TBD (Key Management Interoperability Protocol)

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Technical Committee:
OASIS Key Management Interoperability Protocol (KMIP) TC

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Related work:
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- None

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- TBD

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Abstract:
This document is intended for developers and architects who wish to design systems and applications that interoperate using the Key Management Interoperability Protocol specification.

Status:
This document was last revised or approved by the Key Management Interoperability Protocol TC on the above date. The level of approval is also listed above. Check the "Latest Version" or "Latest Approved Version" location noted above for possible later revisions of this document.

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1 Introduction

This document is intended as a specification of the protocol used for the communication between clients and servers to perform certain management operations on objects stored and maintained by a key management system. These objects will be referred to as *Managed Objects* in this specification. They include symmetric and asymmetric cryptographic keys, digital certificates, and templates used to simplify the creation of objects and control their use. Managed Objects are managed with *operations* that include the ability to generate cryptographic keys, register objects with the key management system, obtain objects from the system, destroy objects from the system, and search for objects maintained by the system. Managed Objects also have associated *attributes*, which are named values stored by the key management system and which can be obtained from the system via operations. Certain attributes may be changed, added or deleted, again by operations.

The protocol specified in this document includes several certificate-related functions for which there are a number of existing protocols – namely Validate (e.g. SVP or XKMS), Certify (e.g. CMP, CMC, SCEP) and Re-certify (e.g. CMP, CMC, SCEP). The protocol does not attempt to define a comprehensive certificate management protocol such as would be required for a certification authority. However, it does include functions that are needed in proxying certificate management functions through a key server.

In addition to the normative definitions for managed objects, operations and attributes, this specification also includes normative definitions for the following aspects of the protocol:

- The expected behavior of the server and client as a result of operations
- Message contents and formats
- Authentication profiles for clients and servers
- Message encoding, including enumerations
- Error handling

This specification is complemented by two other documents. The Usage Guide provides illustrative information on using the protocol. The Test Specification provides samples of protocol messages corresponding to a set of defined test cases.

1.1 Document Roadmap

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1.2 Goals and Requirements

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1.3 Notational Conventions

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1.4 Namespaces

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1.5 Terminology

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1.6 Normative References

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1.7 Non-normative References

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1.8 Compliance

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2 Objects

The following subsections describe the objects that are passed between the clients and servers of the key management system. Some of these object types, called *Base Objects*, are used only in the protocol itself, and are not considered Managed Objects. Key management systems may choose to support a subset of the Managed Objects. The object descriptions refer to the primitive data types they are composed of. These primitive data types are

- Integer
- Long Integer
- Big Integer
- Enumeration – choices from a predefined list of values
- Boolean
- Text String – string of characters representing human-readable text
- Octet String – sequence of unencoded byte values
- Date-Time – date and time, with a granularity of one second
- Interval – time interval expressed in seconds

Structures are composed of ordered lists of primitive data types or structures.

2.1 Base Objects

These objects are used within the messages of the protocol, but are not objects managed by the key management system. They may be components of Managed Objects.

2.1.1 Attribute

An object, used for sending and receiving Managed Object attributes. The *Attribute Name* is a text-string which is used to identify the attribute. The *Attribute Index* is an index number assigned by the key management server when a specified named attribute is allowed to have multiple instances. The index number is used to identify the particular instance. Index numbers start with 0. The index number of an attribute is never changed when other instances are added or deleted. For example, if a particular attribute has 4 instances with index numbers 0, 1, 2 and 3, and the instance with index 2 is deleted, the index number of instance 3 is not changed. Attributes which have a single instance have an Attribute Index of 0, which is assumed if the index is not specified. The *Attribute Value* is either a primitive data type, or structured object, depending on the attribute.

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Object	Encoding	Required
Attribute	Structure	Yes
Attribute Name	Text String	Yes
Attribute Index	Integer	No
Attribute Value	Varies, depending on attribute. See Section 3	Yes

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2.1.2 Credential

A credential is a protocol-only object, used for client identification purposes and not managed by the key management system, e.g., user id/password pairs, Kerberos tokens, etc. See Section 8 .

Object	Encoding	Required
Credential	Structure	Yes
Credential Type	Enumeration	Yes
Credential Value	Octet String	Yes

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2.1.3 Key Block

A *Key Block* object encapsulates all of the information that is closely associated with a cryptographic key. It contains a Key Value of one of the following *Key Value Types*:

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- *Raw* – This is a key which consists of "pure" cryptographic key material, encoded as a string of bytes.
- *Opaque* – This is an encoded key for which the encoding is unknown to the key management system. It is encoded as a string of bytes.
- *PKCS1* – This is an encoded private key, expressed as a DER-encoded ASN.1 PKCS#1 object.
- *PKCS8* – This is an encoded private key, expressed as a DER-encoded ASN.1 PKCS#8 object, supporting both RSAPrivateKey syntax and EncryptedPrivateKey.
- Several *Transparent Key* types – These are algorithm-specific structures containing defined values for the various key types, as defined in Section 2.1.6 .
- *Extensions* – These are vendor-specific extensions to allow for proprietary or legacy key formats.

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It contains also the Cryptogtaphic Algorithm and the Cryptographic Length of the key contained in the Key Value field. Some example values are:

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- RSA keys are typically 1024, 2048 or 3072 bits in length
- 3DES keys are typically 168 bits in length
- AES keys are typically 128 or 256 bits in length

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The Key Block may optionally contain a Key Wrapping Data structure, which indicates that the key in the Key Value field is wrapped (i.e., encrypted, or MACed/signed, or both).

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Object	Encoding	Required
Key Block	Structure	Yes
Key Value Type	Enumeration	Yes
Key Value	Octet String: for wrapped Key Value; Structure: for plaintext Key Value	Yes
Cryptographic Algorithm	Enumeration	Yes, may be omitted only if this information is available from the Key Value. Does not apply to Secret Data or Opaque Objects. If present, Cryptographic Length below must also be present.
Cryptographic Length	Integer	Yes, may be omitted only if this information is available from the Key Value. Does not apply to Secret Data or Opaque Objects. If present, Cryptographic Algorithm above must also be present.
Key Wrapping Data	Structure	No

2.1.4 Key Value

The *Key Value* is used only inside a Key Block and is either an Octet String or a structure:

- The Key Value structure contains the key material, either as an octet string or as a Transparent Key structure (see Section 2.1.7), and optional attribute information that is associated with and encapsulated with the key material. This attribute information differs from the attributes associated with Managed Objects, and which is obtained via the Get Attributes operation, only by the fact that it is encapsulated with, and may be wrapped along with the key material itself.
- The Key Value Octet String is the wrapped TTLV-encoded (see Section 9.1) Key Value structure.

Object	Encoding	Required
Key Value	Structure	Yes
Key Material	Octet String: for Raw, Opaque, PKCS1, PKCS8, or Vendor Extension Key Value types; Structure: for Transparent, or Vendor Extension Key Value Types	Yes
Attribute	Attribute Object, see Section 2.1.1	No. May be repeated

2.1.5 Key Wrapping Data

The Key Block may also supply optional information about a cryptographic key wrapping mechanism used to wrap the Key Value. This consists of a *Key Wrapping Data* structure.

This structure contains fields for:

- A *Wrapping Method* that indicates the method used to wrap the Key Value.
- An *Encryption Key Information* with the Unique Identifier value of the encryption key and associated cryptographic parameters.
- A *MAC/Signature Key Information* with the Unique Identifier value of the MAC/signature key and associated cryptographic parameters.
- A *MAC/Signature* field with the MAC or signature of the Key Value.
- An *IV/Counter/Nonce* if required by the wrapping method.

If wrapping is used, the whole Key Value structure is wrapped unless otherwise specified by the Wrapping Method. The algorithms are given by the Cryptographic Algorithm attributes of the encryption key and/or MAC/signature key; the block-cipher mode, padding method, and hashing algorithm used are given by the Cryptographic Parameters in the Encryption Key Information and/or MAC/Signature Key Information, or, if not present, from the Cryptographic Parameters attribute of the respective key(s).

The following wrapping methods are currently defined:

- *Encrypt* only (i.e., encryption using a symmetric key or public key, or authenticated encryption algorithms that use a single key)
- *MAC/sign* only (i.e., either MAC'ing the Key Value with a symmetric key, or signing the Key Value with a private key)
- *Encrypt then MAC/sign*
- *MAC/sign then encrypt*
- *TR-31*
- *Extensions*

Object	Encoding	Required
Key Wrapping Data	Structure	Yes
Wrapping Method	Enumeration	Yes
Encryption Key Information	Structure	No. Corresponds to the key that was used to encrypt the Key Value.
MAC/Signature Key Information	Structure	No. Corresponds to the symmetric key used to MAC the Key Value or the private key used to sign the Key Value
MAC/Signature	Octet String	No
IV/Counter/Nonce	Octet String	No

The structures of the Encryption Key Information and the MAC/Signature Key Information are as follows:

Object	Encoding	Required
Encryption Key Information	Structure	Yes
Unique Identifier	Text string	Yes
Cryptographic Parameters	Structure	No

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Object	Encoding	Required
MAC/Signature Key Information	Structure	Yes
Unique Identifier	Text string	Yes. It can be the Unique Identifier of the Symmetric Key used to MAC, or of the Private Key (or its corresponding Public Key) used to sign.
Cryptographic Parameters	Structure	No

2.1.6 Key Wrapping Specification

This is a separate structure defined for operations that provide the option to return wrapped keys. The *Key Wrapping Specification* must be specified inside the operation request, if clients wish the server to return a wrapped key. If Cryptographic Parameters are specified in the Encryption Key Information and the MAC/Signature Key Information, then the server can verify that they match one of the instances of the Cryptographic Parameters attribute of the corresponding key. If Cryptographic Parameters are omitted, the server can choose to use the Cryptographic Parameters attribute with the lowest index of the corresponding key. If the corresponding key does not have any Cryptographic Parameters attribute, or if no match is found, an error is returned.

This structure contains :

- A Wrapping Method that indicates the method used to wrap the Key Value.
- An Encryption Key Information with the Unique Identifier value of the encryption key and associated cryptographic parameters.
- A MAC/Signature Key Information with the Unique Identifier value of the MAC/signature key and associated cryptographic parameters.
- Zero or more Attribute Names to indicate the attributes to be wrapped with the key material.

