PKCS #11 v2.11 Amendment 1 – Draft

RSA Laboratories

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Editor's note: This is a draft of PKCS #11 v2.11 Amendment 1, which is available for a 30-day public review period. Please send comments and suggestions, both technical and editorial, to pkcs-editor@rsasecurity.com or pkcs-tng@rsasecurity.com.

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1. Scope

This amendment documents the changes to PKCS #11 v2.11 [4] needed to support:

- tokens capable not only of signing information but also of securely presenting that information to the user; and
- tokens capable of forming CMS [1] (or PKCS #7 [3]) **SignerInfo** values by themselves.

Note – The above capabilities are typical for Personal Trusted Devices (see the next Section), but may also be supported by other types of tokens.

It does so by defining:

- a new hardware feature object describing the presentation capabilities of the token; and
- a new signature mechanism, which allows the caller to submit the information to be signed, rather than the digest of the information.

2. Personal Trusted Devices

2.1 Background

This amendment introduces support for Personal Trusted Devices in PKCS #11. The term "personal trusted device" (PTD) is characterized in [2] as something which "is personal, controlled and used by one person and carried by that person most of the time…has an application platform with associated user interfaces for transaction related services such as banking, payment, bonus programs…[and] has the security functionality required for transaction related services: secure sessions, authentication and authorization." Further, the PTD "contains a Security Element, which is used for protecting its most critical data, such as private keys."

There is also built-in functionality to authenticate the user/owner to the PTD, and to store security-related objects, such as certificates.

A personal trusted device could be a PDA, a mobile phone or some other portable device. The important thing is that its owner can rightfully regard it as a trusted computing base. It is likely that, as mobile commerce evolves, PTDs will be an important enabler of applications that would otherwise not be feasible.

PTDs allow secure signatures to be made both in a personal environment and in more public environments, e.g. web cafés. The changes documented here will, when implemented, allow an application, informed of the fact that a PTD is available to sign the message, to provide the PTD with the message itself, and an indication of *desired* signed attributes. These attributes will then be compared against some configuration in the PTD before being accepted. The PTD may also add attributes of its own before returning the desired signature.

2.2 Security aspects

As indicated above, when a token acts as a personal trusted device, it does so thanks to certain characteristics, including:

- a trusted computing base;
- a user interface which is trusted;
- a security element which protects the signature keys; and
- a requirement of explicit user consent before each usage of the signature keys for non-repudiation purposes.

The combination of these characteristics provides users with a device following the "What You See Is What You Sign" paradigm. Users need therefore not trust software in personal computers in order to make signatures on transactions created in those personal computers – the transaction presented by the PTD is what needs to be authorized. While this provides an added level of security and assurance to signers, it does not, as the next sub-section will discuss, necessarily do so for receivers of these signatures.

2.3 Use of signature policies

A PTD may well add signed attributes of its own. One such attribute could indicate the particular signature policy it is working under. Another such attribute could identify what parts of a multi-part MIME message that has been presented by the PTD. The definition of these attributes is out of scope for this document.

A certificate-issuing authority may also elect to indicate in issued certificates the policies under which the private key may (or can) be used.

A signature-receiving application cannot in general trust signed attributes – a security element in the PTD may have been removed from the PTD and used in another environment which did not allow the user to view the information on a secure display before signing, for example. Such trust may however be asserted, when a certificate-issuing authority has vouched for the usage policies of the private key through, e.g. a certificate policy identifier or similar.

2.4 Authentication of PCs to PTDs

In certain environments or scenarios, there might be a need for the PTD to authenticate the requestor. Since the authentication will be carried out beneath the PKCS #11 interface, it is however out of scope for this document.

