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Portable Symmetric Key Container
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Abstract

This document specifies a symmetric key format for transport and provisioning of symmetric keys (for example One Time Password (OTP) shared secrets or symmetric cryptographic keys) to different types of crypto modules such as a strong authentication device. The standard key transport format enables enterprises to deploy best-of-breed solutions combining components from different vendors into the same infrastructure.

This work is a joint effort by the members of OATH (Initiative for Open AuTHentication) to specify a format that can be freely distributed to the technical community. The authors believe that a common and shared specification will facilitate adoption of two-factor authentication on the Internet by enabling interoperability between commercial and open-source implementations.

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1. Introduction

With increasing use of symmetric key based authentication systems such as systems based one time password (OTP) and challenge response mechanisms, there is a need for vendor interoperability and a standard format for importing, exporting or provisioning symmetric keys from one system to another. Traditionally authentication server vendors and service providers have used proprietary formats for importing, exporting and provisioning these keys into their systems making it hard to use tokens from vendor A with a server from vendor B.

This Internet draft describes a standard format for serializing symmetric keys such as OTP shared secrets for system import, export or network/protocol transport. The goal is that the format will facilitate dynamic provisioning and transfer of a symmetric keys such as an OTP shared secret or an encryption key of different types. In the case of OTP shared secrets, the format will facilitate dynamic provisioning using an online provisioning protocol to different flavors of embedded tokens or allow customers to import new or existing tokens in batch or single instances into a compliant system.

This draft also specifies the key attributes required for computation such as the initial event counter used in the HOTP algorithm [HOTP]. It is also applicable for other time-based or proprietary algorithms.

To provide an analogy, in public key environments the PKCS#12 format [PKCS12] is commonly used for importing and exporting private keys and certificates between systems. In the environments outlined in this document where OTP keys may be transported directly down to smartcards or devices with limited computing capabilities, a format with small (size in bytes) and explicit shared secret configuration attribute information is desirable, avoiding complexity of PKCS#12. For example, one would have to use opaque data within PKCS#12 to carry shared secret attributes used for OTP calculations, whereas a more explicit attribute schema definition is better for interoperability and efficiency.

2. Terminology

2.1. Key Words

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

2.2. Definitions

This section defines terms used in this document. The same terms may be defined differently in other documents.

Authentication Token: A physical device that an authorized user of computer services is given to aid in authentication. The term may

also refer to software tokens.

Bulk Provisioning: Transferring multiple keys linked to multiple devices in a single execution step within one single PSKC KeyContainer

Cryptographic Module: A component of an application, which enables symmetric key cryptographic functionality

Cryptographic Key: A parameter used in conjunction with a cryptographic algorithm that determines its operation in such a way that an entity with knowledge of the key can reproduce or reverse the operation, while an entity without knowledge of the key cannot (see [NIST-SP800-57])

Cryptographic Token: See Authentication Token

Device: A physical piece of hardware, or a software framework, that hosts symmetric keys

Device ID (DeviceId): A unique identifier for the device, representing the identifying criteria to uniquely identify a device

Dynamic Provisioning: Usage of a protocol, such as DSKPP, to make a key container available to a recipient

Encryption Key: A key used to encrypt key

Key: See Cryptographic Key

Hardware Token: See Authentication Token

Key Algorithm: A well-defined computational procedure that takes variable inputs including a cryptographic key and produces an output.

Key Container: An object that encapsulates symmetric keys and their attributes for set of devices

Key ID (KeyID): A unique identifier for the symmetric key

Key Issuer: An organization that issues symmetric keys to end-users

Key Type: The type of symmetric key cryptographic methods for which the key will be used (e.g., OATH HOTP or RSA SecurID authentication, AES encryption, etc.)

Secret Key: The symmetric key data

Software Token: A type of authentication token that is stored on a general-purpose electronic device such as a desktop computer, laptop, PDA, or mobile phone

Token: See Authentication Token

User: The person or client to whom devices are issued

User ID: A unique identifier for the user or client

3. Use Cases

This section describes a comprehensive list of use cases that inspired the development of this specification. These requirements were used to derive the primary requirement that drove the design. These requirements are covered in the next section.

These use cases also help in understanding the applicability of this specification to real world situations.

3.1. Online Use Cases

This section describes the use cases related to provisioning the keys using an online provisioning protocol such as [DSKPP]

3.1.1. Transport of keys from Server to Crypto Module

For example, a mobile device user wants to obtain a symmetric key for use with a cryptomodule on the device. The cryptomodule client from vendor A initiates the provisioning process against a provisioning system from vendor B using a standards-based provisioning protocol such as [DSKPP]. The provisioning entity delivers one or more keys in a standard format that can be processed by the mobile device.

For example, in a variation of the above, instead of the user's mobile phone, a key is provisioned in the user's soft token application on a laptop using a network-based online protocol. As before, the provisioning system delivers a key in a standard format that can be processed by the soft token on the PC.

For example, the end-user or the key issuer wants to update or configure an existing key in the cryptomodule and requests a replacement key container. The container may or may not include a new key and may include new or updated key attributes such as a new counter value in HOTP key case, a modified response format or length, a new friendly name, etc.

3.1.2. Transport of keys from Crypto Module to Crypto Module

For example, a user wants to transport a key from one cryptomodule to another. There may be two cryptographic modules, one on a computer one on a mobile phone, and the user wants to transport a key from the computer to the mobile phone. The user can export the key and related data in a standard format for input into the other cryptomodule.

3.1.3. Transport of keys from Crypto Module to Server

For example, a user wants to activate and use a new key and related data against a validation system that is not aware of this key. This key may be embedded in the cryptomodule (e.g. SD card, USB drive) that the user has purchased at the local electronics retailer. Along with the cryptomodule, the user may get the key on a CD or a floppy in a standard format. The user can now upload via a secure online channel or import this key and related data into the new validation system and start using the key.

3.1.4. Server to server Bulk import/export of keys

From time to time, a key management system may be required to import or export keys in bulk from one entity to another.

For example, instead of importing keys from a manufacturer using a file, a validation server may download the keys using an online protocol. The keys can be downloaded in a standard format that can be processed by a validation system.

For example, in a variation of the above, an OTA key provisioning gateway that provisions keys to mobile phones may obtain key material from a key issuer using an online protocol. The keys are delivered in a standard format that can be processed by the key provisioning gateway and subsequently sent to the end-user's mobile phone.

3.2. Offline Use Cases

This section describes the use cases relating to offline transport of keys from one system to another, using some form of export and import model.

3.2.1. Server to server Bulk import/export of keys

For example, crypto modules such as OTP authentication tokens, may have their symmetric keys initialized during the manufacturing process in bulk, requiring copies of the keys and algorithm data to be loaded into the authentication system through a file on portable media. The manufacturer provides the keys and related data in the form of a file containing records in standard format, typically on a CD. Note that the token manufacturer and the vendor for the validation system may be the same or different. Some crypto modules will allow local PIN management (the device will have a PIN pad) hence random initial PINs set at manufacturing should be transmitted together with the respective keys they protect.

For example, an enterprise wants to port keys and related data from

an existing validation system A into a different validation system B. The existing validation system provides the enterprise with a functionality that enables export of keys and related data (e.g. for OTP authentication tokens) in a standard format. Since the OTP tokens are in the standard format, the enterprise can import the token records into the new validation system B and start using the existing tokens. Note that the vendors for the two validation systems may be the same or different.

4. Requirements

This section outlines the most relevant requirements that are the basis of this work. Several of the requirements were derived from use cases described above.

R1: The format MUST support transport of multiple types of symmetric keys and related attributes for algorithms including HOTP, other OTP, challenge-response, etc.

R2: The format MUST handle the symmetric key itself as well of attributes that are typically associated with symmetric keys. Some of these attributes may be

* Unique Key Identifier
* Issuer information
* Algorithm ID
* Algorithm mode
* Issuer Name
* Key friendly name
* Event counter value (moving factor for OTP algorithms)
* Time value

R3: The format SHOULD support both offline and online scenarios. That is it should be serializable to a file as well as it

should be possible to use this format in online provisioning protocols such as [DSKPP]

R4: The format SHOULD allow bulk representation of symmetric keys

R5: The format SHOULD allow bulk representation of PINs related to specific keys

R6: The format SHOULD be portable to various platforms. Furthermore, it SHOULD be computationally efficient to process.

R7: The format MUST provide appropriate level of security in terms of data encryption and data integrity.

R8: For online scenarios the format SHOULD NOT rely on transport level security (e.g., SSL/TLS) for core security requirements.

R9: The format SHOULD be extensible. It SHOULD enable extension points allowing vendors to specify additional attributes in the future.

R10: The format SHOULD allow for distribution of key derivation data without the actual symmetric key itself. This is to support symmetric key management schemes that rely on key derivation algorithms based on a pre-placed master key. The key derivation data typically consists of a reference to the key, rather than the key value itself.

R11: The format SHOULD allow for additional lifecycle management operations such as counter resynchronization. Such processes require confidentiality between client and server, thus could use a common secure container format, without the transfer of key material.

R12: The format MUST support the use of pre-shared symmetric keys to ensure confidentiality of sensitive data elements.

R13: The format MUST support a password-based encryption (PBE) [PKCS5] scheme to ensure security of sensitive data elements.

This is a widely used method for various provisioning scenarios.

R14: The format SHOULD support asymmetric encryption algorithms such as RSA to ensure end-to-end security of sensitive data elements. This is to support scenarios where a pre-set shared encryption key is difficult to use.

