If No*key type* is provided in the template, but a *length* is provided, then the key produced by this mechanism is a generic secret key of the specified length - created by discarding one or more bytes from the right hand side of the decryption result.
- If a *key type* is provided in the template, but No*length* is provided, then that key type must have a well-defined length. If it does, then the key produced by this mechanism is of the type specified in the template. If it doesn't, an error is returned.
- If both a *key type* and a *length* are provided in the template, the length must be compatible with that key type. The key produced by this mechanism is of the specified type and length. If the length isn't compatible with the key type, an error is returned.
- If the *derived key type* is CKK_DES, or CKK_DES2, the parity bits of the key are set properly.
- If the *derived key value length* requested is more than 16 bytes, an error is returned.

The following *key sensitivity* and *extractability* rules apply for this mechanism:

- The CKA_SENSITIVE, CKA_EXTRACTABLE and CKA_EXPORTABLE attributes in the template for the new key can be specified to be either TRUE or FALSE. If omitted, these attributes each take on the value of the corresponding attribute of the base key. The default value for the CKA_EXTRACTABLE and CKA_ EXPORTABLE attributes is TRUE. The default value of the CKA_SENSITIVE attribute depends on the security flags. If the No clear Pins security flag is set, the default value is TRUE; otherwise, it is false.
- If the base key has its CKA_ALWAYS_SENSITIVE attribute set to FALSE, then the derived key will as well. If the base key has its CKA_ALWAYS_SENSITIVE attribute set to TRUE, then the derived key has its CKA_ ALWAYS_SENSITIVE attribute set to the same value as its CKA_SENSITIVE attribute.
- If the base key has its CKA_NEVER_EXTRACTABLE attribute set to FALSE, then the derived key will too. If the base key has its CKA_NEVER_EXTRACTABLE attribute set to TRUE, then the derived key has its CKA_ NEVER_EXTRACTABLE attribute set to TRUE only if both CKA_EXTRACTABLE and CKA_EXPORTABLE attributes are FALSE. Otherwise, it is set to FALSE.

PTK-C Vendor-Defined Error Codes

The table below lists the error codes that may be returned from ProtectToolkit-C which are vendor extensions to the PKCS#11 standard.

Table 1: Vendor-defined Error Codes

Name	Value	Description
CKR_BIP32_CHILD_ INDEX_INVALID	0x8000007B	BIP32 private key cannot be produced due to passing an invalid index.
CKR_BIP32_INVALID_ HARDENED_ DERIVATION	0x8000007C	Base public key used to derive a hardened BIP32 key. Private and hardened keys must be derived from private keys.
CKR_BIP32_MASTER_ SEED_LEN_INVALID	0x8000007D	CKK_GENERIC_SECRET used to derive a master BIP32 key has an invalid bit length. Use a seed within the accepted range of 128-512 bits.

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Name	Value	Description
CKR_BIP32_MASTER_SEED_INVALID	0x8000007E	Invalid BIP32 public key generated from the seed provided.
CKR_BIP32_INVALID_KEY_PATH_LEN	0x8000007F	Invalid BIP32 key path length.
CKR_OTP_PIN_INCORRECT	0x8000008B	The presented user PIN component is correct, but the OTP PIN is incorrect.
CKR_OTP_PIN_LEN_RANGE	0x8000008C	The presented user PIN component is correct, but the OTP PIN is not the expected length.
CKR_OTP_PIN_ALREADY_INITIALIZED	0x8000008D	Cannot initialize OTP on a slot where it is already initialized.
CKR_OTP_PIN_NOT_INITIALIZED	0x8000008E	Cannot remove OTP from a slot where it has not been initialized.
CKR_ACCESS_DENIED	0x80000102	Attempting to call **C_InitToken** when HSM configured for “No Clear PINs”. Use **CT_InitToken** instead.
CKR_ENCODE_ERROR	0x80000104	Template encode/decode error. Usually internal error but may be caused by badly formed function request parameters.
CKR_SO_NOT_LOGGED_IN	0x80000106	Operation requires session to be in SO RW mode.
CKR_CERT_NOT_VALIDATED	0x80000107	Public key certificate chain not terminated by a TRUSTED certificate.
CKR_PIN_ALREADY_INITIALIZED	0x80000108	Calling **C_InitPIN** when PIN is already initialized. Use **C_SetPIN** instead.
CKR_RESPONSE_INVALID	0x80000111	Failure to disable an FM
CKR_EVENT_LOG_NOT_FULL	0x80000113	Attempting to erase Event log when it is not full.
CKR_OBJECT_READ_ONLY	0x80000114	Attempting to **C_DestroyObject** with CKA_DELETABLE=TRUE
CKR_TOKEN_NOT_INITIALIZED	0x80000116	Attempting to Reset a Token that is not initialized

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Name	Value	Description
CKR_NOT_ADMIN_TOKEN	0x80000117	Attempting to create an object or write an attribute of an object on a normal token that should only be on an Admin token
CKR_CERTIFICATE_NOT_YET_ACTIVE	0x80000120	The certificate's CKA_START_DATE value is a future date (the certificate is not yet valid).
CKR_CERTIFICATE_EXPIRED	0x80000121	The certificate's CKA_END_DATE value is past (the certificate is expired).
CKR_OPERATION_NOT_PERMITTED	0x80000131	Attempting to generate a timestamp when the RTC is not working or trusted. PKCS#12 import package has more than one private key.
CKR_PKCS12_DECODE	0x80000132	PKCS#12 package corrupt
CKR_PKCS12_UNSUPPORTED_SAFEBAG_TYPE	0x80000133	PKCS#12 package contains unrecognised SAFEBAG
CKR_PKCS12_UNSUPPORTED_PRIVACY_MODE	0x80000134	PKCS#12 package contains unrecognised privacy (public key mode not supported)
CKR_PKCS12_UNSUPPORTED_INTEGRITY_MODE	0x80000135	PKCS#12 package contains unrecognised integrity (should be MAC)
CKR_KEY_NOT_ACTIVE	0x80000136	Key has exceeded its usage limit or dates.
CKR_ET_NOT_ODD_PARITY	0x80000140	DES key being loaded into HSM has bad parity (should be odd) - fix key or enable “Des Keys Even Parity Allowed” mode (**ctconf -fd**)
CKR_CANNOT_DERIVE_KEYS	0x80000381	Internal error when establishing a secure messaging connection.
CKR_BAD_REQ_SIGNATURE	0x80000382	Corrupt request to HSM when using secure messaging (network or device driver error)
CKR_BAD_REPLY_SIGNATURE	0x80000383	Corrupt reply from HSM when using secure messaging (network or device driver error)
CKR_SMS_ERROR	0x80000384	General error from secure messaging system - probably caused by HSM failure or network failure.

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Name	Value	Description
CKR_BAD_PROTECTION	0x80000385	Cryptoki library has failed to apply proper secure message protection - internal error.
CKR_DEVICE_RESET	0x80000386	HSM has unexpectedly shut down. Check the event log for errors (**ctconf -e**)
CKR_NO_SESSION_KEYS	0x80000387	Cryptoki library has failed to establish keys for secure message protection - internal error.
CKR_BAD_REPLY	0x80000388	Reply message from HSM is badly formatted (network or device driver error).
CKR_KEY_ROLLOVER	0x80000389	Secure messaging system has not implemented key rollover protocol properly
CKR_NEED_IV_UPDATE	0x80000310	Secure messaging system has not implemented key rollover protocol properly
CKR_HOST_ERROR	0x80001000	Host-side error
CKR_BAD_REQUEST	0x80001001	Badly formed request message (network or device driver error)
CKR_BAD_ATTRIBUTE_PACKING	0x80001002	Cryptoki client has failed to encode attribute list correctly.
CKR_BAD_ATTRIBUTE_COUNT	0x80001003	Cryptoki client has failed to encode attribute list correctly.
CKR_BAD_PARAM_PACKING	0x80001004	Cryptoki client has failed to encode function parameters correctly.
CKR_MSG_ERROR	0x80001300	Message error
CKR_HIMK_NOT_FOUND	0x80001400	Requested Host Interface Master Key not found
CKR_WLD_ERROR	0x80002000	WLD error
CKR_WLD_CONFIG_NOT_FOUND	0x80002001	ET_PTKC_WLD configuration data not consistent
CKR_WLD_CONFIG_ITEM_READ_FAILED	0x80002002	ET_PTKC_WLD configuration data not available
CKR_WLD_CONFIG_NO_TOKEN_LABEL	0x80002003	ET_PTKC_WLD configuration data not formatted correctly

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Name	Value	Description
CKR_WLD_CONFIG_TOKEN_LABEL_LEN	0x80002004	ET_PTKC_WLD configuration data not formatted correctly
CKR_WLD_CONFIG_TOKEN_SERIAL_NUM_LEN	0x80002005	ET_PTKC_WLD configuration data not formatted correctly
CKR_WLD_CONFIG_SLOT_DESCRIPTION_LEN	0x80002006	ET_PTKC_WLD configuration data not formatted correctly
CKR_WLD_CONFIG_ITEM_FORMAT_INVALID	0x80002007	ET_PTKC_WLD configuration data not formatted correctly
CKR_WLD_LOGIN_CACHE_INCONSISTENT	0x80002010	Internal error in cryptoki library where WLD values are inconsistent.
CKR_HA_ERROR	0x80003000	HA error
CKR_HA_MAX_SLOTS_INVALID_LEN	0x80003001	Too many virtual WLD slots are defined
CKR_HA_SESSION_HANDLE_INVALID	0x80003002	Unknown session handle passed to Cryptoki library.
CKR_HA_SESSION_INVALID	0x80003003	HA session is invalid
CKR_HA_OBJECT_INDEX_INVALID	0x80003004	HA Object ID is invalid
CKR_HA_CANNOT_RECOVER_KEY	0x80003005	HA recovery process needs to create a key but is unable to
CKR_HA_NO_HSM	0x80003006	HA has tried to recover a lost session but no more working HSMs are available.
CKR_HA_OUT_OF_OBJS	0x80003007	The HA feature has reached its capacity to manage session objects - too many objects created.
CKR_SECURITY_FLAGS_INCOMPATIBLE	0x80003500	The current security flag settings are not compatible with the requested action.
CKR_FM_ERROR	0x80004000	FM error

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Name	Value	Description
CKR_FM_NOT_REGISTERED	0x80004001	The FM could not be registered.
CKR_FM_DISPATCH_BLOCKED	0x80004002	FM dispatch blocked

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CHAPTER 5: Sample Programs

Sample programs include a variety of PKCS#11 applications. Unless specifically stated, the source code provided with the ProtectToolkit-C SDK product may be modified or incorporated into other programs.

> **NOTE** To avoid running into issues, move samples out of the installation directory before modifying, compiling, or running them.

This chapter contains the following sections:

> "C Samples" below
> "ctdemo" on the next page
> "fcrypt" on page 405
> "Additional C Sample Programs" on page 405

C Samples

Compiling the Sample Programs

The sample programs will need to be compiled prior to use.

> **NOTE** A third-party C software compiler, such as Microsoft Visual C++, must be installed before performing these steps.

To compile under Windows

1. Set the CPROVDIR environment variable to point to your installation.

```
C:\>set CPROVDIR=C:\Program Files\SafeNet\Protect Toolkit 5\Protect Toolkit C SDK
```

2. Use the **nmake** program to compile the examples.

```
C:\Program Files\SafeNet\Protect Toolkit 5\Protect Toolkit C SDK\samples\demo>nmake
```

To compile under UNIX

1. Create a temporary compile directory.

```
% mkdir SafeNet
```

2. Copy the sample program and Makefile into that directory.

```
% cp /opt/safenet/protecttoolkit5/ptk/src/demo/* SafeNet
```

3. Modify the Makefile to point to your installation directory.

```
CFLAGS=-I/opt/safenet/protecttoolkit5/ptk/include -
I/opt/safenet/protecttoolkit5/ptk/src/include
LDFLAGS=-L/opt/safenet/protecttoolkit5/ptk/lib
```


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4. Use the make program to build the demo.

```
% make
```

ctdemo

ctdemo sets up a 4-token key profile that may be used for an electronic commerce trading application. The token profiles include a sample customer, merchant, bank and certifying authority. The application exchanges public keys between each of the tokens and, where CA mechanism extensions are supported, ProtectToolkit-C generates certificates for the public keys.

ProtectToolkit-C must be configured to have at least 4 slots/tokens for this demonstration program to operate correctly.

ctdemo is a console application that takes the following arguments:

ctdemo -s<slotID> **-m**<modulus size> **-q -f -x**

where:

-q	Quick. Does not prompt for values but uses defaults.
-f	Force. Does not warn about overwriting token contents.
-m	Specify modulus size.
-s	First slot number to use.
-x	Extended. Creates more keys.

Defaults:

Security Officer (SO) PIN = 9999

Slot	Token Label	PIN
0	Alice	0000
1	NAB	1111
2	Meyer	2222
3	SAFENET	3333

> **NOTE** This will overwrite the contents of all of the above tokens.

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fcrypt

fcrypt is a file encryption program that takes a recipient's public key and sender's private key and uses these to encrypt and sign the contents of a file. Random transport keys for triple DES are generated for the bulk file content encryption. Alternately the Password Based Encryption (PBE) variant can be used so that only the password needs to be shared and no public keys/certificates need to be exchanged.

fcrypt is a console application that takes the following arguments:

Usage

fcrypt [**-d**] [**-t**] [**-o**<outfile>] **-p**<password> infile

fcrypt [**-d**] [**-t**] [**-o**<outfile>] **-s**<key> **-r**<key> infile

> **NOTE** Correct usage is to either to provide a PBE-password, or to provide a sender and recipient key.

Options

Option	Description
-h	View help
-d	Decrypt instead of encrypt
-o	Output file name
-p	PBE password
-r	Recipient key name
-s	Sender key name
-t	Report timing info

Key Naming Syntax:

```
<token name>(<user pin>)/<key name>
 for example,  -s"Alice(0000)/Sign"
```

> **NOTE** **fcrypt** is also provided as an example tutorial in "API Tutorial: Development of a Sample Application" on page 435.

Additional C Sample Programs

There are also a number of additional C sample programs provided. For more information about the functionality of these programs refer to the description provided at the top of the source file for each of them.

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Java Samples

Compiling and Running the Sample Programs

The binaries for the sample programs are included in jcprovsamples.jar file. However, in order to use the sources provided, you must compile them first.

> **NOTE** JDK 7 or newer is required to compile these samples.

For best results, ensure that jcprov.jar is in your CLASSPATH environment variable before compiling the applications. Since all the applications are registered under the name space **SafeNet_tech.jcprov.samples**, a path that allows this namespace to be used must also be added to the CLASSPATH. If the samples are compiled in their installed locations, the path leading to the "samples" directory in the installation location will allow them to be executed as documented below.

For compiling and running under Windows

1. Set the CLASSPATH environment variable to point to jcprov.jar and sample programs' root path.

   ```
   C:\> set "CLASSPATH=C:\program files\safenet\cprovsdk\bin\jcprov.jar; C:\program files\safenet\cprovsdk\samples"
   ```

2. Use javac program to compile the examples.

   ```
   C:\Program Files\Safenet\CprovSDK\samples\SafeNet_tech\jcprov\samples> javac GetInfo.java
   ```

3. Use java program to run samples.

   ```
   C:\Program files\safenet\CprovSDK\samples\SafeNet_tech\jcprov\samples> javaSafeNet_tech.jcprov.samples.GetInfo -info
   ```

For compiling and running under UNIX

1. Create a temporary compile directory.

   ```
   % mkdir -p SafeNet_tech/jcprov/samples
   ```

2. Copy the sample program and Makefile into that directory.

   ```
   % cp /opt/safenet/protecttoolkit5/ptk/src/SafeNet_tech/jcprov/samples/* SafeNet_tech/jcprov/samples
   ```

3. Set the CLASSPATH environment variable to point to jcprov.jar and sample programs' root path.

   ```
   % export CLASSPATH=/opt/safenet/protecttoolkit5/ptk/lib/jcprov.jar:`pwd`
   ```

4. Change directory to sample programs' path.

   ```
   % cd SafeNet_tech/jcprov/samples
   ```

5. Use `javac` program to compile the examples.

   ```
   % javac GetInfo.java
   ```

6. Use java program to run samples.

   ```
   % java SafeNet_tech.jcprov.samples.GetInfo -info
   ```

The Java Classes

DeleteKey

This class demonstrates the deletion of keys.

java SafeNet_tech.jcprov.samples.DeleteKey -keyType <keytype> **-keyName** <keyname> [**-slot** <slotId>] [**-password** <password>]

Option	Description
keytype	One of (des, des2, des3, rsa). The types of keys supported are: > **des** — single DES key > **des2** — double length Triple DES key > **des3** — triple length Triple DES key > **rsa** — RSA Key Pair
keyname	The name (label) of the key to delete.
slotId	The slot containing the token to delete the key from. The default is (0).
password	The user password of the slot. If specified, a private key is deleted.

EccDemo

This class demonstrates the generation of EC keys (prime192v1) and optionally performs sign/verify option with generated keys

java SafeNet_tech.jcprov.samples.EccDemo [**-g**] **-n**<keylabel>

Option	Description
-g	Generate Key Pair only (do not perform sign/verify)
-n<keylabel>	Labels for key pair

EncDec

This class demonstrates the encryption and decryption operations.

java SafeNet_tech.jcprov.samples.EncDec -keyType <keytype> **-keyName** <keyname> [**-slot** <slotId>] [**-password** <password>]

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Option	Description
keytype	One of (des, des2, des3, rsa). The types of keys supported are: > **des** — single DES key > **des2** — double length Triple DES key > **des3** — triple length Triple DES key > **rsa** — RSA Key Pair
keyname	The name (label) of the key to delete.
slotId	The slot containing the token to delete the key from. The default is (0).
password	The user password of the slot. If specified, a private key is used.

EnumAttributes

This class demonstrates the SafeNet extension to enumerate all attributes of an object.

java SafeNet_tech.jcprov.samples.EnumAttributes -name <objectname> [**-slot** <slotId>] [**-password** <password>]

Option	Description
objectName	The name (label) of the object to enumerate over.
slotId	The slot containing the object. The default is (0).
password	The user password of the slot. If specified, a private object is used.

GenerateKey

This class demonstrates the generation of keys.

java SafeNet_tech.jcprov.samples.GenerateKey -keyType <keytype> **-keyName** <keyname> [**-slot** <slotId>] [**-password** <password>]

Option	Description
keytype	One of (des, des2, des3, rsa). The types of keys supported are: > **des** — single DES key > **des2** — double length Triple DES key > **des3** — triple length Triple DES key > **rsa** — RSA Key Pair > **ec** — EC Key Pair
keyname	The name (label) of the key to delete.

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Option	Description
slotId	The slot containing the token to delete the key from. The default is (0).
password	The user password of the slot. If specified, a private key is created.

GetInfo

The class demonstrates the retrieval of Slot and Token Information.

java SafeNet_tech.jcprov.samples.GetInfo (**-info**, **-slot**, **-token**) [<slotId>]

Option	Description
info	Retrieve the General information.
slot	Retrieve the Slot Information of the specified slot.
token	Retrieve the Token Information of the token in the specified slot.
slotId	The related slot ID of the slot or token information to retrieve. The default is (all).

ListObjects

This class demonstrates the listing of Token objects.

java SafeNet_tech.jcprov.samples.ListObjects [**-slot** <slotId>] [**-password** <password>]

Option	Description
slotId	The slot containing the token objects to list. The default is (0).
password	The user password of the slot. If specified, private objects are also listed.

ReEncrypt

This class demonstrates re-encryption of variable length data.

Re-encryption is where cipher text (encrypted key or data) is decrypted with one key, and then the resulting plain text is encrypted with another key. Typically you want this operation to occur in such a way as to avoid having the intermediate plain text leaving the security of the adapter.

This is achieved in PKCS#11 via the **C_UnwrapKey** and **C_WrapKey** functions. By specifying the intermediate plain text data as a GENERIC_SECRET, SENSITIVE, Session object, you can keep variable length data securely in the adapter. This program assumes that slot 0 exists. All objects generated during program execution are session objects, and as such the contents of the token in slot 0 are not modified.

java SafeNet_tech.jcprov.samples.ReEncrypt

Threading

Sample program to show use of 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 0, and is a Public Token object.

java ...Threading **-numThreads** <numthreads> **-keyName** <keyname> **-locking** <lockingmodel> [**-v**]

Option	Description
numthreads	The number of threads to start.
keyname	The name of the Triple DES key to use for encryption operation.
lockingmodel	The locking model, one of: > **None** — No locking performed. Some of the threads should report failures. > **OS** — Use native OS mechanisms to perform locking. > **Functions** — Use Java functions to perform locking.

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CHAPTER 6: Best Practice Guidelines

ProtectToolkit-C can be used to add cryptographic services to any application requiring such services in a standardized way. Cryptographic services are required where security policy exists, and must be enforced to the fullest possible extent by state of the art existing technology. Currently, cryptographic methods are the only way to assure authenticity, confidentiality and integrity to levels that can be mathematically shown to resist all known attacks for the foreseeable future.

Simplicity is another essential goal since complex systems are extremely difficult to analyze to an extent where all weakness can be found or shown not to exist to a level that is practicable. ProtectToolkit-C is a simple and low-level key management and cryptographic service provider and its simplicity should allow it to be used easily to provide the necessary level of cryptographic service.

There are many independent, and sometimes conflicting, goals in the development life cycle of secure products, so this document shall outline the best approach to the use of ProtectToolkit-C, always keeping these goals in mind. Above all, the developer should always strive to keep implementation simple.

The remainder of this document assumes a basic level of understanding of the ProtectToolkit-C product and the PKCS#11 (Cryptoki) system. It refers to the PKCS#11 device as a security module and this may be a stand-alone appliance, or adapter-based PKCS#11 security module.

This chapter contains the following sections:

> "Introduction" below
> "Application Security" on the next page
> "Application Usability" on page 414
> "Performance" on page 414
> "Capacity" on page 415
> "Setup/Configuration" on page 416
> "Maintainability" on page 417
> "Debugging" on page 417
> "Interoperability" on page 418
> "Programming in FIPS Mode" on page 419
> "Key Management" on page 420
> "Hierarchical Deterministic Wallets in ProtectToolkit" on page 423

Introduction

The best place to start building a ProtectToolkit-C application is with the sample applications that demonstrate how the ProtectToolkit-C system should be initialized and used to perform various cryptographic operations. Although the samples vary in complexity, they are all real working ProtectToolkit-C utilities and cover all ProtectToolkit-C services.

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System security depends mainly on confidentiality, authentication, and access control.

Confidentiality

Confidentiality is critical when data must exist or be transferred through an environment where it may be vulnerable to inspection by an unauthorized person, and damages to the owner of the data may result from such inspection. The best way to protect confidential data is to encrypt it. Examples of confidential information include corporate or personal data, and cryptographic keys.

Integrity / Authentication

Integrity requires that no unauthorized person can alter data without detection. Integrity can be assured by using message authentication codes (MAC), a cryptographic digest of the message that requires knowledge of a secret key.

> **NOTE** It is not necessary to know the value of a secret key to use it to encrypt or sign (MAC) something.

Access Control

Access to certain objects must be restricted to reliable people, or circumstances in which misuse can be easily detected . Access control demands accountability from those who interact with the data. It requires users to be authenticated before access is granted. There are many methods of user authentication.

Getting to Know ProtectToolkit-C

To become proficient at ProtectToolkit-C development, you must understand PKCS#11 and basic security and cryptographic principles. The entire PKCS (Public Key Cryptographic Standard) suite of standards is relevant, since PKCS#11 employs elements of most of the other PKCS standards. All the PKCS standard documentation can be found online.

You should also refer to "PKCS#11 Command Reference" on page 452, which details some of the many differences between the PKCS#11 standard and ProtectToolkit-C.

The sample PKCS#11 application code included in the SDK installation is another excellent starting point for getting to know ProtectToolkit-C. These applications may be compiled and inspected, or used directly for commercial PKCS#11 applications.

Application Security

ProtectToolkit-C applications must provide access control and confidentiality of any keys used by the application.

> **NOTE** In PKCS#11 there are three classes of users: the public, the token user, and the token security officer (SO). Please refer to the PKCS#11 documentation and see the *ProtectToolkit-C Administration Guide* for more about these user classes and their roles and responsibilities.

ProtectToolkit-C Security

The following rules should generally be applied:

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- Use one token per application. The tokens are access-controlled separately, collect all keys related to the application, and will normally be used simultaneously within that application. The application should log in to the token with the appropriate PIN, use the keys, then log out before terminating. This approach provides a completely separate logical security boundary for each application, ensuring that no cross-application leakage can occur.
- Each key in a system should have a clearly defined purpose and be used for only that purpose. This limits the potential damage done by any key's exposure,and lessens the likelihood of misuse.
- Secret values entered on a keyboard, such as PINs and clear keys, should always be masked. The ProtectToolkit-C KMU masks all PIN and key component entry.
- Set appropriate access control for keys. Even if the key value is safe from exposure, a key could still be used by unauthorized personnel. For example, a signature generation key (CKA_SIGN = TRUE) should not be usable for encryption (CKA_ENCRYPT = TRUE). Most keys should be “user” keys (CKA_PRIVATE = TRUE), meaning they are accessible only after a **C_Login** has been performed.

  Keys can be randomly generated, with their attributes set so they can never be known or extracted outside the token. More often, however, keys are backed up shortly after they are generated, then locked into the token with attributes preventing extraction. This is often done with clearly specified procedures, the application should assist where possible in enforcing these.
- Use the Key Management Utility (KMU) for key backup and restore purposes.
- Use the FIPS-compliant mode of the device.

ProtectToolkit-C Security Caveats

- CKA_SENSITIVE = FALSE. This attribute setting allows key values to be extracted from the security module using **C_GetAttributeValue**. Set to TRUE to prevent this form of key value extraction.
- CKA_EXTRACTABLE = TRUE. This attribute setting allows keys to be wrapped (encrypted) by another key. If the wrapper key is known externally, it can be used to obtain the original key value. A wrapping key (CKA_WRAP=TRUE) may be created at any time to wrap extractable keys. To prevent this, use CKA_EXPORTABLE = TRUE; keys with CKA_EXPORT can be created only by the security officer (SO).
- Short PINs can be determined by brute force. Use PINs with more than just numeric characters, longer than 6 characters.
- Any key that has the attribute CKA_MODIFIABLE = TRUE can have most other attributes, including key usage attributes, changed. It is best to have persistent keys with this attribute set to FALSE wherever possible.
- Once a session is logged on, all sessions of the same application are also logged on and can access all user keys on the token.
- FIPS operation may be slower and have some interoperability problems for some existing PKCS#11 applications.
- The PKCS#11 library is a dynamic library the application attaches to, DLL under Win32/64, and shared object under UNIX. The library is not separately authenticated by library signing techniques used by other architectures, e.g., JCE and CryptoAPI. Instead, the application relies on the security of the operating system to assure that substitution or tampering with the library has not occurred. It is reasonable to expect modern operating systems to be capable of protecting system files in this way.

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Application Usability

Usability is an important consideration; if security requirements become an imposition, users are more inclined to work around them. For example, users forced to change their passwords too often tend to write them down or choose simple derivatives of the same password over and over again. Secure systems simply don't work if they are not usable.

ProtectToolkit-C Application Usability

- ProtectToolkit-C allows PINs to be non-numeric and can be quite long (up to 32 characters). In fact, full 8-bit binary data can be used for PINs, but applications tend to use printable characters.
- When naming keys, use the CKA_LABEL attribute and name the key according to its usage and origin (or scope). For example: "KEK - Database" for a key-encrypting-key for use with an applications database. This makes the key's purpose clear to both trained and untrained users, who may not normally need to use it.
- Wherever possible, use the token label to find key sets belonging to a particular application, rather than slot numbers. It is advisable to use separate tokens in separate slots for separate applications.
- For server-type applications, it may not be possible to perform a login every time the system is restarted. This may force keys to be made non-private so that they are accessible without logging in, or the application will have to obtain the login password from some static location - either hard-coded or in some environment variable etc depending on the platform.
- Learn and use the ProtectToolkit-C additional libraries (**CTEXTRA** and **CTUTIL**) which have been provided to implement common PKCS#11 application features.

ProtectToolkit-C Usability Caveats

- The ProtectToolkit-C token browser is a developer's tool and is therefore very low-level. It can be tricky for the user unfamiliar with it or PKCS#11.
- Watch out for embedded and trailing spaces in token and object label names. Some PKCS#11 implementations do exact matches and will not regard labels with and without the NULL termination as equal.
- Many applications only work on slot 0, making interoperability between them on the same platform impossible.

Performance

The product should not perform poorly with security enabled, or users may be tempted to switch it off to meet performance criteria.

ProtectToolkit-C Performance

- In tight loops, it is best to remove as much invariant code as possible. This goes for ProtectToolkit-C session startup, login, key generation / find, and even the cipher initialization. That way only the code that does the cryptographic operation is in the inner loop.

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- Use session keys wherever possible, since they can be created and destroyed much more quickly than token keys. However, watch out for object leaks when using session objects; they will not be visible to anything but the application that creates them.
- Avoid having too many objects on a token, since object lookups are performed by traversing all objects until the correct one is found. Once an object is found it should not need to be searched for again.
- Multiple adapters (an adapter cluster) can be combined to increase overall throughput, where independent streams of cryptographic operations can be allocated to different devices. Key replication is required if cryptographic operations need to be performed by any adapter in the cluster.

ProtectToolkit-C Performance Caveats

- Some operations are limited by a slower operation inside the security module. RSA key generation is a good example. Other operations may be limited by the speed at which data can cross the application-security module interface.
- Performance figures quoted by some PKCS#11 device vendors may be difficult to obtain in real-world application. Cprov includes a PKCS#11 utility that measures performance using only the standard ProtectToolkit-C API. In this case there is no use of undocumented calls to obtain performance figures, and any application developer should expect to obtain them from any well-written PKCS#11 application.
- Performance is often irrelevant for operations that are not time-critical or repetitive.
- FIPS-compliant operation may be slower.

Capacity

Tokens have two kinds of memory: persistent (token) memory and session memory. Keys and other objects may be created and managed in either, and each has its own advantages and capacities.

ProtectToolkit-C does not impose a fixed limit on the number of Tokens or the number of objects in one token. Tokens and objects may be created until the persistent memory is full. However HSM performance will decrease as the number of slots and objects increases. For all practical purposes, the performance will be unacceptably degraded before the memory is full.

As a guideline, the developer should not design a system that requires more than 50 Tokens or more than 100 objects in any one token.

ProtectToolkit-C Capacity Improvement

- Externally-stored keys should be encrypted with a key-encrypting key. This way, only the master KEK needs to be stored on the device. All working keys are unwrapped (**C_UnwrapKey**) prior to use and destroyed afterwards.

> **NOTE** They can usually be unwrapped as session keys. This technique is common for managing a large set of terminals (EFTPOS or other) that have randomly-generated terminal master keys.

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- Use derived keys from a master key stored on the security module. The working key is derived by encrypting some application-supplied data with the master key and using the cipher text data to create a key value. This technique is common for managing a large set of terminals (EFTPOS or other) that have terminal master keys derived from their terminal identifiers. The terminal identifier is usually used as the application-supplied data.
- Back up and restore keys rather than leaving old key sets online. After a key rollover, old key sets should not remain online any longer than necessary.
- Keys may be spread across the storage capacity of multiple HSMs. Cryptographic requests will have to be directed to the HSM containing the necessary specific key.

ProtectToolkit-C Capacity Caveats

- Keys and other objects take up memory according to the number and individual sizes of the attributes that make them up. The number of attributes may also change for different versions of PKCS#11.
- Memory leaks may happen in both token (persistent) memory and session memory. Detecting and plugging the leaks can be quite difficult. Some development tools (**ctconf**) take memory usage snapshots that can help track them down.
- Low memory conditions may make the device fail in unexpected ways.

Setup/Configuration

An application may initialize the token and key sets, or it may presume that they have already been set up. The latter is normally the case and ProtectToolkit-C includes initialization applications to perform this function.

The ProtectServer configuration and management strategy is based on the Administrator token created automatically on all adapters.See the *ProtectToolkit-C Administration Guide* for more details.

ProtectToolkit-C Setup/Configuration

- Decide early how many tokens should be created for the HSM configuration. Changing the number of tokens / slots is a significant change. Generally, one token should be used per application, but there may be necessary exceptions.
- Decide the security settings. FIPS mode enables a collection of different security settings (see the *ProtectToolkit-C Administration Guide* for details), some of which will impact performance. Take this into consideration when writing applications.
- Decide how to manage the user and security officer (SO) PINs for each token. The PINs protect different services and it is important to note that, when not in FIPS mode, both keys and cryptographic services can be used when no PIN has been provided.
- Plan for operations to backup / restore to disk or smart card on working key sets. This will influence what key attributes to set for various keys and may require backup / restore master keys. See the *ProtectToolkit-C Administration Guide* for more information on the available backup options.
- Use the KMU to manually set up key sets, or the **ctkmu** console application to set them up from a batch file. A simple custom application may also be used to set up a key set; both KMU and CTKMU use PKCS#11 functions that any application can call.

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ProtectToolkit-C Setup/Configuration Caveats

- The administrator token in ProtectToolkit-C V3.x may cause confusion, since it appears as a standard PKCS#11 token. This token contains special objects that should not be accessed by any applications other than the ProtectToolkit-C supplied tools.
- Server applications may require the abillity to run from a reboot without any assistance or input (including PINs) from a human operator. This may affect how login PINs are presented to the token.