Object	Encoding	Required
Key Wrapping Specification	Structure	Yes
Wrapping Method	Enumeration	Yes
Encryption Key Information	Structure	No
MAC/Signature Key Information	Structure	No
Attribute Name	Text String	No, May be repeated

The structures of the Encryption Key Information and the MAC/Signature Key Information are defined in Section 2.1.5 .

2.1.7 Transparent Key Structures

Transparent Key structures describe key material in a form that can easily be interpreted by all participants in the protocol. They are used in the Key Value structure.

2.1.7.1 Transparent Symmetric Key

If the Key Value Type in the Key Block is *Transparent Symmetric Key*, then Key Material is a structure as follows:

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Object	Encoding	Required
Key Material	Structure	Yes
Key	Octet String	Yes

2.1.7.2 Transparent DSA Private Key

If the Key Value Type in the Key Block is *Transparent DSA Private Key*, then Key Material is a structure as follows:

Object	Encoding	Required
Key Material	Structure	Yes
P	Big Integer	Yes
Q	Big Integer	Yes
G	Big Integer	Yes
X	Big Integer	Yes

P is the prime modulus. Q is the prime divisor of P-1. G is the generator. X is the private key (refer to NIST FIPS PUB 186-3).

2.1.7.3 Transparent DSA Public Key

If the Key Value Type in the Key Block is *Transparent DSA Public Key*, then Key Material is a structure as follows:

Object	Encoding	Required
Key Material	Structure	Yes
P	Big Integer	Yes
Q	Big Integer	Yes
G	Big Integer	Yes
Y	Big Integer	Yes

P is the prime modulus. Q is the prime divisor of P-1. G is the generator. Y is the public key (refer to NIST FIPS PUB 186-3).

2.1.7.4 Transparent RSA Private Key

If the Key Value Type in the Key Block is *Transparent RSA Private Key*, then Key Material is a structure as follows:

Object	Encoding	Required
Key Material	Structure	Yes
Modulus	Big Integer	Yes
Private Exponent	Big Integer	No
Public Exponent	Big Integer	No
P	Big Integer	No
Q	Big Integer	No
Prime Exponent P	Big Integer	No
Prime Exponent Q	Big Integer	No
CRT Coefficient	Big Integer	No

One of the following must be present (refer to RSA PKCS#1):

- Private Exponent
- P and Q (the first two prime factors of Modulus)
- Prime Exponent P and Prime Exponent Q.

2.1.7.5 Transparent RSA Public Key

If the Key Value Type in the Key Block is *Transparent RSA Public Key*, then Key Material is a structure as follows:

Object	Encoding	Required
Key Material	Structure	Yes
Modulus	Big Integer	Yes
Public Exponent	Big Integer	Yes

2.1.7.6 Transparent DH Private Key

If the Key Value Type in the Key Block is *Transparent DH Private Key*, then Key Material is a structure as follows:

Object	Encoding	Required
Key Material	Structure	Yes
P	Big Integer	Yes
G	Big Integer	Yes
Q	Big Integer	No
J	Big Integer	No
X	Big Integer	Yes

P is the prime, P = JQ + 1. G is the generator $G^Q = 1 \bmod P$. Q is the prime factor of P-1. J is the cofactor. X is the private key (refer to ANSI X9.42).

2.1.7.7 Transparent DH Public Key

If the Key Value Type in the Key Block is *Transparent DH Public Key*, then Key Material is a structure as follows:

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Object	Encoding	Required
Key Material	Structure	Yes
P	Big Integer	Yes
G	Big Integer	Yes
Q	Big Integer	No
J	Big Integer	No
Y	Big Integer	Yes

P is the prime, P = JQ + 1. G is the generator G^Q = 1 mod P. Q is the prime factor of P-1. J is the cofactor. Y is the public key (refer to ANSI X9.42).

2.1.7.8 Transparent ECDSA Private Key

If the Key Value Type in the Key Block is *Transparent ECDSA Private Key*, then Key Material is a structure as follows:

Object	Encoding	Required
Key Material	Structure	Yes
Recommended Curve	Enumeration	Yes
D	Big Integer	Yes

D is the private key (refer to NIST FIPS PUB 186-3).

2.1.7.9 Transparent ECDSA Public Key

If the Key Value Type in the Key Block is *Transparent ECDSA Public Key*, then Key Material is a structure as follows:

Object	Encoding	Required
Key Material	Structure	Yes
Recommended Curve	Enumeration	Yes
Q String	Octet String	Yes

Q String is the public key (refer to NIST FIPS PUB 186-3).

2.1.7.10 Transparent ECDH Private Key

If the Key Value Type in the Key Block is *Transparent ECDH Private Key*, then Key Material is a structure as follows:

Object	Encoding	Required
Key Material	Structure	Yes
Recommended Curve	Enumeration	Yes
D	Big Integer	Yes

2.1.7.11 Transparent ECDH Public Key

If the Key Value Type in the Key Block is *Transparent ECDH Public Key*, then Key Material is a structure as follows:

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Object	Encoding	Required
Key Material	Structure	Yes
Recommended Curve	Enumeration	Yes
Q String	Octet String	Yes

2.1.8 Template-Attribute Structures

These structures are used in various operations to provide the desired attribute values and/or template names in the request and to return the actual attribute values in the response.

The *Template-Attribute*, *Common Template-Attribute*, *Private Key Template-Attribute*, and *Public Key Template-Attribute* structures are defined identically as follows:

Object	Encoding	Required
Template-Attribute, Common Template-Attribute, Private Key Template-Attribute, Public Key Template-Attribute	Structure	Yes
Name	Structure, see Section 3.2	No, May be repeated.
Attribute	Attribute Object, see Section 2.1.1	No, May be repeated

Name is the Name attribute of the Template object defined in Section 2.2.6 .

2.2 Managed Objects

Managed Objects are objects that are the subjects of key management operations, which are described in Sections 4 and 5. *Managed Cryptographic Objects* are the subset of Managed Objects that contain cryptographic material, e.g. certificates, keys, and secret data.

2.2.1 Certificate

A Managed Cryptographic Object, which is a digital certificate, such as an encoded X.509 certificate.

Object	Encoding	Required
Certificate	Structure	Yes
Certificate Type	Enumeration	Yes
Certificate Value	Octet String	Yes

2.2.2 Symmetric Key

A Managed Cryptographic Object, which is a symmetric key.

Object	Encoding	Required
Symmetric Key	Structure	Yes
Key Block	Structure	Yes

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2.2.3 Public Key

A Managed Cryptographic Object, which is the public portion of an asymmetric key pair. This is a "raw" public key, not a certificate.

Object	Encoding	Required
Public Key	Structure	Yes
Key Block	Structure	Yes

2.2.4 Private Key

A Managed Cryptographic Object, which is a the private portion of an asymmetric key pair.

Object	Encoding	Required
Private Key	Structure	Yes
Key Block	Structure	Yes

2.2.5 Split Key

A Managed Cryptographic Object, which is a split key. A split key is a secret, usually a symmetric key or a private key that has been split into a number of parts, each of which can then be distributed to several key holders, for additional security. The *Split Key Parts* field contains the total number of parts, and the *Split Key Threshold* field contains the minimum number of parts needed to reconstruct the entire key. The *Key Part Identifier* indicates which key part is contained in the cryptographic object, and must be at least 1 and less than or equal to Split Key Parts.

Object	Encoding	Required
Split Key	Structure	Yes
Split Key Parts	Integer	Yes
Key Part Identifier	Integer	Yes
Split Key Threshold	Integer	Yes
Split Key Method	Enumeration	Yes
Prime Field Size	Big Integer	No, required only if Split Key Method is Polynomial Sharing Prime Field.
Key Block	Structure	Yes

There are three *Split Key Methods* for secret sharing: the first one is based on XOR and the other two are based on polynomial secret sharing, according to [Adi Shamir, "How to share a secret", Communications of the ACM, vol. 22, no. 11, pp. 612-613. Let *L* be the minimum number of bits needed to represent all values of the secret.

- When the Split Key Method is XOR, the Key Material in the Key Value of the Key Block is of length *L* bits. The number of split keys is Split Key Parts (identical to Split Key Threshold), and the secret is reconstructed by XOR'ing all of the parts.
- When the Split Key Method is Polynomial Sharing Prime Field, secret sharing is performed in the field GF(*Prime Field Size*), represented as integers, where Prime Field Size is a prime bigger than 2^L.
- When the Split Key Method is Polynomial Sharing GF(2^{16}), secret sharing is performed in the field GF(2^{16}). The Key Material in the Key Value of the Key Block is a bit string of length *L*, and when *L* is bigger than 2^{16}, then secret sharing is applied piecewise in pieces of 16 bits each. The Key

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Material in the Key Value of the Key Block is the concatenation of the corresponding shares of all pieces of the secret.

Secret sharing is performed in the field GF(2^{16}), which is represented as an algebraic extension of GF(2^8):

GF(2^{16}) ≈ GF(2^8) [y]/(y^2+y+m), where m is defined later.

An element of this field then consists of a linear combination $uy + v$, where u and v are elements of the smaller field GF(2^8).

The representation of field elements and the notation in this section rely on FIPS PUB 197, Sections 3 and 4. The field GF(2^8) is as described in FIPS PUB 197,

GF(2^8) ≈ GF(2) [x]/($x^8+x^4+x^3+x+1$).

An element of GF(2^8) is represented as an octet. Addition and subtraction in GF(2^8) can be performed as a bitwise XOR of the octets. Multiplication and inversion are more complex: see FIPS PUB 197 Section 4.1 and 4.2 for details.

An element of GF(2^{16}) is represented as a pair of octets (u, v). The element m is given by

$m = x^5+x^4+x^3+x,$

which is represented by the octet 0x3A (or {3A} in notation according to FIPS PUB 197).

Addition and subtraction in GF(2^{16}) both correspond to simply XORing the octets. The product of two elements $ry + s$ and $uy + v$ is given by

$(ry + s)(uy + v) = ((r + s)(u + v) + sv)y + (ru + svm).$

The inverse of an element $uy + v$ is given by

$(uy + v)^{-1} = ud^{-1}y + (u + v)d^{-1}$ where $d = (u + v)v + mu^2$

2.2.6 Template

A Template is a named Managed Object containing the client-settable attributes of a Managed Cryptographic Object. It is essentially a stored, named list of attributes. A Template is used to specify the attributes of a new Managed Cryptographic Object in various operations. It is intended to be used to specify the cryptographic attributes of new objects in a standardized or convenient way. None of the client-settable attributes specified in a Template except the Name attribute apply to the template object itself, but instead apply to any object created using the Template.