5. Portable Key container definition

The portable key container is based on an XML schema definition and contains the following main entities:

1. KeyContainer entity as defined in Section 5.1

2. Device entity as defined in Section 5.2

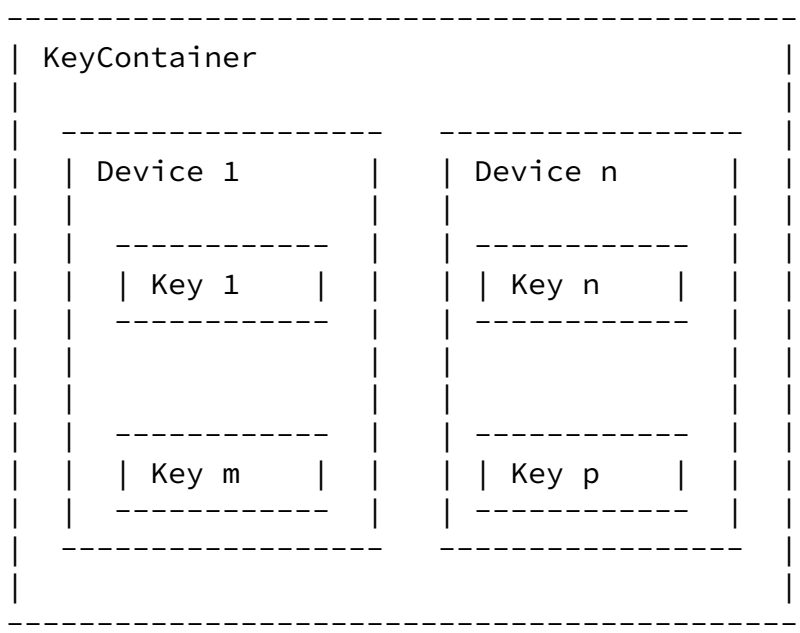
3. Key entity as defined in Section 5.4

Additionally other XML schema types have been defined and are detailed in the relevant subsections of this document

A KeyContainer MAY contain one or more Device entities. A Device MAY contain one or more Key entities

The figure below indicates a possible relationship diagram of a

container.



The following section describe in detail all the entities and related XML schema elements and attributes:

5.1. KeyContainer

The KeyContainer represents the key container entity. A Container MAY contain more than one Device entity; each Device entity MAY contain more than one Key entity.

The KeyContainer is defined as follows:


```
 <xs:complexType name="KeyContainerType">
        <xs:sequence>
                <xs:element name="EncryptionKey"
                        type="ds:KeyInfoType" minOccurs="0"/>
                        <xs:element name="MACAlgorithm"
                        type="pskc:KeyAlgorithmType" minOccurs="0"/>
                        <xs:element name="Device"
                        type="pskc:DeviceType" maxOccurs="unbounded"/>
                <xs:element name="Signature"
                        type="ds:SignatureType" minOccurs="0"/>
        </xs:sequence>
```

```
  <xs:attribute name="Version" type="pskc:VersionType" use="required"/>
</xs:complexType>
```

The elements of the KeyContainer have the following meanings:

- <EncryptionKey (OPTIONAL)>, Identifies the encryption key, algorithm and possible parameters used to protect the Secret Key data in the container. Please see Section 6.1 for detailed description of how to protect key data in transit and the usage of this element.

- <MACAlgorithm (OPTIONAL)>, Identifies the algorithm used to generate a keyed digest of the the Secret Key data values when protection algorithms are used that do not have integrity checks. The digest guarantees the integrity and the authenticity of the key data. for profile and usage please see Section 6.1.1

- <Device>, the host Device for one or more Keys as defined in Section 5.2 The KeyContainer MAY contain multiple Device data elements, allowing for bulk provisioning of multiple devices each containing multiple keys.

- <Signature (OPTIONAL)>, the signature value of the Container. When the signature is applied to the entire container, it MUST use XML Signature methods as defined in [XMLDSIG]. It MAY be omitted when application layer provisioning or transport layer provisioning protocols provide the integrity and authenticity of the payload between the sender and the recipient of the container. When required, this specification recommends using a symmetric key based signature with the same key used in the encryption of the secret key data. The signature is enveloped.

- <Version (MANDATORY)>, the version number for the portable key container format (the XML schema defined in this document).

5.2. Device

The Device represents the Device entity in the Container. A Device MAY be bound to a user and MAY contain more than one keys. A key

SHOULD be bound to only one Device.

The Device is defined as follows:

```
<xs:complexType name="DeviceType">
  <xs:sequence>
    <xs:element name="DeviceId" type="pskc:DeviceIdType" minOccurs="0"/>
    <xs:element name="Key" type="pskc:KeyType" maxOccurs="unbounded"/>
    <xs:element name="UserId" type="xs:string" minOccurs="0"/>
  </xs:sequence>
</xs:complexType>
```

The elements of the Device have the following meanings:

- <DeviceId>, a unique identifier for the device, defined in Section 5.2.1

- <Key>, represents the key entity as defined in Section 5.4

- <UserId>, optionally identifies the owner or the user of the Device, a string representation of a Distinguished Name as defined in [RFC4514]. For example UID=jsmith,DC=example,DC=net. In systems where unique user Ids are used the string representation 'UID=[uniqueId]' MUST be used.

5.2.1. DeviceId

The DeviceId represents the identifying criteria to uniquely identify the device that contains the associated keys. Since devices can come in different form factors such as hardware tokens, smart-cards, soft tokens in a mobile phone or PC etc this element allows different criteria to be used. Combined though the criteria MUST uniquely identify the device. For example for hardware tokens the combination of SerialNo and Manufacturer will uniquely identify a device but not SerialNo alone since two different token manufacturers might issue devices with the same serial number (similar to the IssuerDN and serial number of a certificate). Symmetric Keys used in the payment industry are usually stored on Integrated Circuit Smart Cards. These cards are uniquely identified via the Primary Account Number (PAN, the long number printed on the front of the card) and an expiry date of the card. DeviceId is an extensible type that allows all these different ways to uniquely identify a specific key containing device.

The DeviceId is defined as follows:

```
<xs:complexType name="DeviceIdType">
<xs:sequence>
    <xs:element name="Manufacturer" type="xs:string"/>
    <xs:element name="SerialNo" type="xs:string"/>
    <xs:element name="Model" type="xs:string" minOccurs="0"/>
    <xs:element name="IssueNo" type="xs:string" minOccurs="0"/>
    <xs:element name="ExpiryDate" type="xs:dateTime" minOccurs="0"/>
    <xs:element name="StartDate" type="xs:dateTime" minOccurs="0"/>
</xs:sequence>
</xs:complexType>
```

The elements of DeviceId have the following meanings:

- <Manufacturer>, the manufacturer of the device.
- <SerialNo>, the serial number of the device or the PAN (primary account number) in case of payment smart cards.
- <Model>, the model of the device (e.g one-button-HOTP-token-V1)
- <IssueNo>, the issue number in case of smart cards with the same PAN, equivalent to a PSN (PAN Sequence Number).
- <ExpiryDate>, the expiry date of a device (such as the one on a payment card,used when issue numbers are not printed on cards).
- <StartDate>, the start date of a device (such as the one on a payment card,used when issue numbers are not printed on cards).

5.3. KeyProperties

The KeyProperties represents common properties shared by more than one key held in the container. If a value is set in the properties the Key element can refer to it via KeyPropertiesId attribute. Values that are present in the Key element itself MUST take precendence over values set in KeyProperties. The KeyProperties is defined as follows:

```
<xs:complexType name="KeyPropertiesType">
        <xs:sequence>
                <xs:element name="Issuer" type="xs:string"
                minOccurs="0"/>
                <xs:element name="Usage" type="pskc:UsageType"
                minOccurs="0"/>
                <xs:element name="KeyProfileId" type="xs:string"
                minOccurs="0"/>
                <xs:element name="MasterKeyId" type="xs:string"
                minOccurs="0"/>
                <xs:element name="Data" type="pskc:DataType"
                minOccurs="0" maxOccurs="unbounded"/>
                <xs:element name="PINPolicy"
                type="pskc:PINPolicyType" minOccurs="0"/>
                <xs:element name="ExpiryDate"
                type="xs:dateTime" minOccurs="0"/>
                <xs:element name="StartDate" type="xs:dateTime"
                minOccurs="0"/>
        </xs:sequence>
        <xs:attribute name="KeyPropertiesId" type="xs:string"
        use="required"/>
        <xs:attribute name="KeyAlgorithm"
        type="pskc:KeyAlgorithmType" use="optional"/>
</xs:complexType>
```

The attributes of the KeyProperties entity have the following meanings:

- KeyPropertiesId (MANDATORY), a unique and global identifier of set of KeyProperties. The identifier is defined as a string of alphanumeric characters.

- <KeyAlgorithm (OPTIONAL)>, the unique URI of the type of algorithm to use with the secret key, for profiles are described in Section 6.3

Since KeyProperties are a method to commonalise the elements in Key please refer to section Section 5.4 for detailed description of all elements.

5.4. Key

The Key represents the key entity in the KeyContainer. The Key is defined as follows:


```
<xs:complexType name="KeyType">
        <xs:sequence>
                <xs:element name="Issuer" type="xs:string"
                minOccurs="0"/>
                <xs:element name="Usage" type="pskc:UsageType"
                minOccurs="0"/>
                <xs:element name="KeyProfileId" type="xs:string"
                minOccurs="0"/>
                <xs:element name="MasterKeyId" type="xs:string"
                minOccurs="0"/>
                <xs:element name="FriendlyName" type="xs:string"
                minOccurs="0"/>
                <xs:element name="Data" type="pskc:DataType"
                minOccurs="0" maxOccurs="unbounded"/>
                <xs:element name="PINPolicy"
                type="pskc:PINPolicyType" minOccurs="0"/>
                <xs:element name="ExpiryDate" type="xs:dateTime"
                minOccurs="0"/>
                <xs:element name="StartDate" type="xs:dateTime"
                minOccurs="0"/>
        </xs:sequence>
        <xs:attribute name="KeyId" type="xs:string"
        use="required"/>
        <xs:attribute name="KeyAlgorithm"
        type="pskc:KeyAlgorithmType" use="optional"/>
        <xs:attribute name="KeyPropertiesId" type="xs:string"
        use="optional"/>
</xs:complexType>
```

The attributes of the Key entity have the following meanings:

- KeyId (MANDATORY), a unique and global identifier of the symmetric

key. The identifier is defined as a string of alphanumeric characters.

- <KeyAlgorithm (OPTIONAL)>, the unique URI of the type of algorithm to use with the secret key, for profiles are described in Section 6.3

- <KeyPropertiesId (OPTIONAL)>, the unique id of the KeyProperties whose value the instance of this key inherits. If this value is set implementation MUST lookup the Keyproperties element referred to by this unique Id and this instance of key will inherit all values from the KeyProperties. Values held in the key instance it MUST take precedence over values inherited from KeyProperties."/>

The elements of the Key entity have the following meanings:

- <Issuer (OPTIONAL)>, The key issuer name, this is normally the name of the organization that issues the key to the end user of the key. For example MyBank issuing hardware tokens to their retail banking users 'MyBank' would be the issuer. The Issuer is defined as a String.