Maintainability

Security systems must be maintainable to change with security policy demands. For example, security vulnerabilities have been discovered in certain PKCS#11 mechanisms, and these are no longer available in FIPS Mode (See the *ProtectToolkit-C Administration Guide* for more information). New algorithms are introduced and others are phased out.

Many changes in security applications also relate to the increased use of PKI systems, with related public key certification and cryptographic demands.

ProtectToolkit-C Maintenance

- Give keys meaningful names (CKA_LABEL) referring to their usage and origin. For example: “KEK - Database” for a key-encrypting-key for use with an applications database.
- Use supplied PKCS#11 helper functions from **CTUTIL** library. These are provided to perform most common PKCS#11 operations and have been thoroughly tested.
- Use appropriate key sizes and cryptographic algorithms, and allow for key sizes to increase.
- Write portable code. ProtectToolkit-C is available on many platforms from Win32/64 to UNIX, and the best applications are most likely to be ported.

ProtectToolkit-C Maintenance Caveats

- Watch out for spaces and NULL (‘\0’) characters in ProtectToolkit-C token and object labels.
- Attribute template handling code can become very messy, and there is a tendency to use global variables. Local variables are better and can be made ‘static’ to avoid stack-based initialization compiler warnings.

Debugging

Various development and debugging assistance tools are provided in the ProtectToolkit-C SDK, including a full software emulation variant of the PKCS#11 library. One other such tool is the ProtectToolkit-C logger, a Cryptoki library replacement that intercepts all ProtectToolkit-C calls and reports them with their arguments to a log file before completing the call to the real Cryptoki library. The call results, return code, and arguments are likewise recorded to the same log file.

ProtectToolkit-C Debugging Techniques

- Use the ProtectToolkit-C token browser (**CTBROWSE**) to set up and inspect tokens and keys. The token browser can also be used to verify cryptographic operations, since just about any ProtectToolkit-C function

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can be called.

- Use the software-only emulation of PKCS#11 to avoid any hardware issues, including installation issues. This allows effective PKCS#11 development and debugging to be done on a laptop with no PCI bus for expansion cards, or when not connected to the same network as the HSM hardware.
- Use the ProtectToolkit-C logger to obtain PKCS#11 activity traces. This is useful for reporting problems to Thales support staff.
- Make all keys token keys (CKA_TOKEN = TRUE), rather than session keys. This can help to track down object leaks.
- Make all keys CKA_SENSITIVE=FALSE so they can be inspected with the token browser at any time.
- Use the Key Verification Codes (KVC) to check a key's value without having to see the key's value.
- Give every key a CKA_LABEL whether the application uses it or not. If there is an object leak where many key objects are being managed, the label may be the only way of tracking down the source code that created it.

ProtectToolkit-C Debugging Caveats

- Remember to switch off all debugging support code once the application is working, since some debugging techniques require disabling of normal security options. e.g. `CKA_SENSITIVE=FALSE`. If this code remains active in a production system, security may be compromised.

Interoperability

PKCS#11 is a standard security module interface defined specifically for removable tokens like smart cards, but it is also applicable to non-removable devices. Many vendors have adopted this interface, so the likelihood of any particular application being required to operate with more than one PKCS#11 device is quite high. This interoperability is highly beneficial to the application developer.

ProtectToolkit-C Interoperability

- Look for PKCS#11 security modules that have high interoperability with standard PKCS#11 applications. Common PKCS#11 applications include Netscape, Entrust, Identrus etc.
- Test with multiple devices. Without testing, it is impossible to know for certain that an application is interoperable.

Interoperability Caveats

- Since there is no central compliance-testing lab for generic PKCS#11 implementations, many implementations with low interoperability also exist. Instead, various application-specific compliance test suites have been used.
- Vendor-defined extensions will not be present on other vendors' implementations. These should be used only when there is no alternative, or where vendor independence is not an issue.

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Programming in FIPS Mode

When the device is set to FIPS-compliant mode (see the *ProtectToolkit-C Administration Guide*), the following Security Mode flags are set, altering the behavior of PKCS#11. Programmers must consider these restrictions when designing applications.

No Public Crypto

When this flag is TRUE, each token will have the CKF_LOGIN_REQUIRED flag set and all the cryptographic **C_xxxInit** functions and key operation functions: **C_GenerateKey**, **C_GenerateKeyPair**, **C_WrapKey**, **C_UnwrapKey**, **C_DeriveKey**, **C_DigestKey** will fail unless the session state is in a User mode (that is, either the USER or SO must be logged in).

If the session state is not in a User mode, any attempt to write to a token will fail (that is, using the functions **C_CreateObject**, **C_DestroyObject** and **C_SetAttributeValue**).

No Clear PINS

When this flag is TRUE, the device will not allow clear-text authentication data to pass through the host data port.

With this flag enabled, the **C_InitToken** function will fail with the error result CKR_ACCESS_DENIED. In order to initialize tokens, the SafeNet extension function **CT_InitToken** must be used. The SafeNet tools **ctconf** and **gCTAdmin** are aware of this restriction and will automatically use the appropriate function.

The other functions that supply PINs to the adapter, **C_InitPin**, **C_Login**, **C_SetPin**, and **CT_InitToken**, will encrypt the PINs before supplying the request to the adapter. The **C_CreateObject**, **C_GenerateKey**, **C_SeedRandom** functions will also be encrypted, as they may contain sensitive values. The encryption and decryption is performed by the Secure Messaging System (SMS) and any application will see the request AFTER it has been verified and decrypted by the SMS.

Because the SMS automatically encrypts the PINs, there is no effect on the application.

Finally, with this flag enabled, secret and private key objects will always have their CKA_SENSITIVE attribute set to TRUE. Any attempt to create a non-sensitive key (that is, set CKA_SENSITIVE=FALSE) or specify CKA_SENSITIVE=FALSE for any object on the device will fail.

An application will fail if it attempts to create, derive, or unwrap keys with CKA_SENSITIVE=FALSE.

> **CAUTION!** The *No Clear PINs* flag must be set to enable *Full Secure Messaging Encryption* and *Full Secure Messaging Signing*.

Authentication Protection

This flag is TRUE and all requests coming from an authenticated user (i.e. a request from a logged in user) must be cryptographically signed.

The signature verification is performed by the SMS and any application will see the request AFTER it has been verified by the SMS. This flag does not impact on an application.

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Security Mode Locked

This flag is TRUE and means the settings of the other flags in this mode structure may not be changed (they are Read Only).

This flag may be set to TRUE when FALSE but never FALSE when TRUE. The only way to set this flag to FALSE once it has been set to TRUE is to tamper the device.

Tamper Before Upgrade

This flag is TRUE and all keys, objects and PINs stored in the device's Secure Memory will automatically be erased during any OS Firmware Upgrade, FM Upgrade or FM Disable operation.

Designers should consider their key backup and recovery plans when using FIPS mode.

Only-FIPS Approved Algorithms

This flag is TRUE and restricts the PKCS#11 mechanisms available to only the FIPS approved mechanisms. Some algorithms will have their key sizes limited when this flag is true.

Refer to "ProtectToolkit-C Mechanisms" on page 65 for the list of FIPS-approved mechanisms.

Key Management

Key management is critical to successful deployment of a secure application. It is important to use the right tools and follow standard techniques wherever possible.

Backup and Restore

The KMU provides key backup and restore facilities for keys. Backup operations can only be performed if the keys were created with the right attributes.

The recommended procedure for key backup is to use the CKA_EXPORT and CKA_EXPORTABLE attributes for the KEK and working keys, respectively. These are preferable to CKA_WRAP and CKA_EXTRACTABLE because there is no control on setting the CKA_WRAP attribute (see "Application Security" on page 412). The CKA_EXPORT attribute can be set to TRUE on a key only when the security officer (SO) is logged in to the token. This prevents working key exposures by introducing a known KEK to the device. The SO creates export keys, while the user is able to use them but not create them.

Only keys that have the CKA_EXPORTABLE attribute set to TRUE can be exported, and only by keys that have the CKA_EXPORT attribute set to TRUE. This allows the possibility of keys that can never be exported from the device, or can be exported a limited number of times.

> **NOTE** The backup/restore master KEK must be managed in clear components, for split key entry, or backed up with redundancy separately, either to disk or smart cards. The redundancy is a defense against one of the master key sets being physically damaged or one of the custodians being unable or unwilling to participate in the restore operation. It is normal in any KEK hierarchy for the highest-level keys to be managed by a semi-manual process under the control of highly trusted personnel. These keys are critical to the restore operation, and their loss would make restore operations impossible.

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Key Replication

Key replication is normally done for one of two reasons:

- Fault-tolerant redundancy
- Load balancing

> **NOTE** The normal key backup with a restore per replication is all that is required to do this job. There is no special key replication procedure. The backup/restore key will need to be present in all devices where the keyset will be replicated. For root-level keys, a semi-manual procedure is required as in key restorations (clear components or Smart Card key injection).

Key Generation Variations

DSA and DH key generation is a two step process, where generation parameters produced in step one may be used repeatedly for key pair generation in step two. SafeNet PKCS#11 specifies that step one is outside the API while step two, generation of the actual key pair, is inside. This implementation allows step one to be done inside the library. The support is invoked by not supplying the required “parameters” values in the key templates. Under these circumstances a fully compliant PKCS#11 implementation would return CKR_TEMPLATE_ INCOMPLETE.

Note that the DSA and DH parameters may be generated separately using the other extension CKM_xxx_ PARAMETER_GEN making this extension unnecessary. The use of the alternative mechanism (CKM_xxx_ PARAMETER_GEN) is recommended.

PKCS#11 Interpretations

- The handle for an object may change over the lifetime of the token or object. The handle is allocated to the object when it is read from the token.
- **C_GetObjectSize** reports the sum of the sizes of all the attributes combined for the object. This gives a good indication of the amount of memory committed to the object although there would be some storage overhead for persistent objects.
- Certain key wrapping restrictions are not observed. For example, wrapping a multi DES key with a single DES key is not prevented.
- All key sizes for secret key algorithms, as reported by **C_GetMechanismInfo**, are reported in bytes not bits.

Software-Only Version Specific

- Token serial numbers are all fixed as “0”.
- Token removal processing has not been supported since software tokens cannot really be removed in the normal sense. The token can actually be removed by deleting, or renaming the “token” directory found in the “slot” directory, but automatic detection has not been implemented.
- File system errors are typically reported as CKR_DEVICE_ERROR.

Operator Authentication

The conventional **C_Login** allows the user PIN to be presented directly to the Token.

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Under Cryptoki, all authentication of users to the HSM is valid for the calling process only. Each application must authenticate separately. Once a process has authenticated, it is granted appropriate access to the token's services.

With ProtectToolkit-C, if a process forks a new process then the new process must authenticate itself - it can not inherit the authentication of the parent.

Key Usage Limits

Each private key object on a token may have usage limits applied by the START_DATE, END_DATE, DESTROY_ON_COPY, USAGE_COUNT and USAGE_LIMIT plus the CKA_ADMIN_CERT attributes.

The START_DATE and END_DATE attributes enforce limits on the use of a key based on the date.

The USAGE_COUNT and USAGE_LIMIT attributes enforce limits on the use of a key based on the number of operations of that key. The USAGE_COUNT attribute increases with each use of the key until USAGE_LIMIT is reached. If USAGE_COUNT equals or is greater than USAGE_LIMIT, the key is locked and cannot be used.

In order to stop abuse of the USAGE_COUNT/USAGE_LIMIT controls, any Object with a non-empty CKA_USAGE_LIMIT attribute will be automatically deleted after a successful Copy operation.

Without this rule, a key and its attributes may be copied and therefore the number of operation remaining is automatically doubled.

The START_DATE, END_DATE, USAGE_COUNT and USAGE_LIMIT attributes can be supplied in the template when a key is created or imported. The **C_SetAttributeValue** command can be used to add these attributes to a key if the object is modifiable. But the **C_SetAttributeValue** command cannot be used to modify these attributes.

The CKM_SET_ATTRIBUTES ticket mechanism changes the START_DATE, END_DATE, USAGE_COUNT and USAGE_LIMIT attributes of a specified object when used with the **CT_PresentTicket** function.

Programmatic Use Cases for a Developer

Create Usage Limited Key Object

Developer uses **C_GenerateKeyPair** to create a new key pair. The private key template should include limitation attributes and specify `CKA_MODIFIABLE=False`.

Set Usage Limits of an Object Directly

1. Developer uses **CT_SetLimitsAttributes()** to set usage limitation attributes. Note the key must have `CKA_MODIFIABLE=True`.
2. Developer sets `CKA_MODIFIABLE=False` by calling **CT_MakeObjectNonModifiable()**.

Update Usage Limits of an Object Indirectly

1. Developer calls `CT_GetObjectDigest` on the remote machine (Recommend use of SHA-256 algorithm).
2. Developer sends Object Digest to the Master machine.
3. Optional: on Master machine, Developer locates signing key and reads its CKA_SUBJECT_STR and CKA_USAGE_COUNT attributes. The CKA_SUBJECT_STR value can be used as the issuerRDN value to identify the signing key in the certificate. The CKA_USAGE_COUNT attribute can be used as the certificate serial number.

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4. Developer uses **CT_Create_Set_Attributes_Ticket_Info()** to create a ticketInfo data block. The **CT_SetCKDateStrFromTime()** function can help to construct CKA_START_DATE and CKA_END_DATE values.
5. Developer uses the signing key to create a signature of the ticketInfo data block. For RSA signing key the CKM_SHA256_RSA_PKCS mechanism is recommended.
6. Developer uses **CT_Create_Set_Attributes_Ticket()** to construct the Ticket data block.
7. Developer arranges that the Ticket data block is sent to the remote server machine.
8. Developer uses **CT_PresentTicket()** with CKM_SET_ATTRIBUTES mechanism on remote machine to change limits attributes on target key.

Hierarchical Deterministic Wallets in ProtectToolkit

Bitcoin Improvement Protocol 0032 (BIP32) introduced Hierarchical Deterministic Wallets, which use elliptic curve mathematics to calculate multiple key pair chains from a single root. This eliminates the need for backups after each Bitcoin transaction, by allowing you to create a new public address for each transaction or group of transactions without knowing the private key.

For a full description of BIP32 HD wallets, see https://github.com/bitcoin/bips/blob/master/bip-0032.mediawiki.

BIP32 Implementation in ProtectToolkit

ProtectToolkit introduced support for BIP32 in release 5.4. ProtectToolkit generates HD wallets as PKCS#11 keypairs within the ProtectServer HSM, using the custom algorithms CKM_BIP32_MASTER_DERIVE and CKM_BIP32_CHILD_DERIVE. While public keys can be exported in plaintext, the ProtectServer security architecture prevents the plaintext base58 value of private keys from existing outside of the HSM.

This information is encoded in the key's custom attributes as described below.

Validating BIP32 Test Vectors With ProtectServer

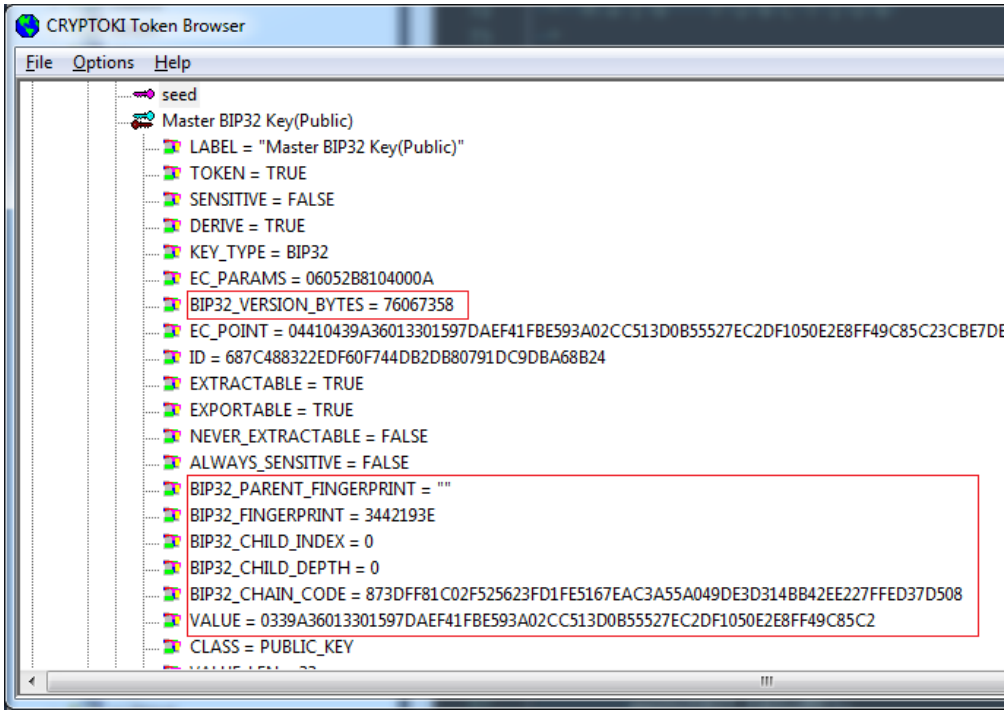
For testing purposes, you can use the procedure below to confirm that BIP32 key generation is functioning properly. The BIP32 test vectors are located at https://github.com/bitcoin/bips/blob/master/bip-0032.mediawiki#test-vectors.

Descriptions of the attributes described below can be found at https://github.com/bitcoin/bips/blob/master/bip-0032.mediawiki#serialization-format.

To validate BIP32 test vectors with ProtectServer

1. Generate a BIP32 master keypair, specifying the seed provided in one of the test vectors (example: Test Vector 1). If you want to confirm the private key, you must set CKA_SENSITIVE=**0** during key creation.

   Example seed (hexadecimal): `000102030405060708090a0b0c0d0e0f`
2. Examine the following key attribute fields (you can also use **C_GetAttribute** to obtain these values):



a. **BIP32_VERSION_BYTES**=<4_bytes>

   This attribute will have one of four values. It is provided in integer form. Convert it to hexadecimal as follows:

Key Type	Decimal	Hexadecimal
Mainnet Public Key	`76067358`	`0488B21E`
Mainnet Private Key	`76066276`	`0488ADE4`
Testnet Public Key	`70617039`	`043587CF`
Testnet Private Key	`70615956`	`04358394`

b. **BIP32_CHILD_DEPTH**=<1_byte>

   Represents the depth of derivations from the master key (`00` on the master node).

c. **BIP32_PARENT_FINGERPRINT**=<4_bytes>

   If this is the master key, the field appears empty. The correct value is `00000000`.

d. **BIP32_CHILD_INDEX**=<4_bytes>

   If necessary, append zeroes to include the full 4 bytes. In this example, the correct value is `00000000`.

e. **BIP32_CHAIN_CODE**=<32_bytes>

f. **VALUE**=<32_bytes>

   The key value in hexadecimal form. This attribute field is only visible if SENSITIVE=**0**.

3. Concatenate these values, in the above order, into a string.

```
0488B21E000000000000000000873DFF81C02F525623FD1FE5167EAC3A55A049DE3D314BB42EE227FFED37D50803
39A36013301597DAEF41FBE593A02CC513D0B55527EC2DF1050E2E8FF49C85C2
```

4. Hash the string twice with SHA-256 to obtain the checksum.

```
AB473B21
```

5. Append the checksum to the end of the original string.

```
0488B21E000000000000000000873DFF81C02F525623FD1FE5167EAC3A55A049DE3D314BB42EE227FFED37D50803
39A36013301597DAEF41FBE593A02CC513D0B55527EC2DF1050E2E8FF49C85C2AB473B21
```

6. Convert the entire string from hexadecimal to base58.

```
xpub661MyMwAqRbcFtXgS5sYJABqqG9YLmC4Q1Rdap9gSE8NqtwybGhePY2gZ29ESFjqJoCu1Rupje8YtGqsefD265TM
g7usUDFdp6W1EGMcet8
```

7. Compare the base58 value to the expected value from the BIP32 test vector.

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CHAPTER 7: ctbrowse - Token Browser

The **ctbrowse** utility is a Windows GUI application for creating tokens and objects that perform simple operations, such as encryption, decryption, signing and verification of a signature, using the mechanisms provided by the token.

This utility allows you to create or view a key pair and certificates. By selecting an object, you can view its properties. If a certificate object is selected, you can view the structure (ASN.1 format) of the certificate and encode it to various formats such as Base64 or DER.

With **ctbrowse**, you can create and verify a signature based on the signing mechanism.

ctbrowse is part of the ProtectToolkit-C SDK and is installed as part of that product. See the *ProtectToolkit-C Administration Guide* for more information.

Compliance

This application expects PKCS#11 V 2.20-compliant implementation and will use SafeNet extensions (see the next section) if they are available.

PKCS#11 Extensions Used

SafeNet's PKCS#11 implementation provides additional services beyond the standard definition of PKCS#11, particularly in the area of Certificate services. For example:

- Uses non-standard Attribute enumeration extension, although this version will fall back to standard methods to enumerate attributes where this extension is not available.
- PKCS#10 and X.509 creation from public key (see "Drag and Drop" on page 433)
- ASN.1 decoder/dumper
- Allows use of additional vendor defined mechanisms and extensions to PKCS#11

See "ProtectToolkit-C Mechanisms" on page 65 for a table of SafeNet vendor-defined mechanisms and extensions to PKCS#11.

Using ctbrowse with ProtectToolkit-J

ProtectToolkit-J is SafeNet's Java Cryptography Architecture (JCA) and Java Cryptography Extension provider (JCE) software.

Tokens and keys created with ProtectToolkit-J can be used and manipulated with **ctbrowse**. Likewise, any tokens and keys set up with **ctbrowse** will be fully compatible with ProtectToolkit-J. For more information, see Key Management in the *ProtectToolkit-J Reference Guide*.

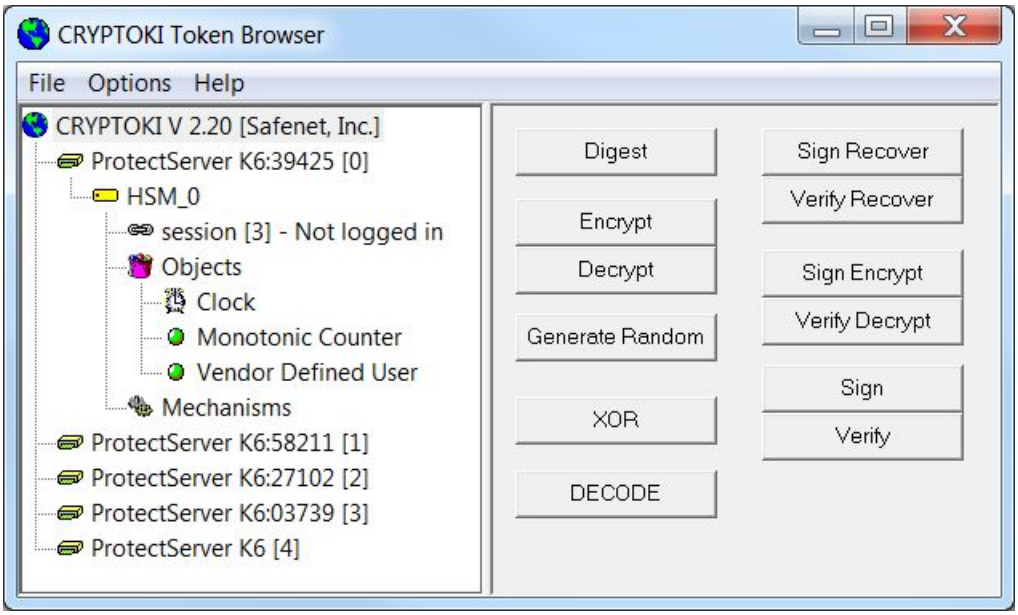
This chapter contains the following sections:

- "User Interface" on the next page
- "Token Management Services" on page 428

> "Cryptographic Services" on page 431
> "Drag and Drop" on page 433
> "Calculate Parameter Value for CK_RSA_PKCS_PSS_PARAMS" on page 434

User Interface

When opened, the **ctbrowse** window contains two panels, left and right. The left panel contains slots, tokens, and objects; the right panel contains services.



Initially, the left panel lists only one item, representing the linked PKCS#11 version. This item represents a tree control. Double-clicking items on the tree will expand the available slots. Double-click new slot items to show tokens in slots.

> **NOTE** More than one slot containing a token may be available. All slots can be opened and browsed independently.

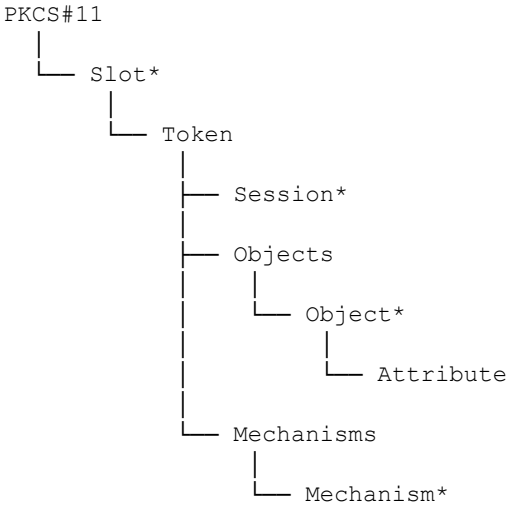
The left panel shows a typical **ctbrowse** session, where the first token (0) has been opened to display its objects and mechanisms. The numbers in square brackets [ ] represent the slot identifiers used to address these items.

The browser can show more than one slot and can be combined with other ProtectToolkit-C products, such as the remote client/server, ProtectToolkit-C ProtectServer (PCI adapter) and ProtectToolkit-C ProtectHost, to allow it to show slots from other PKCS#11 devices, including foreign (non-SafeNet) PKCS#11 devices.

Tree View

The figure below depicts the tree hierarchy. Tree items are identified by labeled icons. The * indicates more than one item at that level of the tree.

Figure 7: Tree Hierarchy



Token Management Services

Token management operations are invoked by right-clicking the desired tree item and selecting from the pop-up menu.

The table below lists the menu items available on each level of the tree hierarchy.

Tree Item	Service	Description
CRYPTOKI	Get info	Shows CRYPTOKI version, manufacturer and description.
Slot	Create token	Initializes a token on the slot selected. Note that this uses a nonstandard extension to PKCS#11. If a token already exists, the user will be prompted to confirm re-initialization of the token. Re-initialization will erase all information currently stored on the token.
	Get info	Shows slot ID, type, manufacturer and description
Token	Init token	Initializes a token and sets the security officer PIN. Note this will erase all the token's contents.
	Open Session	Opens a CRYPTOKI session to the token.
	Close all Sessions	Closes all open sessions for the token.
	Get info	Shows token type, manufacturer, model, serial number, etc.

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Tree Item	Service	Description
Session	Close session	Closes the right-clicked session.
	Login	Logs into the token.
	Logout	Logs out from the token.
	Init user PIN	Initializes the user PIN. Note: the security officer must be logged in to perform this operation.
	Set PIN	Set the PIN of the current user. This may be the security officer or normal user.
	Get info	Shows the session status and flags.
Objects	Create Object	Allows a new object to be created.
	Create Secret Key	Create a secret key. The key value is entered via the keyboard.
	Unwrap	Unwraps a previously wrapped key.
	Generate Key	Generate a secret key. The key value is randomly generated.
	Generate Key Pair	Generate an asymmetric key pair. The key value is randomly generated.
Object	Destroy	Deletes an object.
	Copy	Makes a copy of an object.
	Set attribute	Sets an attribute for an object.
	Wrap	Wraps a key value.
	Derive key	Derives a shared secret key using Diffie Hellmann. Derives a certificate request, or X.509 certificate.
	Show KVC	Calculates and displays the KVC of the object
	Get info	Shows object size and object handle number.

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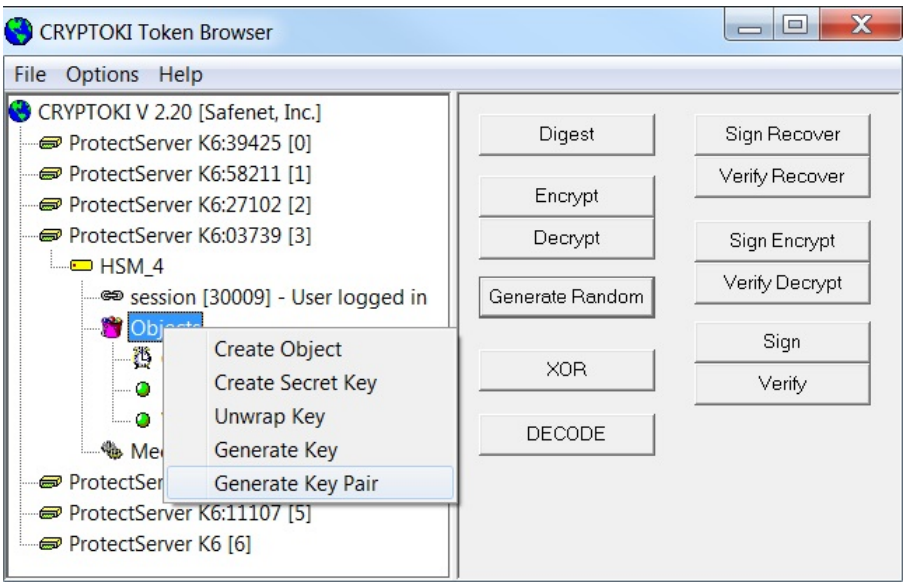
Tree Item	Service	Description
Attribute	Edit	Allows an attribute's value to be changed, imported or exported. Note that some attributes are defined by PKCS#11 to be unchangeable after being initially set. Attributes can be edited in ASCII or HEX and can also be viewed in Base-64 or decoded ASN.1 syntax for encoded values.
Mechanism	Get info	Shows mechanism info.

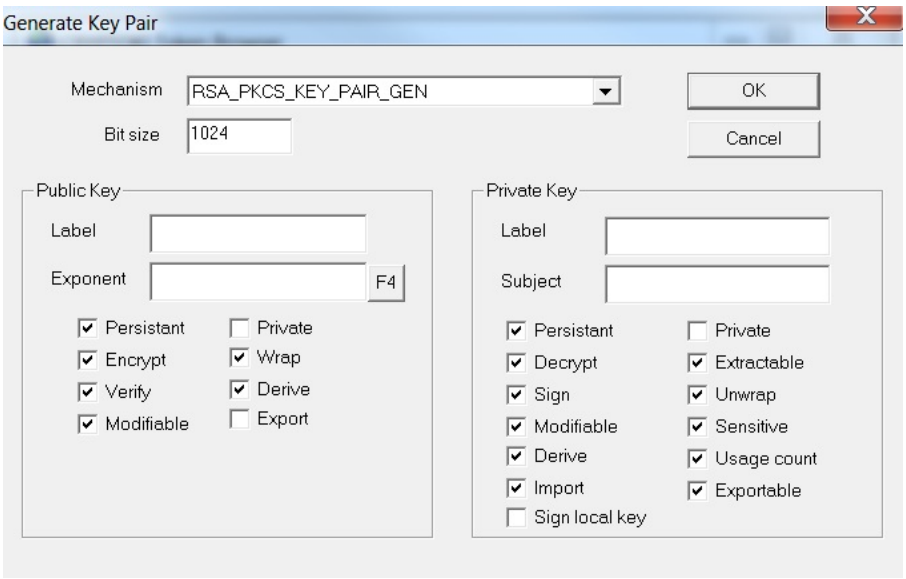
Example Service - Generate Key Pair

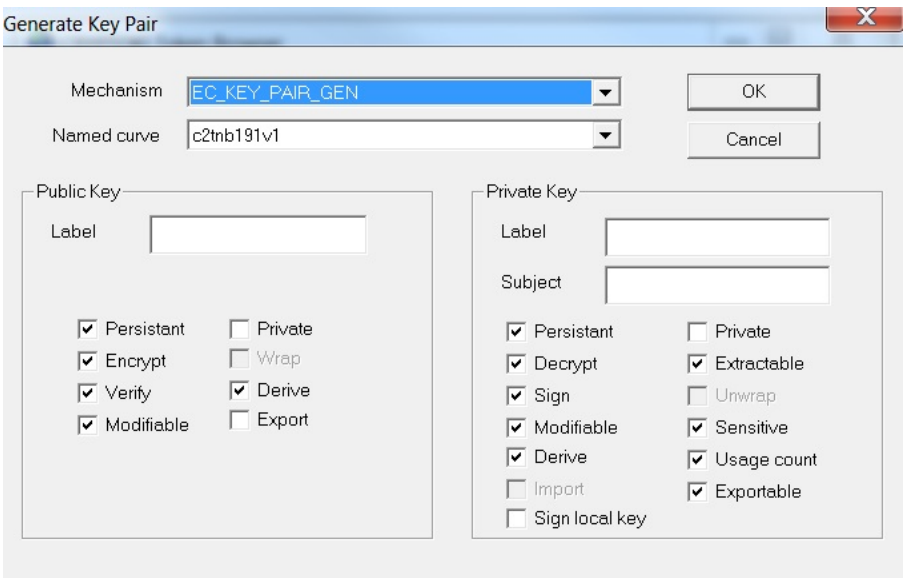
Generating a key pair is one of the management services available. The Generate Key Pair dialog is opened by right-clicking on an objects tree item in the Token Browser window and choosing Generate Key Pair from the popup context menu.



The figures below show how the labels and fields of the Generate Key Pair dialog box typically change according to the mechanism selected for key pair generation.

> **NOTE** The check boxes are enabled and disabled according to the selected Mechanism.