3. Changes to Section 3, "References"

[Add the following references, maintaining the alphabetical ordering of references:]

CC/PP Struct W3C. *Composite Capability/Preference Profiles (CC/PP): Structure and Vocabularies*. World Wide Web Consortium, Working Draft 15 March 2001. URL: http://www.w3.org/TR/CCPP-struct-vocab/

MeT-PTD MeT. *MeT PTD Definition – Personal Trusted Device Definition*, Version 1.0, 21 February 2001. URL: http://www.mobiletransaction.org

RFC 2045 Freed, N., and N. Borenstein. *IETF RFC 2045: Multipurpose Internet Mail Extensions (MIME) Part One: Format of Internet Message Bodies*. November 1996. URL: http://ietf.org/rfc/rfc2045.txt

RFC 2534 Masinter, L., Wing, D., Mutz, A., and K. Holtman. *IETF RFC 2534: Media Features for Display, Print, and Fax*. March 1999. URL: http://ietf.org/rfc/rfc2534.txt

RFC 2630 R. Housley. *IETF RFC 2630: Cryptographic Message Syntax*. June 1999. URL: http://ietf.org/rfc/rfc2630.txt.

4. Changes to Section 4, "Definitions"

[Add the following new definitions to PKCS #11 2.11 Section 4, maintaining the alphabetical order of definitions:]

CMS Cryptographic Message Syntax (see RFC 2630)
PTD Personal Trusted Device, as defined in MeT-PTD

5. Changes to Section 9.4, "Object types"

[Add the following object class definition to the listing under the heading "CK_OBJECT CLASS; CK_OBJECT_PTR"]

```
#define CKO_MECHANISM                0x00000TBA
```

[Add the following hardware feature type definition to the listing under the heading "CK_HW_FEATURE_TYPE":]

```
#define CKH_USER_INTERFACE           0x00000TBA
```

[Add the following attribute type definitions to the listing under the heading "CK_ATTRIBUTE_TYPE":]

```
#define CKA_PIXEL_X                  0x00000TBA
#define CKA_PIXEL_Y                  0x00000TBA
#define CKA_RESOLUTION               0x00000TBA
#define CKA_CHAR_ROWS                0x00000TBA
#define CKA_CHAR_COLUMNS             0x00000TBA
#define CKA_COLOR                    0x00000TBA
#define CKA_BITS_PER_PIXEL           0x00000TBA
#define CKA_CHAR_SETS                0x00000TBA
#define CKA_ENCODING_METHODS         0x00000TBA
#define CKA_MIME_TYPES               0x00000TBA
#define CKA_MECHANISM_TYPE           0x00000TBA
#define CKA_REQUIRED_CMS_ATTRIBUTES  0x00000TBA
#define CKA_DEFAULT_CMS_ATTRIBUTES   0x00000TBA
#define CKA_SUPPORTED_CMS_ATTRIBUTES 0x00000TBA
```

6. Changes to Section 9.5, “Data types for mechanisms”

[Add the following mechanism definition in the listing under the heading “CK_MECHANISM_TYPE; CK_MECHANISM_TYPE_PTR,” maintaining the numerical ordering of definitions:]

```
   #define CKM_CMS_SIG                      0x00000TBA
```

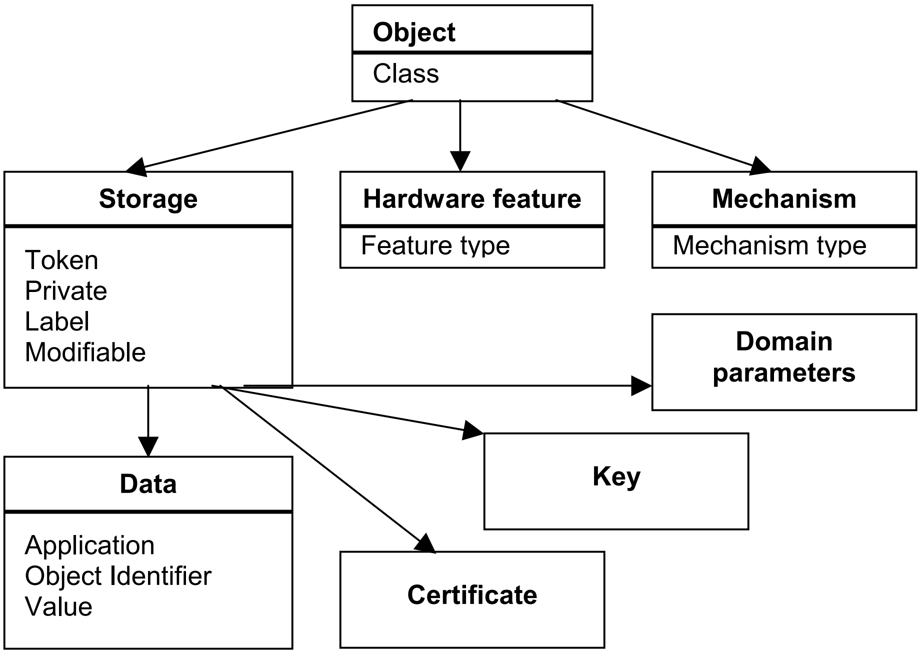
7. Changes to Section 9.6, “Function types”