- <Usage (MANDATORY)>, defines the intended usage of the key and related metadata as defined in Section 5.4.2

- <KeyProfileId (OPTIONAL)>, A unique identifier used between the sending and receiving party of the container to establish a set of constant values related to a key that are not transmitted via the container. For example a smart card application personalisation profile id related to attributes present on a smart card application that have influence when computing a response. An example could be an EMV MasterCard CAP [CAP] application on a card personalised with data for a specific batch of cards such as:

  IAF Internet authentication flag

  CVN Cryptogram version number, for example (MCHIP2, MCHIP4, VISA 13, VISA14)

  AIP (Application Interchange Profile), 2 bytes

  TVR Terminal Verification Result, 5 bytes

CVR The card verification result

AmountOther

TransactionDate

TerminalCountryCode

TransactionCurrencyCode

AmountAuthorised

IIPB

These values are not contained within attributes in the container but are shared between the manufacturing and the validation service through this unique KeyProfileId. The KeyProfileId is defined as a String.

- <MasterKeyId (OPTIONAL)>, The unique reference to a master key when key derivation schemes are used and no specific key is

transported but only the reference to the master key used to derive a specific key and some derivation data.

- <FriendlyName (OPTIONAL)>, The user friendly name that is assigned to the secret key for easy reference. The FriendlyName is defined as a String.

- <Data (OPTIONAL)>, the element carrying the data related to the key as defined in Section 5.4.1

- <PINPolicy (OPTIONAL)>, the policy of the PIN relating to the usage of this key as defined in Section 5.4.4

- <ExpiryDate (OPTIONAL)>, the expiry date of the key, it MUST not be possible to use this key after this date

- <StartDate (OPTIONAL)>, the start date of the key, it MUST not be possible to use this key before this date

5.4.1. Data (OPTIONAL)

Defines the data attributes of the symmetric key. Each is a name value pair which has either a plain value (in case of no encryption) or a encrypted value as defined in EncryptedDataType in XML Encryption.

This is also where the key value is transported, Section 7 defines a list of reserved attribute names.

Data element is defined as follows:

```
<xs:complexType name="DataType">
    <xs:sequence>
    <xs:choice>
       <xs:element name="PlainValue" type="xs:base64Binary"/>
       <xs:element name="EncryptedValue" type="xenc:EncryptedDataType"/>
    </xs:choice>
    <xs:element name="ValueMAC" type="xs:base64Binary" minOccurs="0"/>
    </xs:sequence>
    <xs:attribute name="Name" type="xs:string" use="required"/>
</xs:complexType>
```

The attributes of the Data element have the following meanings:

- Name, defines the name of the name-value pair, Section 7 defines a list of reserved attribute names

The elements of the Data element have the following meanings:

- The <PlainValue> conveys an unencrypted value of the name-value pair in base 64 encoding.

- The <EncryptedValue> element in the DataType conveys an encrypted value of the name-value pair inside an EncryptedDataType as defined in XML Encryption.

- The <ValueMAC (OPTIONAL)> element in the DataType conveys a keyed MAC value of the unencrypted data for the cases where the algorithm to protect key data in transit, as described in section

Section 6.1.1 ,does not support integrity checks.

5.4.2. Usage (MANDATORY)

The Usage element defines the usage attribute(s) of the key entity. Usage is defined as follows:


```
<xs:complexType name="UsageType">
        <xs:sequence>
                <xs:element name="ChallengeFormat" minOccurs="0">
                        <xs:complexType>
                          <xs:attribute name="Format"
```

```
                        type="pskc:ValueFormatType"
                        use="required"/>
                        <xs:attribute name="Min"
                        type="xs:unsignedInt" use="required"/>
                        <xs:attribute name="Max"
                        type="xs:unsignedInt" use="required"/>
                        <xs:attribute name="CheckDigits"
                        type="xs:boolean" default="false"/>
                      </xs:complexType>
                </xs:element>
                <xs:element name="ResponseFormat">
                      <xs:complexType>
                        <xs:attribute name="Format"
                        type="pskc:ValueFormatType"
                        use="required"/>
                        <xs:attribute name="Length"
                        type="xs:unsignedInt" use="required"/>
                        <xs:attribute name="CheckDigits"
                        type="xs:boolean" default="false"/>
                      </xs:complexType>
                </xs:element>
        </xs:sequence>
        <xs:attribute name="OTP" type="xs:boolean"
        default="false"/>
        <xs:attribute name="CR" type="xs:boolean"
        default="false"/>
        <xs:attribute name="Integrity" type="xs:boolean"
        default="false"/>
        <xs:attribute name="Encrypt" type="xs:boolean"
        default="false"/>
        <xs:attribute name="Unlock" type="xs:boolean"
        default="false"/>
</xs:complexType>
```

The attributes of the Usage element define the intended usage of the key and are a combination of one or more of the following (set to true):

- OTP, the key will be used for OTP generation
- CR, the key will be used for Challenge/Response purposes

- Encrypt, the key will be used for data encryption purposes

- Integrity, the key will be used to generate a keyed message digest for data integrity or authentication purposes.

- Unlock, the key will be used for an inverse challenge response in the case a user has locked the device by entering a wrong PIN too many times (for devices with PIN-input capability)

5.4.2.1. OTP and CR specific Usage elements (OPTIONAL)

When the intended usage of a key usage is OTP and/or CR, the following additional elements MUST be provided within the Usage element to support the OTP and/or the response computation as required by the underlying algorithm. These elements also allow to customize or configure the result of the computation (e.g. format, length).

5.4.2.1.1. ChallengeFormat element (MANDATORY)

The ChallengeFormat element defines the characteristics of the challenge in a CR usage scenario. The Challenge element is defined by the following attributes:

- Format (MANDATORY)

  Defines the format of the challenge accepted by the device and MUST be one of the values defined in Section 5.4.3

- CheckDigit (OPTIONAL)

  Defines if the device needs to check the appended Luhn check digit contained in a provided challenge. This is only valid if the Format attribute is 'DECIMAL'. Value MUST be:

  TRUE device will check the appended Luhn check digit in a provided challenge

  FALSE device will not check appended Luhn check digit in challenge

- Min (MANDATORY)

  Defines the minimum size of the challenge accepted by the device for CR mode.

If the Format attribute is 'DECIMAL', 'HEXADECIMAL' or 'ALPHANUMERIC' this value indicates the minimum number of digits/characters.

If the Format attribute is 'BASE64' or 'BINARY', this value indicates the minimum number of bytes of the unencoded value.

Value MUST be:

Unsigned integer.

- Max (MANDATORY)

  Defines the maximum size of the challenge accepted by the device for CR mode.

  If the Format attribute is 'DECIMAL', 'HEXADECIMAL' or 'ALPHANUMERIC' this value indicates the maximum number of digits/characters.

  If the Format attribute is 'BASE64' or 'BINARY', this value indicates the maximum number of bytes of the unencoded value.

  Value MUST be:

  Unsigned integer.

5.4.2.1.2. ResponseFormat element (MANDATORY)

The ResponseFormat element defines the characteristics of the result of a computation. This defines the format of the OTP or of the response to a challenge. The Response attribute is defined by the following attributes:

- Format (MANDATORY)

  Defines the format of the response generated by the device and MUST be one of the values defined in Section 5.4.3

- CheckDigit (OPTIONAL)

Defines if the device needs to append a Luhn check digit to the response. This is only valid if the Format attribute is 'DECIMAL'. Value MUST be:

TRUE device will append a Luhn check digit to the response.

FALSE device will not append a Luhn check digit to the response.

- Length (MANDATORY)

Defines the length of the response generated by the device.

If the Format attribute is 'DECIMAL', 'HEXADECIMAL' or 'ALPHANUMERIC' this value indicates the number of digits/ characters.

If the Format attribute is 'BASE64' or 'BINARY', this value indicates the number of bytes of the unencoded value.

Value MUST be:

Unsigned integer.

5.4.3. ValueFormat

The ValueFormat element defines allowed formats for challenges or responses in OTP algorithms.

ValueFormat is defined as follows:

```
<simpleType name="ValueFormat">
```

```
    <restriction base="string">
      <enumeration value="DECIMAL"/>
      <enumeration value="HEXADECIMAL"/>
      <enumeration value="ALPHANUMERIC"/>
      <enumeration value="BASE64"/>
      <enumeration value="BINARY"/>
    </restriction>
  </simpleType>
```


DECIMAL Only numerical digits

HEXADECIMAL Hexadecimal response

ALPHANUMERIC All letters and numbers (case sensitive)

BASE64 Base 64 encoded

BINARY Binary data, this is mainly used in case of connected devices

5.4.4. PINPolicy

The PINPolicy element provides a mean to define how the usage of a specific key is protected by a PIN. The PIN itself can be transmitted as a key using the container.

If the PINPolicy element is present in the Key element then the key is protected with a PIN as defined within the PINPolicy element.

PINPolicy is defined as follows:

```
  <xs:complexType name="PINPolicyType">
      <xs:sequence>
          <xs:element name="PINUsageMode" type="pskc:PINUsageModeType"/>
          <xs:element name="WrongPINtry" type="xs:unsignedInt"
            minOccurs="0"/>
```

```
    </xs:sequence>
    <xs:attribute name="PINKeyId" type="xs:string" use="required"/>
</xs:complexType>
```

The attributes of PINPolicy have the following meaning

- PINKeyId, the unique key Id within this container that contains the value of the PIN that protects the key

The elements of PINPolicy have the following meaning

- <PINUsageMode (MANDATORY)> , the way the PIN is used during the usage of the key as defined in Section 5.4.4.1

- <WrongPINtry (OPTIONAL)>, the number of times the PIN can be entered wrongly before it MUST not be possible to use the key anymore

5.4.4.1. PINUsageMode

The PINUsageMode element defines how the PIN is used with a specific key

PINUsageMode is defined as follows:

```
<xs:complexType name="PINUsageModeType">
    <xs:choice maxOccurs="unbounded">
        <xs:element name="Local"/>
        <xs:element name="Prepend"/>
        <xs:element name="InAlgo"/>
    </xs:choice>
</xs:complexType>
```

The elements of PINPolicy have the following meaning

- <Local>, the PIN is checked locally on the device before allowing the key to be used in executing the algorithm

- <Prepend>, the PIN is prepended to the OTP or response hance it MUST be chacked by the validation server

- <InAlgo>, the PIN is used as part of the algorithm computation

6. Usage and profile of algorithms for the portable symmetric key container

This section details the use of the XML encryption and XML signature elements to protect the keys transported in the cotainer. It also profiles the number of algorithms supported by XML encryption and XML signature to a mandatory subset for interoperability.