The Template may be the subject of the Register, Locate, Get, Get Attributes, Get Attribute List, Add Attribute, Modify Attribute, Delete Attribute, and Destroy operations.

An attribute specified in a Template is applicable either to the Template itself or to objects created using the Template.

Attributes applicable to the Template itself are: Unique Identifier, Object Type, Name, Initial Date, Archive Date, and Last Changed Date.

Other attributes that may be specified in a Template are applicable to objects created using the Template and include:

- Cryptographic Algorithm
- Cryptographic Length
- Cryptographic Parameters
- Operation Policy Name
- Cryptographic Usage Mask
- Usage Limits

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- Activation Date
- Process Start Date
- Protect Stop Date
- Deactivation Date
- Object Group
- Application Specific Identification
- Contact Information
- Custom Attribute

Object	Encoding	Required
Template	Structure	Yes
Attribute	Attribute Object, see Section 2.1.1	Yes. May be repeated.

2.2.7 Secret Data

A Managed Cryptographic Object containing a shared secret value that is not a key or certificate, e.g., a password. The Key Block of the *Secret Data* object contains a (possibly wrapped) Key Value of the Opaque type.

Object	Encoding	Required
Secret Data	Structure	Yes
Secret Data Type	Enumeration	Yes
Key Block	Structure	Yes

2.2.8 Opaque Object

A Managed Object that the key management server may not be able to interpret, but will store. The context information for this object can be stored and retrieved using Custom Attributes.

Object	Encoding	Required
Opaque Object	Structure	Yes
Opaque Data Type	Enumeration	Yes
Opaque Data Value	Octet String	Yes

3 Attributes

The following subsections describe the attributes that are associated with Managed Objects. These attributes may be obtained by a client from the server using the Get Attribute operation. Some attributes may be set by the Add Attribute operation or updated by the Modify Attribute operation, and some may be deleted by the Delete Attribute operation if they no longer apply to the Managed Object.

When attributes are returned by the server, e.g. via a Get Attributes operation, the returned attribute value may differ depending on the client. For example, the Cryptographic Usage Mask value may be different for different clients, depending on the policy of the server. Similarly, when a client modifies an attribute, this is merely a mechanism for sending information to the server. The server may store the attribute as received, or modify the attribute before saving it, or combine it with information from other sources, or merely use it as advice on how to modify its internal knowledge of the cryptographic object. The choice depends on server functionality, policy, and the kind of attribute being modified.

The attribute name contained in the first row of the Object column of the first table in each subsection is the canonical name used when managing attributes using the Get Attributes, Get Attribute List, Add Attribute, Modify Attribute, and Delete Attribute operations.

The second table in each subsection lists certain attribute characteristics, such as “Must always have a value”. The “When implicitly set” characteristic indicates which operations (other than operations that manage attributes) can implicitly result in adding or modifying the attribute of the object. They can be object(s) on which the operation is performed or object(s) created as a result of the operation. Implicit attribute changes occur even if the attribute is not specified in the operation request itself.

3.1 Unique Identifier

The *Unique Identifier* is generated by the key management system to uniquely identify a Managed Object. It is only required to be unique within the identifier space managed by a single key management system, however it is recommended that this identifier be globally unique, to allow for key management domain export of such objects. This attribute is assigned by the key management system at creation or registration time, and may never be changed or deleted by any entity at any time.

Object	Encoding	Required
Unique Identifier	Text String	Yes

Must always have a value	Yes
Initially set by	Server
Modifiable by server	No
Modifiable by client	No
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Create, Create Key Pair, Register, Derive Key, Certify, Re-certify, Re-key
Applies to Object Types	All Objects

3.2 Name

The *Name* attribute is used to identify and locate the object, assigned by the client, and that can be intepreted by humans. The key management system may specify rules for valid names which may be created by the client. Clients will be informed of such rules by a mechanism which is not specified here. Names must be unique within a given key management domain, but are not required to be globally unique.

Object	Encoding	Required
Name	Structure	Yes
Name Value	Text String	Yes
Name Type	Enumeration	Yes

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Must always have a value	No
Initially set by	Client
Modifiable by server	Yes
Modifiable by client	Yes
Deletable by client	Yes
Multiple instances permitted	Yes
When implicitly set	Re-key, Re-certify
Applies to Object Types	All Objects

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3.3 Object Type

The type of a Managed Object, e.g. public key, private key, symmetric key, etc. This attribute is set by the server when the object is created or registered and is never changed.

Object	Encoding	Required
Object Type	Enumeration	Yes

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Must always have a value	Yes
Initially set by	Server
Modifiable by server	No
Modifiable by client	No
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Create, Create Key Pair, Register, Derive Key, Certify, Re-certify, Re-key
Applies to Object Types	All Objects

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3.4 Cryptographic Algorithm

The cryptographic algorithm used by the object, e.g. RSA, DSA, DES, 3DES, AES, etc. This attribute is set by the server when the object is created or registered and is never changed.

Object	Encoding	Required
Cryptographic Algorithm	Enumeration	Yes

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Must always have a value	Yes
Initially set by	Server
Modifiable by server	No
Modifiable by client	No
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Create, Create Key Pair, Register, Derive Key, Re-key
Applies to Object Types	Keys, Certificates, Templates

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3.5 Cryptographic Length

Cryptographic Length is the length in bits of the cleartext cryptographic key material of the Managed Cryptographic Object. This attribute is set by the server when the object is created or registered, and is never changed.

Object	Encoding	Required
Cryptographic Length	Integer	Yes

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Must always have a value	Yes
Initially set by	Server
Modifiable by server	No
Modifiable by client	No
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Create, Create Key Pair, Register, Derive Key, Re-key
Applies to Object Types	Keys, Certificates, Templates

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3.6 Cryptographic Parameters

The *Cryptographic Parameters* attribute is a structure that contains a set of optional fields that describe certain cryptographic parameters to be used when performing cryptographic operations using the object. Specific fields may only pertain to certain types of Managed Cryptographic Objects.

Object	Encoding	Required
Cryptographic Parameters	Structure	Yes
Block Cipher Mode	Enumeration	No
Padding Method	Enumeration	No
Hashing Algorithm	Enumeration	No
Role Type	Enumeration	No

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Must always have a value	No
Initially set by	Client
Modifiable by server	No
Modifiable by client	Yes
Deletable by client	Yes
Multiple instances permitted	Yes
When implicitly set	Re-key, Re-certify
Applies to Object Types	Keys, Certificates, Templates

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Role Types are defined as follows:

ZMK – Shared key to allow transfer of subordinate keys between two entities
ZPK – Shared key to allow transfer of PINs between two entities
MAC – MAC key, specifically X9.9/19 retail MAC
CVK – Key for generating/verifying 3-digit VISA/Mastercard signature strip codes (CVV/CVC) CSC – Key for generating/verifying 4-digit American Express Card Security Codes
PVKIBM – Derivation key for derived PINs checked with the IBM offset method
PVKPVV – Verification key for random PINs checked with the PVV method
MKCVC – Master key for dynamic CVC calculations MKSMI – Master key for smart card secure messaging integrity
MKSMC – Master key for smart card secure messaging confidentiality
MKIDN – Master key for Card Dynamic Number
MKAC – Master key for Chip card cryptogram
MKCAP – Master key for Cardholder Authentication Programme BDK – Base derivation key for DUKPT

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3.7 Certificate Type

The type of a certificate, e.g. X.509, PGP, etc. This value is set by the server when the certificate is created or registered and is never changed.

Object	Encoding	Required
Certificate Type	Enumeration	Yes

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Must always have a value	Yes
Initially set by	Server
Modifiable by server	No
Modifiable by client	No
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Register, Certify, Re-certify
Applies to Object Types	Certificates

3.8 Certificate Issuer

An identification of a certificate, containing the Issuer Distinguished Name (from the Issuer field of the certificate) and the Certificate Serial Number (from the Serial Number field of the certificate). This value is set by the server when the certificate is created or registered and is never changed.

Object	Encoding	Required
Certificate Issuer	Structure	Yes
Issuer	Text String	Yes
Serial Number	Text String	Yes (for X.509 certificates) / No (for PGP certificates since they don't contain a serial number)

Must always have a value	Yes
Initially set by	Server
Modifiable by server	No
Modifiable by client	No
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Register, Certify, Re-certify
Applies to Object Types	Certificates

3.9 Certificate Subject

Identifies the subject of a certificate, containing the Subject Distinguished Name (from the Subject field of the certificate). It may optionally include one or more alternative names (e.g. email address, IP address, DNS name) for the subject of the certificate (from the Subject Alternative Name extension within the certificate). These values are set by the server when the certificate is created or registered and are not changed until the certificate is renewed.

It is possible to issue an X.509 certificate where the subject field is left blank as long as the Subject Alternative Name extension is included in the certificate and is marked *CRITICAL*. Therefore an empty string is an acceptable value for the Certificate Subject Distinguished Name.

Object	Encoding	Required
Certificate Subject	Structure	Yes
Certificate Subject Distinguished Name	Text String	Yes

Certificate Subject Alternative Name	Text String	No, May be repeated

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Must always have a value	Yes
Initially set by	Server
Modifiable by server	No
Modifiable by client	No
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Register, Certify, Re-certify
Applies to Object Types	Certificates

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3.10 Digest

A digest of the key or secret data (digest of the Key Material), certificate (digest of the Certificate Value), or opaque object (digest of the Opaque Data Value). Multiple digests may be calculated using different algorithms. The mandatory digest is computed with the SHA-256 hashing algorithm, the server can store additional optional digests. The digest(s) are static and generated by the server when the object is created or registered.

Object	Encoding	Required
Digest	Structure	Yes
Hashing Algorithm	Enumeration	Yes
Digest Value	Octet String	Yes

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Must always have a value	Yes
Initially set by	Server
Modifiable by server	Yes
Modifiable by client	No
Deletable by client	No
Multiple instances permitted	Yes
When implicitly set	Create, Create Key Pair, Register, Derive Key, Certify, Re-certify, Re-key
Applies to Object Types	All Cryptographic Objects, Opaque Objects

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3.11 Operation Policy Name

An indication of what entities may perform which key management operations on the object. The contents of the *Operation Policy Name* attribute is the name of a policy object known to the key management system and therefore server dependent. The named policy objects are created and managed using mechanisms outside the scope of the protocol. The policies determine who may perform specified operations on the object, and which of the objects' attributes may be modified, or deleted, and by whom. It is expected that the Operation Policy Name attribute will be set when operations such as Create or

Register are executed. It is set either explicitly or via some default set by the server, and will then apply to all subsequent operations on the object.