[Add the following definition to the list of return values under the heading" CK_RV", maintaining the numerical order of return values:]

```
   #define CKR_FUNCTION_REJECTED            0x00000TBA
```

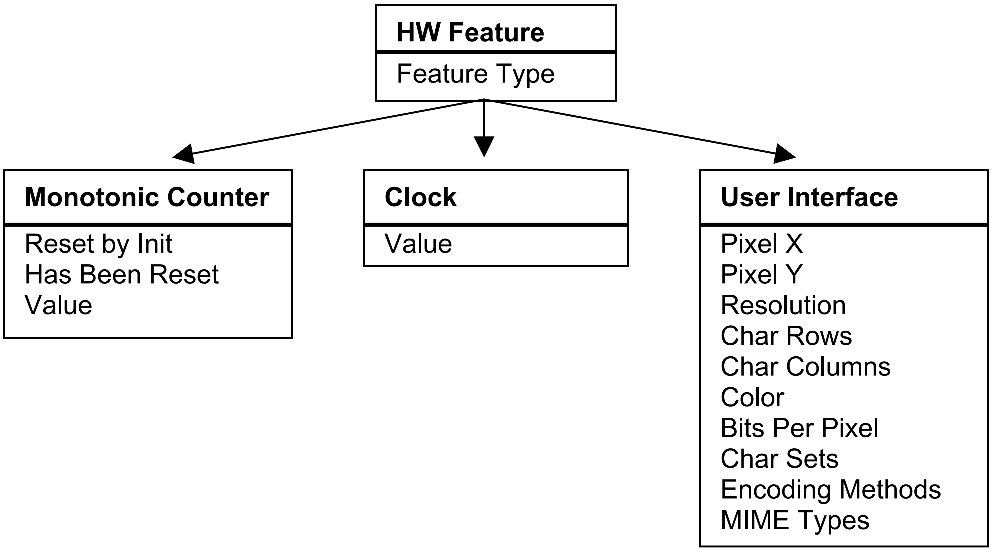
8. Changes to Section 10, “Objects"

[Replace Figure 5 with the following figure:]



9. Changes to Section 10.3, "Hardware Feature Objects"

[Replace Figure 6 with the following figure:]



[Replace the paragraph directly after Table 16 with the following paragraph:]

This version of Cryptoki supports the following values for **CKA_HW_FEATURE_TYPE**: **CKH_MONOTONIC_COUNTER**, **CKH_CLOCK**, and **CKH_USER_INTERFACE**.

[Add a new sub-subsection 10.3.3 as follows:]

10.3.3 User Interface Objects

User interface objects represent the presentation capabilities of the device.