When no algorithm is provided the values within the container are unencrypted, implementations SHALL ensure the privacy of the key data through other standard mechanisms e.g. transport level encryption.

6.1. Usage of EncryptionKey to protect keys in transit

The EncryptionKey element in the KeyContainer defines the key, algorithm and parameters used to encrypt the Secret Key data attributes in the Container. The standard schema [XMLENC] is adopted in carry such information and an encrypted value. The encryption is applied on each individual Secret Key data in the Container. The encryption method MUST be the same for all Secret Key data in the container.

The following sections define specifically the different supported means to protect the keys:

6.1.1. Protecting keys using a pre-shared key via symmetric algorithms

When protecting the payload with pre-shared keys implementations SHOULD set the name of the specific pre-shared key in the KeyName element of the EncryptionKey of the KeyContainer. For example:

```
<KeyContainer Version="1.0"
  xmlns="urn:ietf:params:xml:ns:keyprov:container:1.0"
  xmlns:ds="http://www.w3.org/2000/09/xmldsig#"
  xmlns:xenc="http://www.w3.org/2001/04/xmlenc#">
    <EncryptionKey>
        <ds:KeyName>PRE_SHARED_KEY</ds:KeyName>
    </EncryptionKey>
    ....
```

The following is the list of symmetric key encryption algorithm and possible parameters used to protect the Secret Key data in the container. Systems implementing PSKC MUST support the MANDATORY algorithms detailed below.

The encryption algorithm URI can be one of the following.

- http://www.w3.org/2001/04/xmlenc#tripledes-cbc - MANDATORY
- http://www.w3.org/2001/04/xmlenc#aes128-cbc - MANDATORY
- http://www.w3.org/2001/04/xmlenc#aes192-cbc - OPTIONAL
- http://www.w3.org/2001/04/xmlenc#aes256-cbc - MANDATORY

- http://www.w3.org/2001/04/xmlenc#kw-tripledes - MANDATORY
- http://www.w3.org/2001/04/xmlenc#kw-aes128 - MANDATORY
- http://www.w3.org/2001/04/xmlenc#kw-aes256 - MANDATORY
- http://www.w3.org/2001/04/xmlenc#kw-aes512 - OPTIONAL

When algorithms without integrity checks are used (e.g. http://www.w3.org/2001/04/xmlenc#aes256-cbc) a keyed MAC value using the same key as the encryption key SHOULD be placed in the ValueMAC element of the Data element. In this case the MAC algorithm type MUST be set in the MACAlgorithm element in the key container entity as defined in Section 5.1. Implementations of PSKC MUST support the MANDATORY MAC algorithms detailed below. The MACAlgorithm URI can be one of the following:

- http://www.w3.org/2000/09/xmldsig#hmac-sha1 - MANDATORY

For example:

```
<KeyContainer Version="1.0"
  xmlns="urn:ietf:params:xml:ns:keyprov:container:1.0"
  xmlns:ds="http://www.w3.org/2000/09/xmldsig#"
  xmlns:xenc="http://www.w3.org/2001/04/xmlenc#">
    <EncryptionKey>
        <ds:KeyName>PRE_SHARED_KEY</ds:KeyName>
    </EncryptionKey>
    <MACAlgorithm>http://www.w3.org/2000/09/xmldsig#hmac-sha1
    </MACAlgorithm>
    .....
```

6.1.2. Protecting keys using passphrase based encryption keys

To be able to support passphrase based encryption keys as defined in PKCS#5 the following XML representation of the PBE relates parameters have been introduced in the schema. Although the approach is extensible implementations of PSKC MUST support the KeyDerivationMethod algorithm URI of

http://www.rsasecurity.com/rsalabs/pkcs/schemas/pkcs-5#pbkdf2.

```
<xs:complexType name="DerivedKeyType">
    <xs:sequence>
        <xs:element name="KeyDerivationMethod"
          type="pskc:KeyDerivationMethodType" minOccurs="0"/>
        <xs:element ref="xenc:ReferenceList" minOccurs="0"/>
        <xs:element name="CarriedKeyName" type="xs:string"
          minOccurs="0"/>
    </xs:sequence>
    <xs:attribute name="Id" type="xs:ID" use="optional"/>
    <xs:attribute name="Type" type="xs:anyURI" use="optional"/>
    </xs:complexType>
    <xs:complexType name="KeyDerivationMethodType">
    <xs:sequence>
            <xs:any namespace="##other" minOccurs="0"
              maxOccurs="unbounded"/>
    </xs:sequence>
    <xs:attribute name="Algorithm" type="xs:anyURI"
    use="required"/>
</xs:complexType>
```

The attributes of the DerivedKey have the following meanings:

- ID (OPTIONAL), the unique ID for this key

- Type (OPTIONAL), This attribute was included for conformance with xml encryption, it is an optional attribute identifying type information about the plaintext form of the encrypted content. Please see [XMLENC] section 3.1 Type for more details.

The elements of the DerivedKey have the following meanings:

- <KeyDerivationMethod>: URI of the algorithms used to derive the key e.g. (http://www.rsasecurity.com/rsalabs/pkcs/schemas/pkcs-5#pbkdf2)

- <ReferenceList (OPTIONAL)>: a list of IDs of the elements that have been encrypted by this key

- <CarriedKeyName (OPTIONAL)>: friendly name of the key

When using the PKCS5 PBE algorithm (URI=http://www.rsasecurity.com/rsalabs/pkcs/schemas/pkcs-5#pbes2) and related parameters, the DerivedKey element MUST be used within the EncryptionKey element of the KeyContainer in exactly the form as shown below:

```
<?xml version="1.0" encoding="UTF-8"?>
<KeyContainer
  xmlns="urn:ietf:params:xml:ns:keyprov:container:1.0"
  xmlns:pkcs-5=
    "http://www.rsasecurity.com/rsalabs/pkcs/schemas/pkcs-5v2-0#"
  xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xmlns:ds="http://www.w3.org/2000/09/xmldsig#"
  xmlns:xenc="http://www.w3.org/2001/04/xmlenc#"
  Version="1.0">
    <EncryptionKey>
      <DerivedKey Id="#Passphrase1">
        <CarriedKeyName>Passphrase1</CarriedKeyName>
        <KeyDerivationMethod
          Algorithm=
       "http://www.rsasecurity.com/rsalabs/pkcs/schemas/pkcs-5#pbkdf2">
          <Parameters xsi:type="pkcs-5:PBKDF2ParameterType">
            <Salt>
              <Specified>Df3dRAhjGh8=</Specified>
            </Salt>
            <IterationCount>2000</IterationCount>
            <KeyLength>16</KeyLength>
            <PRF/>
          </Parameters>
        </KeyDerivationMethod>
      </DerivedKey>
    </EncryptionKey>
....
```

6.2. Protecting keys using asymmetric algorithms

The following is the list of asymmetric key encryption algorithm and possible parameters used to protect the Secret Key data in the container. Systems implementing PSKC MUST support the MANDATORY algorithms detailed below. The encryption algorithm URI can be one of the following.

- http://www.w3.org/2001/04/xmlenc#rsa-1_5 - MANDATORY
- http://www.w3.org/2001/04/xmlenc#rsa-oaep-mgf1p - OPTIONAL

For example:

```
<?xml version="1.0" encoding="UTF-8"?>

<pskc:KeyContainer Version="1.0"
  xmlns:pskc="urn:ietf:params:xml:ns:keyprov:container:1.0"
  xmlns:ds="http://www.w3.org/2000/09/xmldsig#"
  xmlns:xenc="http://www.w3.org/2001/04/xmlenc#">
    <pskc:EncryptionKey>
        <ds:X509Data>
            <ds:X509Certificate>miib</ds:X509Certificate>
        </ds:X509Data>
    </pskc:EncryptionKey>
    <pskc:Device>
        <pskc:DeviceId>
            <pskc:Manufacturer>ACME</pskc:Manufacturer>
            <pskc:SerialNo>0755225266</pskc:SerialNo>
        </pskc:DeviceId>
        <pskc:Key KeyAlgorithm=
         "http://www.ietf.org/keyprov/pskc#hotp"
         KeyId="0755225266">
            <pskc:Issuer>AnIssuer</pskc:Issuer>
            <pskc:Usage OTP="true">
                <pskc:ResponseFormat Length="8"
                Format="DECIMAL"/>
            </pskc:Usage>
            <pskc:Data Name="COUNTER">
                <pskc:PlainValue>AprkuA==</pskc:PlainValue>
            </pskc:Data>
            <pskc:Data Name="SECRET">
              <pskc:EncryptedValue Id="ED">
                <xenc:EncryptionMethod
                  Algorithm=
                  "http://www.w3.org/2001/04/xmlenc#rsa_1_5"/>
                <xenc:CipherData>
                  <xenc:CipherValue>rf4dx3rvEPO0vKtKL14NbeVu8nk=
                  </xenc:CipherValue>
                </xenc:CipherData>
```

```
                </pskc:EncryptedValue>
              </pskc:Data>
            </pskc:Key>
          </pskc:Device>
      </pskc:KeyContainer>
```

6.3. Profile of Key Algorithm

This section profiles the type(s) of algorithm of that can be used by the key(s) transported in the container. The following algorithm URIs are among the default support list.