Object	Encoding	Required
Operation Policy Name	Text String	Yes

Must always have a value	No
Initially set by	Server or Client
Modifiable by server	Yes
Modifiable by client	No
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Create, Create Key Pair, Register, Derive Key, Certify, Re-certify, Re-key
Applies to Object Types	All Objects

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3.11.1 Operations outside of operation policy control

Some of the operations should be allowed to any client at any time, without respect to operation policy. These operations are:

- Create
- Create Key Pair
- Register
- Certify
- Validate
- Query
- Cancel
- Poll

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3.11.2 Default Operation Policy

A key management system implementation should implement at least one named operation policy, which is used for objects where the *Operation Policy* attribute is not specified by the Client in a *Create* or *Register* operation, or in a template specified in these operations. This policy is named *default*. It specifies the following rules for operations on objects created or registered with this policy, depending on the object type.

3.11.2.1 Default Operation Policy for Secret Objects

This policy applies to Symmetric Keys, Private Keys, Split Keys, Secret Data, and Opaque Objects.

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Default Operation Policy for Secret Objects	
Operation	**Policy**
Re-Key	Allowed to creator only
Derive Key	Allowed to creator only
Locate	Allowed to creator only
Check	Allowed to creator only
Get	Allowed to creator only
Get Attributes	Allowed to creator only
Get Attribute List	Allowed to creator only
Add Attribute	Allowed to creator only
Modify Attribute	Allowed to creator only
Delete Attribute	Allowed to creator only
Obtain Lease	Allowed to creator only
Get Usage Allocation	Allowed to creator only
Activate	Allowed to creator only
Revoke	Allowed to creator only
Destroy	Allowed to creator only
Archive	Allowed to creator only
Recover	Allowed to creator only

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For mandatory profiles, the creator must be the transport-layer identification (see Usage Guide) provided at the Create or Register operation time.

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3.11.2.2 Default Operation Policy for Certificates and Public Key Objects

This policy applies to Certificates and Public Keys.

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Default Operation Policy for Certificates and Public Key Objects	
Operation	**Policy**
Certify	Allowed to creator only
Re-certify	Allowed to creator only
Locate	Allowed to all
Check	Allowed to all
Get	Allowed to all
Get Attributes	Allowed to all
Get Attribute List	Allowed to all
Add Attribute	Allowed to creator only
Modify Attribute	Allowed to creator only
Delete Attribute	Allowed to creator only
Obtain Lease	Allowed to all

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Activate	Allowed to creator only
Revoke	Allowed to creator only
Destroy	Allowed to creator only
Archive	Allowed to creator only
Recover	Allowed to creator only

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3.11.2.3 Default Operation Policy for Template Objects

The operation policy specified as an attribute in the *Create* operation for a template object is the operation policy used for objects that will be created using that template, and is not the policy used to control operations on the template itself. There is no mechanism provided for specifying a policy used to control operations on template objects, so the default policy for template objects themselves is always used for templates created by clients using the *Register* operation to create template objects.

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Default Operation Policy for Private Template Objects	
Operation	**Policy**
Locate	Allowed to creator only
Get	Allowed to creator only
Get Attributes	Allowed to creator only
Get Attribute List	Allowed to creator only
Add Attribute	Allowed to creator only
Modify Attribute	Allowed to creator only
Delete Attribute	Allowed to creator only
Destroy	Allowed to creator only

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In addition to private template objects, which are controlled by the above policy which can be created by clients or the server, publicly known and usable templates may be created and managed by the server, with a different default policy for these template objects.

Default Operation Policy for Public Template Objects	
Operation	**Policy**
Locate	Allowed to all
Get	Allowed to all
Get Attributes	Allowed to all
Get Attribute List	Allowed to all
Add Attribute	Disallowed to all
Modify Attribute	Disallowed to all
Delete Attribute	Disallowed to all
Destroy	Disallowed to all

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3.12 Cryptographic Usage Mask

The *Cryptographic Usage Mask* defines the cryptographic usage of a key. This is a bit mask which indicates to the client which cryptographic functions may be performed using the key.

- Sign
- Verify

- Encrypt
- Decrypt
- Wrap Key
- Unwrap Key
- Export
- MAC Generate
- MAC Verify
- Derive Key
- Content Commitment
- Key Agreement
- Certificate Sign
- CRL Sign

This list takes into consideration values which may appear in the Key Usage extension in an X.509 certificate. However, the list does not consider the more fine-grained usages which may appear in the Extended Key Usage extension.

X.509 Key Usage values shall be mapped to Cryptographic Usage Mask values in the following manner:

X.509 Key Usage to Cryptographic Usage Mask Mapping	
X.509 Key Usage Value	**Cryptographic Usage Mask Value**
digitalSignature	Sign and Verify
contentCommitment	Content Commitment (Non Repudiation)
keyEncipherment	Wrap Key and Unwrap Key
dataEncipherment	Encrypt and Decrypt
keyAgreement	Key Agreement
keyCertSign	Certificate Sign
cRLSign	CRL Sign
encipherOnly	Encrypt
decipherOnly	Decrypt

The Content Commitment (Non-Repudiation) Cryptographic Usage Mask value shall be set for public keys used to verify digital signatures for non-repudiation purposes (to protect against a signing entity denying an action). Public keys used to verify digital signatures for other purposes (such as authentication and integrity) shall be set with the Sign, Verify or both Cryptographic Usage Mask values.

Object	Encoding	Required
Cryptographic Usage Mask	Integer	Yes

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Must always have a value	Yes
Initially set by	Server or Client
Modifiable by server	Yes
Modifiable by client	No
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Create, Create Key Pair, Register, Derive Key, Certify, Re-certify, Re-key
Applies to Object Types	All Cryptographic Objects, Templates

3.13 Lease Time

The *Lease Time* attribute defines a time interval for a Managed Cryptographic Object that indicates how long a client should use the object. This attribute always holds the initial value of a lease, and not the actual remaining time. Note that once the lease expires, the client must renew the lease by calling Obtain Lease. A server should store in this attribute the maximum Lease Time it is willing to serve and a client will obtain lease times (with Obtain Lease) which are less than, or equal to the maximum Lease Time. This attribute is read-only for clients. It can be modified by the server only.

Object	Encoding	Required
Lease Time	Interval	Yes

Must always have a value	No
Initially set by	Server
Modifiable by server	Yes
Modifiable by client	No
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Create, Create Key Pair, Register, Derive Key, Certify, Re-certify, Re-key
Applies to Object Types	All Cryptographic Objects

3.14 Usage Limits

This is a mechanism for limiting the usage of a Managed Cryptographic Object. It only applies to Managed Cryptographic Objects that can be used for protection purposes (symmetric keys, private keys, public keys, etc.), and it must only reflect their usage for protection (encryption, signing, etc.). This attribute may not exist for all Managed Cryptographic Objects, since some objects may be used without limit, depending on client/server policies. Usage for process purposes (decryption, verification, etc.) is not limited. The attribute has four fields for two different types of limits. Exactly one of these two types (either bytes or objects) shall be present. These limits are:

- *Usage Limits Total Bytes* – the total number of bytes allowed to be protected. This is the total value for the entire life of the object, and is never changed once the object begins to be used for protection purposes.

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- *Usage Limits Byte Count* – the currently remaining number of bytes allowed to be protected.
- *Usage Limits Total Objects* – the total number of objects allowed to be protected. This is the total value for the entire life of the object, and is never changed once the object begins to be used for protection purposes.
- *Usage Limits Object Count* – the currently remaining number of objects allowed to be protected.

When the attribute is initially set, usually during object creation or registration, the values set are the Total values allowed for the useful life of the object. The count values must be ignored by the server if the attribute is specified in a operation that creates a new object. Changes made via the Modify Attribute operation reflect corrections to these Total values, but they cannot be changed once the count values have changed by a Get Usage Allocation operation. The count values cannot be set or modified by the client via the Add Attribute or Modify Attribute operations.

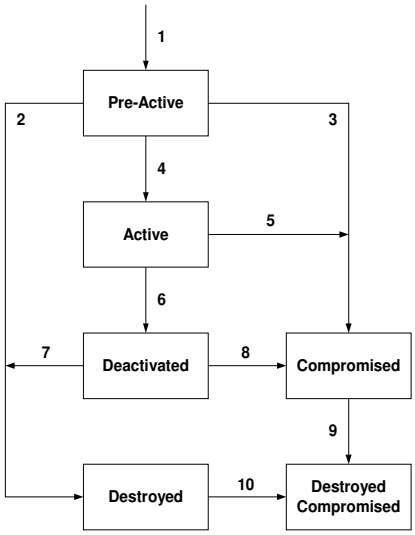
Object	Encoding	Required
Usage Limits	Structure	Yes
Usage Limits Total Bytes	Big Integer	No. Must be present if Usage Limits Byte Count is present
Usage Limits Byte Count	Big Integer	No. May only be present if Usage Limits Object Count is not present
Usage Limits Total Objects	Big Integer	No. Must be present if Usage Limits Object Count is present
Usage Limits Object Count	Big Integer	No. May only be present if Usage Limits Byte Count is not present

Must always have a value	No
Initially set by	Server or Client
Modifiable by server	Yes
Modifiable by client	Yes
Deletable by client	Yes
Multiple instances permitted	No
When implicitly set	Create, Create Key Pair, Register, Derive Key, Re-key, Get Usage Allocation
Applies to Object Types	Keys, Templates

3.15 State

This attribute is an indication of the state of an object as known to the key management server. The state may not be changed by using the Modify Attribute operation on this attribute. The state may only be changed by the server as a side effect of other operations or other server processes. An object may be in one of the following states at any given time. (Note: These states correspond to those described in NIST Special Publication 800-57).

- *Pre-Active*: The object exists but is not yet usable for any cryptographic purpose.
- *Active*: The object may be used for all cryptographic purposes which are allowed by its Cryptographic Usage Mask attribute.
- *Deactivated*: The object may not be used for protection purpose, e.g. encryption or signing, but, if permitted by the Cryptographic Usage Mask attribute, may be used for process purposes, e.g. decryption or verification, but only under extraordinary circumstances and when special permission is granted.
- *Compromised*: The object may have been compromised, and may only be used for process purposes in a client that is trusted to handle compromised cryptographic objects.
- *Destroyed*: The object is no longer usable for any purpose.
- *Destroyed Compromised*: The object is no longer usable for any purpose; however its compromised status may be retained for audit or security purposes.