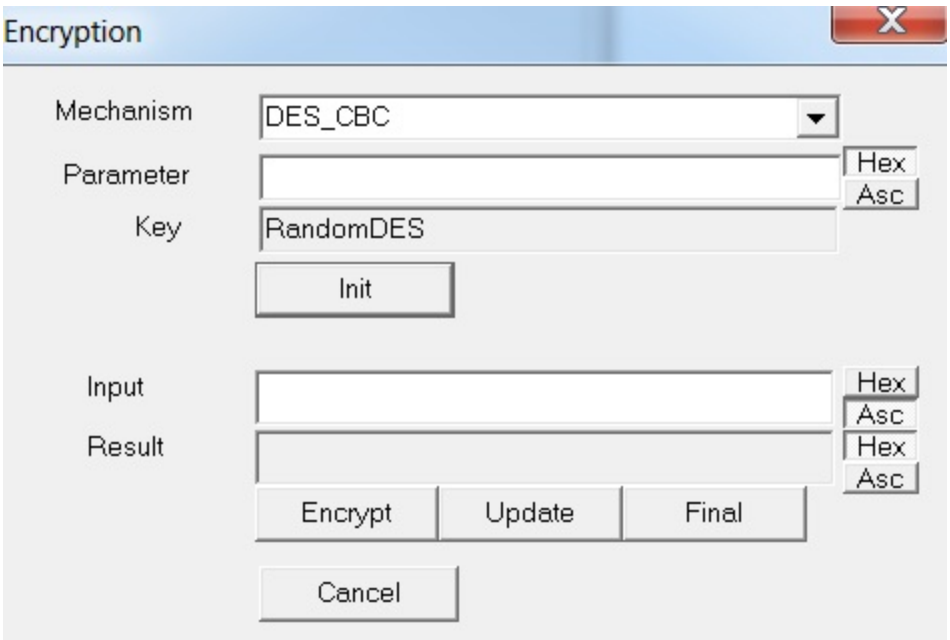


Cryptographic Services

The service buttons in the right-hand panel allow key objects to be used for cryptographic operations such as encryption and digital signing. To use these services, select the key item from the tree and then click the required button.

Clicking a button opens the associated dialog to guide the user through the operation of that service.

The next figure shows a typical dialog for Encrypt/decrypt and sign/verify services.



The **Key** field shows the type of key being used, and the **Mechanism** list shows mechanisms valid for the chosen key. A parameter for the mechanism should be entered if required. See "ProtectToolkit-C Mechanisms" on page 65 for more information on mechanism parameters.

The **Parameter**, **Input**, and **Result** fields all allow display in either hexadecimal or ASCII (text) format. The hexadecimal display is useful for the input, or display, of binary data that cannot normally be displayed. Use the **[Hex]/[Asc]** buttons to toggle between the two display options.

> **NOTE** These entry fields support cut-and-paste for easier input.

To encrypt information

1. Enter a parameter (if required by the mechanism).
2. Click **Init**.
3. Enter an **Input** value (information to be encrypted).
4. Click **Encrypt**.

   The encrypted text is displayed in the result field.

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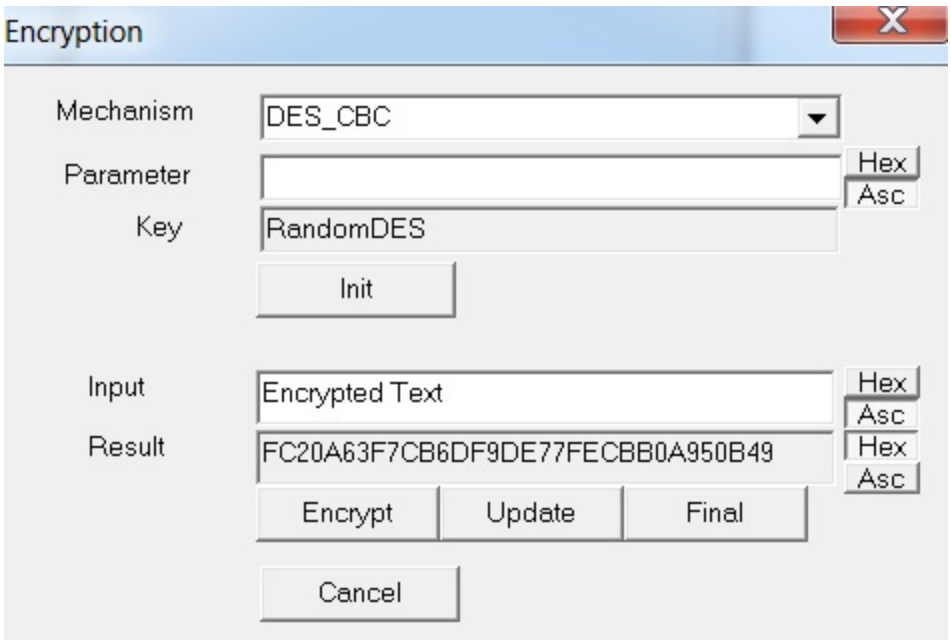

Drag and Drop

Objects such as key values can be copied from one token to another by dragging and dropping the object.

> **NOTE** The object must have the CKA_EXTRACTABLE attribute set to TRUE to allow this operation.

Dropping a public key object onto a private key object will create an X.509 certificate request (PKCS #10 format). This is used to encode a public key together with a subject name (the owner of the key) for distribution to a Certification Authority (CA).

The public key used is from the object being dragged. The subject's name is taken from the CKA_SUBJECT or CKA_SUBJECT_STR attributes of that public key. These attributes were supplied when the key was generated.

> **NOTE** Certificate Requests should be signed with the private key that matches the public key inside the certificate request. The certificate request is created as an object on the token from where the public key was taken.

The secret key used to sign the PKCS#10 encoding may be from another token, but should be the secret key that matches the public key being encoded.

Dropping a PKCS#10 certificate request object onto a private key object will create an X.509 certificate. X.509 certificates are the standard way to securely bind a public key together with a subject name (the owner of the key) for public distribution. X.509 certificates are normally signed by a trusted Certification Authority (CA), also known as the certificate's "issuer". The public key and subject name is extracted from the PKCS#10 object (the one being dragged) and the issuer's name is taken from the CKA_SUBJECT or CKA_SUBJECT_STR attributes of the private key used to sign the certificate (the target of the drag).

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X.509 certificates also have a serial number that is taken from the CKA_USAGE_COUNT attribute that must also be present on the signing key. The certificate is created as an object on the token from where the certificate was requested. The secret key used to sign the X.509 encoding may be from another token and is normally a highly trusted (CA) signing key.

Calculate Parameter Value for CK_RSA_PKCS_PSS_PARAMS

A new mechanism parameter structure was created, `CK_RSA_PKCS_PSS_PARAMS`, for use by `RSA_PKCS_PSS` mechanisms. When `RSA_PKCS_PSS` mechanisms are selected as signing mechanisms in **ctbrowse**, the parameter value must be properly configured. Providing an incorrect parameter value will result in **ctbrowse** reporting a Mechanism Invalid error.

To calculate the parameter value for CK_RSA_PKCS_PSS_PARAMS

1. To calculate the parameter value for `CKM_RSA_PKCS_PSS` mechanisms you must determine the value of **hashAlg**, **mgf**, and **sLen**.

Field	Value
hashAlg	The value for **hashAlg** is based on the mechanism selected from the Mechanism Field in **ctbrowse**. For example if the selected mechanism is `SHA265_RSA_PKCS_PSS` then the value for **hashAlg** would be `CKM_SHA256`.
mgf	The value for **mgf** is based on the mechanism selected from the Mechanism Field in **ctbrowse**. For example if the selected mechanism is `SHA265_RSA_PKCS_PSS` then the value for **mgf** would be `CKG_MGF1_SHA256`.
sLen	The length, in bytes, of the salt value used in the PSS encoding; typical values are the length of the message hash and zero. For example, if **hashAlg**, **mgf**, and **sLen** are 4 bytes each, the salt length value would be 0x0000000C.

2. Convert the value of **hashAlg**, **mgf**, and **sLen** to network byte order using **htonl**.
3. Enter the values in network byte order into the Parameter field in **ctbrowse** without any delimiters in the order of **hashAlg**, **mgf**, and **sLen**.
4. Select the **Init** button.

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CHAPTER 8: API Tutorial: Development of a Sample Application

This tutorial deals with one of the sample applications that are provided with ProtectToolkit-C, namely **frcypt**.

The **frcypt** application enables files to be encrypted for a given recipient and then decrypted by that recipient. Since the encrypted file contains a message authentication code (MAC), the recipient of a document will also be able to verify that the encrypted file was not modified.

In order to follow this example effectively, the reader is strongly encouraged to open or print the source of the application as a reference. The source code for **fcrypt** can be found in the file **fcrypt.c** within your chosen install directory.

> **NOTE** To avoid running into issues, move samples out of the installation directory before modifying, compiling, or running them.

This tutorial contains the following sections:

1. "Required Header Files" below
2. "Runtime Switches" on the next page
3. "Encrypt Functions" on the next page
4. "Decrypt Function" on page 442
5. "fcrypt Usage" on page 445
6. "Wrapped Encryption Key Template" on page 445
7. "Assembling the Application" on page 445

Required Header Files

You will note in the initial code segments that, apart from the standard header files, we include the ProtectToolkit-C set of required library files.

```
#include "cryptoki.h"
#include "ctextra.h"
#include "ctlutil.h"
#include "chkret.h"
```

Whereas **cryptoki.h** is the required PKCS#11 header, the remainder implement some of the advanced or extended features of the ProtectToolkit-C implementation, such as error feedback.

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Runtime Switches

We want to develop **fcrypt** to be able to take a series of command line inputs to allow us to decrypt a message, use password-based encryption (pbe) or to display time information for a cipher operation. With that in mind, the following flags are defined appropriately.

```
static int dflag = 0;
/* 1 - decrypt */static int tflag = 0;
/* 1 - time */static int pflag = 0;
/* 1 - use pbe */
```

Encrypt Functions

1. For our file encryption and subsequent decryption, we define the following two functions:

   ```
   int encryptFile( char * sender, char * recipient, char *ifile,char * ofile );
   int decryptFile( char * sender, char * recipient, char *ifile,char * ofile );
   ```

   We want the encrypt function to take the public key of the receiving party (recipient), encrypt the data (ifile) with the given key and sign the encrypted data with the sender's private key (sender), before outputting and encoding the file to the output file (ofile).

   For error handling purposes, we define the function as follows:

   ```
   #undef FN
   #define FN "encryptFile:"
   int encryptFile( char * sender, char * recipient,char * ifile, char * ofile )
   ```

2. We now need to define the required PKCS#11 data types pertaining to the session, slot identification, and object handles we will use for the sender and recipient keys.

   ```
   /* sender slot key session handles */
   CK_SLOT_ID hsSlot;
   CK_OBJECT_HANDLE hsKey = 0;
   CK_SESSION_HANDLE hsSession;
   /* recipient slot key session handles */
   CK_SLOT_ID hrSlot;
   CK_OBJECT_HANDLE hrKey;
   CK_SESSION_HANDLE hrSession;
   ```

3. We must also allocate variables to define the type of mechanism, digest, and key information during encryption.

   ```
   CK_RV rv; /* Return Value for PKCS#11 function */
   CK_MECHANISM mech; /* Structure for cipher mechanism
   */
   CK_BYTE iv[8]; /* Init. Vector used with CBC
   encryption */
   CK_BYTE digest[80];
   CK_SIZE len;
   CK_OBJECT_HANDLE hKey; /* random encrypting key */
   CK_BYTE wrappedKey[2 * 1024];
   CK_SIZE wrappedKeyLen;
   CK_BYTE signature[2 * 1024];
   unsigned long fileSize;
   unsigned long encodedSize;
   ```


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Earlier, we said that we wanted to be able to perform password-based encryption via a runtime switch, so accordingly this is the first instance that we check for with our **pflag** variable.

4. Our next step is to define our secret key that we will use to encrypt the data. The key type to be used is double-length DES. The CK_BBOOL refers to a byte-sized Boolean flag that we have defined as either `TRUE` or `FALSE` for easier reference.

   CK_ATTRIBUTE is a structure that includes the type, value, and length of an attribute. Since every PKCS#11 key object is required to be assigned certain attributes, this structure is later used during our key derivation and generation to assign those attributes to the key.

```
if ( pflag ) {
/* use PBE to do the encryption */
static CK_OBJECT_CLASS at_class = CKO_SECRET_KEY;
static CK_KEY_TYPE kt = CKK_DES2;
static const CK_BBOOL True = TRUE;
static const CK_BBOOL False = FALSE;
CK_ATTRIBUTE attr[] = {
{CKA_CLASS, &at_class, sizeof(at_class)},{CKA_KEY_TYPE, &kt, sizeof(at_class)},{CKA_
EXTRACTABLE, (void*)&True, sizeof(True)},{CKA_SENSITIVE, (void*)&False, sizeof(False)},{CKA_
DERIVE, (void*)&True, sizeof(True)}};
```

5. The **params** variable is defined using the PKCS#11 definition CK_PBE_PARAMS, a structure that provides all of the necessary information required by the PKCS#11 password-based encryption mechanisms.

```
CK_BYTE iv[8];
CK_PBE_PARAMS params;
memset(&params, 0x0, sizeof(CK_PBE_PARAMS));
params.pInitVector = iv;
params.pPassword = sender;
params.passwordLen = strlen(sender);
params.pSalt = NULL;
params.saltLen = 0;
params.iteration = 1;
```

6. PKCS#11 also uses a structure for defining the mechanism. Within `CK_MECHANISM` we need to specify the mechanism type, a pointer to the parameters we defined earlier and the size of the parameters. The mechanism type we will use is `CKM_PBE_SHA1_DES2_EDE_CBC` that is used for generating a 2-key triple-DES secret key and IV from a password and a salt value by using the SHA-1 digest algorithm and an iteration count.

```
memset(&mech, 0x0, sizeof(CK_MECHANISM));
mech.mechanism = CKM_PBE_SHA1_DES2_EDE_CBC;
mech.pParameter = &params;
mech.parameterLen = sizeof(CK_PBE_PARAMS);
```

7. We have now set up our required structures, and the next step is to open a session between the application and a token in a particular slot using the PKCS#11 call **C_OpenSession**. This call requires the slot ID flags which indicate the type of session, an application-defined pointer to be passed to the notification callback; an address of the notification callback function, and a pointer to the location that receives the handle for the new session.

```
rv = C_OpenSession(0, CKF_RW_SESSION|CKF_SERIAL_SESSION,NULL,NULL, &hsSession);
if ( rv ) return 1;
hrSession = hsSession;
```

8. Once we have successfully opened a session with the token, we now want to generate the key that we will use to encrypt our input file. The **C_GenerateKey** function will generate a secret key and thereby create a

new key object. This function call requires the session's handle, a pointer to the key generation mechanism, a pointer to the template for the new key, the number of attributes in the template and a pointer to the location that receives the handle of the new key.

The CHECK_RV() function call is part of the ProtectToolkit-C extended capability for better error feedback and handling.

```
rv = C_GenerateKey(hsSession, &mech, attr, NUMITEMS(attr),&hKey);
CHECK_RV(FN "C_GenerateKey:CKM_PBE_SHA1_DES2_EDE_CBC", rv);if ( rv ) return 1;
```

9. If we are not using the password-based encryption switch at program execution, the desired reaction is to perform file encryption using RSA, and hence we will need to generate the secret key value for the operation.

The function **FindKeyFromName** is part of the ProtectToolkit-C **CTUTIL** library to provide extended functionality. It is used here to locate the keys which are passed into **fcrypt** at the command line and return the slot ID, session handle and object handle of those keys.

```
else {
/* use RSA to encrypt the file */
/* locate encrypting key */
rv = FindKeyFromName(sender, CKO_PRIVATE_KEY,
&hsSlot, &hsSession, &hsKey);if ( rv ) {fprintf( stderr, "Unable to access sender
(%s)key\n",
sender );CHECK_RV(FN "FindKeyFromName", rv);if ( rv ) return 1;
}
/* locate signing key */
rv = FindKeyFromName(recipient, CKO_CERTIFICATE,
&hrSlot, &hrSession, &hrKey);if ( rv ) {rv = FindKeyFromName(recipient, CKO_PUBLIC_KEY,
  &hrSlot, &hrSession, &hrKey);
}
if ( rv ) {
fprintf( stderr, "Unable to access recipient (%s)
key\n", recipient );CHECK_RV(FN "FindKeyFromName", rv);if ( rv ) return 1;}
```

10. To achieve acceptable performance during file encryption and decryption we need to use a symmetric key cipher such as DES. The DES key we generate for this purpose is to be wrapped with the recipient's RSA key so it can later be unwrapped and used for decryption without the value of the key ever being known.

a. Rather than simply using the same key for each file encryption, we will generate a random DES key for each encryption of the input file. The mechanism used here is `CKM_DES2_KEY_GEN` that is used for generating double-length DES keys.

b. The key wrapping is performed with the **C_WrapKey** function that encrypts (wraps) a private or secret key. The function requires the session handle, the wrapping mechanism, the handle of the wrapping key, the handle of the key to be wrapped, a pointer to the location that receives the wrapped key and a pointer to the location that receives the length of the wrapped key.

c. For the wrapping mechanism we will choose `CKM_RSA_PKCS` that is a multi-purpose mechanism based on the RSA public-key cryptosystem and the block formats defined in PKCS #1. It supports single-part encryption and decryption, single-part signatures and verification with and without message recovery, key wrapping and key unwrapping.

```
/* create a random des key for the encryption */
memset(&mech,0,sizeof(mech));
mech.mechanism = CKM_DES2_KEY_GEN;
/* generate the key */
rv = C_GenerateKey(hrSession, &mech,
wrappedKeyTemp, NUMITEMS(wrappedKeyTemp), &hKey);
CHECK_RV(FN "C_GenerateKey", rv);
```


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```
if ( rv ) return 1;
/* wrap the encryption key with the recipients public key */
memset(&mech,0,sizeof(mech));
mech.mechanism = CKM_RSA_PKCS;
memset(wrappedKey,0,sizeof(wrappedKey));
wrappedKeyLen = sizeof(wrappedKey);
rv = C_WrapKey(hrSession, &mech, hrKey, hKey,
wrappedKey, &wrappedKeyLen);
CHECK_RV(FN "C_WrapKey", rv);
if ( rv ) return 1;
```

11. Now that we have a random secret key to perform the encryption with, we will need to set the required mechanism and parameters prior to encrypting the input file. As a mechanism for the encryption we will choose CKM_DES3_CBC_PAD which is using triple-DES in Cipher Block Chaining mode and PKCS#1 padding.

An application cannot call **C_Encrypt** in a session without having called **C_EncryptInit** first to activate an encryption operation. **C_EncryptInit** requires the session's handle, a pointer to the encryption mechanism and the handle of the encryption key.

In the same manner as we initialized and set up, our digest operation is to be the signature verification to send along to the recipient with the encrypted data. The mechanism used for our digest is SHA-1 that is defined in PKCS#11 terms as `CKM_SHA_1`.

```
/* set up the encryption operation using the random key */
memset(&mech, 0, sizeof(CK_MECHANISM));
mech.mechanism = CKM_DES3_CBC_PAD;
memset(iv, 0, sizeof(iv));
mech.pParameter = iv;
mech.parameterLen = sizeof(iv);
rv = C_EncryptInit(hrSession, &mech, hKey);
CHECK_RV(FN"C_EncryptInit", rv);
if ( rv ) return 1;
/* Set up the digest operation */
memset(&mech, 0, sizeof(CK_MECHANISM));
mech.mechanism = CKM_SHA_1;
rv = C_DigestInit(hrSession, &mech);
CHECK_RV(FN "C_DigestInit", rv);
if ( rv ) return 1;
```

12. We are now ready to process our input file by encrypting the data, generating the message digest and writing the output to file.

```
/*
** Process the file.
*/
{
FILE * ifp; /* input */
FILE * ofp; /* output */
 CK_SIZE curLen;
 CK_SIZE slen;
unsigned char buffer[10 * 1024];
unsigned char encbuffer[10 * 1024];
unsigned int br; /* bytes read */
unsigned int totbw; /* total bytes written */
/* open input and output file pointers */
ifp = fopen(ifile, "rb");
if ( ifp == NULL ) {
fprintf( stderr, "Cannot open %s for input\n",ifile );
```


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```
return -1;
}
ofp = fopen(ofile, "wb");
if ( ofp == NULL ) {
fprintf( stderr, "Cannot open %s for input\n",ofile ); return -1; }
```

If the password based encryption switch wasn't set, the first instance we write to file is the DES secret key wrapped by the recipient's public key.

```
if ( ! pflag ) {/* write the encrypted key to the output file */encodedSize = htonl
((unsigned long) wrappedKeyLen);br = fwrite(&encodedSize, 1, sizeof(encodedSize), ofp);br =
fwrite(wrappedKey, 1, (int)wrappedKeyLen, ofp);
}
/* get the file length */
{
struct _stat buf;
 int result;
result = _fstat( _fileno(ifp), &buf );
if( result != 0 ) {
fprintf( stderr, "Cannot get file size for
%s\n",
ofile );
return -1;
}
fileSize = buf.st_size;
/*
fileSize = _filelength(_fileno(ifp));
*/
}
fileSize = (fileSize + 8) & ~7; /* round up for padding */
/* write file size to output file */
encodedSize = htonl(fileSize); /* big endian */
br = fwrite(&encodedSize, 1, sizeof(encodedSize), ofp);
```

13. Since our mode of encryption is cipher block chaining (CBC) we need to perform our output using four definitive looping steps until our data is processed.

    a. For the digest we use the PKCS#11 function **C_Digest_Update**, which continues a multiple-part message-digesting operation, processing another data part. The function requires the session handle, a pointer to the data part and the length of the data part.

    b. For the encryption, we use **C_EncryptUpdate**, which continues a multiple-part encryption operation, processing another data part. The function requires the session handle, a pointer to the data part; the length of the data part; a pointer to the location that receives the encrypted data part and a pointer to the location that holds the length in bytes of the encrypted data part.

```
/* read, encrypt, digest and write the cipher text in chunks
*/ totbw = 0;
for ( ;; ) {
br = fread(buffer, 1, sizeof(buffer), ifp);
if ( br == 0 )
break;
/* digest */
rv = C_DigestUpdate(hrSession, buffer, (CK_SIZE)br); CHECK_RV(FN "C_DigestUpdate", rv);
if ( rv ) return 1;
/* encrypt */
curLen = sizeof(encbuffer);
rv = C_EncryptUpdate(hrSession, buffer, (CK_SIZE)br,   encbuffer, &curLen);
CHECK_RV(FN "C_EncryptUpdate", rv);
```

```
if ( rv ) return 1;
/* write cipher text */
br = fwrite(encbuffer, 1, (int)curLen, ofp);
totbw += br;}
```

14. Once all the data has been processed, we need to finalize the encryption and digest operation.

a. To finish the encryption, we use the **C_EncryptFinal** call, which finishes a multiple-part encryption operation. The function requires the session handle, a pointer to the location that receives the last encrypted data part, if any, and a pointer to the location that holds the length of the last encrypted data part.

b. For finalizing the digest, we call **C_DigestFinal**, which finishes a multiple-part message-digesting operation, returning the message digest. The function requires the session's handle, a pointer to the location that receives the message digest and a pointer to the location that holds the length of the message digest.

```
/* finish off the encryption */
curLen = sizeof(encbuffer);
rv = C_EncryptFinal(hrSession, encbuffer, &curLen);
CHECK_RV(FN "C_EncryptFinal", rv);
if ( rv ) return 1;
if ( curLen ) {
br = fwrite(encbuffer, 1, (int)curLen, ofp);
totbw += br;}
if ( totbw != fileSize ) {
fprintf( stderr, "size prediction incorrect %ld,
%ld\n", totbw, fileSize );}
/* finish off the digest */
len = sizeof(digest);
rv = C_DigestFinal(hrSession, digest, &len);
CHECK_RV(FN "C_DigestFinal", rv);
if ( rv ) return 1;
```

15. If the password-based encryption flag was set, we use the digest created in the above process as our signature, since there is no recipient key to sign the data with. For our DES encryption we will sign the digest with our recipient's public key.

a. The function **C_SignInit** is our first call and initializes a signature operation, where the signature is an appendix to the data. The function requires the session's handle, a pointer to the signature mechanism and the handle of the signature key.

b. We also need to specify a mechanism to use for our signature operation, in this case `CKM_RSA_PKCS`, which is an RSA PKCS #1 mechanism.

c. The signature generation is performed with the call to **C_Sign** that signs data in a single part, where the signature is an appendix to the data. The function requires the session's handle, a pointer to the data, the length of the data, a pointer to the location that receives the signature, and a pointer to the location that holds the length of the signature.

```
if ( pflag ) {
slen = len;
memcpy(signature, digest, slen);
}
else {/* Set up the signature operation */memset(&mech, 0, sizeof(CK_
MECHANISM));mech.mechanism = CKM_RSA_PKCS;rv = C_SignInit(hsSession, &mech, hsKey);CHECK_
RV(FN "C_SignInit", rv);if ( rv ) return 1;slen = sizeof(signature);rv = C_Sign
(hsSession, digest, len, signature, &slen);CHECK_RV(FN "C_SignInit", rv);if ( rv ) return
1;
```

```
}
/* write the signature to the file */
encodedSize = htonl((unsigned long) slen);
br = fwrite(&encodedSize, 1, sizeof(encodedSize), ofp);
br = fwrite(signature, 1, (int)slen, ofp);
/* clean up */
fclose(ifp);
fclose(ofp);
}
C_CloseSession(hrSession);
C_CloseSession(hsSession);
return 0;
}
```

Decrypt Function

For our decryption, we want to basically reverse the processes that were covered previously in the encryption section.

1. Following the initial function setup, we firstly check for our input and output files.
2. Once file existence is established, we test for our password-based encryption runtime switch. It can be seen that once again we generate the same secret key from the input password that we will need for the decryption. Since this was a secret key cipher, we use the same key for encryption as well as decryption.

```
#undef FN
#define FN "decryptFile:"
int decryptFile( char * sender, char * recipient,char * ifile, char * ofile )
{
 CK_SLOT_ID hsSlot;
 CK_OBJECT_HANDLE hsKey;
 CK_SESSION_HANDLE hsSession;
 CK_SLOT_ID hrSlot;
 CK_OBJECT_HANDLE hrKey;
 CK_SESSION_HANDLE hrSession;
 CK_RV rv;
 CK_MECHANISM mech;
 CK_BYTE digest[80];
 CK_SIZE len;
 CK_OBJECT_HANDLE hKey;
CK_BYTE wrappedKey[2 * 1024];
 CK_SIZE wrappedKeyLen;
CK_BYTE signature[2 * 1024];
 CK_BYTE iv[8];
unsigned long encodedSize;
FILE * ifp;
FILE * ofp;
 int br;
ifp = fopen(ifile, "rb");if ( ifp == NULL ) {fprintf( stderr, "Cannot open %s for
input\n",ifile );
return -1;
}
ofp = fopen(ofile, "wb");
if ( ofp == NULL ) {
fprintf( stderr, "Cannot open %s for input\n",ofile ); return -1; }
if ( pflag ) {/* use PBE to do the encryption */static CK_OBJECT_CLASS at_class = CKO_
SECRET_KEY;static CK_KEY_TYPE kt = CKK_DES2; static const CK_BBOOL True = TRUE;static const
```

```
CK_BBOOL False = FALSE;CK_ATTRIBUTE attr[] = {
  {CKA_CLASS, &at_class, sizeof(at_class)},   {CKA_KEY_TYPE, &kt, sizeof(at_class)},   {CKA_
EXTRACTABLE, (void*)&True,
sizeof(True)},
  {CKA_SENSITIVE, (void*)&False,
sizeof(False)},
  {CKA_DERIVE, (void*)&True, sizeof(True)} };CK_BYTE iv[8]; CK_PBE_PARAMS params; memset
(&params, 0x0, sizeof(CK_PBE_PARAMS));params.pInitVector = iv;params.pPassword =
sender;params.passwordLen = strlen(sender);params.pSalt = NULL;params.saltLen =
0;params.iteration = 1;
memset(&mech, 0x0, sizeof(CK_MECHANISM));mech.mechanism = CKM_PBE_SHA1_DES2_EDE_
CBC;mech.pParameter = &params;mech.parameterLen = sizeof(CK_PBE_PARAMS);
rv = C_OpenSession(0,
CKF_RW_SESSION|CKF_SERIAL_SESSION, NULL,
NULL, &hsSession);
if ( rv ) return 1;
hrSession = hsSession;
rv = C_GenerateKey(hsSession, &mech, attr,
NUMITEMS(attr),
&hKey);CHECK_RV(FN "C_GenerateKey:CKM_PBE_SHA1_DES2_EDE_CBC", rv);if ( rv ) return 1;
memset(&mech, 0x0, sizeof(CK_MECHANISM));mech.mechanism = CKM_SHA1_KEY_DERIVATION;
rv = C_DeriveKey(hsSession, &mech, hKey, attr,NUMITEMS(attr),&hrKey);CHECK_RV(FN "C_
DeriveKey:CKM_SHA1_KEY_DERIVATION", rv); if ( rv ) return 1;}
```

3. For our public key cipher, we will use the recipient's private RSA key to unwrap the secret DES key contained in the input file. The DES key will then be used to decrypt the file.

   The PKCS#11 function **C_UnwrapKey** is used to decrypt (unwrap) a wrapped key, creating a new private key or secret key object. This function requires the session handle, a pointer to the unwrapping mechanism, the handle of the unwrapping key, a pointer to the wrapped key, the length of the wrapped key, a pointer to the template for the new key, the number of attributes in the template, and a pointer to the location that receives the handle of the recovered key.

```
else {
/* decrypting */
rv = FindKeyFromName(sender, CKO_CERTIFICATE,
&hsSlot, &hsSession, &hsKey);if ( rv ) {rv = FindKeyFromName(sender, CKO_PUBLIC_KEY,
  &hsSlot, &hsSession, &hsKey);
}
if ( rv ) {
fprintf( stderr, "Unable to access sender (%s)key\n",
sender );CHECK_RV(FN "FindKeyFromName", rv);if ( rv ) return 1;
}rv = FindKeyFromName(recipient, CKO_PRIVATE_KEY,&hrSlot, &hrSession, &hrKey);if ( rv )
{fprintf( stderr, "Unable to access recipient (%s)
key\n", recipient );CHECK_RV(FN "FindKeyFromName", rv);if ( rv ) return 1;}
/* read the encrypted key to the file */br = fread(&encodedSize, 1, sizeof(encodedSize),
ifp);wrappedKeyLen = (CK_SIZE) ntohl((unsigned long)
encodedSize);br = fread(wrappedKey, 1, (int)wrappedKeyLen, ifp);
/* unwrap decryption key with the recipients private key
*/
memset(&mech,0,sizeof(mech));
mech.mechanism = CKM_RSA_PKCS;
rv = C_UnwrapKey(hrSession, &mech, hrKey,
  wrappedKey, wrappedKeyLen,   wrappedKeyTemp, NUMITEMS(wrappedKeyTemp),   &hKey );
CHECK_RV(FN "C_UnwrapKey", rv);
if ( rv ) return 1;
}
```

4. Now that we have recovered the decryption key, we perform our initialization in exactly the same manner as for our encryption, but using the function **C_DecryptInit**. The digest is calculated in the same manner used for the encryption.
5. For the file decryption we are using the functions **C_DecryptUpdate** and **C_DecryptFinal** which take the same parameters as their encrypt counterparts.

```
/* set up the decryption operation using the random key */
memset(&mech, 0, sizeof(CK_MECHANISM));
mech.mechanism = CKM_DES3_CBC_PAD;
memset(iv, 0, sizeof(iv));
mech.pParameter = iv;
mech.parameterLen = sizeof(iv);
rv = C_DecryptInit(hrSession, &mech, hKey);
CHECK_RV(FN"C_EncryptInit", rv);
if ( rv ) return 1;
/* Set up the digest operation */
memset(&mech, 0, sizeof(CK_MECHANISM));
mech.mechanism = CKM_SHA_1;
rv = C_DigestInit(hrSession, &mech);
CHECK_RV(FN "C_DigestInit", rv);
if ( rv ) return 1;
{
 CK_SIZE curLen;
 CK_SIZE slen;
unsigned char buffer[10 * 1024];
unsigned char decbuffer[10 * 1024];
unsigned int br;
br = fread(&encodedSize, 1, sizeof(encodedSize), ifp);
encodedSize = htonl(encodedSize);
for ( ;encodedSize > 0; ) {
br = sizeof(buffer);
if ( encodedSize < br )
br = (unsigned int)encodedSize;br = fread(buffer, 1, br, ifp);encodedSize -= br;if ( br ) {
  curLen = sizeof(decbuffer); rv = C_DecryptUpdate(hrSession, buffer,(CK_SIZE) br,
   decbuffer, &curLen);   CHECK_RV(FN "C_DecryptUpdate", rv); if ( rv ) return 1;rv = C_
DigestUpdate(hrSession, decbuffer,
curLen);  CHECK_RV(FN "C_DigestUpdate", rv); if ( rv ) return 1;br = fwrite(decbuffer, 1,
(unsigned
int)curLen,
ofp);
}}curLen = sizeof(decbuffer);rv = C_DecryptFinal(hrSession, decbuffer, &curLen);CHECK_RV(FN
"C_DecryptFinal", rv);
if ( rv ) return 1;if ( curLen ) {br = fwrite(decbuffer, 1, (unsigned int)curLen,
ofp); rv = C_DigestUpdate(hrSession, decbuffer, curLen);CHECK_RV(FN "C_DigestUpdate", rv);
}
len = sizeof(digest);
rv = C_DigestFinal(hrSession, digest, &len);
CHECK_RV(FN "C_DigestFinal", rv);
if ( rv ) return 1;
```

6. Finally, we verify the signature contained in the data file. Since the signature is identical to the digest when using the password-based encryption option, it is a simple matter of comparing the two. For our DES encryption on the other hand, we need to verify the signature against the sender's public key.