- http://www.w3.org/2001/04/xmlenc#tripledes-cbc
- http://www.w3.org/2001/04/xmlenc#aes128-cbc
- http://www.w3.org/2001/04/xmlenc#aes192-cbc
- http://www.w3.org/2001/04/xmlenc#aes256-cbc
- http://www.ietf.org/keyprov/pskc#hotp
- http://www.ietf.org/keyprov/pskc#pin

6.3.1. OTP Key Algorithm Identifiers

OTP key algorithm URIs have not been defined in a commonly available standard specification. This document defines the following URIs for the standard OTP algorithms defined in [HOTP].

6.3.1.1. HOTP

Standard document: RFC4226

Identifier: http://www.ietf.org/keyprov/pskc#hotp

Note that the actual URL will be finalized once a URL for this document is determined.

6.3.1.2. Other OTP Algorithms

An implementation should refer to vendor registered OTP key algorithm URIs for other existing OTP algorithms, for example, the RSA SecurID OTP algorithm as follows.

- http://www.rsa.com/rsalabs/otps/schemas/2005/09/otps-wst#SecurID-AES

6.3.2. PIN key value compare algorithm identifier

PIN key algorithm URIs have not been defined in a commonly available standard specification. This document defines the following URIs for a straight value comaprison of the transported secret key data as when required to compare a PIN.

Identifier: http://www.ietf.org/keyprov/pskc#pin

Note that the actual URL will be finalized once a URL for this document is determined.

7. Reserved data attribute names

The following key data attribute names have been reserved:

SECRET: the shared secret key value in binary, base64 encoded

COUNTER: the event counter for event based OTP algorithms. 8 bytes unsigned integer in big endian (i.e. network byte order) form base64 encoded

TIME: the time for time based OTP algorithms. 8 bytes unsigned integer in big endian (i.e. network byte order) form base64 encoded (Number of seconds since 1970)

TIME_INTERVAL: the time interval value for time based OTP algorithms. 8 bytes unsigned integer in big endian (i.e. network byte order) form base64 encoded.

TIME_DRIFT: the device clock drift value for time based OTP algorithms. The value indicates number of seconds that the device clock may drift each day. 2 bytes unsigned integer in big endian (i.e. network byte order) form base64 encoded.

8. Formal Syntax

The following syntax specification uses the widely adopted XML schema format as defined by a W3C recommendation (http://www.w3.org/TR/xmlschema-0/). It is a complete syntax definition in the XML Schema Definition format (XSD)

All implementations of this standard must comply with the schema below.

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:pskc="urn:ietf:params:xml:ns:keyprov:container:1.0"
  xmlns:ds="http://www.w3.org/2000/09/xmldsig#"
```

```
  xmlns:xenc="http://www.w3.org/2001/04/xmlenc#"
  targetNamespace="urn:ietf:params:xml:ns:keyprov:container:1.0"
  elementFormDefault="qualified" attributeFormDefault="unqualified"
  version="1.0">
    <xs:import namespace="http://www.w3.org/2000/09/xmldsig#"
      schemaLocation=
      "http://www.w3.org/TR/2002/REC-xmldsig-core-20020212/
      xmldsig-core-schema.xsd"/>
    <xs:import namespace="http://www.w3.org/2001/04/xmlenc#"
      schemaLocation="http://www.w3.org/TR/2002/
      REC-xmlenc-core-20021210/xenc-schema.xsd"/>

    <xs:complexType name="KeyContainerType">
    <xs:sequence>
        <xs:element name="EncryptionKey" type="ds:KeyInfoType"
          minOccurs="0"/>
        <xs:element name="MACAlgorithm" type="pskc:KeyAlgorithmType"
          minOccurs="0"/>
        <xs:element name="Device" type="pskc:DeviceType"
          maxOccurs="unbounded"/>
        <xs:element name="Signature" type="ds:SignatureType"
          minOccurs="0"/>
    </xs:sequence>
    <xs:attribute name="Version" type="pskc:VersionType"
      use="required"/>
    </xs:complexType>
    <xs:simpleType name="VersionType" final="restriction">
            <xs:restriction base="xs:string">
                    <xs:pattern value="\d{1,2}\.\d{1,3}"/>
            </xs:restriction>
    </xs:simpleType>
        <xs:complexType name="KeyPropertiesType">
                <xs:sequence>
```



```
                        <xs:element name="Issuer"
                        type="xs:string" minOccurs="0"/>
                        <xs:element name="Usage"
                        type="pskc:UsageType" minOccurs="0"/>
                        <xs:element name="KeyProfileId"
                        type="xs:string" minOccurs="0"/>
                        <xs:element name="MasterKeyId"
                        type="xs:string" minOccurs="0"/>
```

```
                        <xs:element name="Data" type="pskc:DataType"
                        minOccurs="0" maxOccurs="unbounded"/>
                        <xs:element name="PINPolicy"
                        type="pskc:PINPolicyType" minOccurs="0"/>
                        <xs:element name="ExpiryDate"
                        type="xs:dateTime" minOccurs="0"/>
                        <xs:element name="StartDate"
                        type="xs:dateTime" minOccurs="0"/>
                </xs:sequence>
                <xs:attribute name="KeyPropertiesId"
                type="xs:string" use="required"/>
                <xs:attribute name="KeyAlgorithm"
                type="pskc:KeyAlgorithmType"
                use="optional"/>
        </xs:complexType>
    <xs:complexType name="KeyType">
        <xs:sequence>
            <xs:element name="Issuer"
            type="xs:string" minOccurs="0"/>
            <xs:element name="Usage"
            type="pskc:UsageType"/>
                        <xs:element name="KeyProfileId"
                        type="xs:string" minOccurs="0"/>
                        <xs:element name="MasterKeyId"
                        type="xs:string" minOccurs="0"/>
            <xs:element name="FriendlyName"
            type="xs:string" minOccurs="0"/>
            <xs:element name="Data" type="pskc:DataType"
            minOccurs="0" maxOccurs="unbounded"/>
            <xs:element name="PINPolicy"
            type="pskc:PINPolicyType" minOccurs="0"/>
            <xs:element name="ExpiryDate"
            type="xs:dateTime" minOccurs="0"/>
            <xs:element name="StartDate"
            type="xs:dateTime" minOccurs="0"/>
        </xs:sequence>
        <xs:attribute name="KeyId"
        type="xs:string" use="required"/>
        <xs:attribute name="KeyAlgorithm"
        type="pskc:KeyAlgorithmType"
```



```
          use="required"/>
```

```
    </xs:complexType>
    <xs:complexType name="DerivedKeyType">
        <xs:sequence>
            <xs:element name="KeyDerivationMethod"
              type="pskc:KeyDerivationMethodType" minOccurs="0"/>
            <xs:element ref="xenc:ReferenceList" minOccurs="0"/>
            <xs:element name="CarriedKeyName" type="xs:string"
              minOccurs="0"/>
        </xs:sequence>
        <xs:attribute name="Id" type="xs:ID" use="optional"/>
        <xs:attribute name="Type" type="xs:anyURI" use="optional"/>
    </xs:complexType>
    <xs:complexType name="KeyDerivationMethodType">
        <xs:sequence>
            <xs:any namespace="##other" minOccurs="0"
            maxOccurs="unbounded"/>
        </xs:sequence>
        <xs:attribute name="Algorithm" type="xs:anyURI"
        use="required"/>
    </xs:complexType>
    <xs:complexType name="PINPolicyType">
        <xs:sequence>
            <xs:element name="PINUsageMode"
              type="pskc:PINUsageModeType"/>
            <xs:element name="WrongPINtry" type="xs:unsignedInt"
              minOccurs="0"/>
        </xs:sequence>
        <xs:attribute name="PINKeyId" type="xs:string"
          use="required"/>
    </xs:complexType>
    <xs:complexType name="PINUsageModeType">
            <xs:choice maxOccurs="unbounded">
                    <xs:element name="Local"/>
                    <xs:element name="Prepend"/>
                    <xs:element name="Embed"/>
            </xs:choice>
    </xs:complexType>
    <xs:complexType name="DeviceIdType">
        <xs:sequence>
        <xs:element name="Manufacturer" type="xs:string"/>
        <xs:element name="SerialNo" type="xs:string"/>
        <xs:element name="Model" type="xs:string"
        minOccurs="0"/>
        <xs:element name="IssueNo" type="xs:string"
        minOccurs="0"/>
        <xs:element name="ExpiryDate" type="xs:dateTime"
        minOccurs="0"/>
```

```
        <xs:element name="StartDate" type="xs:dateTime"
        minOccurs="0"/>
        </xs:sequence>
    </xs:complexType>
    <xs:complexType name="DeviceType">
      <xs:sequence>
        <xs:element name="DeviceId" type="pskc:DeviceIdType"
          minOccurs="0"/>
        <xs:element name="Key" type="pskc:KeyType"
          maxOccurs="unbounded"/>
        <xs:element name="UserId" type="xs:string"
        minOccurs="0"/>
      </xs:sequence>
    </xs:complexType>
    <xs:complexType name="UsageType">
        <xs:sequence>
            <xs:element name="ChallengeFormat" minOccurs="0">
                <xs:complexType>
                    <xs:attribute name="Format"
                      type="pskc:ValueFormatType" use="required"/>
                    <xs:attribute name="Min" type="xs:unsignedInt"
                      use="required"/>
                    <xs:attribute name="Max" type="xs:unsignedInt"
                      use="required"/>
                    <xs:attribute name="CheckDigits" type="xs:boolean"
                      default="false"/>
                </xs:complexType>
            </xs:element>
            <xs:element name="ResponseFormat">
                <xs:complexType>
                    <xs:attribute name="Format"
                      type="pskc:ValueFormatType" use="required"/>
                    <xs:attribute name="Length" type="xs:unsignedInt"
                      use="required"/>
                    <xs:attribute name="CheckDigits" type="xs:boolean"
                      default="false"/>
                </xs:complexType>
            </xs:element>
            </xs:sequence>
            <xs:attribute name="OTP" type="xs:boolean" default="false"/>
            <xs:attribute name="CR" type="xs:boolean" default="false"/>
            <xs:attribute name="Integrity" type="xs:boolean"
              default="false"/>
            <xs:attribute name="Encrypt" type="xs:boolean"
              default="false"/>
            <xs:attribute name="Unlock" type="xs:boolean"
```