State transitions occur as follows:

1. The transition from a non-existent key to the Pre-Active state is determined by the creation of the object. When an object is created or registered, it automatically goes from non-existent to Pre-Active. If, however, the operation that creates or registers the object contains an Activation Date that has already occurred, the state immediately transitions to Active. In this case, the server may set the Activation Date attribute to the time when the operation is received, depending on server policy. If the operation contains an Activation Date attribute in the future, or contains no Activation Date, the Cryptographic Object is initialized in the key management system in the Pre-Active state.
2. The transition from Pre-Active to Compromised is performed by a client issuing a Revoke operation with a Revocation Reason of Compromised.
3. The transition from Pre-Active to Active can occur in one of three ways:
   - The object has an Activation Date in the future. At the time that the Activation Date is reached, the server changes the state to Active.
   - A client issues a Modify Attribute operation, modifying the Activation Date to a date in the past, or the current date. In this case, the server may set the Activation Date attribute to the time when the operation that created or registered the object was received, depending on server policy.
   - A client issues an Activate operation on the object. The server will set the Activation Date to the time the Activate operation is received.
4. The transition from Active to Compromised is performed by a client issuing a Revoke operation with a Revocation Reason of Compromised.
5. The transition from Active to Deactivated can occur in one of three ways:
   - The object's Deactivation Date is reached. The server may change the state to Deactivated.
   - A client issues a Revoke operation, with a Revocation Reason other than Compromised.

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- The client issues a Modify Attribute operation, modifying the Deactivation Date to a date in the past, or the current date. In this case, the server may set the Deactivation Date attribute to the date in the past or the current date, depending on server policy.

6. The transition from Deactivated to Destroyed is requested by a client issuing a Destroy operation. The server will destroy the object when and if server policy dictates.
7. The transition from Deactivated to Compromised is performed by a client issuing a Revoke operation with a Revocation Reason of Compromised.
8. The transition from Compromised to Destroyed Compromised is requested by a client issuing a Destroy operation. The server will destroy the object when and if server policy dictates.
9. The transition from Destroyed to Destroyed Compromised is performed by a client issuing a *R*evoke operation with a Revocation Reason of Compromised.

Only the transitions described above are permitted.

Object	Encoding	Required
State	Enumeration	Yes

Must always have a value	Yes
Initially set by	Server
Modifiable by server	Yes
Modifiable by client	No
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Create, Create Key Pair, Register, Derive Key, Activate, Revoke, Destroy, Certify, Re-certify, Re-key
Applies to Object Types	All Cryptographic Objects

3.16 Initial Date

The date and time when the Managed Object was first created or registered at the server. This time corresponds to state transition 1 (see Section 3.15). This attribute is set by the server when the object is created or registered, and is never changed. This attribute is also set for non-cryptographic objects (e.g. templates) when they are first registered with the server.

Object	Encoding	Required
Initial Date	Date-Time	Yes

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Must always have a value	Yes
Initially set by	Server
Modifiable by server	No
Modifiable by client	No
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Create, Create Key Pair, Register, Derive Key, Certify, Re-certify, Re-key
Applies to Object Types	All Objects

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3.17 Activation Date

The date and time when the Managed Cryptographic Object may begin to be used. This time corresponds to state transition 4 (see Section 3.15). The object may not be used for any cryptographic purpose before the *Activation Date* has been reached. Once the state transition has occurred, this attribute may no longer be modified by the server or client. If a client attempts to set this value to a time in the past, the server may set it to the current time instead, depending on server policy.

Object	Encoding	Required
Activation Date	Date-Time	Yes

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Must always have a value	No
Initially set by	Server or Client
Modifiable by server	Yes
Modifiable by client	Yes
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Create, Create Key Pair, Register, Derive Key, Activate Certify, Re-certify, Re-key
Applies to Object Types	All Cryptographic Objects, Templates

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3.18 Process Start Date

The date and time when a Managed Symmetric Key Object may begin to be used for process purposes, e.g. decryption or unwrapping, depending on the value of its Cryptographic Usage Mask attribute. The object may not be used for these cryptographic purposes before the *Process Start Date* has been reached. This value may be equal to, but may not precede, the Activation Date. Once the Process Start Date has occurred, this attribute may no longer be modified by the server or the client. If a client attempts to set this value to a time in the past, the server may set it to the current time instead, depending on server policy.

Object	Encoding	Required
Process Start Date	Date-Time	Yes

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Must always have a value	No
Initially set by	Server or Client
Modifiable by server	Yes
Modifiable by client	Yes
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Create, Register, Derive Key, Re-key
Applies to Object Types	Symmetric Keys, Split Keys of symmetric keys, Templates

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3.19 Protect Stop Date

The date and time when a Managed Symmetric Key Object may no longer be used for protect purposes, e.g. using encryption or wrapping, depending on the value of its Cryptographic Usage Mask attribute. This value may be equal to, but may not be later than the Deactivation Date. Once the *Protect Stop Date* has occurred, this attribute may no longer be modified by the server or the client. If a client attempts to set this value to a time in the past, the server may set it to the current time instead, depending on server policy.

Object	Encoding	Required
Protect Stop Date	Date-Time	Yes

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Must always have a value	No
Initially set by	Server or Client
Modifiable by server	Yes
Modifiable by client	Yes
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Create, Register, Derive Key, Re-key
Applies to Object Types	Symmetric Keys, Split Keys of symmetric keys, Templates

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3.20 Deactivation Date

The date and time when the Managed Cryptographic Object may no longer be used for any purpose, except for decryption, signature verification, or unwrapping, but only under extraordinary circumstances and when special permission is granted. This time corresponds to state transition 6 (see Section 3.15). Once this transition has occurred, this attribute may no longer be modified by the server or client. If a client attempts to set this value to a time in the past, the server may set it to the current time instead, depending on server policy.

Object	Encoding	Required
Deactivation Date	Date-Time	Yes

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Must always have a value	No
Initially set by	Server or Client
Modifiable by server	Yes
Modifiable by client	Yes
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Create, Create Key Pair, Register, Derive Key, Revoke Certify, Re-certify, Re-key
Applies to Object Types	All Cryptographic Objects, Templates

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3.21 Destroy Date

The date and time when the Managed Object was destroyed. This time corresponds to state transitions 2, 7, or 9 (see Section 3.15). This value is set by the server when the object is destroyed due to the reception of a Destroy operation, or due to server policy or out-of-band administrative action.

Object	Encoding	Required
Destroy Date	Date-Time	Yes

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Must always have a value	No
Initially set by	Server
Modifiable by server	No
Modifiable by client	No
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Destroy
Applies to Object Types	All Cryptographic Objects, Opaque Objects

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3.22 Compromise Occurrence Date

The date and time when the Managed Cryptographic Object was first believed to be compromised. If it is not possible to estimate when the compromise occurred, this value should be set to the Initial Date for the object.

Object	Encoding	Required
Compromise Occurrence Date	Date-Time	Yes

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Must always have a value	No
Initially set by	Server
Modifiable by server	No
Modifiable by client	No
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Revoke
Applies to Object Types	All Cryptographic Objects, Opaque Object

3.23 Compromise Date

The date and time when the Managed Cryptographic Object is entered into the compromised state. This time corresponds to state transitions 3, 5, 8, or 10 (see Section 3.15). This time indicates when the key management system was made aware of the compromise, not necessarily when the compromise occurred. This attribute is set by the server when it receives a Revoke operation with a Revocation Reason of Compromised, or due to server policy or out-of-band administrative action.

Object	Encoding	Required
Compromise Date	Date-Time	Yes

Must always have a value	No
Initially set by	Server
Modifiable by server	No
Modifiable by client	No
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Revoke
Applies to Object Types	All Cryptographic Objects, Opaque Object

3.24 Revocation Reason

An indication of why the Managed Cryptographic Object was revoked, e.g. “compromised”, “expired”, “no longer used”, etc. This attribute is only changed by the server as a side effect of the Revoke Operation.

The *Revocation Message* is an optional field which is used exclusively for audit trail/logging purposes and may contain additional information about why the object was revoked, for example “Laptop stolen”, or “Machine decommissioned”.

Object	Encoding	Required
Revocation Reason	Structure	Yes
Revocation Reason Code	Enumeration	Yes
Revocation Message	Text String	No

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Must always have a value	No
Initially set by	Server
Modifiable by server	Yes
Modifiable by client	No
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Revoke
Applies to Object Types	All Cryptographic Objects, Opaque Object

3.25 Archive Date

The date and time when the Managed Object was placed in archival storage. This value is set by the server as a side effect of the Archive operation. This attribute is deleted whenever a Recover operation is performed.

Object	Encoding	Required
Archive Date	Date-Time	Yes

Must always have a value	No
Initially set by	Server
Modifiable by server	Yes
Modifiable by client	No
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Archive
Applies to Object Types	All Objects

3.26 Object Group

An object may be part of a group of objects. An object may belong to more than one group. To assign an object to a group, the group name should be set into this attribute.

Object	Encoding	Required
Object Group	Text String	Yes

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Must always have a value	No
Initially set by	Client or Server
Modifiable by server	Yes
Modifiable by client	Yes
Deletable by client	Yes
Multiple instances permitted	Yes
When implicitly set	Create, Create Key Pair, Register, Derive Key, Certify, Re-certify, Re-key
Applies to Object Types	All Objects

3.27 Link

A link from a Managed Cryptographic Object to another, closely related target Managed Cryptographic Object. The link has a type, and the allowed types differ, depending on the Object Type of the Managed Cryptographic Object. The *Linked Object Identifier* identifies the target Managed Cryptographic Object by its Unique Identifier. The link can contain such information as the private key corresponding to a public key; the parent certificate for a certificate in a chain; or for a derived symmetric key, the base key from which it was derived.

Possible values of *Link Type* in accordance with the Object Type of the Managed Cryptographic Object are:

- *Private Key Link*. For a Public Key object: the private key corresponding to the public key
- *Public Key Link*. For a Private Key object: the public key corresponding to the private key. For a Certificate object: the public key certified by the certificate
- *Certificate Link*. For Certificate objects: the parent certificate for a certificate in a certificate chain. For Public Key objects: the corresponding certificate(s), containing the same public key
- *Derivation Base Object Link* for a derived Symmetric Key object: the object(s) from which the current symmetric key was derived
- *Derived Key Link*: the symmetric key(s) that were derived from the current object.
- *Replacement Object Link*. For a Symmetric Key, Private Key, or Public Key object: the key that resulted from the re-key of the current key. For a Certificate object: the certificate that resulted from the re-certify. Note that there can only be one such replacement object.
- *Replaced Object Link*. For a Symmetric Key, Private Key, or Public Key object: the key that was re-keyed to obtain the current key. For a Certificate object: the certificate that was re-certified to obtain the current certificate

The Link attribute should be present for private keys and public keys for which a certificate chain is stored by the server, and for certificates in a certificate chain.