   To perform this we start by calling **C_VerifyInit** that initializes a verification operation, where the signature is an appendix to the data. This function requires the session's handle, a pointer to the structure that specifies the verification mechanism and the handle of the verification key.

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```
/* read the signature from the file */br = fread(&encodedSize, 1, sizeof(encodedSize),
ifp);slen = (CK_SIZE) ntohl((unsigned long) encodedSize);br = fread(signature, 1, (unsigned
int)slen, ifp);
if ( pflag ) {
if ( memcmp(digest, signature, len) ) {fprintf( stderr, "Verify failed\n" );return 1;
}
}
else {
/* Set up the signature verify operation */
memset(&mech, 0, sizeof(CK_MECHANISM));
mech.mechanism = CKM_RSA_PKCS;
rv = C_VerifyInit(hsSession, &mech, hsKey);
CHECK_RV(FN "C_VerifyInit", rv);
if ( rv ) return 1;
rv = C_Verify(hsSession, digest, len, signature, slen);
if ( rv ) {
C_ErrorString(rv,ErrorString,sizeof(ErrorString));fprintf( stderr, "Verify failed 0x%x,
%s\n", rv,   ErrorString ); }}
/* clean up */
fclose(ifp);
fclose(ofp);
}
C_CloseSession(hrSession);
C_CloseSession(hsSession);
return (int)rv;
}
```

fcrypt Usage

When no command line inputs are received by the application, it can be useful to show the required inputs on screen in a help context.

```
void usage(void){ printf( "usage fcrypt -d [-s<sender>] [-r<recipient>]
[-o<output file>] <input file>\n" );printf( " or\n" );printf( "usage fcrypt -d [-p<password>]
[-o<outputfile>]
<input file>\n" );printf( " -d decrypt\n" );printf( " -p PBE password\n" );printf( " -s Sender
name\n" );printf( " -r Recipient name\n" );printf( " -o output file name\n" );printf( " -t
Report timing info\n" );printf( "\nKey naming syntax :\n");printf( " <token name>(<user
pin>)/<key name>\n" );printf( " for example, -sAlice(0000)/Sign\n"
);}
```

Wrapped Encryption Key Template

The DES encryption key that we wrap with the user RSA key will need to have its attributes specified within a template as follows:

```
/* Wrapped encryption key template */static char True = TRUE;static CK_OBJECT_CLASS Class =
CKO_SECRET_KEY;static CK_KEY_TYPE Kt = CKK_DES2;static CK_ATTRIBUTE wrappedKeyTemp[] = {
{CKA_CLASS, &Class, sizeof(Class)},{CKA_KEY_TYPE, &Kt, sizeof(Kt)},{CKA_EXTRACTABLE, &True, 1},
{CKA_ENCRYPT, &True, 1},};
```

Assembling the Application

1. Now bring all the required components for the **fcrypt** application together in the main application body.

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```
#undef FN
#define FN "main:"
int main(int argc, char ** argv)
{  CK_RV rv; int err = 0;char * arg;char * sender = NULL; /* provides signing key */char *
recipient = NULL; /* provides encryption key */char * ofile = "file.enc"; /* default output
file name
*/ printf( "Cryptoki File Encryption $Revision: 1.1 $\n" );printf( "Copyright (c) SafeNet,
Inc 1999-2006\n" );
```

2. The first call within a PKCS#11 application must be **C_Initialize**, which initializes the PKCS#11 library. The function takes as an argument either value NULL_PTR or points to a CK_C_INITIALIZE_ARGS structure containing information on how the library should deal with multi-threaded access - no threading information is required for ProtectToolkit-C, so a NULL_PTR is used as the argument.
3. The function call to **CT_ErrorString** is part of the ProtectToolkit-C extended capability within **ctutil.h** and converts a PKCS#11 error code into a printable string.

```
/* This must be the first PKCS#11 call made */
rv = C_Initialize(NULL_PTR);
if ( rv ) {
C_ErrorString(rv,ErrorString,sizeof(ErrorString));fprintf(stderr, "C_Initialize error %x,
%s\n", rv,ErrorString);}
```

4. Since Thales supports versions of PKCS#11 that are incompatible with one another, the **CheckCryptokiVersion** function is called to ensure that an application compiled for V1.X compliance is not going to fail if it links against a V 2.X-compliant DLL and vice versa. This function is part of the extended ProtectToolkit-C functionality within **ctutil.h** and ensures that the version of PKCS#11 is correct.

```
/* Check PKCS#11 version */
rv = CheckCryptokiVersion();
if ( rv ) {printf( "Incompatible PKCS#11 version (0x%x)\n", rv ); return -1;
}
/* process command line arguments */
for ( argv++; (arg = *argv) != NULL; argv++ ) {
if ( arg[0] == '-' || arg[0] == '/' ) {
switch( arg[1] ) {
case 'd':
dflag = 1;break;
case 't':
  tflag = 1;
break;
case 'o':
  ofile = arg+2;
break;
case 's':
  sender = arg+2;
break;
case 'r':
  recipient = arg+2;
break;
case 'p': recipient = sender = arg+2;  pflag = 1; break;
default:
usage();
  return 1;
}
}
 else {
time_t now, t1, t2; /* we will time the     operation */
if ( sender == NULL || recipient == NULL ) {usage();  return 2;
```

```
}
if ( tflag ) {/* Mark the time now */for ( t1 = now = time(NULL); now == t1; )
   t1 = time(NULL);
}
/* process the file */if ( dflag )err = decryptFile( sender, recipient, arg,ofile );else err
= encryptFile( sender, recipient, arg,ofile );
/* report error or timing */if ( err ) {fprintf(stderr, "Error %scrypting file
    %s\n", dflag?"de":"en", arg ); }else if ( tflag ) {
  t2 = time(NULL);
  printf("%d seconds\n", t2-t1);
}
}
}
/* shut down PKCS#11 operations */
```

5. When the application is done using PKCS#11, it calls the PKCS#11 function **C_Finalize** and ceases to be a PKCS#11 application. It should be the last PKCS#11 call made by an application. The parameter is reserved for future versions and should be set to NULL_PTR.

```
rv = C_Finalize(NULL_PTR);
if ( rv ) {C_ErrorString(rv,ErrorString,sizeof(ErrorString));fprintf(stderr, "C_Finalize
error %x, %s\n", rv,
ErrorString);
}
return err;
```


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CHAPTER 9: PKCS#11 Logger Library

The logger library produces a log of all PKCS#11 function calls called by an application. It is a useful tool for debugging applications that are developed using the ProtectToolkit-C API.

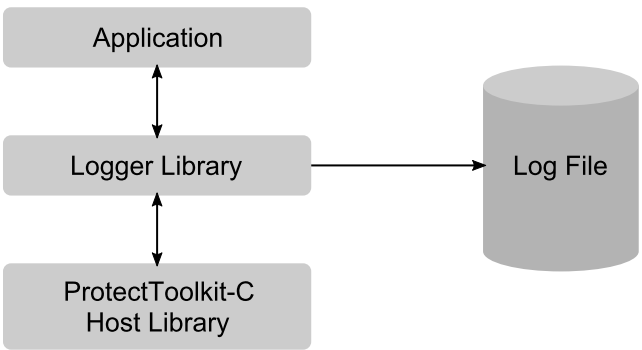
This library can be used with ProtectToolkit-C in any of the three operating modes; hardware, client/server or software only.

This chapter contains the following sections:

> "Logger Architecture and Functionality" below
> "Logger Setup" on the next page
> "Activating Logging" on the next page
> "Deactivating Logger Operation" on page 450

Logger Architecture and Functionality

Figure 8: PKCS#11 Logger Architecture Model



The logger is interposed between the application and the ProtectToolkit-C host library. There, it intercepts PKCS#11 function calls and responses. Details are logged to the log file before the messages are passed through to their intended destination.

For each PKCS#11 call, the logger creates an entry in the log file. By default, these entries contain the following details:

> the calling process ID (PID)
> the thread ID (TID)
> the date and time of the call
> all numeric data
> buffer addresses
> contents of buffer addresses at the input and output of functions (excluding PIN values)

Optionally, the logger may be configured to:

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- return the PIN values used to login to tokens that are provided to the **C_Login** function
- remove any or all of the following from the output:
- the calling process ID (PID)
- the thread ID (TID)
- the date and time of the call
- contents of buffer addresses at the input and output of functions

Logger Setup

As discussed above, the logger logs information passing between an application and the ProtectToolkit-C host library to a log file. The following configuration steps must be carried out *before starting the application*.

1. Activate logging by setting up redirection of ProtectToolkit-C host library calls sent from the application so that they are instead delivered to the logger.
2. Store the name and filepath of the ProtectToolkit-C host library file for the logger to use when forwarding the redirected calls it receives to their intended destination.

If required, you may also:

3. Change the name and location of the log file from the default values.
4. Change the amount of detail recorded by the logger from the default settings.

Each of these steps is covered in detail in the sections that follow. Once they have been carried out, the logger is active whenever the application is running. To deactivate the logger, see "Deactivating Logger Operation" on the next page.

Activating Logging

Logging is activated by setting up redirection of ProtectToolkit-C host library calls sent from the application so that they are instead delivered to the logger. This procedure differs between Windows and UNIX systems. To activate logging, consult the section below applicable to your operating system.

Windows Systems

To activate logging on a Windows-based system, ProtectToolkit-C host library calls are redirected to the logger by replacing the path to the ProtectToolkit-C host library (Cryptoki provider) with the path to the logger. This change can be made in either the Windows registry or the environment variables. The ProtectToolkit-C host library and the logger are both named **cryptoki.dll** so the application does not detect any difference and is unaffected by this change.

To enable the logger in the system environment variables

1. Edit the Environment Variables in the Windows Control Panel.
2. Create new system environment variables for ET_PTKC_LOGGER_FILE and ET_PTKC_LOGGER_PKCS11LIB. For more information about configuring these environment variables, refer to Logger Configuration Items.

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To enable the logger in the Windows registry

1. Open the Windows Registry Editor (**regedit.exe**).
2. Create a new key: **HKEY_LOCAL_MACHINE\SOFTWARE\Safenet\PTKC\LOGGER**
3. Under this key, create two string values for ET_PTKC_LOGGER_FILE and ET_PTKC_LOGGER_PKCS11LIB. For more information about the valid string values for these environment variables, refer to Logger Configuration Items.

UNIX Systems

To activate logging on a UNIX based system, ProtectToolkit-C host library calls are redirected to the logger by:

1. Reassigning the **libcryptoki.so** (**libcryptoki.sl** for HP-UX on PA-RISC, **libcryptoki.a** for AIX) symbolic link from the ProtectToolkit-C host library (Cryptoki provider) that was set up during installation to the logger shared library **liblogger.so** (**liblogger.sl** for HP-UX on PA-RISC, **liblogger.a** for AIX).
2. Including the logger library in the LD_LIBRARY_PATH (SHLIB_PATH for HP-UX on PA-RISC, LIBPATH on AIX) environment variable.

The application does not detect any difference and is unaffected by this change.

For example, use the following commands to reassign the **libcryptoki.so** symbolic link:

 # cd /opt/safenet/protecttoolkit5/ptk/lib # ln -sf liblogger.so libcryptoki.so

Changing Detail Recorded by the Logger

To change the level of detail recorded by the logger, override the default values of the following configuration items:

- ET_PTKC_LOGGER_LOGPID
- ET_PTKC_LOGGER_LOGTID
- ET_PTKC_LOGGER_LOGTIME
- ET_PTKC_LOGGER_LOGMEM
- ET_PTKC_LOGGER_LOGPIN

For more information about these configuration items, refer to Logger Configuration Items.

The changes can be made at the temporary, user or system levels on both UNIX and Windows platforms. Refer to Configuration Items in the *ProtectServer HSM and ProtectToolkit Installation Guide* for more information.

Deactivating Logger Operation

To deactivate the logger, the steps taken in "Activating Logging" on the previous page must be reversed. Consult the applicable section for your system.

Windows Systems

Delete the registry key or system environment variables you created to enable logging.

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To disable the logger in the Windows registry

1. Open the Windows Registry Editor (**regedit.exe**).
2. Delete the registry key: **HKEY_LOCAL_MACHINE\SOFTWARE\Safenet\PTKC\LOGGER**

To disable the logger in the system environment variables

1. Edit the Environment Variables in the Windows Control Panel.
2. Delete the following system environment variables:
   - **ET_PTKC_LOGGER_FILE**
   - **ET_PTKC_LOGGER_PKCS11LIB**

   For more information about the location of these environment variables, refer to Logger Configuration Items.

UNIX Systems

The symbolic link **libcryptoki.so** (**libcryptoki.sl** for HP-UX on PA-RISC, **libcryptoki.a** for AIX) must be re-assigned to the ProtectToolkit-C host library required.

For example, if ProtectToolkit-C is being used in hardware or client/server mode, the commands to use would be:

```
# cd /opt/safenet/protecttoolkit5/ptk/lib# ln -sf liblogger.so libcthsm.so
```

In software-only mode, use the following commands:

```
# cd /opt/safenet/protecttoolkit5/ptk/lib# ln -sf liblogger.so libctsw.so
```


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CHAPTER 10: PKCS#11 Command Reference

This chapter provides a reference guide to PKCS#11 functions. It contains the following sections:

- "General Purpose Functions" on the next page
- "Slot and Token Management Functions" on page 455
- "Session Management Functions" on page 463
- "Object Management Functions" on page 468
- "Encryption Functions" on page 473
- "Decryption Functions" on page 475
- "Message Digesting Functions" on page 477
- "Signing and MACing Functions" on page 479
- "Functions for Verifying Signatures and MACs" on page 481
- "Dual-function Cryptographic Functions" on page 484
- "Key Management Functions" on page 486
- "Random Number Generation Functions" on page 489
- "Parallel Function Management Functions" on page 490
- "Extra Functions" on page 491

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General Purpose Functions

This section describes the following PKCS#11 functions:

> "C_Initialize" below
> "C_Finalize" below
> "C_GetInfo" on the next page
> "C_GetFunctionList" on the next page

C_Initialize

C_INITIALIZE initializes the Cryptoki library.

The **pInitArgs** either has the value NULL_PTR or points to a CK_C_INITIALIZE_ARGS structure containing information on how the library should deal with multi-threaded access.

If the system is currently uninitialized, this function will perform a full initialization. This means that any configuration changes since the last full initialization will now take effect. If the system is already initialized, this function will simply prepare it for the new application.

Synopsis

```
C_Initialize(
        CK_VOID_PTR pInitArgs
);
```

Operation in WLD Mode

When ProtectToolkit is configured to operate in WLD mode and **C_INITIALIZE()** is invoked, the user slots associated with WLD slots are interrogated to assess their availability. User slots are defined as associated with a WLD slot when they contain a token with a token label that matches that of the WLD slot.

If, for every WLD slot, there are no associated user slots available, the error CKR_TOKEN_NOT_PRESENT is returned. If, however, at least one associated user slot is available for at least one WLD slot the error CKR_TOKEN_NOT_PRESENT will *not* be returned.

> **NOTE** The token labels for WLD slots are defined in the WLD environment variables ET_PTKC_WLD_SLOT_*n*. Refer to WLD System Setup in the "Cryptoki Configuration" section of the *ProtectToolkit-C Administration Guide* for details regarding configuration of WLD environment variables.

C_Finalize

This function behaves as specified in PKCS#11, but with the following additional features:

If there are no other active applications, ProtectToolkit-C will free all allocated resources. The next call to **C_INITIALIZE** will therefore perform a full initialization of the system updating for any configuration changes.

Synopsis

```
C_Finalize(
        CK_VOID_PTR pReserved
);
```


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C_GetInfo

This function behaves as specified in PKCS#11.

The cryptokiVersion value is 2.20.

The manufacturerId is "SafeNet, Inc."

The flags are all zero.

The libraryDescription is “Software Only”, “ProtectServer K7”, or "ProtectServer K6" as appropriate.

The libraryVersion represents the client version.

Synopsis

```
C_GetInfo(
        CK_INFO_PTR pInfo
);
```

C_GetFunctionList

This function behaves as specified in PKCS #11.

Synopsis

```
C_GetFunctionList(
        CK_FUNCTION_LIST_PTR_PTR_PTR ppFunctionList
);
```


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Slot and Token Management Functions

This section describes the following PKCS#11 functions:

- "C_GetSlotList" below
- "C_GetSlotInfo" on the next page
- "C_GetTokenInfo" on the next page
- "C_WaitForSlotEvent" on page 458
- "C_GetMechanismList" on page 458
- "C_GetMechanismInfo" on page 459
- "C_InitToken" on page 459
- "CT_InitToken" on page 460
- "CT_ResetToken" on page 460
- "C_InitPIN" on page 461
- "C_SetPIN" on page 461

C_GetSlotList

This function operates as specified in PKCS#11.

Note however that when multiple devices are installed in a single machine they will appear as a set of consecutive slots. For example, for two devices using their default configuration, 4 slots are visible. The first and third slots are normal user slots, the second and fourth slots are the Admin slots for their respective adapters.

Synopsis

```
C_GetSlotList(
        CK_BBOOL tokenPresent,
        CK_SLOT_ID_PTR pSlotList,
        CK_ULONG_PTR pulCount
);
```

Operation in WLD Mode

When ProtectToolkit is configured to operate in WLD mode, this function returns the list of slots specified in the WLD configuration. Specifically:

- When tokenPresent is FALSE, and pSlotList is NULL_PTR, the value *pulcount is set to hold the number of WLD Slots.
- When tokenPresent is FALSE, and pSlotList is not NULL_PTR, the value *pulcount is set to hold the number of WLD Slots and pSlotList contains the list of WLD Slots.
- When tokenPresent is TRUE, and pSlotList is NULL_PTR, the value *pulcount is set to hold the number of WLD Slots that have available HSM Tokens.
- When tokenPresent is TRUE, and pSlotList is not NULL_PTR, the value *pulcount is set to hold the number of WLD Slots that have available HSM Tokens and pSlotList contains the list of WLD Slots that have available HSM Tokens.

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C_GetSlotInfo

This function operates as specified in PKCS#11.

The information returned will vary depending on the ProtectToolkit-C runtime in use as well as the actual slot type, for example, if it is a ProtectToolkit-C user slot or a Smart Card slot.

This information is returned in the CK_SLOT_INFO structure.

SlotDescription	“ProtectServer :xxxx, “Safenet Software Only.” or smart card reader type.* where xxxx is the slot serialnumber
ManufacturerID	"SafeNet, Inc.” or smart card reader manufacturer.
Flags	CKF_HW_SLOT (hardware only), CKF_REMOVABLE_DEVICE (smart card slots only).
HardwareVersion	Current hardware revision or 0.0 for software only.
FirmwareVersion	Current firmware version or 0.0 for software only.

Synopsis

```
C_GetSlotInfo(
        CK_SLOT_ID slotID,
        CK_SLOT_INFO_PTR pInfo
);
```

Operation in WLD Mode

When ProtectToolkit is configured to operate in WLD mode, a random slot from the HSM Token List for the provided slot ID is chosen, so as not to overload a particular device and the command is forwarded to that slot. The following WLD specific information is returned in the CK_SLOT_INFO structure:

SlotDescription	The slot description specified for the virtual WLD Slot in environment variables ET_PTKC_WLD_SLOT_n. Refer to WLD System Setup in the "Cryptoki Configuration" section of the *ProtectToolkit-C Administration Guide* for details.
Flags	The CKF_WLD_SLOT bit is set to indicate that it is a WLD Slot. If there are no HSM Tokens available for the particular slot, then the CKF_TOKEN_PRESENT bit in is set to 0.[1]

[1] This breaks PKCS#11 compliance, as this bit should be set to 0 if and only if CKF_REMOVABLE_DEVICE is set. The CKF_REMOVABLE_DEVICE bit is set only for Smart card Slots in the SafeNet implementation.

C_GetTokenInfo

This function operates as specified in PKCS#11. The information returned will vary depending on the type of slot specified by the slotID parameter. This information is returned in the `CK_TOKEN_INFO` structure.

Label	This is the string specified by the user during the C_InitToken command, unless the token is the administration token, in which case the value is: AdminToken(ssss) Where ssss is the HSM serial number.
ManufacturerID	"SafeNet, Inc."
Model	"PSI-E2:PLxxx" Where xxx is the performance level or smartcard manufacturer.
SerialNumber	"xxxx-xxxx" Where the first field is the HSM serial number and the second field is a randomly assigned token serial number or the smartcard serial number.
Flags	CKF_RNG (for non-smart card slots only) + CKF_CLOCK_ON_TOKEN (if the module's clock has been set) + CKF_DUAL_CRYPTO_OPERATIONS + Other flags based on the current state of the slot. CKF_LOGIN_REQUIRED flag is set if the security mode specifies "no public crypto". Admin slot have CKF_ADMIN_TOKEN and CKF_LOGIN_REQUIRED set.
ulMaxSessionCount	The value of that CKA_MAX_SESSIONS for the associated slot object.
ulSessionCount	Determined at run time - this is the total number of session to this Token by all applications.
ulMaxRwSessionCount	The value of that CKA_MAX_SESSIONS for the associated slot object.
ulRwSessionCount	Determined at run time - this is the number of RW sessions the calling application has to the Token.
ulMaxPinLen	CK_MAX_PIN_LEN = 32.
UlMinPinLength	This is the value specified in the configuration as shown by the CKA_MIN_PIN attribute of the slot object.
UlTotalPublicMemory	Determined at run time.
ulFreePublicMemory	Determined at run time.
ulTotalPrivateMemory	Determined at run time.
ulFreePrivateMemory	Determined at run time.
hardwareVersion	'G'.0 (or later)
FirmwareVersion	1.0 (or later)

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UtcTime	Current time is returned if the modules clock has been set (else ASCII zeros are returned).

Synopsis

```
C_GetTokenInfo(
        CK_SLOT_ID slotID,
        CK_TOKEN_INFO_PTR pInfo
);
```

Operation in WLD Mode

When ProtectToolkit is configured to operate in WLD mode, a random slot from the HSM Token List for the provided slot ID is chosen, so as not to overload a particular device and the command is forwarded to that slot. The following WLD specific information is returned in the CK_TOKEN_INFO structure:

SerialNumber	The serial number specified for the virtual WLD Slot in environment variables ET_PTKC_WLD_SLOT_n. Refer to WLD System Setup in the "Cryptoki Configuration" section of the *ProtectToolkit-C Administration Guide* for details.
Flags	The CKF_WLD_TOKEN bit is set to indicate that it is a WLD Token.

C_WaitForSlotEvent

This function operates as specified in PKCS#11 except:

The library cannot block while waiting for an event therefore the `CKF_DONT_BLOCK` must always be set.

If `CKF_DONT_BLOCK` is not set and there is no event pending on any slot then:

`CKR_FUNCTION_FAILED` is returned.

Slot Events supported:

There are no events supported by this library.

Synopsis

```
C_WaitForSlotEvent(
        CK_FLAGS flags,
        CK_SLOT_ID_PTR pSlot,
        CK_VOID_PTR pReserved
);
```

C_GetMechanismList

This function operates as specified in PKCS#11.

See the section Mechanisms for a description of the mechanisms supported by this module.

Please note the list of mechanisms may vary at run time depending on Mode settings and other configuration values. For example the smart card slots do not support any mechanisms.

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Synopsis

```
C_GetMechanismList(
        CK_SLOT_ID slotID,
        CK_MECHANISM_TYPE_PTR pMechanismList,
        CK_ULONG_PTR pulCount
);
```

Operation in WLD Mode

When ProtectToolkit is configured to operate in WLD mode, a random slot from the HSM Token List for the provided slot ID is chosen, so as not to overload a particular device and the command is forwarded to that slot.

C_GetMechanismInfo

This function operates as specified in PKCS#11 with the following exception. Normally ProtectToolkit-C will return `CKR_MECHANISM_INVALID` if the mechanism type is not recognized, however, if the EntrustReady Mode is set, the structure pointed to by pInfo is cleared and `CKR_OK` is returned.

See the section Mechanisms for a description of the mechanisms supported by this module.

Synopsis

```
C_GetMechanismInfo(
        CK_SLOT_ID slotID,
        CK_MECHANISM_TYPE type,
        CK_MECHANISM_INFO_PTR pInfo
);
```

Operation in WLD Mode

When ProtectToolkit is configured to operate in WLD mode, a random slot from the HSM Token List for the provided slot ID is chosen, so as not to overload a particular device and the command is forwarded to that slot.

C_InitToken

This function operates as specified in PKCS#11 but with these following extensions. This function is *disabled* if the NoClearPINs flag is set in the Mode register. Any attempt to call this function in this mode will result in a result in the `CKR_ACCESS_DENIED` error being returned. The Administrator must use the `CT_ResetToken` function instead.

The “protected authentication path” is not applicable to this module.

The module will detect if a session is active on the token and, if so, return CKR_SESSION_EXISTS.

If the token has been already initialized and the module is not in Entrust-ready modes then the supplied pin is checked against the current SO pin. If the pin is correct, the token is wiped and the label is set (the SO pin is not changed).

If the token is currently uninitialized, or the module is in Entrust-ready mode, the token is wiped, and the new label and SO pin are set.

The Admin token may not be re-initialized, this function will return `CKR_SLOT_ID_INVALID` if the specified slot id is the admin token.

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Synopsis

```
C_InitToken(
        CK_SLOT_ID slotID,
        CK_CHAR_PTR pPin,
        CK_ULONG ulPinLen,
        CK_CHAR_PTR pLabel
);
```

Operation in WLD Mode

When ProtectToolkit is configured to operate in WLD mode, this function is not supported and will return the error CKR_FUNCTION_NOT_SUPPORTED.

CT_InitToken

This function is a SafeNet extension to PKCS#11, it allows the Administrator to initialize a new Token.

It initializes the token indicated by slotId with the SO pin (**pPin** and **ulPinLen**) and **pLabel**.

The session **hSession**, must be a session to the Admin Token of the adapter and be in RW User Mode for this function to succeed otherwise `CKR_SESSION_HANDLE_INVALID` is returned.

The **slotId** value must refer to a valid slot where the token in the slot must be in an un-initialized state, otherwise `CKR_SLOT_ID_INVALID` is returned. If the **slotID** is valid but the token is not present then `CKR_TOKEN_NOT_PRESENT` is returned.

Synopsis

```
CT_InitToken(
        CK_SESSION_HANDLE hSession,
        CK_SLOT_ID slotID,
        CK_CHAR_PTR pPin,
        CK_ULONG ulPinLen,
        CK_CHAR_PTR pLabel
);
```

Operation in WLD Mode

When ProtectToolkit is configured to operate in WLD mode, this function is not supported and will return the error CKR_FUNCTION_NOT_SUPPORTED.

CT_ResetToken

This function is a SafeNet extension to PKCS#11, it will erase (reset) the token which the session is connected to.

The session must be in RW SO Mode for this function to succeed otherwise `CKR_USER_NOT_LOGGED_IN` is returned.

This function allows Token Security Officers to reset a Token. The module will detect if other sessions are active on the token and, if so, return `CKR_SESSION_EXISTS`.

This function will erase all objects it can from the token - depending on the token type some objects will no be erased. The token is left in an initialized state where the SO pin and label are set as specified by the **pPin** and **pLabel** parameters.

> **NOTE** **pPin** becomes the new SO pin and need not match the old SO pin value. The session is automatically terminated by this call.

Synopsis

```
CT_ResetToken(
        CK_SESSION_HANDLE hSession,
        CK_CHAR_PTR pPin,
        CK_ULONG ulPinLen,
        CK_CHAR_PTR pLabel
);
```

Operation in WLD Mode

When ProtectToolkit is configured to operate in WLD mode, this function is not supported and returns the error CKR_FUNCTION_NOT_SUPPORTED.

C_InitPIN

This function operates as specified in PKCS#11 with the following extensions. When the module is in the NoClearPins mode, the host library protection system will encrypt the sensitive material before presenting it to the adapter.

The function returns an error if the Token has already had the user pin specified, that is, the SO does not have the rights to replace a user pin, only initialize it.

Synopsis

```
C_InitPIN(
        CK_SESSION_HANDLE hSession,
        CK_CHAR_PTR pPin,
        CK_ULONG ulPinLen
);
```

Operation in WLD Mode

When ProtectToolkit is configured to operate in WLD mode, this function is not supported and will return the error CKR_FUNCTION_NOT_SUPPORTED.

C_SetPIN

This function operates as specified in PKCS#11.

When the module is in the NoClearPINs mode the host library protection system will encrypt the sensitive material before presenting it to the adapter.

Synopsis

```
C_SetPIN(
        CK_SESSION_HANDLE hSession,
        CK_CHAR_PTR pOldPin,
        CK_ULONG ulOldLen,
        CK_CHAR_PTR pNewPin,
        CK_ULONG ulNewLen
);
```


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Operation in WLD Mode

When ProtectToolkit is configured to operate in WLD mode, this function is not supported and will return the error CKR_FUNCTION_NOT_SUPPORTED.

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Session Management Functions

> **NOTE**
> - The ProtectServer HSM supports up to 65534 concurrent sessions.
> - ProtectToolkit-C allows an application to have concurrent sessions with more than one token. It is also possible for a token to have concurrent sessions with more than one application.

This section describes the following PKCS#11 functions:

- "C_OpenSession" below
- "C_CloseSession" on the next page
- "C_CloseAllSessions" on the next page
- "C_GetSessionInfo" on the next page
- "C_GetOperationState" on page 465
- "C_SetOperationState" on page 465
- "C_Login" on page 466
- "C_Logout" on page 467

C_OpenSession

This function operates as specified in PKCS#11 with the following exceptions:

- The Notify parameter is ignored.
- The `CKF_SERIAL_SESSION` flag is ignored.
- PKCS#11 states “If the application calling `C_OpenSession` already has a R/W SO session open with the token, then any attempt to open a R/O session with the token fails with error code `CKR_SESSION_READ_WRITE_SO_EXISTS`” this is not enforced with ProtectToolkit-C.

Synopsis

```
C_OpenSession(
        CK_SLOT_ID slotID,
        CK_FLAGS flags,
        CK_VOID_PTR pApplication,
        CK_NOTIFY Notify,
        CK_SESSION_HANDLE_PTR phSession
);
```

Operation in WLD Mode

When ProtectToolkit is configured to operate in WLD mode, the first **C_OpenSession()** call selects a random token from the list of available WLD tokens to open the session with. Subsequent **C_OpenSession()** calls, randomly select a token from those with the least number of sessions.

If successful, a WLD session handle is returned. The WLD session handle is internally mapped to the appropriate HSM token and session handle.

If unsuccessful, for ANY reason, another token is chosen and ProtectToolkit-C retries to open a session utilizing this token. This is repeated until either a session is opened successfully or no more tokens are available.

If the HSM token used did not result in a session opening successfully for one of the following error conditions, the token will no longer be considered for WLD for the life of the application:

- CKR_GENERAL_ERROR
- CKR_DEVICE_ERROR
- CKR_MESSAGE_ERROR number space (SafeNet vendor defined)

> **NOTE** When the any of the above error conditions are detected **C_OpenSession()** will not return the associated error code as ProtectToolkit-C will retry to open a session using another token until all tokens are exhausted. If there are no tokens available the error CKR_TOKEN_NOT_PRESENT are returned.

C_CloseSession

This function operates as specified in PKCS#11 with the following exception:

- ProtectToolkit-C has no capability to “eject” the token from its reader.

Synopsis

```
C_CloseSession(
        CK_SESSION_HANDLE hSession
);
```

C_CloseAllSessions

This function operates as specified in PKCS#11 with the following exception:

- ProtectToolkit-C has no capability to “eject” the token from its reader. Further, this function will perform a “logout” on each token if necessary.

Synopsis

```
C_CloseAllSessions(
        CK_SLOT_ID slotID
);
```

C_GetSessionInfo

This function operates as specified in PKCS#11 with the following exception

- Any non-zero **ulDeviceError** value is cleared by this operation.

Synopsis

```
C_GetSessionInfo(
        CK_SESSION_HANDLE hSession,
        CK_SESSION_INFO_PTR pInfo
);
```


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Operation in WLD Mode

When ProtectToolkit is configured to operate in WLD mode, the following WLD specific information is returned in the CK_SESSION_INFO structure:

SlotID	The Slot Number specified for the virtual WLD Slot in environment variables ET_PTKC_WLD_SLOT_*n*. Refer to WLD System Setup in the "Cryptoki Configuration" section of the *ProtectToolkit-C Administration Guide* for more information.
Flags	The CKF_WLD_SESSION bit is set to indicate that it is a WLD Session.

C_GetOperationState

C_GetOperationState obtains a copy of the cryptographic Operation State for a session, encoded as a string of Bytes. **hSession** is the session's handle; **pOperationState** points to the location that receives the state; **pulOperationStateLen** points to the location that receives the length in bytes of the state.

ProtectToolkit-C implements a subset of the full PKCS#11 specification - only the current Message Digest state and object attribute search state may be saved and restored. This means that the current encryption, decryption, signing and verification states are not saved by this function.

The state need not have been obtained from the same session (the "source session") as it is being restored to (the "destination session"). However, the source session and destination session should have a common session state (e.g., CKS_RW_USER_FUNCTIONS), and should be with a common token. Message digest operation states may be carried across logins but not across different Cryptoki implementations.