```
            default="false"/>
    </xs:complexType>
```



```
    <xs:complexType name="DataType">
        <xs:sequence>
            <xs:choice>
                <xs:element name="PlainValue" type="xs:base64Binary"/>
                <xs:element name="EncryptedValue"
                  type="xenc:EncryptedDataType"/>
            </xs:choice>
            <xs:element name="ValueMAC" type="xs:base64Binary"
              minOccurs="0"/>
        </xs:sequence>
        <xs:attribute name="Name" type="xs:string" use="required"/>
    </xs:complexType>
    <xs:simpleType name="KeyAlgorithmType">
        <xs:restriction base="xs:anyURI"/>
    </xs:simpleType>
    <xs:simpleType name="ValueFormatType">
        <xs:restriction base="xs:string">
            <xs:enumeration value="DECIMAL"/>
            <xs:enumeration value="HEXADECIMAL"/>
            <xs:enumeration value="ALPHANUMERIC"/>
            <xs:enumeration value="BASE64"/>
            <xs:enumeration value="BINARY"/>
        </xs:restriction>
    </xs:simpleType>
    <xs:element name="KeyContainer" type="pskc:KeyContainerType"/>
</xs:schema>
```

9. IANA Considerations

9.1. Content-type registration for 'application/pskc+xml'

This specification requests the registration of a new MIME type according to the procedures of RFC 4288 [RFC4288] and guidelines in RFC 3023 [RFC3023].

MIME media type name: application

MIME subtype name: pskc+xml

Mandatory parameters: none

Optional parameters: charset

Indicates the character encoding of enclosed XML.

Encoding considerations: Uses XML, which can employ 8-bit characters, depending on the character encoding used. See RFC 3023 [RFC3023], Section 3.2.

Security considerations: This content type is designed to carry PSKC protocol payloads.

Interoperability considerations: None

Published specification: RFCXXXX [NOTE TO IANA/RFC-EDITOR: Please replace XXXX with the RFC number of this specification.]

Applications which use this media type: This MIME type is being used as a symmetric key container format for transport and provisioning

of symmetric keys (One Time Password (OTP) shared secrets or symmetric cryptographic keys) to different types of strong authentication devices. As such, it is used for key provisioning systems.

Additional information:

Magic Number: None

File Extension: .pskcxml

Macintosh file type code: 'TEXT'

Personal and email address for further information: Philip Hoyer, Philip.Hoyer@actividentity.com

Intended usage: LIMITED USE

Author: This specification is a work item of the IETF KEYPROV working group, with mailing list address <keyprov@ietf.org>.

Change controller: The IESG <iesg@ietf.org>

9.2. XML Schema Registration

This section registers an XML schema as per the guidelines in [RFC3688].

URI: urn:ietf:params:xml:ns:keyprov:container:1.0

Registrant Contact: IETF KEYPROV Working Group, Philip Hoyer (Philip.Hoyer@actividentity.com).

XML Schema: The XML schema to be registered is contained in Section 8. Its first line is

```
<?xml version="1.0" encoding="UTF-8"?>
```

and its last line is

```
</xs:schema>
```

9.3. URN Sub-Namespace Registration for urn:ietf:params:xml:ns:keyprov:container:1.0

This section registers a new XML namespace, "urn:ietf:params:xml:ns:keyprov:container:1.0", per the guidelines in [RFC3688].

URI: urn:ietf:params:xml:ns:keyprov:container:1.0

Registrant Contact: IETF KEYPROV Working Group, Philip Hoyer (Philip.Hoyer@actividentity.com).

XML:


```
BEGIN
<?xml version="1.0"?>
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML Basic 1.0//EN"
  "http://www.w3.org/TR/xhtml-basic/xhtml-basic10.dtd">
<html xmlns="http://www.w3.org/1999/xhtml">
<head>
  <meta http-equiv="content-type"
        content="text/html;charset=iso-8859-1"/>
  <title>PSKC Namespace</title>
</head>
<body>
  <h1>Namespace for PSKC</h1>
  <h2>urn:ietf:params:xml:ns:keyprov:container:1.0</h2>
<p>See <a href="[URL of published RFC]">RFCXXXX
    [NOTE TO IANA/RFC-EDITOR:
     Please replace XXXX with the RFC number of this
    specification.]</a>.</p>
</body>
```