Note that a Managed Object may have multiple instances of the Link attribute. For example, a Private Key may have links to the associated certificate as well as the associated public key. As another example, a Certificate object may have links to both the public key and to the certificate of the certification authority that signed the certificate.

It is also possible that a Managed Object does not have links to associated cryptographic objects. This can occur in cases where the associated key material is not available to the server or client (consider the registration of a CA Signer certificate with a server, where the corresponding private key is held in a different manner).

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Object	Encoding	Required
Link	Structure	Yes
Link Type	Enumeration	Yes
Linked Object Identifier	Text String	Yes

Must always have a value	No
Initially set by	Server
Modifiable by server	Yes
Modifiable by client	Yes
Deletable by client	Yes
Multiple instances permitted	Yes
When implicitly set	Create Key Pair, Derive Key, Certify, Re-certify, Re-key
Applies to Object Types	All Cryptographic Objects

3.28 Application Specific Identification

The *Application Specific Identification* is used to specify the intended use of a Managed Object. It consists of two parts: the application name space that the object will be used with, and an identification specific to that application name space. The application name spaces are arbitrary text strings so that new types of application identifiers can be used without requiring the standard to be updated.

Some examples of application name space and identifier pairs:

- SMIME, 'someuser@company.com'
- SSL, 'some.domain.name'
- Volume Identification, '123343434'
- File Name, 'secret.doc'

The following application names spaces are recommended:

- SMIME
- SSL
- IPSEC
- HTTPS
- PGP
- Volume Identification
- File Name

Other values may be used according to server policy. No extension mechanism is defined or needed, as any text string is allowable.

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Object	Encoding	Required
Application Specific Identification	Structure	Yes
Application Name Space	Text String	Yes
Application Identifier	Text String	Yes

Must always have a value	No
Initially set by	Client
Modifiable by server	No
Modifiable by client	Yes
Deletable by client	Yes
Multiple instances permitted	Yes
When implicitly set	Re-key, Re-certify
Applies to Object Types	All Objects

3.29 Contact Information

The *Contact Information* attribute is optional, and its content is used for contact purposes only. It is not used for policy enforcement. The attribute is set by the client or the server.

Object	Encoding	Required
Contact Information	Text String	Yes

Must always have a value	No
Initially set by	Client or Server
Modifiable by server	Yes
Modifiable by client	Yes
Deletable by client	Yes
Multiple instances permitted	No
When implicitly set	Create, Create Key Pair, Register, Derive Key, Certify, Re-certify, Re-key
Applies to Object Types	All Objects

3.30 Last Changed Date

A meta attribute that contains the date and time of the last change to the contents or attributes of the specified object.

Object	Encoding	Required
Last Changed Date	Date-Time	Yes

Must always have a value	Yes
Initially set by	Server
Modifiable by server	Yes
Modifiable by client	No
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Create, Create Key Pair, Register, Derive Key, Activate, Revoke, Destroy, Archive, Recover, Certify, Re-certify, Re-key, Add Attribute, Modify Attribute, Delete Attribute, Get Usage Allocation
Applies to Object Types	All Objects

3.31 Custom Attribute

A *Custom Attribute* is a client- or server-defined attribute intended for vendor-specific purposes. It is created by the client and not interpreted by the server, or created by the server and either understood or not understood by the client. All custom attributes created by the client must adhere to a naming scheme where the name of the attribute must have a prefix of 'x-', meaning extended. The key management server may create and manage custom attributes which have a prefix of 'y-'. The tag type Custom Attribute cannot identify the particular attribute; hence, such an attribute can only appear in an Attribute Structure with its name as defined in Section 2.1.1 .

Object	Encoding	Required
Custom Attribute	Any data type or structure	Yes. The name of the attribute must start with 'x-' or 'y-'.

Must always have a value	No
Initially set by	Client or Server
Modifiable by server	Yes, for server-created attributes
Modifiable by client	Yes, for client-created attributes
Deletable by client	Yes, for client-created attributes
Multiple instances permitted	Yes
When implicitly set	Create, Create Key Pair, Register, Derive Key, Activate, Revoke, Destroy, Certify, Re-certify, Re-key
Applies to Object Types	All Objects

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4 Client-to-Server Operations

The following subsections describe the operations that may be requested by a key management client. Not all clients have to be capable of issuing all operation requests; however any client that issues a specific request must be capable of understanding the response to the request. All Object Management operations are sent in requests from clients to servers, and in responses from servers to clients. These operations may be combined into a batch, which allows multiple operations to be contained in a single request/response message pair.

A number of the operations whose descriptions follow are affected by a mechanism referred to as the *ID Placeholder.*

The key management server must implement a temporary variable called the ID Placeholder. This value consists of a single Unique Identifier. It is a variable stored inside the server that is only valid and preserved during the execution of a batch of operations. Once the batch of operations has been completed, the ID Placeholder value is discarded and/or invalidated by the server, so that subsequent requests will not find this previous ID Placeholder available.

The ID Placeholder is obtained from the Unique Identifier returned by the Create, Create Pair, Register, Derive Key, Re-Key, Certify, Re-Certify, Locate, and Recover operations. If any of these operations successfully completes and returns a Unique Identifier, then the server must copy this Unique Identifier into the ID Placeholder variable, where it is held until the completion of the operations remaining in the batched request. Subsequent operations in the batched request that need a Unique Identifier may make use of the ID Placeholder. This is indicated by omitting the Unique Identifier field from the request payloads for these operations. This mechanism is only valid if the Batch Error Continuation Option is set to Stop and the Batch Order Option is set to true.

Requests may contain attribute values to be assigned to the object. This information is specified with a Template-Attribute (see Section 2.1.8) that contains zero or more template names and zero or more individual attributes. If more than one template name is specified, and there is a conflict between the single-instance attributes in the templates, the value in the subsequent template takes precedence. If there is a conflict between the single-instance attributes in the request and the single-instance attributes in a specified template, the attribute values in the request take precedence. For multi-value attributes, the union of attribute values is used when the attributes are specified more than once.

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Responses may contain attribute values that have been set differently than specified in the request. This information is specified with a Template-Attribute that contains one or more individual attributes.

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4.1 Create

This operation requests the server to generate a new symmetric key as a Managed Cryptographic Object. This operation is not used to create Template object (see Register operation, Section 4.3).

The request contains information about the type of object being created, and some of the attributes to be assigned to the object, e.g. Cryptographic Algorithm, Cryptographic Length, etc. This information may be specified by the names of Template objects which already exist.

Only on-line Template objects can be specified. Archived objects must first be moved back on-line through a Recover operation before they can be specified.

The response contains the Unique Identifier of the created object. The server must copy the Unique Identifier returned by this operation into the ID Placeholder variable.

Request Payload		
Object	**Required**	**Description**
Object Type	Yes	Determines the type of object to be created
Template-Attribute	Yes	Specifies desired object attributes using templates and/or as individual attributes

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Response Payload		
Object	**Required**	**Description**
Object Type	Yes	Type of object created
Unique Identifier	Yes	The Unique Identifier of the newly created object
Template-Attribute	No	A list of object attributes with values that the key management server chose differently from those specified in the request (either explicitly or via template). Only those attributes that were specified in the request and were set to different values by the server are included here

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720 The following attributes must be included in the Create request, either explicitly, or via specification of a
721 template that contains the attribute.

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Attribute	Required
Cryptographic Algorithm	Yes
Cryptographic Usage Mask	Yes

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722 ## 4.2 Create Key Pair

723 This operation requests the server to generate a new public/private key pair and register the two
724 corresponding new Managed Cryptographic Objects.

725 The request contains attributes to be assigned to the objects, e.g. Cryptographic Algorithm, Cryptographic
726 Length, etc. Attributes and Template Names can be specified for both keys at the same time, by
727 specifying a Common Template-Attribute object in the request. Attributes not common to both keys (e.g.,
728 Name, Cryptographic Usage Mask) may be specified using the Private Key Template-Attribute and Public
729 Key Template-Attribute objects in the request which take precedence over the Common Template-
730 Attribute object.

731 Only on-line Template objects can be specified. Archived objects must first be moved back on-line
732 through a Recover operation before they can be specified.

733 A Link Attribute is automatically created by the server for each object, pointing to the corresponding
734 object. The response contains the Unique Identifiers of both created objects. The ID Placeholder value
735 will be set to the Unique Identifier of the Private Key.

Request Payload		
Object	**Required**	**Description**
Common Template-Attribute	No	Specifies desired attributes in templates and/or as individual attributes that apply to both the Private and Public Key Objects
Private Key Template-Attribute	No	Specifies templates and/or attributes that apply to the Private Key Object. Order of precedence applies
Public Key Template-Attribute	No	Specifies templates and/or attributes that apply to the Public Key Object. Order of precedence applies

For multi-instance attributes, the union of the values found in the templates and attributes of the Common, Private, and Public Key Template-Attribute is used. For single-instance attributes, the order of precedence is as follows:

1. attributes specified explicitly in the Private and Public Key Template-Attribute, then
2. attributes specified via templates in the Private and Public Key Template-Attribute, then
3. attributes specified explicitly in the Common Template-Attribute, then
4. attributes specified via templates in the Common Template-Attribute

If there are multiple templates in the Common, Private, or Public Key Template-Attribute, then the subsequent value of the single-instance attribute takes precedence.

Response Payload		
Object	**Required**	**Description**
Private Key Unique Identifier	Yes	The Unique Identifier of the newly created Private Key object
Public Key Unique Identifier	Yes	The Unique Identifier of the newly created Public Key object
Private Key Template-Attribute	No	A list of attributes, for the Private Key Object, with values that the key management server chose differently from those specified in the request (either explicitly or via template). Only those attributes that were specified in the request and were set to different values by the server are included here
Public Key Template-Attribute	No	A list of attributes, for the Public Key Object, with values that the key management server chose differently from those specified in the request (either explicitly or via template). Only those attributes that were specified in the request and were set to different values by the server are included here

The following attributes must be included and/or must have the same value in the *Create Key Pair* operation, either explicitly, or via specification of a template that contains the attribute.