Synopsis

```
C_GetOperationState(
        CK_SESSION_HANDLE hSession,
        CK_BYTE_PTR pOperationState,
        CK_ULONG_PTR pulOperationStateLen
);
```

Operation in WLD Mode

When ProtectToolkit is configured to operate in WLD mode, this function is not supported and will return the error CKR_FUNCTION_NOT_SUPPORTED.

C_SetOperationState

C_SetOperationState restores the cryptographic Operations State of a session from a string of bytes obtained with **C_GetOperationState**. ProtectToolkit-C implements a subset of the full PKCS#11 specification - only the current Message Digest state and object search state may be saved and restored.

hSession is the session's handle; **pOperationState** points to the location holding the saved state; **ulOperationStateLen** holds the length of the saved state; **hEncryptionKey** and **hAuthenticationKey** must be zero.

The state need not have been obtained from the same session (the "source session") as it is being restored to (the "destination session"). However, the source session and destination session should have a common session state (for example, `CKS_RW_USER_FUNCTIONS`), and should be with a common **tokenMessage** digest operation states may be carried across logins but not across different Cryptoki implementations.

If **C_SetOperationState** is supplied with a saved cryptographic Operations State, which it determines is not a valid saved State, it fails with the error `CKR_SAVED_STATE_INVALID`. Invalid States include cryptographic Operations State from a session with a different session state and cryptographic Operations State from a different token.

C_SetOperationState can successfully restore the message digest Operations State to a session, even if that session has an active message digest or object search operation when **C_SetOperationState** is called. The ongoing operations are abruptly cancelled. However if the saved state did not contain an active message digest operation and the current session does, then the **C_SetOperationState** function will have no effect on the current operation.

Synopsis

```
C_SetOperationState(
        CK_SESSION_HANDLE hSession,
        CK_BYTE_PTR pOperationState,
        CK_ULONG ulOperationStateLen,
        CK_OBJECT_HANDLE hEncryptionKey,
        CK_OBJECT_HANDLE hAuthenticationKey
);
```

Operation in WLD Mode

When ProtectToolkit is configured to operate in WLD mode, this function is not supported and will return the error CKR_FUNCTION_NOT_SUPPORTED.

C_Login

This function operates as specified in PKCS#11 with the following exceptions:

- If the security mode NoClearPINs is enabled, then the PIN value is encrypted by the host library before it is supplied to the module.
- To negate a brute force attack on the PIN, after the third failed attempt, a delay is imposed (incrementing in multiples of 5 seconds) until the next presented PIN is checked.

  For example, after the third failed attempt, the device imposes a delay of 1*5 seconds, after the fourth the delay is 2*5=10 seconds, after the fifth, the delay is 3*5=15 seconds, and so on.

  If a PIN presentation occurs before the delay period has expired, the attempt fails with CKR_PIN_LOCKED.

Synopsis

```
C_Login(
        CK_SESSION_HANDLE hSession,
        CK_USER_TYPE userType,
        CK_CHAR_PTR pPin,
        CK_ULONG ulPinLen
);
```

Operation in WLD Mode

When ProtectToolkit is configured to operate in WLD mode, the login state is replicated across all tokens in user slots associated with the same WLD slot. For example, if an application has 3 sessions, across 3 HSMs, with one session on each HSM then any change in the login state in one session, will result in the session on the other 2 HSMs being changed to the same session state.

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C_Logout

This function operates as specified in PKCS #11.

Synopsis

```
C_Logout(
        CK_SESSION_HANDLE hSession
);
```

Operation in WLD Mode

When ProtectToolkit is configured to operate in WLD mode, the login state is replicated across all tokens in user slots associated with the same WLD slot. For example, if an application has 3 sessions, across 3 HSMs, with one session on each HSM then any change in the login state in one session, will result in the session on the other 2 HSMs being changed to the same session state.

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Object Management Functions

This section describes the following PKCS#11 functions:

> "C_CreateObject" below
> "C_CopyObject" below
> "CT_CopyObject" on the next page
> "C_DestroyObject" on page 470
> "C_GetObjectSize" on page 470
> "C_GetAttributeValue" on page 470
> "C_SetAttributeValue" on page 471
> "C_FindObjectsInit" on page 471
> "C_FindObjects" on page 471
> "C_FindObjectsFinal" on page 472

C_CreateObject

This function operates as specified in PKCS#11 with the following exceptions:

If the security mode NoClearPINs is enabled, the host library version of the function will encrypt the template before submitting it to the module and the module function will verify the data was encrypted.

If the object is of type `CKO_PUBLIC_KEY`, `CKO_PRIVATE_KEY`, `CKO_CERTIFICATE` or `CKO_CERTIFICATE_REQUEST` and the key type is `CKK_RSA` or `CKK_DSA`, the key is checked for validity.

Synopsis

```
C_CreateObject(
        CK_SESSION_HANDLE hSession,
        CK_ATTRIBUTE_PTR pTemplate,
        CK_ULONG ulCount,
        CK_OBJECT_HANDLE_PTR phObject
);
```

C_CopyObject

This function operates as specified in PKCS#11. except that if the base object has a valid CKA_USAGE_LIMIT attribute then the base object is deleted after a successful copy.

> **NOTE** If the “Increased Security” flag is set as part of the security policy, then **C_CopyObject** does not allow changing the CKA_MODIFIABLE flag from **FALSE** to **TRUE**.

Synopsis

```
C_CopyObject(
        CK_SESSION_HANDLE hSession,
        CK_OBJECT_HANDLE hObject,
        CK_ATTRIBUTE_PTR pTemplate,
```


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```
        CK_ULONG ulCount,
        CK_OBJECT_HANDLE_PTR phNewObject
);
```

Operation in WLD Mode

When ProtectToolkit is configured to operate in WLD mode, this function is not supported and will return the error CKR_FUNCTION_NOT_SUPPORTED.

CT_CopyObject

This function is a SafeNet extension to PKCS #11. It is identical to the **C_CopyObject** function, except it is capable of copying objects from one token to another token where the two tokens belong to the same adapter.

> **NOTE** This function can only be used to copy objects whose attribute CKA_ EXTRACTABLE=TRUE.

This function copies an object from one session to another session, creating a new object for the copy.

- **hSourceSession** is the source session's handle;
- **hDestSession** is the destination's session handle;
- **hObject** is the object's handle;
- **pTemplate** points to the template for the new object;
- **ulCount** is the number of attributes in the template;
- **phNewObject** points to the location that receives the handle for the copy of the object.

Synopsis

```
CT_CopyObject(
        CK_SESSION_HANDLE hDestSession,
        CK_SESSION_HANDLE hSourceSession,
        CK_OBJECT_HANDLE hObject,
        CK_ATTRIBUTE_PTR pTemplate,
        CK_ULONG ulCount,
        CK_OBJECT_HANDLE_PTR phNewObject
);
```

If the base object has a valid CKA_USAGE_LIMIT attribute, then the base object is deleted after a successful copy.

The template may specify new values for any attributes of the object that can ordinarily be modified (for example: in the course of copying a secret key, a key's CKA_EXTRACTABLE attribute may be changed from **TRUE** to **FALSE**, but not the other way around. If this change is made, the new key's CKA_NEVER_EXTRACTABLE attribute will have the value **FALSE**.

Similarly, the template may specify that the new key's CKA_SENSITIVE attribute be **TRUE**; the new key will have the same value for its CKA_ALWAYS_SENSITIVE attribute as the original key). It may also specify new values of the CKA_TOKEN and CKA_PRIVATE attributes (e.g., to copy a session object to a token object).

If the template specifies a value of an attribute which is incompatible with other existing attributes of the object, the call fails with the return code `CKR_TEMPLATE_INCONSISTENT`.

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If a call to **CT_CopyObject** cannot support the precise template supplied to it, it will fail and return without creating any object.

Only session objects can be created during a read-only session. Only public objects can be created unless the normal user is logged in.

> **NOTE** If the “Increased Security” flag is set as part of the security policy, then **C_CopyObject** does not allow changing the CKA_MODIFIABLE flag from **FALSE** to **TRUE**.

C_DestroyObject

This function operates as specified in PKCS#11.

If the object has the optional attribute `CKA_DELETABLE` set to **FALSE** the object cannot be deleted with this function and `CKR_OBJECT_READ_ONLY` is returned.

Synopsis

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

C_GetObjectSize

This function operates as specified in PKCS#11.

ProtectToolkit-C interprets the object size to be the amount of memory guaranteed to be sufficient to encode the object’s attributes.

Synopsis

```
C_GetObjectSize(
        CK_SESSION_HANDLE hSession,
        CK_OBJECT_HANDLE hObject,
        CK_ULONG_PTR pulSize
);
```

C_GetAttributeValue

This function operates as specified in PKCS#11 with the following extensions. With ProtectToolkit-C it is possible to enumerate through all attributes for a given object. This extension is supported as follows.

Synopsis

```
C_GetAttributeValue(
        CK_SESSION_HANDLE hSession,
        CK_OBJECT_HANDLE hObject,
        CK_ATTRIBUTE_PTR pTemplate,
        CK_ULONG ulCount
);
```

The first call **C_GetAttributeValue** operates as follows to initialize the enumeration.

```
CK_ATTRIBUTE at;
rv = C_GetAttributeValue(hSession, hObject, &at, 0);
```


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Then, to get all the attributes, loop as follows:

```
for (;;) {
        at.type = CKA_ENUM_ATTRIBUTE;
        at.pValue = 0;
        rv = C_GetAttributeValue(hSession, hObject, &at, 1);
        if ( rv == CKR_ATTRIBUTE_TYPE_INVALID )
        break; /* got all the attributes */
}
```

Sensitive attributes are returned with the type and length information but an empty value, and also return a result value of CKR_ATTRIBUTE_SENSITIVE. On implementations where this extension is not supported, the calls to **C_GetAttributeType** are likely to fail with the CKR_ATTRIBUTE_TYPE_INVALID error code.

With a result code of CKR_OK or CKR_ATTRIBUTE_SENSITIVE, the CK_ATTRIBUTE structure has the type and **valueLen** fields set appropriately for the next attribute, however the **pValuefield** will be NULL_PTR. To retrieve the actual value of the attribute, it is necessary to allocate the required room for the value and then make a second call to **C_GetAttributeValue**.

Special processing or access checks may be made if the object is a Hardware Feature. See "Hardware Feature Objects" on page 39.

C_SetAttributeValue

This function operates as specified in PKCS#11.

Special processing or access checks may be made if the object is a Hardware Feature. See "Hardware Feature Objects" on page 39.

Synopsis

```
C_SetAttributeValue(
        CK_SESSION_HANDLE hSession,
        CK_OBJECT_HANDLE hObject,
        CK_ATTRIBUTE_PTR pTemplate,
        CK_ULONG ulCount
);
```

C_FindObjectsInit

This function operates as specified in PKCS#11 with the following exception:

PKCS#11 states that to match `CKO_HW_FEATURE` objects this class must be specified in the supplied template. ProtectToolkit-C does not enforce this requirement.

Synopsis

```
C_FindObjectsInit(
        CK_SESSION_HANDLE hSession,
        CK_ATTRIBUTE_PTR pTemplate,
        CK_ULONG ulCount
);
```

C_FindObjects

This function operates as specified in PKCS#11.

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Synopsis

```
C_FindObjects(CK_SESSION_HANDLE hSession,
        CK_OBJECT_HANDLE_PTR phObject,
        CK_ULONG ulMaxObjectCount,
        CK_ULONG_PTR pulObjectCount
);
```

C_FindObjectsFinal

This function operates as specified in PKCS#11.

Synopsis

```
C_FindObjectsFinal(
        CK_SESSION_HANDLE hSession
);
```


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Encryption Functions

This section describes the following PKCS#11 encryption functions:

> "C_EncryptInit" below
> "C_Encrypt" below
> "C_EncryptUpdate" on the next page
> "C_EncryptFinal" on the next page

C_EncryptInit

This function operates as specified in PKCS#11.

The session will retain its initialized state even when a **C_Encrypt** or **C_EncryptFinal** operation has occurred.

If the `CKF_LOGIN_REQUIRED` flag is set for the Token associated with the provided session the session state must be either `CKS_RW_USER_FUNCTIONS`, or `CKS_RO_USER_FUNCTIONS` otherwise the error result `CKR_USER_NOT_LOGGED_IN` is returned.

If the **hKey** parameter refers to a certificate object this function will perform the same certificate verification as specified in the `C_VerifyInit` function.

If the object referenced by the **hKey** parameter has the `CKA_USAGE_COUNT` attribute its value is incremented by this function.

Synopsis

```
C_EncryptInit(
        CK_SESSION_HANDLE hSession,
        CK_MECHANISM_PTR pMechanism,
        CK_OBJECT_HANDLE hKey
);
```

C_Encrypt

This function operates as specified in PKCS#11 except for the following:

> Symmetric cipher operations are terminated by this function.
> **C_Encrypt** can be used to terminate a multi-part operation.

  Although this function will terminate the current encryption operation, the session's encryption state will not be cleared.

> **NOTE** If the mechanism in use is a multi-part mechanism and the data supplied exceeds a single block, that portion of the data is processed regardless of the result returned by the call. For example if 12 bytes are passed to a DES ECB operation, 8 bytes are processed even though an error result (due to the padding requirements not being met) is returned.

Cryptoki specifies that a successful return from one of these functions (when not used for length prediction) should result in the cipher state of that session being reset (to the uninitialized state). ProtectToolkit-C, however, leaves the state initialized so that another operation (using the same key) may be performed without calling the appropriate **C_xxxInit** function.

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Synopsis

```
C_Encrypt(
        CK_SESSION_HANDLE hSession,
        CK_BYTE_PTR pData,
        CK_ULONG ulDataLen,
        CK_BYTE_PTR pEncryptedData,
        CK_ULONG_PTR pulEncryptedDataLen
);
```

C_EncryptUpdate

This function operates as specified in PKCS#11.

Synopsis

```
C_EncryptUpdate(
        CK_SESSION_HANDLE hSession,
        CK_BYTE_PTR pPart,
        CK_ULONG ulPartLen,
        CK_BYTE_PTR pEncryptedPart,
        CK_ULONG_PTR pulEncryptedPartLen
);
```

C_EncryptFinal

This function operates as specified in PKCS#11.

Although this function will terminate the current encryption operation the session's encryption state will not be cleared.

Cryptoki specifies that a successful return from one of these functions (when not used for length prediction) should result in the cipher state of that session being reset (to the uninitialized state). ProtectToolkit-C, however, leaves the state initialized so that another operation (using the same key) may be performed without calling the appropriate **C_xxxInit** function.

Synopsis

```
C_EncryptFinal(
        CK_SESSION_HANDLE hSession,
        CK_BYTE_PTR pLastEncryptedPart,
        CK_ULONG_PTR pulLastEncryptedPartLen
);
```


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Decryption Functions

This section describes the following PKCS#11 decryption functions:

> "C_Decrypt" below
> "C_Decrypt" below
> "C_DecryptUpdate" on the next page
> "C_DecryptFinal" on the next page

C_DecryptInit

This function operates as specified in PKCS#11.

The session will retain its initialized state even when a `C_Decrypt` or `C_DecryptFinal` operation has occurred.

If the `CKF_LOGIN_REQUIRED` flag is set for the Token associated with the provided session the session state must be either `CKS_RW_USER_FUNCTIONS` or `CKS_RO_USER_FUNCTIONS`,otherwise the error result `CKR_USER_NOT_LOGGED_IN` is returned.

If the object referenced by the **hKey** parameter has the `CKA_USAGE_COUNT` attribute its value is incremented by this function.

Synopsis

```
C_DecryptInit(
        CK_SESSION_HANDLE hSession,
        CK_MECHANISM_PTR pMechanism,
        CK_OBJECT_HANDLE hKey
);
```

C_Decrypt

This function operates as specified in PKCS#11 except for the following:

Symmetric cipher operations are terminated by this function. Although this function terminates the current decryption operation the session's decryption state is not cleared.

> **NOTE** If the mechanism in use is a multi-part mechanism and the data supplied exceeds a single block, that portion of the data is processed regardless of the result returned by the call. For example if 12 bytes are passed to a DES ECB operation, 8 bytes are processed even though an error result (due to the padding requirements not being met) is returned.

Cryptoki specifies that a successful return from one of these functions (when not used for length prediction) should result in the cipher state of that session being reset (to the uninitialized state). ProtectToolkit-C, however, leaves the state initialized so that another operation (using the same key) may be performed without calling the appropriate **C_xxxInit** function.

Synopsis

```
C_Decrypt(
        CK_SESSION_HANDLE hSession,
        CK_BYTE_PTR pEncryptedData,
        CK_ULONG ulEncryptedDataLen,
```


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```
        CK_BYTE_PTR pData,
        CK_ULONG_PTR pulDataLen
);
```

C_DecryptUpdate

This function operates as specified in PKCS#11.

Synopsis

```
C_DecryptUpdate(CK_SESSION_HANDLE hSession,
        CK_BYTE_PTR pEncryptedPart,
        CK_ULONG ulEncryptedPartLen,
        CK_BYTE_PTR pPart,
        CK_ULONG_PTR pulPartLen
);
```

C_DecryptFinal

This function operates as specified in PKCS#11.

Although this function will terminate the current encryption operation the session's decryption state will not be cleared.

Cryptoki specifies that a successful return from one of these functions (when not used for length prediction) should result in the cipher state of that session being reset (to the uninitialized state). ProtectToolkit-C, however, leaves the state initialized so that another operation (using the same key) may be performed without calling the appropriate **C_xxxInit** function.

Synopsis

```
C_DecryptFinal(
        CK_SESSION_HANDLE hSession,
        CK_BYTE_PTR pLastPart,
        CK_ULONG_PTR pulLastPartLen
);
```


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Message Digesting Functions

This section describes the following PKCS#11 functions:

> "C_DigestInit" below
> "C_Digest" below
> "C_DigestUpdate" below
> "C_DigestKey" below
> "C_DigestFinal" on the next page

C_DigestInit

This function operates as specified in PKCS#11. Note that it is not required for the user to be logged in to access this function.

Synopsis

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

C_Digest

This function operates as specified in PKCS#11.

Synopsis

```
C_Digest(
        CK_SESSION_HANDLE hSession,
        CK_BYTE_PTR pData,
        CK_ULONG ulDataLen,
        CK_BYTE_PTR pDigest,
        CK_ULONG_PTR pulDigestLen
);
```

C_DigestUpdate

This function operates as specified in PKCS#11.

Synopsis

```
C_DigestUpdate(
        CK_SESSION_HANDLE hSession,
        CK_BYTE_PTR pPart,
        CK_ULONG ulPartLen
);
```

C_DigestKey

This function operates as specified in PKCS#11, although it may be used on any PKCS#11 object.

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If the CKF_LOGIN_REQUIRED flag is set for the Token associated with the provided session the session state must be either CKS_RW_USER_FUNCTIONS or CKS_RO_USER_FUNCTIONS,otherwise the error result CKR_USER_NOT_LOGGED_IN is returned.

Synopsis

```
C_DigestKey(
        CK_SESSION_HANDLE hSession,
        CK_OBJECT_HANDLE hKey
);
```

C_DigestFinal

This function operates as specified in PKCS#11.

Synopsis

```
C_DigestFinal(
        CK_SESSION_HANDLE hSession,
        CK_BYTE_PTR pDigest,
        CK_ULONG_PTR pulDigestLen
);
```


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Signing and MACing Functions

This section describes the following PKCS#11 functions:

> "C_SignInit" below
> "C_Sign" below
> "C_SignUpdate" below
> "C_SignFinal" on the next page
> "C_SignRecoverInit" on the next page
> "C_SignRecover" on the next page

C_SignInit

This function operates as specified in PKCS#11.

In addition it is required to specify the signing key and signing mechanism used to create X509 certificates with the `CKM_ENCODE_X_509`, `CKM_ENCODE_LOCAL_CERT` and `CKM_ENCODE_PKCS10` mechanisms.

If the `CKF_LOGIN_REQUIRED` flag is set for the Token associated with the provided session, the session state must be either `CKS_RW_USER_FUNCTIONS`, or `CKS_RO_USER_FUNCTIONS` otherwise the error result `CKR_USER_NOT_LOGGED_IN` is returned.

If the object referenced by the **hKey** parameter has the `CKA_USAGE_COUNT` attribute its value is incremented by this function.

Synopsis

```
C_SignInit(
        CK_SESSION_HANDLE hSession,
        CK_MECHANISM_PTR pMechanism,
        CK_OBJECT_HANDLE hKey
);
```

C_Sign

This function operates as specified in PKCS#11.

Synopsis

```
C_Sign(
        CK_SESSION_HANDLE hSession,
        CK_BYTE_PTR pData,
        CK_ULONG ulDataLen,
        CK_BYTE_PTR pSignature,
        CK_ULONG_PTR pulSignatureLen
);
```

C_SignUpdate

This function operates as specified in PKCS#11.

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Synopsis

```
C_SignUpdate(
        CK_SESSION_HANDLE hSession,
        CK_BYTE_PTR pPart,
        CK_ULONG ulPartLen
);
```

C_SignFinal

This function operates as specified in PKCS#11.

Synopsis

```
C_SignFinal(CK_SESSION_HANDLE hSession,
        CK_BYTE_PTR pSignature,
        CK_ULONG_PTR pulSignatureLen
);
```

C_SignRecoverInit

This function operates as specified in PKCS#11.

If the `CKF_LOGIN_REQUIRED` flag is set for the Token associated with the provided session the session state must be either `CKS_RW_USER_FUNCTIONS`, or `CKS_RO_USER_FUNCTIONS` otherwise the error result `CKR_USER_NOT_LOGGED_IN` is returned.

If the object referenced by the **hKey** parameter has the `CKA_USAGE_COUNT` attribute its value is incremented by this function.

Synopsis

```
C_SignRecoverInit(
        CK_SESSION_HANDLE hSession,
        CK_MECHANISM_PTR pMechanism,
        CK_OBJECT_HANDLE hKey
);
```

C_SignRecover

This function operates as specified in PKCS#11.

Synopsis

```
C_SignRecover(
        CK_SESSION_HANDLE hSession,
        CK_BYTE_PTR pData,
        CK_ULONG ulDataLen,
        CK_BYTE_PTR pSignature,
        CK_ULONG_PTR pulSignatureLen
);
```


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Functions for Verifying Signatures and MACs

This section describes the following PKCS#11 functions:

> "C_VerifyInit" below
> "C_Verify" on the next page
> "C_VerifyUpdate" on the next page
> "C_VerifyFinal" on the next page
> "C_VerifyRecoverInit" on the next page
> "C_VerifyRecover" on page 483

C_VerifyInit

This function operates as specified in PKCS#11.

If the `CKF_LOGIN_REQUIRED` flag is set for the Token associated with the provided session the session state must be either `CKS_RW_USER_FUNCTIONS` or `CKS_RO_USER_FUNCTIONS`,otherwise the error `CKR_USER_NOT_LOGGED_IN` is returned.

If the object referenced by the **hKey** parameter has the `CKA_USAGE_COUNT`attribute its value is incremented by this function.

ProtectToolkit-C also allows that **hKey** may specify a certificate object in place of a public key. In this case the certificate object is verified with the algorithm below. If this verification succeeds the session is initialized using the public key stored in the certificate. If the verification fails `CKR_INVALID_KEY` is returned and the session is not initialized. Further the certificate object's `CKA_TRUST_LEVEL` is updated to indicate that the verification has failed.

To perform the certificate verification the object's CKA_TRUSTED is checked. If it has the value **TRUE** the verification succeeds. If the attribute has the value **FALSE** the certificate is validated.

For self-signed certificates (that is, where the subject and the issuer are the same) the certificate is validated if the `CKA_TRUSTED` is **TRUE** and the certificate's signature is correct. If `CKA_TRUSTED` is **FALSE** for a self-signed certificate then the validation fails with `CKR_CERT_NOT_VALIDATED`. If the certificate is not self-signed, a search is made for the issuer's certificate which is the certificate whose `CKA_SUBJECT` matches the `CKA_ISSUER` of the current certificate. If the issuer's certificate is not found, the verification fails. If a matching issuer's certificate is found the verification algorithm is performed on that certificate, and if that succeeds the original certificate's signature is verified. Issuer certificate validation will continue recursively up the certificate chain until a trusted certificate (self signed or not) is reached or a certificate in the chain fails validation for any reason including not being present.

> **NOTE** This function does not enforce certificate expiry or key usage flags store in the certificate. Rather it relies on the standard Cryptoki attributes. This function will not always fail when an inappropriate key type is supplied. For example, if a private key is supplied to the function, it may succeed. In this case, however, the **C_Verify** will never return CKA_OK.

Synopsis

```
C_VerifyInit(
        CK_SESSION_HANDLE hSession,
```

```
        CK_MECHANISM_PTR pMechanism,
        CK_OBJECT_HANDLE hKey
);
```

C_Verify

This function operates as specified in PKCS#11.

Synopsis

```
C_Verify(
        CK_SESSION_HANDLE hSession,
        CK_BYTE_PTR pData,
        CK_ULONG ulDataLen,
        CK_BYTE_PTR pSignature,
        CK_ULONG ulSignatureLen
);
```

C_VerifyUpdate

This function operates as specified in PKCS#11.

Synopsis

```
C_VerifyUpdate(
        CK_SESSION_HANDLE hSession,
        CK_BYTE_PTR pPart,
        CK_ULONG ulPartLen
);
```

C_VerifyFinal

This function operates as specified in PKCS#11.

Synopsis

```
C_VerifyFinal(
        CK_SESSION_HANDLE hSession,
        CK_BYTE_PTR pSignature,
        CK_ULONG ulSignatureLen
);
```

C_VerifyRecoverInit

This function operates as specified in PKCS#11.

- If the `CKF_LOGIN_REQUIRED` flag is set for the Token associated with the provided session the session state must be either `CKS_RW_USER_FUNCTIONS` or `CKS_RO_USER_FUNCTIONS`,otherwise the error `CKR_USER_NOT_LOGGED_IN` is returned.
- If the object referenced by the **hKey** parameter has the `CKA_USAGE_COUNT` attribute its value is incremented by this function.
- If the **hKey** parameter refers to a certificate object this function will perform the same certificate verification as specified in the **C_VerifyInit** function.

Synopsis

```
C_VerifyRecoverInit(
        CK_SESSION_HANDLE hSession,
        CK_MECHANISM_PTR pMechanism,
        CK_OBJECT_HANDLE hKey
);
```

C_VerifyRecover

This function operates as specified in PKCS#11.

Synopsis

```
C_VerifyRecover(CK_SESSION_HANDLE hSession,
        CK_BYTE_PTR pSignature,
        CK_ULONG ulSignatureLen,
        CK_BYTE_PTR pData,CK_ULONG_PTR pulDataLen
);
```


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Dual-function Cryptographic Functions

> **NOTE** ProtectToolkit-C provides the following functions to perform two cryptographic operations “simultaneously” within a session. These functions are provided so as to avoid unnecessarily passing data back and forth to and from a token.

This section describes the following dual-function cryptographic functions:

> "C_DigestEncryptUpdate" below
> "C_DecryptDigestUpdate" below
> "C_SignEncryptUpdate" below
> "C_DecryptVerifyUpdate" on the next page

C_DigestEncryptUpdate

This function operates as specified in PKCS#11.

Synopsis

```
C_DigestEncryptUpdate(
        CK_SESSION_HANDLE hSession,
        CK_BYTE_PTR pPart,
        CK_ULONG ulPartLen,
        CK_BYTE_PTR pEncryptedPart,
        CK_ULONG_PTR pulEncryptedPartLen
);
```

C_DecryptDigestUpdate

This function operates as specified in PKCS#11.

Synopsis

```
C_DecryptDigestUpdate(CK_SESSION_HANDLE hSession,
        CK_BYTE_PTR pEncryptedPart,
        CK_ULONG ulEncryptedPartLen,
        CK_BYTE_PTR pPart,CK_ULONG_PTR pulPartLen
);
```

C_SignEncryptUpdate

This function operates as specified in PKCS#11.

Synopsis

```
C_SignEncryptUpdate(CK_SESSION_HANDLE hSession,
        CK_BYTE_PTR pPart,
        CK_ULONG ulPartLen,CK_BYTE_PTR pEncryptedPart,
        CK_ULONG_PTR pulEncryptedPartLen
);
```


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C_DecryptVerifyUpdate

This function operates as specified in PKCS#11.

Synopsis

```
C_DecryptVerifyUpdate(CK_SESSION_HANDLE hSession,
        CK_BYTE_PTR pEncryptedPart,
        CK_ULONG ulEncryptedPartLen,
        CK_BYTE_PTR pPart,CK_ULONG_PTR pulPartLen
);
```


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Key Management Functions

This section describes the following PKCS#11 functions:

> "C_GenerateKey" below
> "C_GenerateKeyPair" below
> "C_WrapKey" on the next page
> "C_UnwrapKey" on the next page
> "C_DeriveKey" on the next page

C_GenerateKey

This function operates as specified in PKCS#11.

If the `CKF_LOGIN_REQUIRED` flag is set for the Token associated with the provided session the session state must be either `CKS_RW_USER_FUNCTIONS` or `CKS_RO_USER_FUNCTIONS`,otherwise the error `CKR_USER_NOT_LOGGED_IN` is returned.

Synopsis

```
C_GenerateKey(
        CK_SESSION_HANDLE hSession
        CK_MECHANISM_PTR pMechanism,
        CK_ATTRIBUTE_PTR pTemplate,
        CK_ULONG ulCount,
        CK_OBJECT_HANDLE_PTR phKey
);
```

C_GenerateKeyPair

This function operates as specified in PKCS#11.

If the `CKF_LOGIN_REQUIRED` flag is set for the Token associated with the provided session the session state must be either `CKS_RW_USER_FUNCTIONS` or `CKS_RO_USER_FUNCTIONS`,otherwise the error `CKR_USER_NOT_LOGGED_IN` is returned.

If `CKA_ID` is not specified in either template then the library sets default values for these that are the same for both public and private object with a high likelihood of being unique. The value is a SHA1 hash of the modulus.

Synopsis

```
C_GenerateKeyPair(
        CK_SESSION_HANDLE hSession,
        CK_MECHANISM_PTR pMechanism,
        CK_ATTRIBUTE_PTR pPublicKeyTemplate,
        CK_ULONG ulPublicKeyAttributeCount,
        CK_ATTRIBUTE_PTR pPrivateKeyTemplate,
        CK_ULONG ulPrivateKeyAttributeCount,
        CK_OBJECT_HANDLE_PTR phPublicKey,
        CK_OBJECT_HANDLE_PTR phPrivateKey
);
```


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C_WrapKey

This function operates as specified in PKCS#11.

If the CKF_LOGIN_REQUIRED flag is set for the Token associated with the provided session the session state must be either CKS_RW_USER_FUNCTIONS or CKS_RO_USER_FUNCTIONS,otherwise the error CKR_USER_NOT_LOGGED_IN is returned.

Synopsis

```
C_WrapKey(
        CK_SESSION_HANDLE hSession,
        CK_MECHANISM_PTR pMechanism,
        CK_OBJECT_HANDLE hWrappingKey,
        CK_OBJECT_HANDLE hKey,
        CK_BYTE_PTR pWrappedKey,
        CK_ULONG_PTR pulWrappedKeyLen
);
```

C_UnwrapKey

This function operates as specified in PKCS#11.

If the CKF_LOGIN_REQUIRED flag is set for the Token associated with the provided session the session state must be either CKS_RW_USER_FUNCTIONS or CKS_RO_USER_FUNCTIONS,otherwise the error CKR_USER_NOT_LOGGED_IN is returned.

Synopsis

```
C_UnwrapKey(
        CK_SESSION_HANDLE hSession,
        CK_MECHANISM_PTR pMechanism,
        CK_OBJECT_HANDLE hUnwrappingKey,
        CK_BYTE_PTR pWrappedKey,
        CK_ULONG ulWrappedKeyLen,
        CK_ATTRIBUTE_PTR pTemplate,
        CK_ULONG ulAttributeCount,
        CK_OBJECT_HANDLE_PTR phKey
);
```

C_DeriveKey

This function operates as specified in PKCS#11.

If the CKF_LOGIN_REQUIRED flag is set for the Token associated with the provided session the session state must be either CKS_RW_USER_FUNCTIONS or CKS_RO_USER_FUNCTIONS,otherwise the error CKR_USER_NOT_LOGGED_IN is returned.

Simple derivation mechanisms are restricted to working on secret keys of type CKK_GENERIC_SECRET.