Attribute	Data type	Meaning
CKA_PIXEL_X	CK_ULONG	Screen resolution (in pixels) in X-axis (e.g. 1280)
CKA_PIXEL_Y	CK_ULONG	Screen resolution (in pixels) in Y-axis (e.g. 1024)
CKA_RESOLUTION	CK_ULONG	DPI, pixels per inch
CKA_CHAR_ROWS	CK_ULONG	For character-oriented displays; number of character rows (e.g. 24)
CKA_CHAR_COLUMNS	CK_ULONG	For character-oriented displays: number of character columns (e.g. 80). If display is of proportional-font type, this is the width of the display in "em"-s (letter "M"), see CC/PP Struct.
CKA_COLOR	CK_BBOOL	Color support
CKA_BITS_PER_PIXEL	CK_ULONG	The number of bits of color or grayscale information per pixel.
CKA_CHAR_SETS	RFC 2279 string	List of integers indicating supported character sets, as defined by IANA MIBenum sets (www.iana.org). Supported character sets are separated with ";". E.g. a token supporting iso-8859-1 and us-ascii would set the attribute value to "`4;3`".
CKA_ENCODING_METHODS	RFC 2279 string	String indicating supported content transfer encoding methods, as defined by IANA (www.iana.org). Supported methods are separated with ";". E.g. a token supporting 7bit, 8bit and base64 could set the attribute value to "`7bit;8bit;base64`".
CKA_MIME_TYPES	RFC 2279 string	String indicating supported (presentable) MIME-types; see IANA. Supported types are separated with ";". E.g. a token supporting MIME types "a/b", "a/c" and "a/d" would set the attribute value to "`a/b;a/c;a/d`".

The selection of attributes, and associated data types, has been done in an attempt to stay as aligned with RFC 2534 and CC/PP Struct as possible. The special value CK_UNAVAILABLE_INFORMATION may be used for CK_ULONG-based attributes when information is not available or applicable.

None of the attribute values may be set by an application.

The value of the **CKA_ENCODING_METHODS** attribute may be used when the application needs to send MIME objects with encoded content to the token.

10. New section 10.12

[Add a new section 10.12 as follows:]

10.12 Mechanism Objects

Mechanism objects provide information about mechanisms supported by a device beyond that given by the **CK_MECHANISM_INFO** structure.

When searching for objects using **C_FindObjectsInit** and **C_FindObjects**, mechanism objects are not returned unless the **CKA_CLASS** attribute in the template has the value **CKO_MECHANISM**. This protects applications written to previous versions of cryptoki from finding objects that they do not understand.

Attribute	**Data Type**	**Meaning**
CKA_MECHANISM_TYPE	CK_MECHANISM_TYPE	The type of mechanism object

This version of cryptoki supports the following values for **CKA_MECHANISM_TYPE**: **CKM_CMS_SIG.**

The **CKA_MECHANISM_TYPE** attribute may not be set.

10.12.1 CMS Signature Mechanism Objects

These objects provide information relating to the CKM_CMS_SIG mechanism. CKM_CMS_SIG mechanism object attributes represent information about supported CMS signature attributes in the token. They are only present on tokens supporting the **CKM_CMS_SIG** mechanism, but must be present on those tokens.

Attribute	**Data type**	**Meaning**
CKA_REQUIRED_CMS_ATTRIBUTES	Byte array	Attributes the token always will include in the set of CMS signed attributes
CKA_DEFAULT_CMS_ATTRIBUTES	Byte array	Attributes the token will include in the set of CMS signed attributes in the absence of any attributes specified by the application
CKA_SUPPORTED_CMS_ATTRIBUTES	Byte array	Attributes the token may include in the set of CMS signed attributes upon request by the application

The contents of each byte array will be a DER-encoded list of CMS **Attributes** with optional accompanying values. Any attributes in the list shall be identified with its object identifier, and any values shall be DER-encoded. The list of attributes is defined in ASN.1 as:

```
Attributes ::= SET SIZE (1..MAX) OF Attribute

Attribute ::= SEQUENCE {
    attrType    OBJECT IDENTIFIER,
    attrValues SET OF ANY DEFINED BY OBJECT IDENTIFIER OPTIONAL
}
```

The client may not set any of the attributes.