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Attribute	Required	Must contain the same value for both Private and Public Key
Cryptographic Algorithm	Yes	Yes
Cryptographic Length	Yes	Yes
Cryptographic Usage Mask	Yes	No
Cryptographic Parameters	No	Yes

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4.3 Register

This operation requests the server to register a Managed Object (created by the client or obtained by the client through some other means), allowing the server to manage the object. The arguments in the request are similar to those in the Create operation, but also may contain the object itself, for storage by the server. Optionally, objects which the client does not wish to be stored by the key management system may be omitted from the request, for example, private keys.

The request contains information about the type of object being registered, and some of the attributes to be assigned to the object, e.g. Cryptographic Algorithm, Cryptographic Length, etc. This information may be specified by the use of a Template-Attribute object.

Only on-line Template objects can be specified. Archived objects must first be moved back on-line through a Recover operation before they can be specified.

The response contains the Unique Identifier assigned by the server to the registered object. The server must copy the Unique Identifier returned by this operations into the ID Placeholder variable. The Initial Date attribute of the object is set to the current time.

Request Payload		
Object	**Required**	**Description**
Object Type	Yes	Determines the type of object being registered
Template-Attribute	Yes	Specifies desired object attributes using templates and/or as individual attributes
Certificate, Symmetric Key, Private Key, Public Key, Split Key, Secret Data or Opaque Object	No	The object being registered. The object and attributes may be wrapped. Some objects, e.g. Private Keys, may be omitted from the request

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Response Payload		
Object	**Required**	**Description**
Unique Identifier	Yes	The Unique Identifier of the newly registered object
Template-Attribute	No	A list of object attributes with values that the key management server chose differently from those specified in the request (either explicitly or via template). Only those attributes that were specified in the request and were set to different values by the server are included here

If a Managed Cryptographic Object is registered, the following attributes must be included in the Register request, either explicitly, or via specification of a template that contains the attribute.

Attribute	Required
Cryptographic Algorithm	Yes, may be omitted only if this information is encapsulated in the Key Block. Does not apply to Secret Data. If present, Cryptographic Length below must also be present.
Cryptographic Length	Yes, may be omitted only if this information is encapsulated in the Key Block. Does not apply to Secret Data. If present, Cryptographic Algorithm above must also be present.
Cryptographic Usage Mask	Yes.

4.4 Re-key

This request is used to generate a replacement key for an existing symmetric key. It is analogous to the Create operation, except that many of the attributes of the new key are unchanged from the original key.

As the replacement key takes over the name attribute of the existing key, Re-key should only be performed once on a given key.

The server must copy the Unique Identifier of the replacement key returned by this operation into the ID Placeholder variable.

Only on-line objects can be specified. Archived objects must first be moved back on-line through a Recover operation before they can be specified.

As a result of Re-key, attributes of the existing key are changed similarly to performing a Revoke on that key with a Revocation Reason of Superseded, and the Link attribute is set to point to the replacement key.

If Offset is set, then the times of the new key will be set based on the times of the existing key (if such times exist) as follows:

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Deleted: When registering a new Template, the attributes that may be included in the request are specified in Section 2.2.6 (note however that the Name attribute may not be specified). For all other object types that can be

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Attribute in Existing Key	Attribute in New Key
Initial Date (IT_1)	Initial Date (IT_2) > IT_1
Activation Date (AT_1)	Activation Date (AT_2) = IT_2 + *Offset*
Process Start Date (CT_1)	Process Start Date = $CT_1+(AT_2- AT_1)$
Protect Stop Date (TT_1)	Protect Stop Date = $TT_1+(AT_2- AT_1)$
Deactivation Date (DT_1)	Deactivation Date = $DT_1+(AT_2- AT_1)$

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779 Attributes that are not copied from the existing key and are handled in a specific way are:

Attribute	Action
Initial Date	Set to current time
Destroy Date	Not set
Compromise Occurrence Date	Not set
Compromise Date	Not set
Revocation Reason	Not set
Unique Identifier	New value generated
Usage Limits	The Total Bytes/Total Objects value is copied from the existing key, while the Byte Count/Object Count values are set to the Total Bytes/Total Objects.
Name	Set to the name(s) of the existing key; all name attributes of the existing key are removed.
State	Set based on attributes
Digest	Recomputed from the new key value
Link	Set to point to the existing key as the replaced key
Last Change Date	Set to current time

780

Request Payload		
Object	**Required**	**Description**
Unique Identifier	No	Determines the Symmetric Key being re-keyed. If omitted, the ID Placeholder is substituted by the server
Offset	No	An Interval object indicating the difference between the Initialization Time of the new key and the Activation Date of the new key
Template-Attribute	No	Specifies desired object attributes using templates and/or as individual attributes

781

Response Payload		
Object	**Required**	**Description**
Unique Identifier	Yes	The Unique Identifier of the new Symmetric Key
Template-Attribute	No	A list of object attributes with values that the key management server chose differently from those specified in the request (either explicitly or via template). Only those attributes that were specified in the request and were set to different values by the server are included here

782 4.5 Derive Key

783 This request is used to derive a symmetric key using a key or secret data that is already known to the key
784 management system. It only applies to Managed Cryptographic Objects that can be used for key
785 derivation (The Derive Key bit must be set in the Cryptographic Usage Mask attribute of the specified
786 Managed Object). If the operation is issued for an object that does not have this bit set, the server must
787 return a response with a Result Reason of Operation Not Supported. For all derivation methods, the client
788 must specify the desired length of the derived key or secret using the Cryptographic Length attribute. If a
789 key is created, the client must specify both its Cryptographic Length and Cryptographic Algorithm. If the
790 specified length exceeds the output of the derivation method, the server must return an error. Clients
791 have the option to derive multiple keys and IVs by creating a Secret Data object and specifying a
792 Cryptographic Length that is the total length of the derived object. The length must not exceed the length
793 of the output that can be returned by the chosen derivation method.

794 The fields in the request specify the Unique Identifiers of the keys or secrets to be used for derivation
795 (some derivation methods may require multiple keys or secrets to derive the result), the method to be
796 used to perform the derivation, and any parameters needed by the specified method. The method is
797 specified as an enumerated value. Currently defined derivation methods include:

798 • *PBKDF2* – This method is used to derive a symmetric key from a password or pass phrase. The
799 PBKDF2 method is published in RSA Laboratories' Public-Key Cryptography Standards (PKCS)
800 series, specifically PKCS #5 v2.0, and also published as Internet Engineering Task Force's RFC
801 2898.

802 • *HASH* – This method derives a key by computing a hash over the derivation key or the derivation
803 data.

804 • *HMAC* – This method derives a key by computing an HMAC over the derivation data.

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- *ENCRYPT* – This method derives a key by encrypting the derivation data.
- *NIST800-108-C* – This method derives a key by computing the KDF in Counter Mode as specified in NIST SP 800-108.
- *NIST800-108-F* – This method derives a key by computing the KDF in Feedback Mode as specified in NIST SP 800-108.
- *NIST800-108-DPI* – This method derives a key by computing the KDF in Double-Pipeline Iteration Mode as specified in NIST SP 800-108.
- *Extensions*

Only on-line objects can be specified. Archived objects must first be moved back on-line through a Recover operation before they can be specified. The server must perform the derivation function, and then register the derived object as a new Managed Object, returning the new Unique Identifier for the new object in the response. The server must copy the Unique Identifier returned by this operation into the ID Placeholder variable.

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As a result of Derive Key, the Link attributes (Derived Key Link in the objects from which the key is derived, and the Derivation Base Object Link in the derived key) of all objects involved are set to point to the corresponding objects.

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Request Payload		
Object	**Required**	**Description**
Object Type	Yes	Determines the type of object to be created
Unique Identifier	Yes. May be repeated	Determines the object or objects to be used to derive a new key from. At most, two can be specified: one for the derivation key and another for the secret data. Note that the ID Placeholder cannot be used here.
Derivation Method	Yes	An Enumeration object specifying the method to be used to derive the new key
Derivation Parameters	Yes	A Structure object containing the parameters needed by the specified derivation method
Template-Attribute	Yes	Specifies desired object attributes using templates and/or as individual attributes; length must always be specified and algorithm is required for the creation of symmetric keys.

Response Payload		
Object	**Required**	**Description**
Unique Identifier	Yes	The Unique Identifier of the newly derived key
Template-Attribute	No	A list of object attributes with values that the key management server chose differently from those specified in the request (either explicitly or via template). Only those attributes that were specified in the request and were set to different values by the server are included here

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The *Derivation Parameters* for all derivation methods consist of the following parameters, except PBKDF2 that requires two additional parameters.

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Object	Encoding	Required
Derivation Parameters	Structure	Yes
Cryptographic Parameters	Structure	Yes, except for HMAC derivation keys
Initialization Vector	Octet String	No, depends on PRF and mode of operation: empty IV is assumed if not provided.
Derivation Data	Octet String	Yes, unless the Unique Identifier of a Secret Data object is provided

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Cryptographic Parameters identify the Pseudorandom Function (PRF) or the mode of operation of the PRF. For example, if a key is to be derived using the HASH derivation method, clients are required to indicate the hash algorithm inside Cryptographic Parameters. Similarly, if a key is to be derived using AES in CBC mode, clients are required to indicate the Block Cipher Mode. The server will verify that the specified mode matches one of the instances of Cryptographic Parameters set for the corresponding key. If Cryptographic Parameters are omitted, the server will pick the Cryptographic Parameters set with the lowest index for the specified key. If the corresponding key does not have any Cryptographic Parameters attribute, or if no match is found, an error is returned.

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If a key is derived using HMAC, the attributes of the derivation key provides enough information about the PRF and Cryptographic Parameters are ignored.

Derivation Data can either be the data to be encrypted, hashed, or HMACed. For NIST SP 800-108 methods, Derivation Data is Label||{0x00}||Context, where the all-zero octet is optional.

Most derivation methods, such as ENCRYPT, require a derivation key and the derivation data to be encrypted. The HASH derivation method requires either a derivation key or derivation data. Derivation data can either be explicitly provided by the client with the Derivation Data field or implicitly by providing the Unique Identifier of a Secret Data object. An error is returned if both are provided.