Synopsis

```
C_DeriveKey(
        CK_SESSION_HANDLE hSession,
        CK_MECHANISM_PTR pMechanism,
        CK_OBJECT_HANDLE hBaseKey,
        CK_ATTRIBUTE_PTR pTemplate,
```


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```
        CK_ULONG ulAttributeCount,
        CK_OBJECT_HANDLE_PTR phKey
);
```


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Random Number Generation Functions

This section describes the following PKCS#11 functions:

> "C_SeedRandom" below

> "C_GenerateRandom" below

C_SeedRandom

This function operates as specified in PKCS#11, however, it is not required to be called as the ProtectServer adapter has a hardware random generation source.

Also note this function will only operate for those tokens with the `CKF_RNG` flag set in their `CK_TOKEN_INFO` flags.

Synopsis

```
C_SeedRandom(
        CK_SESSION_HANDLE hSession,
        CK_BYTE_PTR pSeed,
        CK_ULONG ulSeedLen
);
```

C_GenerateRandom

This function operates as specified in PKCS#11.

Also note this function will only operate for those tokens with the `CKF_RNG` flag set in their `CK_TOKEN_INFO` flags.

Synopsis

```
C_GenerateRandom(
        CK_SESSION_HANDLE hSession,
        CK_BYTE_PTR pRandomData,
        CK_ULONG ulRandomLen
);
```


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Parallel Function Management Functions

> **NOTE** ProtectToolkit-C provides the following functions for managing parallel execution of cryptographic functions. These functions exist only for backward compatibility.

This section describes the following PKCS#11 functions:

> "C_GetFunctionStatus" below

> "C_CancelFunction" below

C_GetFunctionStatus

Synopsis

```
C_GetFunctionStatus(
        CK_SESSION_HANDLE hSession
);
```

Description

This function operates as specified in PKCS#11.

C_GetFunctionStatus is a legacy function, which will simply return the value CKR_FUNCTION_NOT_PARALLEL.

C_CancelFunction

This function operates as specified in PKCS#11.

C_GetFunctionStatus is a legacy function, which will simply return the value CKR_FUNCTION_NOT_PARALLEL.

Synopsis

```
C_CancelFunction(
        CK_SESSION_HANDLE hSession
);
```


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Extra Functions

This section describes the following PKCS#11 extra functions:

> "CT_SetHsmDead" below
> "CT_GetHSMId" below
> "CT_ToHsmSession" on the next page
> "FMSC_SendReceive" on the next page

CT_SetHsmDead

This function can be used by an application to simulate the behavior of the WLD or HA system when an HSM fails. See also "CT_GetHSMId" below.

Summary

```
CK_DEFINE_FUNCTION(CK_RV, CT_SetHsmDead)(
        CK_ULONG hsmIDx,
        CK_BBOOL bDisable
);
```

Return Code	Description
CKR_OK	Successful.
CKR_ARGUMENTS_BAD	The supplied hsmID is invalid.
CKR_FUNCTION_NOT_SUPPORTED	The library is not in WLD mode

This function is a SafeNet extension to PKCS #11.

CT_GetHSMId

This function can be used to identify the HSM that a particular WLD or HA session has been assigned to.

This function is a SafeNet extension to PKCS #11.

Summary

```
CK_DEFINE_FUNCTION(CK_RV, CT_GetHSMId)(
        CK_SESSION_HANDLE hSession,
        CK_ULONG_PTR pHsmid
);
```

Return Value	Description
CKR_OK	Successful
CKR_ARGUMENTS_BAD	The supplied pHsmID is NULL
CKR_FUNCTION_NOT_SUPPORTED	The library is not in WLD mode

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CT_ToHsmSession

This function can be used to convert the Cryptoki session handle seen by the application into the session handle used by the HSM.

Summary

```
CK_DEFINE_FUNCTION(CK_RV, CT_ToHsmSession)(
        CK_SESSION_HANDLE hSessionApp,
        CK_SESSION_HANDLE_PTR phHsmSession
);
```

Return Value	Description
CKR_OK	Successful
CKR_ARGUMENTS_BAD	The supplied hSessionApp is INVALID or phHsmSession is NULL.

This function is a SafeNet extension to PKCS #11.

FMSC_SendReceive

This is an extended function supporting custom Functionality Module (FM) calls through cryptoki. Previously, PKCS-patched FMs were invoked through the cryptoki interface while Custom FMs were invoked through the Message Dispatcher interface (ETHSM). With this new API, Custom FMs can be called directly through the cryptoki interface. Also, custom FM calls can now use features such as:

- **Secure Messaging** - requests are sent/received in encrypted form
- **High Availability/Work Load Distribution** - WLD can now be used with FMs

Summary

```
CK_RV FMSC_SendReceive(
        CK_SESSION_HANDLE hSession,
        CK_USHORT fmNumber,
        CK_BYTE_PTR pRequest,
        CK_ULONG requestLen,
        CK_BYTE_PTR pResponse,
        CK_ULONG responseLen,
        CK_ULONG_PTR pReceivedLen,
        uint32 *pfmStatus
);
```

Header File

ctfext.h

Parameter	Description
hSession	Session handle to be associated with the request.
fmNumber	Identifies the FM number this message is intended for. Make sure it matches the FM number defined in the FM application.

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Parameter	Description
pRequest	Pointer to request buffer.
prequestLen	Number of bytes in the request.
pResponse	When the function returns, the response from the FM is contained in these buffers.
responseLen	Length of the initialized response buffer in bytes
pReceivedLen	Actual length of response received from the FM.
pfmStatus	Status code returned by the FM.

In addition to the standard PKCS#11 and extended function codes, the function can return:

Return Code	Description
CKR_FM_NOT_REGISTERED	'fmNumber' presented in this call is not registered/loaded.
CKR_FM_DISPATCH_BLOCKED	Message dispatching on FM is blocked.

Please see the *ProtectToolkit FM SDK Programming Guide* for a full description of FM development. A sample is provided along with the FM SDK to demonstrate the function of this API.

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CHAPTER 11: ctutil.h Functionality Reference

The ProtectToolkit-C Software Development Kit offers a number of extended API libraries with functionality that is extended to that of the standard PKCS#11 function set.

The following additional features do not form part of the standard PKCS#11 functionality, but are provided by Thales as part of the SafeNet ProtectToolkit-C API within the **ctutil.h** library.

This reference contains descriptions of the following features:

- "BuildDhKeyPair" on page 497
- "BuildDsaKeyPair" on page 499
- "BuildRsaCrtKeyPair" on page 501
- "BuildRsaKeyPair" on page 503
- "C_ErrorString" on page 505
- "calcKvc" on page 506
- "calcKvcMech" on page 507
- "cDump" on page 508
- "CheckCryptokiVersion" on page 509
- "CreateDesKey" on page 510
- "CreateSecretKey" on page 511
- "CT_AttrToString" on page 512
- "CT_CreateObject" on page 513
- "CT_CreatePublicObject" on page 514
- "CT_Create_Set_Attributes_Ticket_Info" on page 515
- "CT_Create_Set_Attributes_Ticket" on page 516
- "CT_DerEncodeNamedCurve" on page 517
- "CT_GetObjectDigest" on page 521
- "CT_GetECCDomainParameters" on page 522
- "CT_GetObjectDigestFromParts" on page 523
- "CT_ErrorString" on page 524
- "CT_GetECKeySize" on page 525
- "CT_MakeObjectNonModifiable" on page 526
- "CT_OpenObject" on page 527
- "CT_ReadObject" on page 528

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- "CT_RenameObject" on page 529
- "CT_SetCKDateStrFromTime" on page 530
- "CT_Structure_To_Armor" on page 531
- "CT_Structure_From_Armor" on page 532
- "CT_SetLimitsAttributes" on page 533
- "CT_WriteObject" on page 534
- "DateConvertGmtToLocal" on page 535
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- "DumpAttributes" on page 537
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- "FindAttribute" on page 541
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- "GenerateDhKeyPair" on page 544
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- "GetAttr" on page 549
- "getDerEncodedNamedCurve" on page 550
- "GetDeviceError" on page 551
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- "rmTrailSpace" on page 557
- "SetAttr" on page 558
- "ShowSlot" on page 559
- "ShowToken" on page 560
- "strAttribute" on page 561
- "strError" on page 562
- "strKeyType" on page 563
- "strMechanism" on page 564
- "strObjClass" on page 565

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- "strSesState" on page 566
- "TransferObject" on page 567
- "valAttribute" on page 568
- "valError" on page 569
- "valKeyType" on page 570
- "valMechanism" on page 571
- "valObjClass" on page 572
- "valSesState" on page 573

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BuildDhKeyPair

Create a DH key pair given the required components.

Synopsis

```
CK_RV BuildDhKeyPair(
CK_SESSION_HANDLE hSession,
char * txt,
int tok,
int priv,
CK_OBJECT_HANDLE * phPub,
CK_OBJECT_HANDLE * phPri,
char * prime,
char * base,
char * pub,
char * pri);
```

Parameter	Description
hSession	Open session handle
txt	Optional label
tok	1 for a Token object, 0 for Session object
priv	1 for Private object, 0 for Public object
phPub	Reference to object handle to hold created public key
phPri	Reference to object handle to hold created private key
prime	Prime
base	Base
pub	Public key value
pri	Private key value

On successful return

***phPub** — handle to newly-created public key

***phPri** — handle to newly-created private key

In addition to the Public key attributes set via the parameters, the following are set:

```
CKA_CLASS CKO_PUBLIC_KEY
CKA_KEY_TYPE CKK_DH
CKA_EXTRACTABLE TRUE
```

In addition to the Private key attributes set via the parameters, the following are set:

```
CKA_CLASS CKO_PRIVATE_KEY
CKA_KEY_TYPE CKK_DH
CKA_EXTRACTABLE TRUE
```


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BuildDsaKeyPair

Create DSA key pair given required components.

Synopsis

```
CK_RV BuildDsaKeyPair(
CK_SESSION_HANDLE hSession,
char * txt,
int tok,
int priv,
CK_OBJECT_HANDLE * phPub,
CK_OBJECT_HANDLE * phPri,
char * prime,
char * subprime,
char * base,
char * pub,
char * pri);
```

Parameter	Description
hSession	Open session handle
txt	Optional label
tok	1 for a Token object, 0 for Session object
priv	1 for Private object, 0 for Public object
phPub	Reference to object handle to hold created public key
phPri	Reference to object handle to hold created private key
prime	Prime
subprime	SubPrime
base	Base
pub	Public key value
pri	Private key value

On successful return

***phPub** — handle to newly created public key

***phPri** — handle to newly created private key

In addition to the Public key attributes set via the parameters, the following are set:

```
CKA_CLASS CKO_PUBLIC_KEY
CKA_KEY_TYPE CKK_DSA
CKA_EXTRACTABLE TRUE
```

In addition to the Private key attributes set via the parameters, the following are set:

```
CKA_CLASS CKO_PRIVATE_KEY
CKA_KEY_TYPE CKK_DSA
CKA_EXTRACTABLE TRUE
```


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BuildRsaCrtKeyPair

Create an RSA key pair given the modulus and exponents, as well as the additional arguments used in Chinese Remainder Theorem processing. If the values for P, Q, E1, E2 and U are not specified, a normal RSA key pair is created.

Synopsis

```
CK_RV BuildRsaCrtKeyPair(
CK_SESSION_HANDLE hSession,
char * txt,
int tok,
int priv,
CK_OBJECT_HANDLE * phPub,
CK_OBJECT_HANDLE * phPri,
char * modulusStr,
char * pubExpStr,
char * priExpStr,
char * priPStr,
char * priQStr,
char * priE1Str,
char * priE2Str,
char * priUStr);
```

Parameter	Description
hSession	Open session handle
txt	Optional label
tok	1 for a Token object, 0 for Session object
priv	1 for Private object, 0 for Public object
phPub	Reference to object handle to hold created public key
phPri	Reference to object handle to hold created private key
modulusStr	Key modulus
pubExpStr	Public key exponent
priExpStr	Private key exponent
priPStr	Optional Private key Prime1
priQStr	Optional (optionality set by priPStr) Private key Prime2
priE1Str	Optional (optionality set by priPStr) Private key Exponent1

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Parameter	Description
priE2Str	Optional (optionality set by priPStr) Private key Exponent2
priUStr	Optional (optionality set by priPStr) Private key Coefficient

On successful return

***phPub** — handle to newly created public key

***phPri** — handle to newly created private key

In addition to the Public key attributes set via the parameters, the following are set:

```
CKA_CLASS
CKO_PUBLIC_KEY
CKA_KEY_TYPE
CKK_RSA
CKA_VERIFY TRUE
CKA_SIGN FALSE
CKA_DECRYPT FALSE
CKA_ENCRYPT TRUE
CKA_EXTRACTABLE TRUE
CKA_WRAP FALSE
```

In addition to the Private key attributes set via the parameters, the following are set:

```
CKA_CLASS
CKO_PRIVATE_KEY
CKA_KEY_TYPE
CKK_RSA
CKA_VERIFY FALSE
CKA_SIGN TRUE
CKA_DECRYPT TRUE
CKA_ENCRYPT FALSE
CKA_EXTRACTABLE TRUE
CKA_WRAP FALSE
```


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BuildRsaKeyPair

Create an RSA key pair given the modulus and exponents.

Synopsis

```
CK_RV BuildRsaKeyPair(
CK_SESSION_HANDLE hSession,
char * txt,
int tok,
int priv,
CK_OBJECT_HANDLE * phPub,
CK_OBJECT_HANDLE * phPri,
char * modulusStr,
char * pubExponentStr,
char * priExponentStr);
```

Parameter	Description
hSession	Open session handle
txt	Optional label
tok	1 for a Token object, 0 for Session object
priv	1 for Private object, 0 for Public object
phPub	Reference to object handle to hold created public key
phPri	Reference to object handle to hold created private key
modulusStr	Key modulus
pubExponentStr	Public key exponent
priExponentStr	Private key exponent

On successful return

***phPub** — handle to newly created public key

***phPri** — handle to newly created private key

In addition to the Public key attributes set via the parameters, the following are set:

```
CKA_CLASS
CKO_PUBLIC_KEY
CKA_KEY_TYPE
CKK_RSA
CKA_VERIFY TRUE
CKA_SIGN FALSE
CKA_DECRYPT FALSE
```


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```
CKA_ENCRYPT TRUE
CKA_EXTRACTABLE TRUE
CKA_WRAP FALSE
```

In addition to the Private key attributes set via the parameters, the following are set:

```
CKA_CLASS
CKO_PRIVATE_KEY
CKA_KEY_TYPE
CKK_RSA
CKA_VERIFY FALSE
CKA_SIGN TRUE
CKA_DECRYPT TRUE
CKA_ENCRYPT FALSE
CKA_EXTRACTABLE TRUE
CKA_WRAP FALSE
```


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C_ErrorString

Convert a Cryptoki error code into a printable string. Note that this function is not a part of the PKCS#11 definition.

The sample programs use this extensively to map Cryptoki error numbers to meaningful text to display to the user.

Synopsis

```
CK_RV C_ErrorString(CK_RV ret, char * errstr, unsigned int len);
```


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calcKvc

Calculate and return an AS2805 KVC for a key. The key must be capable of doing an encryption operation using the mechanism determined from the key type (see mechFromKt) for this to succeed. Note that mechanism parameters are set to NULL.

> **NOTE** The CKA_CHECK_VALUE attribute can be used to get the KVC of a key that does not support the encryption operation.

Synopsis

```
CK_RV calcKvc(
CK_SESSION_HANDLE hSession,
CK_OBJECT_HANDLE hKey,
unsigned char * kvc,
int kvclen,
int * pkvclen);
```

Parameter	Description
hSession	Open session handle
hKey	Handle to the key to use for the encryption
kvc	Buffer to hold the encryption result
kvclen	Total number of bytes referenced by kvc
pkvclen	Reference to int to hold number of bytes copied into kvc

On successful return

kvc — holds the encryption result

***pkvclen** — number of bytes copied into kvc

If kvclen is smaller than the encryption result, then only kvclen bytes are copied into kvc.

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calcKvcMech

Calculate and return an AS2805 KVC for a key. The key must be capable of doing an encryption operation using the supplied mechanism for this to succeed. Note that mechanism parameters are set to NULL.

> **NOTE** The CKA_CHECK_VALUE attribute can be used to get the KVC of a key that does not support the encryption operation.

Synopsis

```
CK_RV calcKvcMech(
CK_SESSION_HANDLE hSession,
CK_OBJECT_HANDLE hKey,
CK_MECHANISM_TYPE mt,
unsigned char * kvc,
int kvclen,
int * pkvclen);
```

Parameter	Description
hSession	Open session handle
hKey	Handle to the key to use for the encryption
mt	Encryption mechanism to use
kvc	Buffer to hold the encryption result
kvclen	Total number of bytes referenced by kvc
pkvclen	Reference to int to hold number of bytes copied into kvc

On successful return

kvc — holds the encryption result

***pkvclen** — number of bytes copied into kvc

If kvclen is smaller than the encryption result, then only kvclen bytes are copied into kvc.

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cDump

Dump buf contents in hex via printf.

Synopsis

```
int cDump(char * title,unsigned char * buf,unsigned int len);
```

Parameter	Description
title	Heading
buf	Bytes to dump
len	Number of bytes to dump

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CheckCryptokiVersion

Thales supports multiple versions of PKCS#11, but V 1.x and v 2.x are incompatible. An application compiled for V 1.x compliance is likely to crash if it links against a V 2.x compliant DLL, and vice versa.

This function is used to check that the version of CRYPTOKI is correct for the application and will report if an incompatible Cryptoki DLL is loaded. The application should report this fact and terminate.

All the sample applications make this call to check the Cryptoki version they are running.

Synopsis

```
CK_RV CheckCryptokiVersion(void);
```

Note that this API is implemented as a macro.

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CreateDesKey

Create a secret key object, and set the key type to CKK_DES, CKK_DES2or CKK_DES3 (based on len).

Synopsis

```
CK_RV CreateDesKey(
CK_SESSION_HANDLE hSession,
char * txt,
int tok,
int priv,
CK_BYTE * keyValue,
int len,
CK_OBJECT_HANDLE * phKey);
```

Parameter	Description
hSession	Open session handle
txt	Optional label
tok	1 for a Token object, 0 for Session object
priv	1 for private object, 0 for public object
keyValue	Key value
len	Length of key value
phKey	Reference to object handle to hold created key

On successful return

***phKey**— handle to newly created key

In addition to the key attributes set via the parameters, the following are set:

```
CKA_CLASS CKO_SECRET_KEY
CKA_KEY_TYE CKK_DES, CKK_DES2 OR CKK_DES3
CKA_ID “ID”
CKA_DERIVE TRUE
CKA_EXTRACTABLE TRUE
CKA_UNWRAP TRUE
CKA_WRAP FALSE
```


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CreateSecretKey

Create a secret key object.

Synopsis

```
CK_RV CreateSecretKey(
CK_SESSION_HANDLE hSession,
char * txt,
int tok,
int priv,
CK_KEY_TYPE kt,
CK_BYTE * keyValue,
int len,
CK_OBJECT_HANDLE * phKey);
```

Parameter	Description
hSession	Open session handle
txt	Optional label
tok	1 for a Token object, 0 for Session object
priv	1 for private object, 0 for public object
kt	Key type
keyValue	Key value
len	Length of key value
phKey	Reference to object handle to hold created key

On successful return

***phKey** — handle to newly created key

In addition to the key attributes set via the parameters, the following are set:

```
CKA_CLASS CKO_SECRET_KEY
CKA_ID “ID”
CKA_DERIVE TRUE
CKA_EXTRACTABLE TRUE
CKA_UNWRAP TRUE
CKA_WRAP FALSE
```


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CT_AttrToString

Get the value of the given attribute as a printable string

Synopsis

```
CK_RV CT_AttrToString(CK_ATTRIBUTE_PTR pAttr,char* pStringVal,CK_SIZE* pStringValLen);
```

Parameter	Description
param pAttr	pointer to the attribute whose value is to be stringified
pStringVal	location to hold the value as a string (if NULL, the length required to hold the string is still copied into pStringValLen)
pStringValLen	location to store the length of the value as a string (if pStringVal was supplied, this contains the number of bytes copied into the buffer or, if pStringVal is NULL, this contains the required size of the buffer to hold the value as a string).

On successful return

* **pStringVal** — pointer to the returned string value
* **pStringValLen** — length of the string

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CT_CreateObject

Create a private token object of the specified class with the defined label.

Synopsis

```
CK_RV CT_CreateObject(
CK_SESSION_HANDLE hSession,
CK_OBJECT_CLASS cl,
char * name,
CK_OBJECT_HANDLE * phObj); Parameters
```

Parameter	Description
hSession	Open session on the slot to create the object in
cl	Class of the object
name	Label of the object
phObj	Reference to object handle to hold created object

On successful return

***phObj** — handle to the newly created object

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CT_CreatePublicObject

Create a public token object of the specified class with the defined label.

Synopsis

```
CK_RV CT_CreatePublicObject(
CK_SESSION_HANDLE hSession,
CK_OBJECT_CLASS cl,
char * name,
CK_OBJECT_HANDLE * phObj);
```

Parameter	Description
hSession	Open session on the slot to create the object in
cl	Class of the object
name	Label of the object
phObj	Reference to object handle to hold created object

On successful return

***phObj** — handle to the newly created object

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CT_Create_Set_Attributes_Ticket_Info

The function creates an unsigned CKM_SET_ATTRIBUTES ticket.

The function supports length prediction.

See "CT_Create_Set_Attributes_Ticket" on the next page.

Synopsis

```
CK_RV CT_Create_Set_Attributes_Ticket_Info(
  /* specify the target */
     CK_MECHANISM_TYPE objectDigestAlg, /* digest alg */
     unsigned char * objectDigest, /* digest of target object */
    unsigned int objectDigestLen,
    /* specify issuer */
     char * issuerRDN,       /* may be NULL or
                              * DER of DistName or
                              * Common Name string or
                              * RDN Seq string (CN=Fred+C=USA) */
     unsigned int issuerRDNLen,

  /* ticket details */
     CK_MECHANISM_TYPE signatureAlg, /* signature alg */
     unsigned long sno,      /* Attrib Cert serial number */
     char * notBefore,       /* YYYYMMDD string */
     char * notAfter,        /* YYYYMMDD string */

  /* attributes on key to modify */
     unsigned long * limit,  /* NULL if no CKA_USAGE_LIMIT */
     char * start,           /* NULL if no CKA_START_DATE */
     char * end,             /* NULL if no CKA_END_DATE */
     char * cert,            /* NULL if no CKA_ADMIN_CERT */
     unsigned int certLen,

  /* output */
          void * pTicketInfo,    /* OUT new unsigned ticket returned here */
          unsigned int* puiTicketLen; /* IN/OUT pTicketInfo buffer length */
);
```

CT_Create_Set_Attributes_Ticket

The function combines the AttributeCertificateInfo DER encoding returned from the CT_Create_Set_Attributes_Ticket_Info function with a digital signature to form the DER encoded AttributeCertificate that may be passed to a CT_PresentTicket function using the CKM_SET_ATTRIBUTES mechanism.

Synopsis

```
CK_RV CT_Create_Set_Attributes_Ticket(
void * pTicketInfo,    /* IN unsigned ticket */
 unsigned int uiTicketInfoLen; /* IN pTicketInfo buffer length */

 CK_MECHANISM_TYPE signatureAlg, /* signature alg */
 unsigned char * pSignature, /* signature of pTicketData */
 unsigned int uiSigLen; /* IN pSignature buffer length */

 void * pTicketData,    /* OUT new unsigned ticket returned here */
 unsigned int * puiTicketLen; /* IN/OUT pTicketData buffer length */
);
```


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CT_DerEncodeNamedCurve

Helper function to provide the DER encoding of a supported named curve. This function is typically used to populate the CKA_EC_PARAMS attribute of the template used during EC key pair generation.

Synopsis

```
CK_RV CT_DerEncodeNamedCurve(
CK_BYTE_PTR buf,
CK_SIZE_PTR len,
const char *name);
```

Parameter	Description
buf	Buffer to hold the DER encoding
len	*len is total number of bytes referenced by buf
name	String name of the curve to get the encoding for

Supported Curves

Curve	OID
brainpoolP160r1	{ iso(1) identified-organization(3) TeleTrusT(36) algorithm(3) signatureAlgorithm(3) ecSign (2) ecStdCurvesAndGeneration(8) ellipticCurve(1) versionOne(1) brainpoolP160r1(1) }
brainpoolP160t1	{ iso(1) identified-organization(3) TeleTrusT(36) algorithm(3) signatureAlgorithm(3) ecSign (2) ecStdCurvesAndGeneration(8) ellipticCurve(1) versionOne(1) brainpoolP160t1(2) }
brainpoolP192r1	{ iso(1) identified-organization(3) TeleTrusT(36) algorithm(3) signatureAlgorithm(3) ecSign (2) ecStdCurvesAndGeneration(8) ellipticCurve(1) versionOne(1) brainpoolP192r1(3) }
brainpoolP192t1	{ iso(1) identified-organization(3) TeleTrusT(36) algorithm(3) signatureAlgorithm(3) ecSign (2) ecStdCurvesAndGeneration(8) ellipticCurve(1) versionOne(1) brainpoolP192t1(4) }
brainpoolP224r1	{ iso(1) identified-organization(3) TeleTrusT(36) algorithm(3) signatureAlgorithm(3) ecSign (2) ecStdCurvesAndGeneration(8) ellipticCurve(1) versionOne(1) brainpoolP224r1(5) }
brainpoolP224t1	{ iso(1) identified-organization(3) TeleTrusT(36) algorithm(3) signatureAlgorithm(3) ecSign (2) ecStdCurvesAndGeneration(8) ellipticCurve(1) versionOne(1) brainpoolP224t1(6) }
brainpoolP256r1	{ iso(1) identified-organization(3) TeleTrusT(36) algorithm(3) signatureAlgorithm(3) ecSign (2) ecStdCurvesAndGeneration(8) ellipticCurve(1) versionOne(1) brainpoolP256r1(7) }
brainpoolP256t1	{ iso(1) identified-organization(3) TeleTrusT(36) algorithm(3) signatureAlgorithm(3) ecSign (2) ecStdCurvesAndGeneration(8) ellipticCurve(1) versionOne(1) brainpoolP256t1(8) }

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Curve	OID
brainpoolP320r1	{ iso(1) identified-organization(3) TeleTrusT(36) algorithm(3) signatureAlgorithm(3) ecSign (2) ecStdCurvesAndGeneration(8) ellipticCurve(1) versionOne(1) brainpoolP320r1(9) }
brainpoolP320t1	{ iso(1) identified-organization(3) TeleTrusT(36) algorithm(3) signatureAlgorithm(3) ecSign (2) ecStdCurvesAndGeneration(8) ellipticCurve(1) versionOne(1) brainpoolP320t1(10) }
brainpoolP384r1	{ iso(1) identified-organization(3) TeleTrusT(36) algorithm(3) signatureAlgorithm(3) ecSign (2) ecStdCurvesAndGeneration(8) ellipticCurve(1) versionOne(1) brainpoolP384r1(11) }
brainpoolP384t1	{ iso(1) identified-organization(3) TeleTrusT(36) algorithm(3) signatureAlgorithm(3) ecSign (2) ecStdCurvesAndGeneration(8) ellipticCurve(1) versionOne(1) brainpoolP384t1(12) }
brainpoolP512r1	{ iso(1) identified-organization(3) TeleTrusT(36) algorithm(3) signatureAlgorithm(3) ecSign (2) ecStdCurvesAndGeneration(8) ellipticCurve(1) versionOne(1) brainpoolP512r1(13) }
brainpoolP512t1	{ iso(1) identified-organization(3) TeleTrusT(36) algorithm(3) signatureAlgorithm(3) ecSign (2) ecStdCurvesAndGeneration(8) ellipticCurve(1) versionOne(1) brainpoolP512t1(14) }
c2tnb191v1	{ iso(1) member-body(2) US(840) x9-62(10045) curves(3) characteristicTwo(0) c2tnb191v1 (5) }
c2tnb191v1e (Non FIPS curve)	{ iso(1) member-body(2) US(840) x9-62(10045) curves(3) characteristicTwo(0) c2tnb191v1e (15) }
curve25519	{ iso(1) identified-organization(3) dod(6) internet(1) private(4) enterprise(1) 3029 algorithm (1) ecc(5) curvey25519(1) }
ed25519	{ iso(1) identified-organization(3) dod(6) internet(1) private(4) enterprises(1) GNUProject (11591) ellipticCurve(15) ed25519(1) }
P-192 (prime192v1 / secp192r1)	{ iso(1) member-body(2) US(840) x9-62(10045) curves(3) prime(1) prime192v1(1) }
P-224 (secp224r1)	{ iso(1) identified-organization(3) Certicom(132) certicom_ellipticCurve(0) secp224r1(33) }
P-256 (prime256v1 / secp256r1)	{ iso(1) member-body(2) US(840) x9-62(10045) curves(3) prime(1) prime256v1(7) }
P-384 (secp384r1)	{ iso(1) identified-organization(3) Certicom(132) certicom_ellipticCurve(0) secp384r1(34) }
P-521 (secp521r1)	{ iso(1) identified-organization(3) Certicom(132) certicom_ellipticCurve(0) secp521r1(35) }

On successful return

buf — contains a string.

Example: “hh:mm:ss DD/MM/YYYY“ *len Number of bytes copied to buf

To determine the encoding length, pass in `NULL` for buf and check the resulting value of `*len`.

curve25519

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	No
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes
Wrap and Unwrap	No
Derive	Yes
FIPS-approved	No

> **NOTE** The generated public key is the same length as the generated private key. As such, Curve25519 should only be used for ECDH operations. It cannot be used for signing or verifying crypto objects.

Parameters

Curve25519 uses the **CKM_ECDH1_DERIVE** mechanism. Users are required to use the **CKM_ECDH1_DERIVE** mechanism and fill in the **CK_ECDH1_DERIVE_PARAMS** structure to access Curve25519.

For more information about the key derivation mechanism see "CKM_ECDH1_DERIVE" on page 183

ed25519

Supported Operations

Encrypt and Decrypt	No
Sign and Verify	Yes
SignRecover and VerifyRecover	No
Digest	No
Generate Key/Key-Pair	Yes

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Wrap and Unwrap	No
Derive	No
FIPS-approved	No

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CT_GetObjectDigest

Compute the object digest as used by SET Attributes Ticket to identify the target object.

Synopsis

```
CK_RV CT_GetObjectDigest(
       CK_SESSION_HANDLE hSession,  /* IN */
       CK_OBJECT_HANDLE hObject,    /* IN */
       CK_MECHANISM_PTR pDigestMech,/* IN */

       CK_BYTE_PTR * ppDigest,  /* OUT returned buffer must be freed */
       CK_ULONG    * pulDigest  /* OUT length of returned buffer */
              );
```


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CT_GetECCDomainParameters

This function returns the DER encoded Domain Parameters for a curve specified by name.

First the CT_DerEncodeNamedCurve function is used to see if the curve is known to the HSM. If not, then this function looks up the appropriate Domain Parameter object in the token indicated by hSession.

Summary

#include“ctlutil.h”

Windows Library: ctlutil.lib

UNIX Library: Libctlutil.a

```
CK_RV CT_GetECCDomainParameters(
CK_SESSION_HANDLE hSession,
CK_ATTRIBUTE_PTR  attr,
const char *name)
```

Parameter	Description
param hSession	Session where Domain Parameter object can be found
param attr	ptr to attribute structure to hold encoding of domain parameters (length prediction supported)
param name	Label of Domain Parameter object or known named curve
return	Cryptoki error returned, CKR_OK if successful

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CT_GetObjectDigestFromParts

Compute the object digest as used by SET Attributes Ticket to identify the target object by using parts.

See also "CT_GetObjectDigest" on page 521.

Synopsis

```
CK_RV CT_GetObjectDigestFromParts(
         CK_SESSION_HANDLE hSession,  /* IN */
         CK_MECHANISM_PTR pDigestMech,/* IN */
         char * tokenSerialNumber,    /* IN */
         char * tokenLabel,           /* IN */
         char * objLabel,             /* IN */
         CK_BYTE_PTR  objID,          /* IN */
         CK_ULONG     objIDlen,       /* IN */

         CK_BYTE_PTR * ppDigest,   /* OUT returned buffer
(must be freed by caller) */
         CK_ULONG    * pulDigest   /* OUT length of returned buffer */
                 );
```


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CT_ErrorString

Get a printable string representation of a Cryptoki error code.

Synopsis

```
CK_RV C_ErrorString(
CK_RV ret,
char * errstr,
unsigned int len); Parameters
```

Parameter	Description
ret	Cryptoki error code
errstr	buffer to hold the printable string
len	number of characters referenced by errstr

On successful return

errstr — contains the printable string, or as much as will fit

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CT_GetECKeySize

Helper function to return key size (in bits) for a given EC parameter

Synopsis

```
CK_RV CT_GetECKeySize(const CK_ATTRIBUTE_PTR ecParam,CK_SIZE_PTR size);
```

Parameter	Description
ecParam	handle that points to EC parameter
size	returned key size

On successful return

size — pointer to the value of key size

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CT_MakeObjectNonModifiable

Change an object CKA_MODIFIABLE attribute from **TRUE** to **FALSE**.

This involves copying the object - so the handle of the object will change.

The original object is deleted.

Synopsis

```
CK_RV CT_MakeObjectNonModifiable(
        CK_SESSION_HANDLE hSession,   /* IN */
        CK_OBJECT_HANDLE  hObj,       /* IN */
        CK_OBJECT_HANDLE *phObj       /* OUT (may be NULL) */
                                );
```


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CT_OpenObject

Get a handle to an object with the specified class and label. This function returns the first object satisfying the criteria.

Synopsis

```
CK_RV CT_OpenObject(
CK_SESSION_HANDLE hSession,
CK_OBJECT_CLASS cl,
char * name,
CK_OBJECT_HANDLE * phObj);
```

Parameter	Description
hSession	open session on the slot containing the object
cl	class of the object
name	label of the object
phObj	reference to object handle to hold opened object

On successful return

***phObj** — handle to the opened object

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CT_ReadObject

Get the value of an object.

Synopsis

```
CK_RV CT_ReadObject(
CK_SESSION_HANDLE hSession,
CK_OBJECT_HANDLE hObj,
unsigned char * buf,
unsigned int len,
unsigned int * pbr); Parameters
```

Parameter	Description
hSession	open session on the slot containing the object
hObj	object whose value is to be returned
buf	buffer to hold the object value
len	total number of bytes referenced by buf
pbr	reference to int to hold number of bytes copied into buf

On successful return

buf — contains the object value

***pbr** — number of bytes copied into buf

If buf is too small to hold the attribute value (that is, len is < attribute value length), then CKR_ATTRIBUTE_TYPE_INVALID is returned.

To determine the attribute value length, pass in 0 for len, and check the resulting value of *pbr.