```
</html>
END
```

9.4. Symmetric Key Algorithm Identifier Registry

This specification requests the creation of a new IANA registry for symmetric key cryptographic algorithm identifiers in accordance with the principles set out in RFC 2434 [RFC2434]as follows:

9.4.1. Applicability

The use of URIs as algorithm identifiers provides an effectively unlimited namespace. While this eliminates the possibility of namespace exhaustion it creates a new concern, that divergent identifiers will be employed for the same purpose in different contexts.

The key algorithm registry is intended to provide a means of specifying the canonical identifier to be used for a given algorithm. If an algorithm has an identifier specified in the registry a application that is conformant to a protocol specification that specifies use of that registry to define identifiers SHOULD always use that particular form of the identifier when originating data. A conformant application MAY accept other identifiers in data that is received.

For the sake of expediency, the initial registry only defines algorithm classes for symmetric algorithms plus cryptographic message digest functions (one-way hash). While the same principles may be extended to asymmetric algorithms, doing so would require much

greater consideration of issues such as key length and treatment of parameters, particularly where eliptic curve cryptography algorithms are concerned.

As part of this registry the IANA will maintain the following information:

Common Name The name by which the algorithm is generally referred.

Class The type of algorithm, encryption, Message Authentication Code (MAC), One Time Pawword (OTP), Digest, etc.

Cannonical URI The cannonical URI to be used to identify the algorithm.

Algorithm Definition A reference to the document in which the algorithm described by the identifier is defined.

Identifier Definition A reference to the document in which the use of the identifier to refer to the algorithm is described. This would ideally be the document in which the algorithm is defined.

In the case where the registrant does not request a particular URI, the IANA will assign it a Uniform Resource Name (URN) that follows RFC 3553 [RFC3553].

Note that where a single algorithm has different forms distinguished by paremeters such as key length, the algorithm class and each combination of algorithm parameters may be considered a distinct algorithm for the purpose of assigning identifiers.

9.4.2. Registerable Algorithms

9.4.2.1. Assigned URIs

If the registrant wishes to have a URI assigned, then a URN of the form

urn:ietf:params:xml:<class>:<id>

will be assigned where <class> is the type of the algorithm being identified (see below). <id> is a unique id specified by the party making the request and will normally be either the common name of the algorithm or an abbreviation thereof.

NOTE: in order for a URN of this type to be assigned, the item being registered MUST have been through the IETF consensus process. Basically, this means that it must be documented in a RFC.

NOTE: Expert Review is sufficient in cases where the request does not require a URN assignment inthe IETF namespace. IETF consensus is not required.

9.4.2.2. Assigned Classes

Each algorithm MUST belong to an assigned algorithm class. In the case that additional classes are required these are to be specified by IETF Consensus action.

The initial assigned classes are:

Digest A cryptographic Digest algorithm.

MAC A Message Authentication Code algorithm.

Symmetric A symmetric encryption algorithm.

OTP A one time password (OTP) algorithm.

9.4.3. Registration Procedures

9.4.3.1. Review

Algorithm identifier registrations are to be subject to Expert Review as per RFC 2434 [RFC2434].

The need for supporting documentation for the registration depends on the nature of the request. In the case of a cryptographic algorithm that is being described for publication as an RFC, the request for a URI allocation would normally appear within the RFC itself. In the case of a cryptographic algorithm that is fully and comprehensively defined in another form, it would not be necessary to duplicate the information for the sake of issuing the information in the RFC series. In other cases an RFC may be required in order to ensure that certain algorithm parameters are sufficiently and unambiguously defined.

The scope of such expert review is to be strictly limited to identifying possible ambiguity and/or duplication of existing identifiers. The expert review MUST NOT consider the cryptographic properties, intellectual property considerations or any other factor not related to the use of the identifier.

In reviewing a request, the expert should consider whether other URI identifiers are already defined for a given algorithm. In such cases it is the duty of the expert to bring the potential duplication to the notice of the proposers of the registration and the Security Area

Directors. If the proposers are not willing to accept registration of the existing identifier the IETF Consensus policy is to apply.

In reviewing a request, the expert should consider whether the algorithm is sufficiently defined to allow successful interoperation. In particular the expert should consider whether issues such as key sizes and byte order are sufficiently defined to allow for interoperation.

While the defintion requirement MAY be satisifed by a comprehensive specification of the algorithm, disclosure of the algorithm is not mandatory.

9.4.3.2. Canonical URI

Until the IANA requests or implements an automated process for the registration of these elements, any specifications must make that request part of the IANA considerations section of their respective documents. That request must be in the form of the following template:

Common Name The name by which the algorithm is generally referred.

Class The type of algorithm, encryption, Message Authentication Code (MAC), One Time Pawword (OTP), Digest, etc. As specified by a defined algorithm class.

URI The cannonical URI to be used to identify the algorithm.

Algorithm Definition A reference to the document in which the algorithm described by the identifier is defined.

Identifier Definition A reference to the document in which the use of the identifier to refer to the algorithm is described. This would ideally be the document in which the algorithm is defined.

Registrant Contact A reference to the document in which the use of the identifier to refer to the algorithm is described. This would ideally be the document in which the algorithm is defined.

9.4.3.3. Alias URI

In the case that multiple identifiers have been assigned to the same identifiers, additional identifiers MAY be registered as aliases. An entry for an alias contains all the entries for a canonical URI with the addition of a reference to the canonical URI to be used:

Alias for URI The cannonical URI that identifies the algorithm. The URI referenced MUST be a canonical URI.

In the case of dispute as to which URI is to be considered canonical the matter is to be settled by IESG action.

9.4.4. Initial Values

The following initial values are defined. Note that these values are limited to identifiers that are required by KEYPROV but not specified elsewhere:

9.4.4.1. HOTP

Common Name: HOTP

Class: OTP

URI: http://www.ietf.org/keyprov/pskc#hotp

Algorithm Definition: http://www.ietf.org/rfc/rfc4226.txt

Identifier Definition (this RFC)

Registrant Contact: IESG

9.4.4.2. HOTP-HMAC-SHA-1

Common Name: HOTP-HMAC-SHA-1

Class: OTP

URI: http://www.ietf.org/rfc/rfc4226.txt#HOTP-HMAC-SHA-1

Algorithm Definition: http://www.ietf.org/rfc/rfc4226.txt

Identifier Definition (this RFC)

Registrant Contact: IESG

9.4.4.3. KEYPROV-PIN

Common Name: KEYPROV-PIN

Class: Symmetric static credential comparison

URI: http://www.ietf.org/keyprov/pskc#pin

Algorithm Definition: (this document)

Identifier Definition (this document)

Registrant Contact: IESG

9.4.4.4. SecurID-AES

Common Name: SecurID-AES

Class: OTP

URI: http://www.rsasecurity.com/rsalabs/otps/schemas/2005/09/otps-wst#SecurID-AES

Algorithm Definition: http://www.rsa.com/rsalabs/node.asp?id=2821

Identifier Definition http://www.rsa.com/rsalabs/node.asp?id=2821

Registrant Contact: Andrea Doherty, RSA the Security Division of EMC, <andrea.doherty@rsa.com>

9.4.4.5. SecurID-ALGOR

Common Name: SecurID-ALGOR

Class: OTP

URI: http://www.rsasecurity.com/rsalabs/otps/schemas/2005/09/otps-wst#SecurID-ALGOR

Algorithm Definition: http://www.rsa.com/rsalabs/node.asp?id=2821

Identifier Definition http://www.rsa.com/rsalabs/node.asp?id=2821

Registrant Contact: Andrea Doherty, RSA the Security Division of EMC, <andrea.doherty@rsa.com>

9.4.4.6. ActivIdentity-3DES

Common Name: ActivIdentity-3DES

Class: OTP

URI: http://www.actividentity.com/2008/04/algorithms/algorithms#ActivIdentity-3DES

Algorithm Definition: http://www.actividentity.com/2008/04/algorithms/algorithms#ActivIdentity-3DES

Identifier Definition http://www.actividentity.com/2008/04/algorithms/algorithms#ActivIdentity-3DES

Registrant Contact: Philip Hoyer, ActivIdentity Inc, <philip.hoyer@actividentity.com>

9.4.4.7. ActivIdentity-AES

Common Name: ActivIdentity-AES

Class: OTP

URI: http://www.actividentity.com/2008/04/algorithms/algorithms#ActivIdentity-AES

Algorithm Definition: http://www.actividentity.com/2008/04/algorithms/algorithms#ActivIdentity-AES

Identifier Definition http://www.actividentity.com/2008/04/algorithms/algorithms#ActivIdentity-AES

Registrant Contact: Philip Hoyer, ActivIdentity Inc,
<philip.hoyer@actividentity.com>

9.4.4.8. ActivIdentity-DES

Common Name: ActivIdentity-DES

Class: OTP

URI: http://www.actividentity.com/2008/04/algorithms/algorithms#ActivIdentity-DES

Algorithm Definition: http://www.actividentity.com/2008/04/algorithms/algorithms#ActivIdentity-DES

Identifier Definition http://www.actividentity.com/2008/04/algorithms/algorithms#ActivIdentity-DES

Registrant Contact: Philip Hoyer, ActivIdentity Inc,
<philip.hoyer@actividentity.com>

9.4.4.9. ActivIdentity-EVENT

Common Name: ActivIdentity-EVENT

Class: OTP

URI: http://www.actividentity.com/2008/04/algorithms/algorithms#ActivIdentity-EVENT

Algorithm Definition: http://www.actividentity.com/2008/04/algorithms/algorithms#ActivIdentity-EVENT

Identifier Definition http://www.actividentity.com/2008/04/algorithms/algorithms#ActivIdentity-EVENT

Registrant Contact: Philip Hoyer, ActivIdentity Inc,

<philip.hoyer@actividentity.com>

9.5. XML Data Tag Identifier Registry

This specification requests the creation of a new IANA registry for XML Data Tag identifiers in accordance with the principles set out in RFC 2434 [RFC2434]as follows:

[More explanation of why an escape to tag value lists is desirable when inserting unstructured data into an XML schema]

9.5.1. Applicability

As part of this registry the IANA will maintain the following information:

Common Name Common name for by which the tag is referred to

Cannonical URI The cannonical URI to be employed when citing the tag.

Data Type The data type of the data that is bound to the tag.

Definition A reference to the document in which the data tag defined by the identifier is defined.

In the case where the registrant does not request a particular URI, the IANA will assign it a Uniform Resource Name (URN) that follows RFC 3553 [RFC3553].

9.5.2. Registerable Data Tags

9.5.2.1. Assigned URIs

If the registrant wishes to have a URI assigned, then a URN of the form

urn:ietf:params:xml:datatag:<tag>

will be assigned where <tag> is a unique id specified by the party making the request and will normally be either the common name of the tag or an abbreviation thereof.

NOTE: in order for a URN of this type to be assigned, the item being registered MUST have been through the IETF consensus process. Basically, this means that it must be documented in a RFC.

NOTE: Expert Review is sufficient in cases where the request does not require a URN assignment inthe IETF namespace. IETF consensus is not required.

9.5.3. Registration Procedures

9.5.3.1. Review

Data tag registrations are to be subject to Expert Review as per RFC 2434 [RFC2434].

9.5.3.2. Data Tag Entry

Until the IANA requests or implements an automated process for the registration of these elements, any specifications must make that request part of the IANA considerations section of their respective documents. That request must be in the form of the following template:

Common Name Common name for by which the tag is referred to

Cannonical URI The cannonical URI to be employed when citing the tag.

Data Type The data type of the data that is bound to the tag.

Definition A reference to the document in which the data tag defined by the identifier is defined.

9.5.4. Initial Values

The following initial values are defined. Note that these values are limited to identifiers that are required by KEYPROV but not specified elsewhere:

9.5.4.1. Secret

Common Name Secret

Cannonical URI urn:ietf:params:xml:datatag:secret

Data Type binary, base64 encoded

Defined in (this document)

9.5.4.2. Counter

Common Name Counter

Cannonical URI urn:ietf:params:xml:datatag:counter

Data Type 8 bytes unsigned integer in big endian (i.e. network byte order) form base64 encoded

Defined in (this document)

9.5.4.3. Time

Common Name Time

Cannonical URI urn:ietf:params:xml:datatag:time

Data Type 8 bytes unsigned integer in big endian (i.e. network byte order) form base64 encoded (Number of seconds since 1970)

Defined in (this document)

9.5.4.4. Time Interval

Common Name Time Interval

Cannonical URI urn:ietf:params:xml:datatag:time_interval

Data Type 8 bytes unsigned integer in big endian (i.e. network byte order) form base64 encoded.

Defined in (this document)

9.5.4.5. Time Drift

Common Name urn:ietf:params:xml:datatag:time_drift

Cannonical URI Time Drift

Data Type 2 bytes unsigned integer in big endian (i.e. network byte order) form base64 encoded.

Defined in (this document)

10. Security Considerations

The portable key container carries sensitive information (e.g., cryptographic keys) and may be transported across the boundaries of one secure perimeter to another. For example, a container residing within the secure perimeter of a back-end provisioning server in a secure room may be transported across the internet to an end-user device attached to a personal computer. This means that special care must be taken to ensure the confidentiality, integrity, and authenticity of the information contained within.

10.1. Payload confidentiality

By design, the container allows two main approaches to guaranteeing the confidentiality of the information it contains while transported.

First, the container key data payload may be encrypted.

In this case no transport layer security is required. However, standard security best practices apply when selecting the strength of the cryptographic algorithm for payload encryption. Symmetric cryptographic cipher should be used - the longer the cryptographic key, the stronger the protection. At the time of this writing both 3DES and AES are mandatory algorithms but 3DES may be dropped in the relatively near future. Applications concerned with algorithm longevity are advised to use AES-256-CBC. In cases where the exchange of encryption keys between the sender and the receiver is not possible, asymmetric encryption of the secret key payload may be employed. Similarly to symmetric key cryptography, the stronger the asymmetric key, the more secure the protection is.

If the payload is encrypted with a method that uses one of the password-based encryption methods provided above, the payload may be subjected to password dictionary attacks to break the encryption password and recover the information. Standard security best practices for selection of strong encryption passwords apply [Schneier].

Practical implementations should use PBESalt and PBEIterationCount when PBE encryption is used. Different PBESalt value per key container should be used for best protection.

The second approach to protecting the confidentiality of the payload is based on using transport layer security. The secure channel established between the source secure perimeter (the provisioning server from the example above) and the target perimeter (the device attached to the end-user computer) utilizes encryption to transport the messages that travel across. No payload encryption is required

in this mode. Secure channels that encrypt and digest each message provide an extra measure of security, especially when the signature of the payload does not encompass the entire payload.

Because of the fact that the plain text payload is protected only by the transport layer security, practical implementation must ensure protection against man-in-the-middle attacks [Schneier]. Validating the secure channel end-points is critically important for eliminating intruders that may compromise the confidentiality of the payload.

10.2. Payload integrity

The portable symmetric key container provides a mean to guarantee the integrity of the information it contains through digital signatures. For best security practices, the digital signature of the container should encompass the entire payload. This provides assurances for the integrity of all attributes. It also allows verification of the integrity of a given payload even after the container is delivered through the communication channel to the target perimeter and channel message integrity check is no longer possible.

10.3. Payload authenticity

The digital signature of the payload is the primary way of showing its authenticity. The recipient of the container may use the public key associated with the signature to assert the authenticity of the sender by tracing it back to a preloaded public key or certificate. Note that the digital signature of the payload can be checked even after the container has been delivered through the secure channel of communication.

A weaker payload authenticity guarantee may be provided by the transport layer if it is configured to digest each message it transports. However, no authenticity verification is possible once the container is delivered at the recipient end. This approach may

be useful in cases where the digital signature of the container does not encompass the entire payload.

11. Acknowledgements

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12. Appendix A - Example Symmetric Key Containers

All examples are syntactically correct and compatible with the XML schema in section 7.

12.1. Symmetric Key Container with a single Non-Encrypted HOTP Secret Key