11. Changes to Section 12, "Mechanisms"

[Add the following entry to Table 63, just after the "CKM_TLS_KEY_AND_MAC_DERIVE" entry, indicating that the new mechanism supports signatures with and without message recovery:]

CKM_CMS_SIG		✓	✓				

[Add new sub-sections 12.44 and 12.45 as follows:]

12.44 CMS mechanism parameters

- **CK_CMS_SIG_PARAMS, CK_CMS_SIG_PARAMS_PTR**

CK_CMS_SIG_PARAMS is a structure that provides the parameters to the **CKM_CMS_SIG** mechanism. It is defined as follows:

```
typedef struct CK_CMS_SIG_PARAMS {
CK_OBJECT_HANDLE      certificateHandle;
CK_MECHANISM_PTR      pSigningMechanism;
CK_MECHANISM_PTR      pDigestMechanism;
CK_UTF8CHAR_PTR       pContentType;
CK_BYTE_PTR           pRequestedAttributes;
CK_ULONG              ulRequestedAttributesLen;
CK_BYTE_PTR           pRequiredAttributes;
CK_ULONG_PTR          ulRequiredAttributesLen;
} CK_CMS_SIG_PARAMS;
```

The fields of the structure have the following meanings:

certificateHandle Object handle for a certificate associated with the signing key. The token may use information from this certificate to identify the signer in the **SignerInfo** result value. *CertificateHandle* may be NULL_PTR if the certificate is not available as a PKCS #11 object or if the calling application leaves the choice of certificate completely to the token.

pSigningMechanism Mechanism to use when signing a constructed CMS **SignedAttributes** value. E.g. **CKM_SHA1_RSA_PKCS**.

pDigestMechanism Mechanism to use when digesting the data. Value shall be NULL_PTR when the digest mechanism to use follows from the *pSigningMechanism* parameter.

pContentType NULL-terminated string indicating complete MIME Content-type of message to be signed; or the value NULL_PTR if the message is a MIME object (which the token can parse to determine its MIME Content-type if required). Use the value "`application/octet-stream`" if the MIME type for the message is unknown or undefined. Note that the *pContentType* string shall conform to the syntax specified in RFC 2045, i.e. any parameters needed for correct presentation of the content by the token (such as, for example, a non-default "`charset`") must be present. The token must follow rules and procedures defined in RFC 2045 when presenting the content.

pRequestedAttributes Pointer to DER-encoded list of CMS **Attributes** the caller requests to be included in the signed attributes. Token may freely ignore this list or modify any supplied values.

ulRequestedAttributesLen Length in bytes of the value pointed to by *pRequestedAttributes*

pRequiredAttributes Pointer to DER-encoded list of CMS **Attributes** (with accompanying values) required to be included in the resulting signed attributes. Token must not modify any supplied values. If the token does not support one or more of the attributes, or does not accept provided values, the signature operation will fail. The token will use its own default attributes when signing if both the *pRequestedAttributes* and *pRequiredAttributes* field are set to NULL_PTR.

ulRequiredAttributesLen Length in bytes, of the value pointed to by *pRequiredAttributes*.

12.45 CMS mechanisms

12.45.1 CMS signatures

The CMS mechanism, denoted **CKM_CMS_SIG**, is a multi-purpose mechanism based on the structures defined in PKCS #7 and RFC 2630. It supports single- or multiple-part signatures with and without message recovery. The mechanism is intended for use with, e.g., PTDs (see MeT-PTD) or other capable tokens. The token will construct a CMS **SignedAttributes** value and compute a signature on this value. The content of the **SignedAttributes** value is decided by the token, however the caller can suggest some attributes in the parameter *pRequestedAttributes*. The caller can also require some attributes to be present through the parameters *pRequiredAttributes*. The signature is computed in accordance with the parameter *pSigningMechanism*.