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CT_RenameObject

Change the label of the object with the specified class and label.

Synopsis

```
CK_RV CT_RenameObject(
CK_SESSION_HANDLE hSession,
CK_OBJECT_CLASS cl,
char * oldName,
char * newName);
```

Parameter	Description
hSession	open session on the slot containing the object
cl	class of the object
oldName	current label of the object
newName	new label for the object

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CT_SetCKDateStrFromTime

Convert time_t structure to the DATE format used by "CT_SetLimitsAttributes" on page 533 and "CT_Create_Set_Attributes_Ticket_Info" on page 515.

Synopsis

```
void  CT_SetCKDateStrFromTime(
 char pd[9], /* OUT - pointer to a buffer at least 9 bytes*/
 time_t *t);  /* IN - time value to convert */
```


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CT_Structure_To_Armor

Armoring is the term used in PGP and MIME to describe the formatting of binary data such that it can be unambiguously embedded in a printable document such as an email.

The Base 64 encoding method is used to make binary data printable and the encoding is clearly marked with BEGIN and END statements.

The function formats an arbitary structure - such as a ticket - into an Armored (printable format).

The result is returned as a buffer that the caller must free after use.

Synopsis

```
CK_RV CT_Structure_To_Armor(

    char *  pLabel,/* IN Armor label (string) */
    char * pComment,/* optional comment string */
    CK_VOID_PTR pData, /* IN data to armor */
    CK_ULONG ulDataLen /* IN length of data */

    CK_BYTE_PTR *pArmor, /* OUT Armored structure created
(free after use) */
    CK_ULONG_PTR pulArmorLen /* IN/OUT pArmor buffer length */
);
```

Example

If Armoring the binary data 01h 23h 45h 67h 89h abh cdh efh with the label “SETATTRIBUTE TICKET” and the comment “This is a trial certificate\n”.

You get:

```
This is a trial certificate
-----BEGIN SETATTRIBUTE TICKET-----
ASNFZ4mrze8=
-----END SETATTRIBUTE TICKET-----
```


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CT_Structure_From_Armor

Armoring is the term used in PGP and MIME to describe the formatting of binary data such that it can be unambiguously embedded in a printable document such as an email.

The function extracts a data structure from an Armored (printable format) buffer.

The result is returned as a buffer that the caller must free after use.

Synopsis

```
CK_RV CT_Structure_From_Armor (

    Char * pLabel,/* IN Armor label (string) */
    CK_BYTE_PTR pArmor,/* IN Armored structure */
    CK_ULONG ulArmorLen /* IN pArmor buffer length */

    CK_VOID_PTR *pData, /* OUT extracted structure */
    CK_ULONG_PTR pulDataLen /* OUT *pData buffer length */
);
```


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CT_SetLimitsAttributes

Apply limit attributes to an object. The optional inputs may be set to NULL to indicte that that Attributes should not be set.

> **NOTE** Object should have CKA_MODIFIABLE-false for this function to work.

Synopsis

```
CK_RV CT_SetLimitsAttributes(
     CK_SESSION_HANDLE hSession, /* IN */
     CK_OBJECT_HANDLE  hObj,     /* IN */
     CK_VOID_PTR pCertData,    /* IN - optional CKA_ADMIN_CERT value */
     CK_ULONG    ulCertDataLen, /* IN - length of pCertData */
     CK_ULONG    * usage_limit,  /* IN - optional CKA_USAGE_LIMIT */
     CK_ULONG    * usage_count,  /* IN - optional CKA_USAGE_COUNT */
     char *        start_date,   /* IN - optional CKA_START_DATE */
     char *        end_date      /* IN - optional CKA_END_DATE */
               );
```

CT_WriteObject

Set the value of an object.

Synopsis

```
CK_RV CT_WriteObject(
CK_SESSION_HANDLE hSession,
CK_OBJECT_HANDLE hObj,
const unsigned char * buf,
unsigned int len,
unsigned int * pbr);
```

Parameter	Description
hSession	Open session on the slot containing the object
hObj	Object whose value is to be set
buf	Value of the object to set
len	:ength of buf
pbr	Reference to int to hold number of bytes copied from buf

On successful return

***pbr** — set to equal len

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DateConvertGmtToLocal

Converts a GMT date string of the format YYYYMMDDhhmmssxx into the Local Time format "DD/MM/YYYY hh:mm:ss (TimeZone)".

Synopsis

```
DateConvertGmtToLocal(char * fmt,const char * ts);
```

Parameter	Description
fmt	pointer to the buffer that holds the converted value
ts	GMT date string

On Successful Return

***fmt** — pointer to the buffer that holds the converted value

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DateConvert

Convert “YYYYMMDDhhmmss00” to “hh:mm:ss DD/MM/YYYY“.

Synopsis

```
void DateConvert(
char * fmt,
const char * ts); Parameters
```

Parameter	Description
fmt	Destination string
ts	Source string

On Successful Return

fmt — contains a string like "hh:mm:ss DD/MM/YYYY"

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DumpAttributes

Dumps attribute details via logtrace.

Synopsis

```
void DumpAttributes(CK_ATTRIBUTE * na,CK_COUNT attrCount);
```

Parameter	Description
na	Array of attributes to dump
attrCount	Number of attributes in na

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DumpDHKeyPair

Dump DH key pair details via printf.

Synopsis

```
CK_RV DumpDHKeyPair(
int cStyle,
CK_SESSION_HANDLE hSession,
CK_OBJECT_HANDLE hPub,
CK_OBJECT_HANDLE hPri);
```

Parameter	Description
cStyle	1 for a form which can be included in C code, 0 for standard dump
hSession	Open session handle
hPub	Handle to public key
hPri	Handle to private key

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DumpDSAKeyPair

Dump DSA key pair details via printf.

Synopsis

```
CK_RV DumpDSAKeyPair(
int cStyle,
CK_SESSION_HANDLE hSession,
CK_OBJECT_HANDLE hPub,
CK_OBJECT_HANDLE hPri);
```

Parameter	Description
cStyle	1 for a form which can be included in C code, 0 for standard dump
hSession	Open session handle
hPub	Handle to public key
hPri	Handle to private key

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DumpRSAKeyPair

Dump RSA key pair details via printf.

Synopsis

```
CK_RV DumpRSAKeyPair(
int cStyle,
CK_SESSION_HANDLE hSession,
CK_OBJECT_HANDLE hPub,
CK_OBJECT_HANDLE hPri);
```

Parameter	Description
cStyle	1 for a form which can be included in C code, 0 for standard dump
hSession	Open session handle
hPub	Handle to public key
hPri	Handle to private key

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FindAttribute

Find the first attribute of the specified type in an attribute template.

Synopsis

```
CK_ATTRIBUTE * FindAttribute(
CK_ATTRIBUTE_TYPE attrType,
const CK_ATTRIBUTE * attr,
CK_COUNT attrCount);
```

Parameter	Description
attrType	Type of the attribute to locate
attr	Attribute temple (that is, array of CK_ATTRIBUTE)
attrCount	Number of attributes referenced by attr

On Successful Return

Return a pointer to the attribute of the specified type.

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FindKeyFromName

Find the key with a given class and label within the specified token, and open a session to this token.

Synopsis

```
CK_RV FindKeyFromName(
const char * keyName,
CK_OBJECT_CLASS cl,
CK_SLOT_ID * phSlot,
CK_SESSION_HANDLE * phSession,
CK_OBJECT_HANDLE * phKey);
```

Parameter	Description
keyName	String identifying the key to locate format "token(pin)/key" or "token/key" token name of the Token containing the key pin optional user pin key label of the key in the Token
cl	Class of the object
phSlot	Reference to slot id to hold located slot id
phSession	Reference to session handle to hold opened session
phKey	Reference to object handle to hold located key handle

On Successful Return

***phSlot** — slot holding the key

***phSession** — open session handle

***phKey** — handle to the key object

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FindTokenFromName

Find a token with the specified label and return the corresponding slot id.

Synopsis

```
CK_RV FindTokenFromName(
char * label,
CK_SLOT_ID * pslotID); Parameters
```

Parameter	Description
label	String identifying Token to find
pslotID	Reference to slot id to hold located slot id

On Successful Return

***pslotID** — slot which contains the Token

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GenerateDhKeyPair

Generate a DH key pair.

Synopsis

```
CK_RV GenerateDhKeyPair(
CK_SESSION_HANDLE hSession,
char * txt,
int ftok,
int priv,
int param,
CK_SIZE valueBits,
CK_OBJECT_HANDLE * phPublicKey,
CK_OBJECT_HANDLE * phPrivateKey);
```

Parameter	Description
hSession	Open session handle
txt	Optional label
ftok	1 for a Token object, 0 for Session object
priv	1 for private object, 0 for public object
param	Not used
valueBits	Number of prime bits
phPublicKey	Reference to object handle to hold created public key
phPrivateKey	Reference to object handle to hold created private key

On Successful Return

***phPublicKey** — handle to newly created public key

***phPrivateKey** — handle to newly created private key

In addition to the Public key attributes set via the parameters, the following are set:

```
CKA_CLASS CKO_PUBLIC_KEY
CKA_KEY_TYPE CKK_DH
CKA_VERIFY TRUE
CKA_EXTRACTABLE TRUE
```

In addition to the Private key attributes set via the parameters, the following are set:

```
CKA_CLASS CKO_PRIVATE_KEY
CKA_KEY_TYPE CKK_DH
CKA_SUBJECT_STR "SUBJECT"
CKA_ID 123
CKA_SENSITIVE TRUE
CKA_SIGN TRUE
CKA_EXTRACTABLE TRUE
```


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GenerateDsaKeyPair

Generate DSA key pair.

Synopsis

```
CK_RV GenerateDsaKeyPair(
CK_SESSION_HANDLE hSession,
char * txt,
int ftok,
int priv,
int param,
CK_SIZE valueBits,
CK_OBJECT_HANDLE * phPublicKey,
CK_OBJECT_HANDLE * phPrivateKey);
```

Parameter	Description
hSession	Open session handle
txt	Optional label
ftok	1 for a Token object, 0 for Session object
priv	1 for private object, 0 for public object
param	1 to generate new DSA parameters, 0 to use defaults (see below)
valueBits	Number of bits in Prime
phPublicKey	Reference to object handle to hold created public key
phPrivateKey	Reference to object handle to hold created private key

On Successful Return

***phPublicKey** — handle to newly created public key

***phPrivateKey** — handle to newly created private key

In addition to the Public key attributes set via the parameters, the following are set:

```
CKA_CLASS CKO_PUBLIC_KEY
CKA_KEY_TYPE CKK_DSA
CKA_VERIFY TRUE
CKA_EXTRACTABLE TRUE
```

In addition to the Private key attributes set via the parameters, the following are set:

```
CKA_CLASS CKO_PRIVATE_KEY
CKA_KEY_TYPE CKK_DSA
CKA_SUBJECT_STR "SUBJECT"
CKA_ID 123
CKA_SENSITIVE TRUE
CKA_SIGN TRUE
CKA_EXTRACTABLE TRUE
```


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The default values for the DSA parameters are:

512 P = fca682ce8e12caba26efccf7110e526db078b05edecbcd1eb4a208f3ae1617ae01f35b91a47e6df6
3413c5e12ed0899bcd132acd50d99151bdc43ee737592e17

512 Q = 962eddcc369cba8ebb260ee6b6a126d9346e38c5

512 G = 678471b27a9cf44ee91a49c5147db1a9aaf244f05a434d6486931d2d14271b9e35030b71fd73da
179069b32e2935630e1c2062354d0da20a6c416e50be794ca4

1024 P = e2662c8df32db56309ccb7f8f419e73263c55c1a89954fa68d85d8b09c720618532bd05dc0994b
e245526367b08888f4ef07bb0977ac6aa3c4653f6d70151027fb73a9d7f99e63a63ea5c89de1b1
5b35ecc0beae18a89ee4aac0f75b2c364026c3b6ef8ad13cdd6886d93f9b86c71cb2537b449643
4412033ab3002de749d963

1024 Q = fd5274d166045c96e5f180ab181ccde55804a9c7

1024 G = 0c8392be4b9c222526fc2160864b117b7c8d9e3bec9faa1f7e4d8cfcecbfbf521a0aca11620aaaf0
f847068e8f6c936438bd482cd2d6ee2bbac519b63f5809c412dbd39664fa4e05567fc9bf01f83e3
f816aa945304f31e832a243e138b7b776bb519411d5669b4c6e38c840c2b9ae195f84f04b8b508
7271613c12d938720cc

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GenerateRsaKeyPair

Generate an RSA key pair.

Synopsis

```
CK_RV GenerateRsaKeyPair(
CK_SESSION_HANDLE hSession,
char * txt,
int ftok,
int priv,
CK_SIZE modulusBits,
int expType,
CK_OBJECT_HANDLE * phPublicKey,
CK_OBJECT_HANDLE * phPrivateKey);
```

Parameter	Description
hSession	Open session handle
txt	Optional label
ftok	1 for a Token object, 0 for Session object
priv	1 for private object, 0 for public object
modulusBits	Size of modulus to generate
expType	0 for random exponent, 1 for Fermat 4 exponent (\x00010001), 2 for smallest valid exponent (3)
phPublicKey	Reference to object handle to hold created public key
phPrivateKey	Reference to object handle to hold created private key

On Successful Return

***phPublicKey** — handle to newly created public key

***phPrivateKey** — handle to newly created private key

In addition to the Public key attributes set via the parameters, the following are set:

```
CKA_CLASS CKO_PUBLIC_KEY
CKA_KEY_TYPE CKK_RSA
CKA_SUBJECT_STR "SUBJECT"
CKA_ENCRYPT TRUE
CKA_VERIFY TRUE
CKA_WRAP FALSE
CKA_EXTRACTABLE TRUE
```

In addition to the Private key attributes set via the parameters, the following are set:

```
CKA_CLASS
CKO_PRIVATE_KEY
CKA_KEY_TYPE
```


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```
CKK_RSA
CKA_SUBJECT_STR "SUBJECT"
CKA_ID 123
CKA_SENSITIVE TRUE
CKA_DECRYPT TRUE
CKA_SIGN TRUE
CKA_UNWRAP FALSE
CKA_EXTRACTABLE TRUE
```


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GetAttr

Get a single attribute of an object.

Synopsis

```
CK_RV GetAttr(
CK_SESSION_HANDLE hSession,
CK_OBJECT_HANDLE obj,
CK_ATTRIBUTE_TYPE type,
CK_VOID_PTR buf,
CK_SIZE len,
CK_SIZE_PTR size);
```

Parameter	Description
hSession	Open session on the slot containing the object
obj	Object whose attribute is to be retrieved
type	Attribute to retrieve
buf	Buffer to hold the attribute value
len	Total number of bytes referenced by buf
size	Reference to CK_SIZE to hold the number of bytes copied into buf

On Successful Return

buf — contains the attribute value

***size** — number of bytes copied to buf

If buf is too small to hold the attribute value (that is, len is < attribute value length), then `CKR_ATTRIBUTE_TYPE_INVALID` is returned.

To determine the attribute value length, pass in 0 for len, and check the resulting value of *size.

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getDerEncodedNamedCurve

Access curve OIDs from the Cryptoki library. Previous JCPROV versions require explicitly coded elliptic curve OIDs in java code. The JCPROV enhancement allows Java to get curve OIDs from the Cryptoki library.

Synopsis

```
getDerEncodedNamedCurve <pszCurveName>
```

To get curve OIDs from the Cryptoki library

To use JCPROV to get curve OIDs from the Cryptoki Library include the following syntax in the Java code:

```
{
       LongRef oidBufLen = new LongRef();

       CTUtilEx.CTU_DerEncodeNamedCurve(pszCurveName.getBytes(),
                      null, oidBufLen);
       //System.out.println("oidBufLen=" + (int)oidBufLen.value);
       byte[] oidBuf = new byte[(int)oidBufLen.value];
       CTUtilEx.CTU_DerEncodeNamedCurve(pszCurveName.getBytes(),
                      oidBuf, oidBufLen);
       //System.out.println("oidBufLen=" + (int)oidBufLen.value);
       return oidBuf;
}
```

...where the pszCurveName variable may be assigned to P-192, ..., brainpoolP512t1 values.

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GetDeviceError

Returns the device-error value for a given slot ID

Synopsis

```
CK_RV GetDeviceError( CK_SLOT_ID slotID,CK_NUMERIC *pDeviceError);
```

Parameter	Description
slotID	Slot to be queried
pDeviceError	Error code

On Successful Return

***pDeviceError** — returned error code

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GetObjectCount

Determine the number of objects on a token.

Synopsis

```
CK_RV GetObjectCount(
CK_SLOT_ID slotID,
unsigned int * pCount);
```

Parameter	Description
slotID	Slot ID containing objects to count
pCount	Reference to int to hold number of objects

On Successful Return

***pCount** — number of objects

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GetSecurityMode

Get the security mode for the slot id given by inputSlotID.

Synopsis

```
CK_RV GetSecurityMode(CK_SLOT_ID inputSlotId,
CK_SLOT_ID* pAdminSlotId,
CK_FLAGS* pSecMode);
```

Parameter	Description
inputSlotId	Slot ID to retrieve the security flags from
pAdminSlotId	Location to store the ID of the Admin Slot; Optional - ignored if NULL
pSecMode	Location to store the security mode

On Successful Return

* **pStringVal** — pointer to the returned string value
* **pStringValLen** — length of the string

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GetSessionCount

Determine the number of sessions on a token

Synopsis

```
CK_RV GetSessionCount(
CK_SLOT_ID slotID,
unsigned int * pSessionCount,
unsigned int *prwSessionCount);
```

Parameter	Description
slotID	Slot ID containing objects to count
pSessionCount	Reference to int to hold the number of open session
prwSessionCount	Reference to int to hold the number of open RW session

On Successful Return

***pSessionCount** — number of open session

***prwSessionCount** — number of open RW session

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GetTotalSessionCount

Determine the total number of sessions open on all tokens on all adapters.

Synopsis

```
CK_RV GetTotalSessionCount(
unsigned int *pSessionCount);
```

Parameter	Description
pSessionCount	Reference to int to hold the number of open session

On Successful Return

***pSessionCount** — total number of open sessions

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NUMITEMS

This is a macro that returns the number of elements in an array. Note that only array definitions may be sized by this macro, not pointer definitions.

It is used wherever object templates are defined since the number of items in the template is always passed along with the template address into Cryptoki functions. Use of this macro is preferred to hard coding the number of items in the template that may change with code maintenance.

Synopsis

```
#define NUMITEMS(type)  (sizeof((type))/sizeof((type)[0]))
```


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rmTrailSpace

Remove trailing spaces from a string.

Synopsis

```
void rmTrailSpace(
char * txt,
int len);
```

Parameter	Description
txt	String to process
len	Length of the string

On Successful Return

txt — string no longer has trailing spaces

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SetAttr

Set a single attribute of an object.

Synopsis

```
CK_RV SetAttr(
CK_SESSION_HANDLE hSession,
CK_OBJECT_HANDLE obj,
CK_ATTRIBUTE_TYPE type,
const CK_VOID_PTR buf,
CK_SIZE len);
```

Parameter	Description
hSession	Open session on the slot containing the object
obj	Object whose attribute is to be retrieved
type	Attribute to retrieve
buf	Contains the attribute value to set
len	Number of bytes referenced by buf

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ShowSlot

Dump slot details via printf.

Synopsis

```
CK_RV ShowSlot(
CK_SLOT_ID slotID,
int verbose);
```

Parameter	Description
slotID	Slot to dump
verbose	0 for description and manufacturer, 1 for more details

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ShowToken

Dump token details via printf.

Synopsis

```
CK_RV ShowToken(
CK_SLOT_ID slotID,
int verbose);
```

Parameter	Description
slotID	Slot containing Token to dump
verbose	0 for brief details, 1 for more details

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strAttribute

Given the numeric value of an attribute, return the string name.

Synopsis

```
char * strAttribute(
CK_NUMERIC val);
```

Parameter	Description
val	Numeric value of an attribute

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strError

Given the numeric value of an error, return the string name.

Synopsis

```
char * strError(
CK_NUMERIC val);
```

Parameter	Description
val	Numeric value of an error

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strKeyType

Given the numeric value of a key type, return the string name.

Synopsis

```
char * strKeyType(
CK_NUMERIC val);
```

Parameter	Description
val	Numeric value of a key type

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strMechanism

Given the numeric value of a mechanism, return the string name.

Synopsis

```
char * strMechanism(
CK_NUMERIC val);
```

Parameter	Description
val	Numeric value of a mechanism

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strObjClass

Given the numeric value of an object class, return the string name.

Synopsis

```
char * strObjClass(
CK_NUMERIC val);
```

Parameter	Description
val	Numeric value of an object class

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strSesState

Given the numeric value of a session state, return the string name.

Synopsis

```
char * strSesState(
CK_NUMERIC val);
```

Parameter	Description
val	Numeric value of a session state

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TransferObject

Copies an object from one Token to another.

Synopsis

```
CK_RV TransferObject(
CK_SESSION_HANDLE sTo,
CK_SESSION_HANDLE sFrom,
CK_OBJECT_HANDLE hObj,
CK_OBJECT_HANDLE * phObj,
CK_ATTRIBUTE_PTR pTemplate,
CK_COUNT ulCount);
```

Parameter	Description
sTo	Open session handle on destination Token
sFrom	Open session handle on source Token
hObj	Handle to object to transfer
phObj	Reference to handle to hold new object
pTemplate	Specifies new values for some attributes of the new object
ulCount	Number of attributes in pTemplate

On Successful Return

***phObj** — handle to newly copied object

pTemplate — can only overwrite attributes which are ordinarily writeable.

This function tries the following methods to copy the object, in order:

1. Using the `CKM_ENCODE_ATTRIBUTES` vendor defined key wrapping mechanism to transfer keys.
2. Reading all the attributes of the existing object and creating a new object with them.

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valAttribute

Given the string name of an attribute, return the numeric value.

Synopsis

```
CK_NUMERIC valAttribute(
const char * txt);
```

Parameter	Description
txt	String name of an attribute

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valError

Given the string name of an error, return the numeric value.

Synopsis

```
CK_NUMERIC valError(
const char * txt);
```

Parameter	Description
txt	String name of an error

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valKeyType

Given the string name of a key type, return the numeric value.

Synopsis

```
CK_NUMERIC valKeyType(
const char * txt);
```

Parameter	Description
txt	String name of a key type

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valMechanism

Given the string name of a mechanism, return the numeric value.

Synopsis

```
CK_NUMERIC valMechanism(
const char * txt);
```

Parameter	Description
txt	String name of a mechanism

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valObjClass

Given the string name of an object class, return the numeric value.

Synopsis

```
CK_NUMERIC valObjClass(
const char * txt);
```

Parameter	Description
txt	String name of the object class

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valSesState

Given the string name of a session state, return the numeric value.

Synopsis

```
CK_NUMERIC valSesState(
const char * txt);
```

Parameter	Description
txt	String name of a session state

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CHAPTER 12: ctextra.h Library Reference

The ProtectToolkit-C Software Development Kit offers a number of extended API libraries with functionality that is extended to that of the standard PKCS#11 function set.

The following additional features do not form part of the standard PKCS#11 functionality, but are provided by Thales as part of the SafeNet ProtectToolkit-C API within the **ctextra.h** library.

This chapter provides descriptions of the following features:

- "AddAttributeSets" on page 576
- "at_assign" on page 577
- "ConcatAttributeSets" on page 578
- "CopyAttribute" on page 579
- "DupAttributes" on page 580
- "DupAttributeSet" on page 581
- "ExtractAllAttributes" on page 582
- "FindAttr" on page 583
- "FreeAttributes" on page 584
- "FreeAttributeSet" on page 585
- "FreeAttributesNoClear" on page 586
- "FreeMechData" on page 587
- "genkMechanismTabFromMechanismTab" on page 588
- "genkpMechanismTabFromMechanismTab" on page 589
- "genMechanismTabFromMechanismTab" on page 590
- "GetCryptokiVersion" on page 591
- "GetObjAttrInfo" on page 592
- "GetObjectClassAndKeyType" on page 593
- "hashMech" on page 594
- "intAttr" on page 595
- "intAttrLookup" on page 596
- "isBooleanAttr" on page 597
- "isEnumeratedAttr" on page 598
- "isGenMech" on page 599
- "isNumericAttr" on page 600
- "isSensitiveAttr" on page 601

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- "KeyFromPin" on page 602
- "kgMech" on page 603
- "kpgMech" on page 604
- "ktFromMech" on page 605
- "LookupMech" on page 606
- "MatchAttributeSet" on page 607
- "mechDeriveFromKt" on page 608
- "mechFromKt" on page 609
- "mechFromTokKt" on page 610
- "mechSignFromKt" on page 611
- "mechSignRecFromKt" on page 612
- "NewAttributeSet" on page 613
- "numAttr" on page 614
- "numAttrLookup" on page 615
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- "PvcFromPin" on page 617
- "ReadAttr" on page 618
- "slotIDfromSes" on page 619
- "TransferAttr" on page 620
- "UnwrapDec" on page 621
- "WrapEnc" on page 622
- "WriteAttr" on page 623

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AddAttributeSets

Add two attribute sets being careful to drop duplicates. The 'base' attributes will override 'user' attributes where duplicates are concerned. Resulting set is located in *pSum.

Synopsis

```
CK_RV AddAttributeSets(TOK_ATTR_DATA ** pSum,const TOK_ATTR_DATA * base,const TOK_ATTR_DATA *
user);
```

Parameter	Description
pSum	Reference to addition of base and user sets
base	Attribute set to add to user set
user	Attribute set to add to base set

On Successful Return

***pSum**—reference to a newly allocated attribute set resulting from the addition. This memory needs to be released via a call to **FreeAttributeSet**.

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at_assign

Assign one attribute value to another. Attribute types and lengths have to match up.

Synopsis

```
CK_RV at_assign(
CK_ATTRIBUTE * tgtNa,
const CK_ATTRIBUTE * srcNa);
```

Parameter	Description
tgtNa	Target attribute
srcNa	Source attribute

To determine the length of tgtNa->pValue required, set tgtNa->pValue to NULL and check tgtNa->valueLen after invocation.

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ConcatAttributeSets

Append attributes from the user set to the base set. The 'base' attributes will override 'user' attributes where duplicates are concerned.

Synopsis

```
CK_RV ConcatAttributeSets(
TOK_ATTR_DATA * base,
const TOK_ATTR_DATA * user);
```

Parameter	Description
base	Reference to attribute set to append to
user	Reference to attribute set to append

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CopyAttribute

Make a copy of an attribute from one attribute set to another. Only copy it if it is in 'src'. Overwrite it if it is in 'tgt'. Returns reference to the copied attribute in tgt attribute set.

Synopsis

```
CK_ATTRIBUTE * CopyAttribute(
CK_ATTRIBUTE_TYPE at,
TOK_ATTR_DATA * tgt,
const TOK_ATTR_DATA * src);
```

Parameter	Description
at	Attribute to copy
tgt	Target attribute set
src	Source attribute set

On Successful Return

tgt — contains value of the specified attribute from src

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DupAttributes

Make a copy of an array of attributes. The returned attribute set is newly allocated. This memory needs to be released via a call to **FreeAttributeSet**.

Synopsis

```
TOK_ATTR_DATA * DupAttributes(
const CK_ATTRIBUTE * attr,
CK_COUNT attrCount);
```

Parameter	Description
attr	Attribute array to duplicate
attrCount	Number of attributes in attr

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DupAttributeSet

Make a copy of an attribute set. The returned attribute set is newly allocated. This memory needs to be released via a call to **FreeAttributeSet**.

Synopsis

```
TOK_ATTR_DATA * DupAttributeSet(
const TOK_ATTR_DATA * attrData);
```

Parameter	Description
attrData	Attribute set to duplicate

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ExtractAllAttributes

Extract all non-sensitive valid attributes of an object.

Synopsis

```
CK_RV ExtractAllAttributes(
CK_SESSION_HANDLE hSession,
CK_OBJECT_HANDLE hobj,
TOK_ATTR_DATA ** pna);
```

Parameter	Description
hSession	Open session handle
hObj	Object to extract from
pna	Reference to a reference to extracted attribute set

On Successful Return

***pna** — newly allocated attribute set of extracted attributes; this memory needs to be freed (see "FreeAttributeSet" on page 585)

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FindAttr

Find the first attribute of the specified type in an attribute set.

Synopsis

```
CK_ATTRIBUTE * FindAttr(CK_ATTRIBUTE_TYPE attrType,const TOK_ATTR_DATA * attrData);
```

Parameter	Description
attrType	Type of attribute to locate
attrData	Attribute set

On Successful Return

Return a pointer to the attribute of the specified type.

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FreeAttributes

Free all attributes contained in the attribute array, then free the array itself. This function also explicitly writes **0xaa** to the memory to be freed before freeing.

Synopsis

```
void FreeAttributes(
CK_ATTRIBUTE_PTR attr,
CK_COUNT attrCount);
```

Parameter	Description
attr	Attribute array to free
attrCount	Number of attributes in the array

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FreeAttributeSet

Free all of the attributes contained in the attribute set, and then free the set itself. This function also explicitly writes **0xaa** to the memory to be freed before freeing.

Synopsis

```
void FreeAttributeSet(
TOK_ATTR_DATA * attr);
```

Parameter	Description
attr	Reference to the attribute set to free

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FreeAttributesNoClear

Free all attributes contained in the attribute array, then free the array itself. This function does not explicitly write **0xaa** to the memory to be freed before freeing.

Synopsis

```
void FreeAttributesNoClear(
CK_ATTRIBUTE_PTR attr,
CK_COUNT attrCount);
```

Parameter	Description
attr	Attribute array to free
attrCount	Number of attributes in the array

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FreeMechData

Free dynamic memory of pMech, including pMech itself.

Synopsis

```
void FreeMechData(
TOK_MECH_DATA * pMech);
```

Parameter	Description
pMech	Mechanism list to free

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genkMechanismTabFromMechanismTab

Creates a key generation mechanism table for the list of mechanisms supplied in mTab

Synopsis

```
CK_MECHANISM_TYPE * genkMechanismTabFromMechanismTab(
TOK_MECH_DATA * mTab,
unsigned int * len);
```

Parameter	Description
mTab	Number of mechanisms to look up
len	Number of returned mechanisms

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genkpMechanismTabFromMechanismTab

Creates a key pair generation mechanism table for the list of mechanisms supplied in mTab.

Synopsis

```
CK_MECHANISM_TYPE * genkpMechanismTabFromMechanismTab(TOK_MECH_DATA * mTab,unsigned int * len);
```

Parameter	Description
mTab	List of mechanisms to look up
len	Number of returned mechanisms

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genMechanismTabFromMechanismTab

Creates a mechanism table for the list of mechanisms supplied in mTab.

Synopsis

```
CK_MECHANISM_TYPE * genMechanismTabFromMechanismTab(
TOK_MECH_DATA * mTab,
unsigned int * len);
```

Parameter	Description
mTab	List of mechanisms to look up
len	Number of returned mechanisms

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GetCryptokiVersion

Returns the Cryptoki version information.

Synopsis

```
CK_VOID GetCryptokiVersion(CK_VERSION_PTR pVer);
```

Parameter	Description
pVer	Returned Cryptoki version

On Successful Return

pVer — pointer to a value which holds Cryptoki version

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GetObjAttrInfo

Get the list of attributes (type and size) of the specified object.

This function relies on the SafeNet extension CKA_ENUM_ATTRIBUTES to retrieve the list of attributes. Only the attribute type and size are returned. Attribute values must be retrieved by the caller as required.

Synopsis

```
CK_RV GetObjAttrInfo(CK_SESSION_HANDLE hSession,
CK_OBJECT_HANDLE hObj,
CK_ATTRIBUTE_PTR* ppAttributes,
CK_ULONG_PTR pAttrCount);
```

Parameter	Description
hSession	Handle to a valid session
hObj	Handle to the object to operate on
ppAttributes	Location to receive the attribute array (on return, *ppAttributes references an array of CK_ATTRIBUTE - the caller must free the memory allocated at *ppAttributes).
pAttrCount	Location to hold the number of CK_ATTRIBUTE entries (on return, *pAttrCount is the number of CK_ATTRIBUTE entries referenced by *ppAttributes).

On Successful Return

***ppAttributes** — handle that points to the returned attributes

pAttrCount — number of returned attributes

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GetObjectClassAndKeyType

Extract the object class and key type from an attribute set.

Synopsis

```
CK_RV GetObjectClassAndKeyType(
const TOK_ATTR_DATA * attr,
CK_OBJECT_CLASS * at_class,
CK_KEY_TYPE * kt);
```

Parameter	Description
attr	Attribute set to extract from
at_class	Reference to object class to hold resulting value
kt	Reference to key type to hold resulting value

On Successful Return

at_class — references located object class

kt — references located key type

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hashMech

Return an array of all related mechanisms.

Synopsis

```
CK_MECHANISM_TYPE * hashMech(
unsigned int * len);
```

Parameter	Description
len	Reference to int to hold the number of items returned

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intAttr

Return the value of the attribute as an int.

Synopsis

```
unsigned int intAttr(
const CK_ATTRIBUTE * at);
```

Parameter	Description
at	Reference to attribute whose value is to be returned

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intAttrLookup

Extract an int attribute from an attribute template.

Synopsis

```
unsigned int intAttrLookup(CK_ATTRIBUTE_TYPE atype,const CK_ATTRIBUTE * attr,CK_COUNT
attrCount);
```

Parameter	Description
atype	Type of attribute to extract attr array of attributes to search attrCount number of attributes in attr array

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isBooleanAttr

Return `TRUE` if an attribute is a Boolean.

Synopsis