```
<?xml version="1.0" encoding="UTF-8"?>
<KeyContainer Version="1.0"
  xmlns="urn:ietf:params:xml:ns:keyprov:container:1.0">
    <Device>
        <DeviceId>
            <Manufacturer>ACME</Manufacturer>
            <SerialNo>0755225266</SerialNo>
        </DeviceId>
        <Key KeyAlgorithm="http://www.ietf.org/keyprov/pskc#hotp"
          KeyId="0755225266">
            <Issuer>AnIssuer</Issuer>
            <Usage OTP="true">
```

```
                <ResponseFormat Length="6" Format="DECIMAL"/>
            </Usage>
            <Data Name="COUNTER">
                <PlainValue>AprkuA==</PlainValue>
            </Data>
            <Data Name="SECRET">
                <PlainValue>/4h3rOTeBegJwGpmTTq4F+RlNR0=</PlainValue>
            </Data>
            <ExpiryDate>2012-12-31T00:00:00</ExpiryDate>
        </Key>
    </Device>
</KeyContainer>
```

12.2. Symmetric Key Container with a single PIN protected Non-Encrypted HOTP Secret Key


```
<?xml version="1.0" encoding="UTF-8"?>
<KeyContainer Version="1.0"
  xmlns="urn:ietf:params:xml:ns:keyprov:container:1.0">
    <Device>
        <DeviceId>
            <Manufacturer>ACME</Manufacturer>
            <SerialNo>0755225266</SerialNo>
        </DeviceId>
        <Key KeyAlgorithm="http://www.ietf.org/keyprov/pskc#hotp"
          KeyId="0755225266">
            <Issuer>AnIssuer</Issuer>
            <Usage OTP="true">
                <ResponseFormat Length="6" Format="DECIMAL"/>
            </Usage>
```

```
                <Data Name="COUNTER">
                    <PlainValue>AprkuA==</PlainValue>
                </Data>
                <Data Name="SECRET">
                    <PlainValue>/4h3rOTeBegJwGpmTTq4F+RlNR0=</PlainValue>
                </Data>
                <PINPolicy PINKeyId="07552252661">
                    <PINUsageMode>
                        <Local/>
                    </PINUsageMode>
                </PINPolicy>
            </Key>
            <Key KeyId="07552252661"
              KeyAlgorithm="http://www.ietf.org/keyprov/pskc#pin">
                <Usage>
                    <ResponseFormat Length="4" Format="DECIMAL"/>
                </Usage>
                <Data Name="SECRET">
                    <PlainValue>MTIzNA==</PlainValue>
                </Data>
            </Key>
        </Device>
    </KeyContainer>
```

12.3. Symmetric Key Container with a single AES-256-CBC Encrypted HOTP Secret Key


```
<?xml version="1.0" encoding="UTF-8"?>
<KeyContainer Version="1.0"
  xmlns="urn:ietf:params:xml:ns:keyprov:container:1.0"
  xmlns:ds="http://www.w3.org/2000/09/xmldsig#"
  xmlns:xenc="http://www.w3.org/2001/04/xmlenc#">
    <EncryptionKey>
        <ds:KeyName>PRE_SHARED_KEY</ds:KeyName>
```

```
    </EncryptionKey>
    <MACAlgorithm>http://www.w3.org/2000/09/xmldsig#hmac-sha1
    </MACAlgorithm>
    <Device>
        <DeviceId>
            <Manufacturer>ACME</Manufacturer>
            <SerialNo>0755225266</SerialNo>
        </DeviceId>
        <Key KeyAlgorithm="http://www.ietf.org/keyprov/pskc#hotp"
          KeyId="0755225266">
            <Issuer>AnIssuer</Issuer>
            <Usage OTP="true">
                <ResponseFormat Length="8" Format="DECIMAL"/>
            </Usage>
            <Data Name="COUNTER">
                <PlainValue>AprkuA==</PlainValue>
            </Data>
            <Data Name="SECRET">
                <EncryptedValue>
                    <xenc:EncryptionMethod
                   Algorithm="http://www.w3.org/2001/04/xmlenc#aes256-cbc"/>
                    <xenc:CipherData>
                      <xenc:CipherValue>
                        kyzrWTJuhJKQHhZtf2CWbKC5H3LdfAPvKzHHQ8SdxyE=
                      </xenc:CipherValue>
                    </xenc:CipherData>
                </EncryptedValue>
                <ValueMAC>cwJI898rRpGBytTqCAsegaQqPZA=</ValueMAC>
            </Data>
        </Key>
    </Device>
</KeyContainer>
```

12.4. Symmetric Key Container with signature and a single Password-based Encrypted HOTP Secret Key

```
 <?xml version="1.0" encoding="UTF-8"?>
 <pskc:KeyContainer
   xmlns:pskc="urn:ietf:params:xml:ns:keyprov:container:1.0"
   xmlns:pkcs-5=
```

```
  "http://www.rsasecurity.com/rsalabs/pkcs/schemas/pkcs-5v2-0#"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:ds="http://www.w3.org/2000/09/xmldsig#"
xmlns:xenc="http://www.w3.org/2001/04/xmlenc#"
Version="1.0">
  <pskc:EncryptionKey>
    <pskc:DerivedKey Id="#Passphrase1">
      <pskc:CarriedKeyName>Passphrase1</pskc:CarriedKeyName>
      <pskc:KeyDerivationMethod
        Algorithm=
   "http://www.rsasecurity.com/rsalabs/pkcs/schemas/pkcs-5#pbkdf2">
        <pkcs-5:Parameters xsi:type="pkcs-5:PBKDF2ParameterType">
          <Salt>
            <Specified>Df3dRAhjGh8=</Specified>
          </Salt>
          <IterationCount>2000</IterationCount>
          <KeyLength>16</KeyLength>
          <PRF/>
        </pkcs-5:Parameters>
      </pskc:KeyDerivationMethod>
      <xenc:ReferenceList>
        <xenc:DataReference URI="#ED"/>
      </xenc:ReferenceList>
    </pskc:DerivedKey>
  </pskc:EncryptionKey>
<pskc:Device>
  <pskc:DeviceId>
    <pskc:Manufacturer>ACME</pskc:Manufacturer>
    <pskc:SerialNo>0755225266</pskc:SerialNo>
  </pskc:DeviceId>
      <pskc:Key KeyAlgorithm="http://www.ietf.org/keyprov/pskc#hotp"
        KeyId="0755225266">
          <pskc:Issuer>AnIssuer</pskc:Issuer>
          <pskc:Usage OTP="true">
              <pskc:ResponseFormat Length="6" Format="DECIMAL"/>
          </pskc:Usage>
          <pskc:Data Name="COUNTER">
              <pskc:PlainValue>AprkuA==</pskc:PlainValue>
          </pskc:Data>
          <pskc:Data Name="SECRET">
              <pskc:EncryptedValue Id="ED">
                <xenc:EncryptionMethod Algorithm=
                "http://www.w3.org/2001/04/xmlenc#kw-aes128"/>
                <xenc:CipherData>
                  <xenc:CipherValue>rf4dx3rvEPO0vKtKL14NbeVu8nk=
                  </xenc:CipherValue>
                </xenc:CipherData>
              </pskc:EncryptedValue>
```

```
            </pskc:Data>
          </pskc:Key>
    </pskc:Device>
    <pskc:Signature>
      <ds:SignedInfo>
        <ds:CanonicalizationMethod
          Algorithm="http://www.w3.org/2001/10/xml-exc-c14n#"/>
        <ds:SignatureMethod
          Algorithm="http://www.w3.org/2000/09/xmldsig#rsa-sha1"/>
        <ds:Reference URI="">
          <ds:DigestMethod Algorithm=
            "http://www.w3.org/2000/09/xmldsig#sha1"/>
          <ds:DigestValue>j6lwx3rvEPO0vKtMup4NbeVu8nk=</ds:DigestValue>
        </ds:Reference>
      </ds:SignedInfo>
      <ds:SignatureValue>j6lwx3rvEPO0vKtMup4NbeVu8nk=</ds:SignatureValue>
      <ds:KeyInfo>
        <ds:X509Data>
          <ds:X509IssuerSerial>
            <ds:X509IssuerName>CN=KeyProvisioning'R'Us.com,C=US
            </ds:X509IssuerName>
            <ds:X509SerialNumber>12345678</ds:X509SerialNumber>
          </ds:X509IssuerSerial>
        </ds:X509Data>
      </ds:KeyInfo>
    </pskc:Signature>
  </pskc:KeyContainer>
```

12.5. Symmetric Key Container with a single RSA 1.5 Encrypted HOTP Secret Key

```
<?xml version="1.0" encoding="UTF-8"?>
<pskc:KeyContainer Version="1.0"
  xmlns:pskc="urn:ietf:params:xml:ns:keyprov:container:1.0"
  xmlns:ds="http://www.w3.org/2000/09/xmldsig#"
  xmlns:xenc="http://www.w3.org/2001/04/xmlenc#">
    <pskc:EncryptionKey>
        <ds:X509Data>
            <ds:X509Certificate>miib</ds:X509Certificate>
        </ds:X509Data>
    </pskc:EncryptionKey>
    <pskc:Device>
        <pskc:DeviceId>
            <pskc:Manufacturer>ACME</pskc:Manufacturer>
            <pskc:SerialNo>0755225266</pskc:SerialNo>
        </pskc:DeviceId>
        <pskc:Key KeyAlgorithm="http://www.ietf.org/keyprov/pskc#hotp"
                  KeyId="0755225266">
            <pskc:Issuer>AnIssuer</pskc:Issuer>
            <pskc:Usage OTP="true">
                <pskc:ResponseFormat Length="8" Format="DECIMAL"/>
            </pskc:Usage>
            <pskc:Data Name="COUNTER">
                <pskc:PlainValue>AprkuA==</pskc:PlainValue>
            </pskc:Data>
            <pskc:Data Name="SECRET">
              <pskc:EncryptedValue Id="ED">
                <xenc:EncryptionMethod
                  Algorithm="http://www.w3.org/2001/04/xmlenc#rsa_1_5"/>
                <xenc:CipherData>
                  <xenc:CipherValue>rf4dx3rvEPO0vKtKL14NbeVu8nk=
                  </xenc:CipherValue>
                </xenc:CipherData>
              </pskc:EncryptedValue>
            </pskc:Data>
        </pskc:Key>
    </pskc:Device>
```

```
</pskc:KeyContainer>
```


13. References

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