When this mechanism is used in successful calls to **C_Sign** or **C_SignFinal**, the *pSignature* return value will point to a DER-encoded value of type **SignerInfo**. **SignerInfo** is defined in ASN.1 as follows (for a complete definition of all fields and types, see RFC 2630):

```
SignerInfo ::= SEQUENCE {
    version CMSVersion,
    sid SignerIdentifier,
    digestAlgorithm DigestAlgorithmIdentifier,
    signedAttrs [0] IMPLICIT SignedAttributes OPTIONAL,
    signatureAlgorithm SignatureAlgorithmIdentifier,
    signature SignatureValue,
    unsignedAttrs [1] IMPLICIT UnsignedAttributes OPTIONAL }
```

The *certificateHandle* parameter, when set, helps the token populate the **sid** field of the **SignerInfo** value. If *certificateHandle* is NULL_PTR the choice of a suitable certificate reference in the **SignerInfo** result value is left to the token (the token could, e.g., interact with the user).

This mechanism shall not be used in calls to **C_Verify** or **C_VerifyFinal** (use the *pSigningMechanism* mechanism instead).

In order for an application to find out what attributes are supported by a token, what attributes that will be added by default, and what attributes that always will be added, it shall analyze the contents of the **CKH_CMS_ATTRIBUTES** hardware feature object.

For the *pRequiredAttributes* field, the token may have to interact with the user to find out whether to accept a proposed value or not. The token should never accept any proposed attribute values without some kind of confirmation from its owner (but this could be through, e.g., configuration or policy settings and not direct interaction). If a user rejects proposed values, or the signature request as such, the value CKR_FUNCTION_REJECTED shall be returned.

When possible, applications should use the **CKM_CMS_SIG** mechanism when generating CMS-compatible signatures rather than lower-level mechanisms such as **CKM_SHA1_RSA_PKCS**. This is especially true when the signatures are to be made on content that the token is able to present to a user. Exceptions may include those cases where the token does not support a particular signing attribute. Note however that the token may refuse usage of a particular signature key unless the content to be signed is known (i.e. the **CKM_CMS_SIG** mechanism is used).

When a token does not have presentation capabilities, the PKCS #11-aware application may avoid sending the whole message to the token by electing to use a suitable signature mechanism (e.g. **CKM_RSA_PKCS**) as the *pSigningMechanism* value in the **CKM_CMS_SIG_PARAMS** structure, and digesting the message itself before passing it to the token.

PKCS #11-aware applications making use of tokens with presentation capabilities, should attempt to provide messages to be signed by the token in a format possible for the token to present to the user. Tokens that receive multipart MIME-messages for which only certain parts are possible to present may fail the signature operation with a return value of **CKR_DATA_INVALID**, but may also choose to add a signing attribute indicating which parts of the message that were possible to present.

A. Intellectual property considerations

RSA Security makes no patent claims on the general constructions described in this document, although specific underlying techniques may be covered.

License to copy this document is granted provided that it is identified as "RSA Security Inc. Public-Key Cryptography Standards (PKCS)" in all material mentioning or referencing this document.

RSA Security makes no representations regarding intellectual property claims by other parties. Such determination is the responsibility of the user.

B. References

[1] R. Housley. *IETF RFC 2630: Cryptographic Message Syntax*. June 1999. URL: http://ietf.org/rfc/rfc2630.txt.

[2] "*MeT PTD Definition – Personal Trusted Device Definition*," Version 1.0, 21 February 2001. URL: http://www.mobiletransaction.org

[3] RSA Laboratories. *PKCS #7 v1.5: Cryptographic Message Syntax Standard*. November 1, 1993. URL: http://www.rsalabs.com/pkcs/

[4] RSA Laboratories. *PKCS #11 v2.11 (Revision 1): Cryptographic Token Interface*. November 2001. URL: http://www.rsalabs.com/pkcs/

C. About PKCS

The *Public-Key Cryptography Standards* are specifications produced by RSA Laboratories in cooperation with secure systems developers worldwide for the purpose of accelerating the deployment of public-key cryptography. First published in 1991 as a result of meetings with a small group of early adopters of public-key technology, the PKCS documents have become widely referenced and implemented. Contributions from the PKCS series have become part of many formal and *de facto* standards, including ANSI X9 documents, PKIX, SET, S/MIME, and SSL.

Further development of PKCS occurs through mailing list discussions and occasional workshops, and suggestions for improvement are welcome. For more information, contact:

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