```
int isBooleanAttr(const CK_ATTRIBUTE * na);
```

Parameter	Description
na	Reference to attribute to check

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isEnumeratedAttr

Return `TRUE` if attribute is enumerated and can have Vendor defined values.

Synopsis

```
int isEnumeratedAttr(
const CK_ATTRIBUTE * na);
```

Parameter	Description
na	Reference to attribute to check

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isGenMech

Return `TRUE` if mechType is a key or key pair generation mechanism.

Synopsis

```
int isGenMech(
CK_MECHANISM_TYPE mechType);
```

Parameter	Description
mechType	Mechanism type to check

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isNumericAttr

Return TRUE if an attribute is a numeric.

Synopsis

```
int isNumericAttr(const CK_ATTRIBUTE * na);
```

Parameter	Description
na	Reference to attribute to check

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isSensitiveAttr

Report `TRUE` for potentially sensitive attributes, as per the PKCS#11 spec. Note that the object has to be marked sensitive for this to have any effect.

ProtectToolkit-C extension: all objects have the `CKA_VALUE` as sensitive if the object has `CKA_SENSITIVE` set to `TRUE`. This is useful for objects that are used internally only, or just wrapped for transmission elsewhere.

Synopsis

```
int isSensitiveAttr(
const struct TOK_ATTR_DATA * attrData,
const CK_ATTRIBUTE * na);
```

Parameter	Description
na	Reference to attribute to check

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KeyFromPin

Generate a double length key from a PIN, using PKCS#5 password based encryption.

Synopsis

```
void KeyFromPin(
unsigned char key[16],
unsigned int klen,
CK_USER_TYPE user,
const unsigned char * pin,
unsigned int pinLen);
```

Parameter	Description
key	Buffer to hold generated key
keylen	Number of bytes in key (should be 16)
user	Salt value for key generation
pin	Password used for key generation
pinLen	Number of bytes referenced by pin

On Successful Return

key — contains the generated key

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kgMech

Return an array of all key generation related mechanisms.

Synopsis

```
CK_MECHANISM_TYPE * kgMech(
unsigned int * len);
```

Parameter	Description
mechType	Reference to int to hold the number of items returned

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kpgMech

Return an array of all key pair generation related mechanisms.

Synopsis

```
CK_MECHANISM_TYPE * kpgMech(
unsigned int * len);
```

Parameter	Description
len	Reference to int to hold the number of items returned

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ktFromMech

Return an array of key types valid for the given mechanism. The returned array does not need to be freed.

Synopsis

```
CK_KEY_TYPE * ktFromMech(
CK_MECHANISM_TYPE mt,
unsigned int * len);
```

Parameter	Description
mt	Mechanism type to get key types for
len	Reference to int to hold the number of items in returned array

On Successful Return

***len** number of items in returned array

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LookupMech

Return `TRUE` if mechType is in the pMech list.

Synopsis

```
int LookupMech(
TOK_MECH_DATA * pMech,
CK_MECHANISM_TYPE mechType);
```

Parameters	Description
pMech	Reference to mechanism list
mechType	Mechanism to look for in pMech list

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MatchAttributeSet

Do a comparison of two attribute sets. Every attribute in the 'match' set must be found in the 'ad' set. It is OK if 'ad' is a super set of 'match'. Return `TRUE` if all attributes in 'match' were found in 'ad'.

Synopsis

```
int MatchAttributeSet(
const TOK_ATTR_DATA * match,
const TOK_ATTR_DATA * ad);
```

Parameter	Description
match	Attribute set to look for
ad	Attribute set to compare to

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mechDeriveFromKt

Return an array of derive mechanisms valid for the given key type. The returned array is newly allocated and needs to be freed.

Synopsis

```
CK_MECHANISM_TYPE * mechDeriveFromKt(CK_KEY_TYPE kt,unsigned int * len);
```

Parameter	Description
kt	Key type to look up
len	Pointer to integer that receives length of returned array

On Successful Return

Array of CK_MECHANISM_TYPE values or NULL if key type is invalid. Caller should free the array when finished.

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mechFromKt

Return an array of mechanisms valid for the given key type. The returned array is newly allocated and needs to be freed.

Synopsis

```
CK_MECHANISM_TYPE * mechFromKt(
CK_KEY_TYPE kt,
unsigned int * len);
```

Parameter	Description
kt	Key type to get mechanisms for
len	Reference to int to hold number of items in returned array

On Successful Return

Array of CK_MECHANISM_TYPE values or NULL if key type is invalid. Caller should free the array when finished.

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mechFromTokKt

Return an array of mechanisms valid for the given key type. The returned array is newly allocated and needs to be freed.

Synopsis

```
CK_MECHANISM_TYPE * mechFromTokKt(
TOK_MECH_DATA * mTab,
CK_KEY_TYPE kt,
unsigned int * len);
```

Parameter	Description
mTab	List of mechanisms to look up
kt	Key type to get mechanisms for
len	Reference to int to hold number of items in returned array

On Successful Return

Array of CK_MECHANISM_TYPE values or NULL if key type is invalid. Caller should free the array when finished.

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mechSignFromKt

Return an array of signing mechanisms valid for the given key type. The returned array is newly allocated and needs to be freed.

Synopsis

```
CK_MECHANISM_TYPE * mechSignFromKt(CK_KEY_TYPE kt,unsigned int * len);
```

Parameter	Description
kt	Key type to get mechanisms for
len	Reference to int to hold number of items in returned array

On Successful Return

Array of CK_MECHANISM_TYPE values or NULL if key type is invalid. Caller should free the array when finished.

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mechSignRecFromKt

Return an array of signing mechanisms valid for the given key type. The returned array is newly allocated and needs to be freed.

Synopsis

```
CK_MECHANISM_TYPE * mechSignRecFromKt(CK_KEY_TYPE kt,unsigned int * len);
```

Parameter	Description
kt	Key type to get mechanisms for
len	Reference to int to hold number of items in returned array

On Successful Return

Array of CK_MECHANISM_TYPE values or NULL if key type is invalid. Caller should free the array when finished.

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NewAttributeSet

Allocate memory for an attribute set to hold the specified number of attributes. The returned memory needs to be freed (see *FreeAttributeSet*)

Synopsis

```
TOK_ATTR_DATA * NewAttributeSet(
unsigned int count);
```

Parameter	Description
count	Number of attribute place holders to allocate in the set

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numAttr

Return the value of the attribute as a numeric.

Synopsis

```
CK_NUMERIC numAttr(
const CK_ATTRIBUTE * at);
```

Parameter	Description
at	Reference to attribute whose value is to be returned

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numAttrLookup

Extract a numeric attribute from an attribute template.

Synopsis

```
CK_NUMERIC numAttrLookup(CK_ATTRIBUTE_TYPE atype,const CK_ATTRIBUTE * attr,CK_COUNT attrCount);
```

Parameter	Description
atype	Type of attribute to extract attr array of attributes to search
attrCount	Number of attributes in attr array

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NUMITEMS

This is a macro that returns the number of elements in an array. Note that only array definitions may be sized by this macro, not pointer definitions.

It is used wherever object templates are defined since the number of items in the template is always passed along with the template address into Cryptoki functions. Use of this macro is preferred to hard coding the number of items in the template that may change with code maintenance.

Synopsis

```
#define NUMITEMS(type)  (sizeof((type))/sizeof((type)[0]))
```


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PvcFromPin

Create a PVC from a PIN using PKCS#5 password based encryption.

Synopsis

```
void PvcFromPin(unsigned char * key,unsigned int klen,CK_USER_TYPE user,const unsigned char *
pin,unsigned int pinLen);
```

Parameter	Description
key	Resulting pvc
klen	Number of bytes referenced by key
user	Salt value
pin	Password
pinLen	Number of bytes referenced by pin

On Successful Return

key — contains the pvc

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ReadAttr

Read an attribute value from an attribute set. Return `TRUE` if the attribute was present.

Synopsis

```
int ReadAttr(
void * buf,
unsigned int len,
unsigned int * plen,
CK_ATTRIBUTE_TYPE attrType,
const TOK_ATTR_DATA * attr);
```

Parameter	Description
buf	Buffer to receive attribute value
len	Number of bytes referenced by buf
plen	Reference to int to hold number of bytes copied to buf
attrType	Type of attribute to extract from attr
attr	Attribute set to search

On Successful Return

buf — contains attribute value

plen — references number of bytes copied into buf

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slotIDfromSes

Extract a **CK_SLOT_ID** from a **CK_SESSION_HANDLE**. This function only works with SafeNet's Cryptoki product because it includes an encoding of the SLOT id in the session handle. For other PKCS#11 implementations the slot ID can be obtained from the session info **C_GetSessionInfo()** call.

Synopsis

```
CK_SLOT_ID slotIDfromSes(CK_SESSION_HANDLE h);
```


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TransferAttr

Using at_assign, copy attribute values from one array to another. The order of the attributes must be the same in both arrays.

Synopsis

```
CK_RV TransferAttr(
CK_ATTRIBUTE * pTgtTemplate,
const CK_ATTRIBUTE * pSrcTemplate,
CK_COUNT attrCount);
```

Parameter	Description
pTgtTemplate	Target attribute array
pSrcTemplate	Source attribute array
attrCount	Number of attributes to copy from source to target

On Successful Return

pTgtTemplate — contains copy of attribute values from pSrcTemplate

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UnwrapDec

Unwrap a key and decode its attributes.

Synopsis

```
int UnwrapDec(
CK_SESSION_HANDLE hSession,
CK_OBJECT_HANDLE hUnwrapper,
CK_OBJECT_HANDLE * hUnwrappedKey,
unsigned char * buf,
unsigned int bufLen);
```

Parameter	Description
hSession	Open session handle
hUnwrapper	Handle to unwrapping key
hUnwrappedKey	Reference to handle to the key unwrapped
buf	Reference to bytes containing the key and attributes
bufLen	Number of bytes referenced by buf

On Successful Return

***hUnwrappedKey** — handle to unwrapped key with attributes

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WrapEnc

Wrap a key, encode its attributes and write it to a buffer.

Synopsis

```
int WrapEnc (
CK_SESSION_HANDLE hSession,
CK_OBJECT_HANDLE hWrapper,
CK_OBJECT_HANDLE hWrappee,
unsigned char * buf,
unsigned int bufLen,
CK_SIZE * bytesWritten);
```

Parameter	Description
hSession	Open session handle
hWrapper	Handle to wrapping key
hWrappee	Wrappee handle to the key to wrap
buf	Reference to bytes to hold the result
bufLen	Number of bytes referenced by buf
bytesWritten	Reference to value to hold the number of bytes written to buf

On Successful Return

buf — contains the wrapped key and encoded attributes *bytesWritten number of bytes written to buf

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WriteAttr

Add/Replace an attribute to an attribute set. Delete attribute if len is 0.

Synopsis

```
CK_RV WriteAttr(
const void * buf,
unsigned int len,
CK_ATTRIBUTE_TYPE attrType,
TOK_ATTR_DATA * attr);
```

Parameter	Description
buf	Value to add to attribute set
len	Number of bytes to add from buf
attrType	Type of attribute to add
attr	Attribute set to modify

On Successful Return

attr — modified attribute set

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CHAPTER 13: hex2bin.h Library Reference

The ProtectToolkit-C Software Development Kit offers a number of extended API libraries with functionality that is extended to that of the standard PKCS#11 function set.

The following additional features do not form part of the standard PKCS#11 functionality, but are provided by Thales as part of the SafeNet ProtectToolkit-C API within the **hex2bin.h** library.

This chapter describes the following features:

> "hex2bin" on the next page
> "bin2hex" on page 626
> "bin2hexM" on page 627
> "memdump" on page 628
> "SetOddParity" on page 629
> "isOddParity" on page 630

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hex2bin

Used to convert ASCII HEX strings to binary data.

The function ignores white space in 'hex' and converts pairs of HEX characters into their equivalent binary representation.

Synopsis

```
int hex2bin(
void * bin,
const char * hex,
unsigned maxLen );
```

Parameter	Description
bin Output	A buffer to receive the binary data
hex Input	A string of ASCII HEX characters to be converted
maxLen Input	The maximum number of characters that 'bin' can hold

Example

```
Input -
hex = "41424300"
maxLen = 4

Output -
bin[4] = "ABC"
```


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bin2hex

Converts binary data into an ASCII HEX. This function is the inverse of **hex2bin**.

Synopsis

```
int bin2hex(
char * hex,
const void * bin,
unsigned maxLen );
```

Parameter	Description
bin Input	A buffer of binary data
hex Output	A buffer to receive the string of ASCII HEX characters
maxLen Input	The number of characters that 'bin' contains that should be converted (this is not the length of the output buffer 'hex')

Example

```
Input -
bin = "abc"
maxLen = 3
Output -
 hex[7] = "616263"
```


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bin2hexM

As for bin2hex, converts binary data into an ASCII HEX and then inserts a '\n' after every 'lineLen' characters for display formatting.

Synopsis

```
int bin2hexM(
char * hex,
const void * bin,
unsigned maxLen,
unsigned int lineLen);
```

Parameter	Description
bin Input	A buffer of binary data
hex Output	A buffer to receive the string of ASCII HEX characters
maxLen Input	The number of characters that 'bin' contains that should be converted (this is *not* the length of the output buffer 'hex')
lineLen	Number of characters before a new line (\n) is added

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memdump

This function prints the contents of the memory as binary data to **stdout** for debugging purposes.

Synopsis

```
void memdump(
const char * txt,
const unsigned char * buf,
unsigned int len);
```

Parameter	Description
txt Input	Title string (may be NULL)
buf Input	Binary data that is to be hex dumped
len Input	Length of 'buf'

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SetOddParity

Converts a buffer of binary data to 'odd' parity.

For each byte in 'string' this function will flip the least significant bit, if necessary, to make the number of one bits in the entire byte an odd number (odd parity).

Synopsis

```
void SetOddParity(
unsigned char * string,
unsigned int count);
```

Parameter	Description
string	Input/output, binary data to convert
count	Length of 'string'

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isOddParity

This function checks the parity of the supplied data and returns 1 if buffer contains bytes that are all of odd parity.

Synopsis

```
int isOddParity(
const unsigned char * string,
unsigned int count);
```

Parameter	Description
string	Input, binary data to check
count	Input, length of 'string'

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CHAPTER 14: hsmadmin.h Library Reference

The ProtectToolkit-C Software Development Kit offers a number of extended API libraries with functionality that is extended to that of the standard PKCS#11 function set.

The following additional features do not form part of the standard PKCS#11 functionality, but are provided by Thales as part of the SafeNet ProtectToolkit-C API within the **hsmadmin.h** library.

This reference contains descriptions of the following features:

> "HSMADM_GetTimeOfDay" on page 633
> "HSMADM_AdjustTime" on page 634
> "HSMADM_SetRtcStatus" on page 635
> "HSMADM_GetRtcStatus" on page 636
> "HSMADM_GetRtcAdjustAmount" on page 637
> "HSMADM_GetRtcAdjustCount" on page 638
> "HSMADM_GetHsmUsageLevel" on page 639

The following functions provide an interface to the HSM's real-time clock (RTC). This library is used in conjunction with the **ctconf** utility. The **ctconf** utility provides the capability to set the access control configuration parameters for the RTC.

This library cannot be used in software emulation mode.

Return Codes

The return code of all of the functions in the HSMAdmin Library is the enumerated type HSMADM_RV which can have the following values.

Return Code	Meaning
HSMADM_OK	The operation was successful.
HSMADM_BAD_PARAMETER	One or more of the parameters have an invalid value.
HSMADM_ADJ_TIME_LIMIT	The delta value passed to the HSMADM_AdjustTime() is too large, and will not be used.
HSMADM_ADJ_COUNT_LIMIT	The number of calls made to the HSMADM_AdjustTime() that change the time is too large. The adjustment will not be made.

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Return Code	Meaning
HSMADM_NO_MEMORY	There is not enough memory to complete operation.
HSMADM_SYSERR	There was a system error. The operation was not performed.

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HSMADM_GetTimeOfDay

Obtains the current time of day from the HSM RTC.

Synopsis

```
#include hsmadmin.h
HSMADM_RV HSMADM_GetTimeOfDay(unsigned int hsmIndex,HSMADM_TimeVal_t * tv );
```

Parameter	Description
hsmIndex	Zero-based index of the HSM number to be used
tv	Address of the variable which is to be initialized with the current time of day. It indicates the time passed since midnight, 1 Jan 1970. This struct contains a field tv_usec, which is the number of microseconds. The HSM real-time clock only has millisecond resolution; therefore, tv_usec is always rounded up to the nearest millisecond HSMADM_TimeVal_t is defined in **hsmadmin.h**.

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HSMADM_AdjustTime

Either adjust the time, or obtain the current adjustment value.

The parameter, delta, indicates the adjustment to be applied to the HSM RTC. The HSM is only capable of performing Slew Adjustment when updating the real-time clock (RTC). This prevents large (multiple second) negative or positive steps of the current RTC. The RTC has a Slew Adjustment of 1 second for every 10 seconds of elapsed time, hence if the RTC was out by 1000 seconds, it will take approx 10000 seconds (2.7 hours) to match the external time source.

Because Slew Adjustment is the means by which the RTC is updated, the HSM may not have completed making an adjustment requested by a previous HSMADM_AdjustTime call. If there is an adjustment being performed when this function is called, then this adjustment is discarded, and the new adjustment value is used instead.

This function can alternatively be used to obtain the value of the time adjustment that remains to be completed. If the parameter delta is NULL, and oldDelta is a valid pointer, it will return the pending adjustment.

> **NOTE** The adjustment value added by this function is discarded if the HSM is rebooted or shut down.

Synopsis

```
#include hsmadmin.h
HSMADM_RV HSMADM_AdjustTime(unsigned int hsmIndex,const HSMADM_TimeVal_t * delta,HSMADM_
TimeVal_t * oldDelta );
```

Parameter	Description
hsmIndex	Zero-based index of the HSM number to be used
delta	Amount of adjustment to be made to the RTC. This parameter must be NULL if **oldDelta** is not NULL. HSMADM_TimeVal_t is defined in **hsmadmin.h**
oldDelta	Address of the variable that will receive the value of the adjustment that remains to be completed. HSMADM_TimeVal_t is defined in **hsmadmin.h**. If this parameter is not NULL, delta must be NULL

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HSMADM_SetRtcStatus

Changes the RTC status.

Synopsis

```
#include hsmadmin.h
HSMADM_RV HSMADM_SetRtcStatus(unsigned int hsmIndex,HSMADM_RtcStatus_t status );
```

Parameter	Description
hsmIndex	Zero-based index of the HSM number to be used
status	New status of the RTC. Possible values of the RTC status are defined in **hsmadmin.h** and are described below.

Return Codes

Value	Meaning
HSMADM_RTC_ UNINITIALIZED	The RTC is not initialized yet.
HSMADM_RTC_STAND_ ALONE	The RTC is in the stand alone mode. This means that it is completely controlled by the crypto subsystem. In this mode, all cryptographic operations are allowed to use the value of the clock.
HSMADM_RTC_ MANAGED_UNTRUSTED	The RTC is being controlled by an external program; but the value is not trusted yet. This means certain cryptographic operations are refused access to the RTC because the value is (possibly) incorrect. When the RTC Status is set to this value, the **ctconf -t** command, which normally is used to set the RTC, cannot be used.
HSMADM_RTC_ MANAGED_TRUSTED	The RTC is being controlled by an external program, and its value may be trusted. This means that all cryptographic operations are allowed to use the value of the clock. When the RTC Status is set to this value, the **ctconf -t** command, which normally is used to set the RTC, cannot be used.

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HSMADM_GetRtcStatus

Obtain the HSM RTC status.

Synopsis

```
#include hsmadmin.h
HSMADM_RV HSMADM_GetRtcStatus(unsigned int hsmIndex,HSMADM_RtcStatus_t* status );
```

Parameter	Description
hsmIndex	Zero-based index of the HSM number to be used. This parameter is only valid if RTC Access Control is enabled. RTC Access Control can be modified via the **ctconf** utility.
status	Address of the variable that will obtain the current status of the RTC. This parameter must not be NULL. Possible values of the RTC status are defined in **hsmadmin.h**and are described below.

Return Codes

Value	Meaning
HSMADM_RTC_ UNINITIALIZED	The RTC is not initialized yet.
HSMADM_RTC_ STAND_ALONE	The RTC is in the stand alone mode. This means that it is completely controlled by the crypto subsystem. In this mode, all cryptographic operations are allowed to use the value of the clock.
HSMADM_RTC_ MANAGED_ UNTRUSTED	The RTC is being controlled by an external program; but the value is not trusted yet. This means certain cryptographic operations are refused access to the RTC because the value is (possibly) incorrect. When the RTC Status is set to this value, the **ctconf -t** command, which normally is used to set the RTC, cannot be used.
HSMADM_RTC_ MANAGED_ TRUSTED	The RTC is being controlled by an external program, and its value may be trusted. This means that all cryptographic operations are allowed to use the value of the clock. When the RTC Status is set to this value, the **ctconf -t** command, which normally is used to set the RTC, cannot be used.

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HSMADM_GetRtcAdjustAmount

Get the effective total amount, in milliseconds, of adjustment made to the RTC using the **HSMADM_AdjustTime()** function.

Synopsis

```
#include hsmadmin.h
HSMADM_RV HSMADM_GetRtcAdjustAmount(unsigned int hsmIndex, long *totalMs);
```

Parameter	Description
hsmIndex	Zero-based index of the HSM number to be used.
totalMs	Address of the variable that will contain the total amount adjusted. The total amount adjusted is calculated by summing the adjust amounts specified via a valid HSMADM_AdjustTime() call. For instance if two adjustments are made of 20ms and -3ms this parameter should return 17ms. This parameter must not be NULL. This parameter is only valid if RTC Access Control is enabled. RTC Access Control can be modified via the **ctconf** utility.

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HSMADM_GetRtcAdjustCount

Get the effective count of adjustments made to the RTC using the **HSMADM_AdjustTime()** function.

Synopsis

```
#include hsmadmin.h
HSMADM_RV HSMADM_GetRtcAdjustCount(unsigned int hsmIndex, unsigned long *totalCount);
```

Parameter	Description
hsmIndex	Zero-based index of the HSM number to be used.
totalCount	Address of the variable that will obtain the total count of adjustments. The total count of adjustments indicates the a count of the number of valid adjustments made via HSMADM_AdjustTime() call. This parameter must not be NULL. This parameter is only valid if RTC Access Control is enabled. RTC Access Control can be modified via the **ctconf** utility.

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HSMADM_GetHsmUsageLevel

Get the usage level of the HSM as a percentage i.e. the load on the HSM.

Synopsis

```
#include hsmadmin.h
HSMADM_RV HSMADM_GetHsmUsageLevel (unsigned int hsmIndex,
unsigned long* value
);
```

Parameter	Description
hsmIndex	Zero-based index of the HSM number to be used.
totalCount	Address of the variable that will obtain the value. This parameter must not be NULL

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APPENDIX A: Attribute Certificate

The Set Attribute Ticket, which is used to authorize updates to key usage limits, has the format of an Attribute Certificate defined by PKIX (RFC 3281).

```
AttributeCertificate ::= SEQUENCE {
   acinfo               AttributeCertificateInfo,
   signatureAlgorithm   AlgorithmIdentifier,
   signatureValue       BIT STRING
}

AttributeCertificateInfo ::= SEQUENCE {
      version              AttCertVersion -- version is v2,
      holder               Holder,
      issuer               AttCertIssuer,
      signature            AlgorithmIdentifier,
      serialNumber         CertificateSerialNumber,
      attrCertValidityPeriod   AttCertValidityPeriod,
      attributes           SEQUENCE OF Attribute,
      issuerUniqueID       UniqueIdentifier OPTIONAL,
      extensions           Extensions OPTIONAL
}

AttCertVersion ::= INTEGER { v2(1) }

Holder ::= SEQUENCE {
       baseCertificateID   [0] IssuerSerial OPTIONAL,
    -- the issuer and serial number of
    -- the holder's Public Key Certificate

       entityName          [1] GeneralNames OPTIONAL,
       objectDigestInfo    [2] ObjectDigestInfo OPTIONAL
           -- used to directly authenticate the target key,
           -- see further description below
}

ObjectDigestInfo ::= SEQUENCE {
       digestedObjectType  ENUMERATED {
       publicKey            (0),
       publicKeyCert        (1),
       otherObjectTypes     (2) },
       -- otherObjectTypes only to be used
       otherObjectTypeID   OBJECT IDENTIFIER OPTIONAL,
              -- must be OID_X509_ATTR_KEY_DIGEST
       digestAlgorithm     AlgorithmIdentifier,
       objectDigest        BIT STRING
            }
```

The algorithm `OID_X509_ATTR_KEY_DIGEST` is:

```
objectDigest  = Digest(Token_Serial_Number | Token_Label | ObjectID)
```

Where:

`ObjectID` is the concatenation of the CKA_LABEL and CKA_ID attributes of the target Object.

```
AttCertIssuer ::= CHOICE {
      v1Form   GeneralNames,  -- MUST NOT be used in this
                              -- profile
     v2Form   [0] V2Form     -- v2 only
}

V2Form ::= SEQUENCE {
     issuerName            GeneralNames  OPTIONAL,
     baseCertificateID     [0] IssuerSerial  OPTIONAL,
     objectDigestInfo      [1] ObjectDigestInfo  OPTIONAL
     -- issuerName MUST be present in this profile
     -- baseCertificateID and objectDigestInfo MUST NOT
     -- be present in this profile
}

IssuerSerial  ::=  SEQUENCE {
     issuer         GeneralNames,
     serial         CertificateSerialNumber,
     issuerUID      UniqueIdentifier OPTIONAL
}

AttCertValidityPeriod  ::= SEQUENCE {
     notBeforeTime  GeneralizedTime,
     notAfterTime   GeneralizedTime
}


Attribute ::= SEQUENCE {
     type      AttributeType,
     values    SET OF AttributeValue
     -- at least one value is required
}

AttributeType ::= OBJECT IDENTIFIER
-- there is a different OID for each type of Cryptoki Attribute
-- see below for a list

AttributeValue ::= ANY DEFINED BY AttributeType
      -- the data type depends on the type field but it
      -- represents the value part of the Cryptoki attribute.
```


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OID Used to Indicate Key Digest Algorithm

OID	OID-type
{ iso(1) identified-organization(3) dod(6) internet(1) private(4) enterprises(1) safeNetInc (23629) safenetRoot(1) safenetHSM(4) ptkc(2) objDigests(2) key(1) }	`OID_X509_ATTR_KEY_DIGEST`

OID Value	OID-type	Cryptoki Attribute Type	DER Encoded Value
{ iso(1) identified-organization(3) dod(6) internet(1) private(4) enterprises(1) safeNetInc(23629) safenetRoot(1) safenetHSM(4) ptkc(2) p11Attrs(1) usage_limit(1) }	`OID_X509_ATTR_USAGE_LIMIT`	CKA_USAGE_LIMIT	INTEGER
{ iso(1) identified-organization(3) dod(6) internet(1) private(4) enterprises(1) safeNetInc(23629) safenetRoot(1) safenetHSM(4) ptkc(2) p11Attrs(1) end_date(2) }	`OID_X509_ATTR_END_DATE`	CKA_END_DATE	PrintableString
{ iso(1) identified-organization(3) dod(6) internet(1) private(4) enterprises(1) safeNetInc(23629) safenetRoot(1) safenetHSM(4) ptkc(2) p11Attrs(1) start_date(3) }	`OID_X509_ATTR_START_DATE`	CKA_START_DATE	PrintableString
{ iso(1) identified-organization(3) dod(6) internet(1) private(4) enterprises(1) safeNetInc(23629) safenetRoot(1) safenetHSM(4) ptkc(2) p11Attrs(1) admin_cert(4) }	`OID_X509_ATTR_ADMIN_CERT`	CKA_ADMIN_CERT	

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Glossary

A

Adapter

The printed circuit board responsible for cryptographic processing in a HSM

AES

Advanced Encryption Standard

API

Application Programming Interface

ASO

Administration Security Officer

Asymmetric Cipher

An encryption algorithm that uses different keys for encryption and decryption. These ciphers are usually also known as public-key ciphers as one of the keys is generally public and the other is private. RSA and ElGamal are two asymmetric algorithms

B

Block Cipher

A cipher that processes input in a fixed block size greater than 8 bits. A common block size is 64 bits

Bus

One of the sets of conductors (wires, PCB tracks or connections) in an IC

C

CA

Certification Authority

CAST

Encryption algorithm developed by Carlisle Adams and Stafford Tavares

Certificate

A binding of an identity (individual, group, etc.) to a public key which is generally signed by another identity. A certificate chain is a list of certificates that indicates a chain of trust, i.e. the second certificate has signed the first, the

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third has signed the second and so on

CMOS

Complementary Metal-Oxide Semiconductor. A common data storage component

Cprov

ProtectToolkit C - SafeNet's PKCS #11 Cryptoki Provider

Cryptoki

Cryptographic Token Interface Standard. (aka PKCS#11)

CSA

Cryptographic Services Adapter

CSPs

Microsoft Cryptographic Service Providers

D

Decryption

The process of recovering the plaintext from the ciphertext

DES

Cryptographic algorithm named as the Data Encryption Standard

Digital Signature

A mechanism that allows a recipient or third party to verify the originator of a document and to ensure that the document has not be altered in transit

DLL

Dynamically Linked Library. A library which is linked to application programs when they are loaded or run rather than as the final phase of compilation

DSA

Digital Signature Algorithm

E

Encryption

The process of converting the plaintext data into the ciphertext so that the content of the data is no longer obvious. Some algorithms perform this function in such a way that there is no known mechanism, other than decryption with the appropriate key, to recover the plaintext. With other algorithms there are known flaws which reduce the difficulty in recovering the plaintext

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F

FIPS

Federal Information Protection Standards

FM

Functionality Module. A segment of custom program code operating inside the CSA800 HSM to provide additional or changed functionality of the hardware

FMSW

Functionality Module Dispatch Switcher

H

HA

High Availability

HIFACE

Host Interface. It is used to communicate with the host system

HSM

Hardware Security Module

I

IDEA

International Data Encryption Algorithm

IIS

Microsoft Internet Information Services

IP

Internet Protocol

J

JCA

Java Cryptography Architecture

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JCE

Java Cryptography Extension

K

Keyset

A keyset is the definition given to an allocated memory space on the HSM. It contains the key information for a specific user

KWRAP

Key Wrapping Key

M

MAC

Message authentication code. A mechanism that allows a recipient of a message to determine if a message has been tampered with. Broadly there are two types of MAC algorithms, one is based on symmetric encryption algorithms and the second is based on Message Digest algorithms. This second class of MAC algorithms are known as HMAC algorithms. A DES based MAC is defined in FIPS PUB 113, see http://www.itl.nist.gov/div897/pubs/fip113.htm. For information on HMAC algorithms see RFC-2104 at http://www.ietf.org/rfc/rfc2104.txt

Message Digest

A condensed representation of a data stream. A message digest will convert an arbitrary data stream into a fixed size output. This output will always be the same for the same input stream however the input cannot be reconstructed from the digest

MSCAPI

Microsoft Cryptographic API

MSDN

Microsoft Developer Network

P

Padding

A mechanism for extending the input data so that it is of the required size for a block cipher. The PKCS documents contain details on the most common padding mechanisms of PKCS#1 and PKCS#5

PCI

Peripheral Component Interconnect

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PEM

Privacy Enhanced Mail

PIN

Personal Identification Number

PKCS

Public Key Cryptographic Standard. A set of standards developed by RSA Laboratories for Public Key Cryptographic processing

PKCS #11

Cryptographic Token Interface Standard developed by RSA Laboratories

PKI

Public Key Infrastructure

ProtectServer

SafeNet HSM

ProtectToolkit C

SafeNet's implementation of PKCS#11. Protecttoolkit C represents a suite of products including various PKCS#11 runtimes including software only, hardware adapter, and host security module based variants. A Remote client and server are also available

ProtectToolkit J

SafeNet's implementation of JCE. Runs on top of ProtectToolkit C

R

RC2/RC4

Ciphers designed by RSA Data Security, Inc.

RFC

Request for Comments, proposed specifications for various protocols and algorithms archived by the Internet Engineering Task Force (IETF), see http://www.ietf.org

RNG

Random Number Generator

RSA

Cryptographic algorithm by Ron Rivest, Adi Shamir and Leonard Adelman

RTC

Real-Time Clock

S

SDK

Software Development Kits Other documentation may refer to the SafeNet Cprov and Protect Toolkit J SDKs. These SDKs have been renamed ProtectToolkit C and ProtectToolkit J respectively. The names Cprov and ProtectToolkit C refer to the same device in the context of this or previous manuals. The names Protect Toolkit J and ProtectToolkit J refer to the same device in the context of this or previous manuals.

Slot

PKCS#11 slot which is capable of holding a token

SlotPKCS#11

Slot which is capable of holding a token

SO

Security Officer

Symmetric Cipher

An encryption algorithm that uses the same key for encryption and decryption. DES, RC4 and IDEA are all symmetric algorithms

T

TC

Trusted Channel

TCP/IP

Transmission Control Protocol / Internet Protocol

Token

PKCS#11 token that provides cryptographic services and access controlled secure key storage

TokenPKCS#11

Token that provides cryptographic services and access controlled secure key storage

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U

URI

Universal Resource Identifier

V

VA

Validation Authority

X

X.509

Digital Certificate Standard

X.509 Certificate

Section 3.3.3 of X.509v3 defines a certificate as: "user certificate; public key certificate; certificate: The public keys of a user, together with some other information, rendered unforgeable by encipherment with the private key of the certification authority which issued it"

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