The PBKDF2 derivation method requires two additional parameters:

Object	Encoding	Required
Derivation Parameters	Structure	Yes
Cryptographic Parameters	Structure	No, depends on the PRF

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Initialization Vector	Octet String	No, depends on PRF and mode of operation: empty IV is assumed if not provided.
Derivation Data	Octet String	Yes, unless the Unique Identifier of a Secret Data object is provided
Salt	Octet String	Yes
Iteration Count	Integer	Yes

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4.6 Certify

This request is used to obtain a new certificate for a public key. Only a single certificate can be requested at a time. Server support for this operation is optional, as it requires that the key management system have access to a certification authority.

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Requests are passed as Octet Strings, which allow multiple certificate request types for X.509 certificates (e.g. PKCS#10, PEM, etc) or PGP certificates to be submitted to the server.

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The server must copy the Unique Identifier of the certificate returned by this operation into the ID Placeholder variable. The new Certificate object whose Unique Identifier is returned may be obtained by the client via a Get operation in the same batch, using the ID Placeholder mechanism.

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As a result of Certify, the Link attribute of the Public Key and of the new Certificate are set to point at each other.

The server must copy the Unique Identifier of the new certificate returned by this operation into the ID Placeholder variable.

Only on-line objects can be specified. Archived objects must first be moved back on-line through a Recover operation before they can be specified.

If the information in the Certificate Request conflicts with the attributes specified in the Template-Attribute, then the information in the Certificate Request takes precedence.

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Request Payload		
Object	**Required**	**Description**
Unique Identifier	No	The Unique Identifier of the Public Key being certified. If omitted, the ID Placeholder is substituted by the server
Certificate Request Type	Yes	An Enumeration object specifying the type of certificate request
Certificate Request	Yes	An Octet String object with the certificate request
Template-Attribute	No	Specifies desired object attributes using templates and/or as individual attributes

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Response Payload		
Object	**Required**	**Description**
Unique Identifier	Yes	The Unique Identifier of the new certificate
Template-Attribute	No	A list of object attributes with values that the key management server chose differently from those specified in the request (either explicitly or via template). Only those attributes that were specified in the request and were set to different values by the server are included here

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4.7 Re-certify

This request is used to renew an existing certificate with the same key pair. Only a single certificate can be renewed at a time. Server support for this operation is optional, as it requires that the key management system have access to a certification authority.

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Requests are passed as Octet Strings, which allow multiple certificate request types for X.509 certificates (e.g. PKCS#10, PEM, etc) or PGP certificates to be submitted to the server.

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The server must copy the Unique Identifier of the certificate returned by this operation into the ID Placeholder variable.

Only on-line objects can be specified. Archived objects must first be moved back on-line through a Recover operation before they can be specified.

If the information in the Certificate Request conflicts with the attributes specified in the Template-Attribute, then the information in the Certificate Request takes precedence.

As the new certificate takes over the name attribute of the existing certificate, Re-certify should only be performed once on a given certificate.

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As a result of Re-certify, attributes of the existing certificate are changed similarly to performing a Revoke on that certificate with a Revocation Reason of Superseded.

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In addition, the Link attribute of the existing certificate and of the new certificate are set to point at each other. In addition, the Link attribute of the Public Key is changed to point to the new certificate. If *Offset* is set, then the times of the new certificate will be set based on the times of the existing certificate (if such times exist) as follows:

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Attribute in Existing Certificate	Attribute in New Certificate
Initial Date (IT_1)	Initial Date (IT_2) > IT_1
Activation Date (AT_1)	Activation Date (AT_2) = IT_2 + *Offset*
Deactivation Date (DT_1)	Deactivation Date = DT_1+(AT_2- AT_1)

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Attributes that are not copied from the existing certificate and are handled in a specific way are:

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Attribute	Action
Initial Date	Set to current time
Destroy Date	Not set
Revocation Reason	Not set
Unique Identifier	New value generated
Name	Set to the name(s) of the existing certificate; all name attributes of the existing certificate are removed.
State	Set based on attributes
Digest	Recomputed from the new certificate value
Link	Set to point to the existing certificate as the replaced certificate
Last Change Date	Set to current time

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Request Payload		
Object	**Required**	**Description**
Unique Identifier	No	The Unique Identifier of the Certificate being renewed. If omitted, the *ID Placeholder* is substituted by the server
Certificate Request Type	Yes	An Enumeration object specifying the type of certificate request
Certificate Request	Yes	An Octet String object with the certificate request
Offset	No	An Interval object indicating the difference between the Initialization Time of the new certificate and the Activation Date of the new certificate
Template-Attribute	No	Specifies desired object attributes using templates and/or as individual attributes

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Response Payload		
Object	**Required**	**Description**
Unique Identifier	Yes	The Unique Identifier of the new certificate
Template-Attribute	No	A list of object attributes with values that the key management server chose differently from those specified in the request (either explicitly or via template). Only those attributes that were specified in the request and were set to different values by the server are included here

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4.8 Locate

This operation requests that the server searches for one or more Managed Objects, specified by one or more attributes. All attributes are allowed to be used. However, no attributes specified in the request should contain index values. Attribute Index values will be ignored by the *Locate* operation. The request may also contain a *Maximum Items* field, which specifies the maximum number of objects that the client wishes returned by Locate. If the Maximum Items field is omitted, then the server may return all objects matched, or may impose an internal maximum limit due to resource limitations.

The response may contain Unique Identifiers for multiple Managed Objects, if more than one object satisfies the identification criteria specified in the request. Returned objects must match **all** of the attributes in the request. If no objects match, an empty response payload is returned.

The server returns a list of Unique Identifiers of the found objects, which then must be retrieved using the Get operation, or if the objects are archived, then the Recover and Get operations must be used. If a single Unique Identifier is returned to the client, then the server must copy the Unique Identifier returned by this operation into the ID Placeholder variable. If the Locate operation matches more than one object, and the Maximum Items value is omitted in the request, or is set to a value larger than one, then the server must not set the ID Placeholder value, so that any subsequent operations that are batched with the Locate, and which do not specify a Unique Identifier explicitly will fail. This ensures that these batched operations will be allowed to proceed only if a single object is returned by Locate.

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When using the Name or Object Group attributes for identification, wild-cards or regular expressions may be supported by specific key management system implementations. The protocol neither requires nor disallows such use.

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The Date attributes (Initial Date, Activation Date, etc) may be used to specify a time or a time range. If a single instance of a given Date attribute is used, such as the Activation Date, then objects with the same Activation Date are matching candidate objects. If two instances of the same Date attribute are used (with two different values specifying a range), then objects for which the Activation Date is inside or at a limit of the range are matching candidate objects. If a Date attribute is set to its largest possible value, then it is equivalent to an undefined attribute.

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When the Cryptographic Usage Mask attribute is specified in the request, candidate objects are compared against this field via an operation which consists of a logical AND of the requested mask with the mask in the candidate object, and then a straight comparison of the resulting value with the requested mask. For example, if the request contains a mask value of 10001100010000, and a candidate object mask contains 10000100010000, the logical AND of the two masks is 10000100010000, which is compared against 10001100010000 and fails the match. This means that a matching candidate object must have all of the bits set in its mask that are set in the requested mask, but may have additional bits set.

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When the Usage Allocation attribute is specified in the request, matching candidate objects must have an Object or Byte Count and Total Objects or Bytes equal to or larger than the values specified in the request.

When an attribute defined as a structure is specified, not all of the structure fields must be specified. For instance, for the Link attribute, the Linked Object Identifier value may be specified without the Link Type value, and matching candidate objects must have the Linked Object Identifier as specified, irrespective of their Link Type.

The Storage Status Mask field (see Section 9.1.3.3.2) is used to indicate whether only on-line objects, or only archived objects, or both on-line and archived objects must be searched. Note that the server may store attributes of archived objects in order to expedite Locate operations searching through archived objects.

Request Payload		
Object	**Required**	**Description**
Maximum Items	No	An Integer object that indicates the maximum number of object identifiers the server should return
Storage Status Mask	No	An Integer object (used as a bit mask) that indicates whether only on-line objects, or only archived objects, or both on-line and archived objects must be searched. If omitted, on-line only is assumed.
Attribute	Yes, may be repeated	Specifies an attribute and its value that must match the desired object

Response Payload		
Object	**Required**	**Description**
Unique Identifier	No, May be repeated	The Unique Identifier of the located objects

4.9 Check

This operation requests that the server checks for the use of a Managed Object according to values specified in the request. This operation should only be used when placed in a batched set of operations, usually following a Locate, Create, Create Pair, Derive Key, Certify, Re-Certify or Re-Key operation, and followed by a Get operation. The Unique Identifier field in the request may be omitted if the operation is in a batched set of operations and follows an operation that sets the ID Placeholder variable.

If the server determines that the client is allowed to use the object specified according to the given attributes, the server returns the Unique Identifier of the object. If the server determines that the specified attributes fall outside allowed policy, then the server returns no Unique Identifier, the server invalidates the ID Placeholder value, and the operation returns the set of attributes specified in the request that caused the server policy denial. Only those attributes that the server judged to be out of policy are returned, allowing the client to determine how to proceed. The operation also returns a failure, and the server must ignore any subsequent operations in the batch.

The additional objects that may be specified in the request are limited to (note that these objects are not encoded in an Attribute structure as shown in Section 2.1.1):

- Usage Limits Byte Count or Usage Limits Object Count (see Section 3.14)– The request may contain the usage amount that the client deems necessary to complete its needed function. This does not require that any subsequent Get Usage Allocation operations request this amount. It only means that the client is ensuring that the amount specified is available.

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- Cryptographic Usage Mask – This is used to specify the cryptographic operations for which the client intends to use the object (see Section 3.12). This allows the server to determine if the policy allows this client to perform these operations with the object. Note that this may be a different value from the one specified in a *Locate* operation that precedes this operation. Locate, for example, may specify a Cryptographic Usage Mask requesting a key that can be used for both Encryption and Decryption, but the value in the Check operation may specify that the the client is only using the key for Encryption at this time.
- Lease Time – This specifies a desired lease time (see Section 3.13). The client may use this to determine if the server will allow the client to use the object with the specified lease or longer. Including this attribute in the Check operation does not actually cause the server to grant a lease, but only indicates that the requested lease time value will be granted if requested by a subsequent, batched, Obtain Lease operation.

Only on-line objects can be specified. Archived objects must first be moved back on-line through a Recover operation before they can be specified

Request Payload		
Object	**Required**	**Description**
Unique Identifier	No	Determines the object being checked. If omitted, the ID Placeholder is substituted by the server
Usage Limits Byte Count	No	Specifies the number of bytes to be protected to be checked against server policy. May only be present if Usage Limits Object Count is not present
Usage Limits Object Count	No	Specifies the number of objects to be protected to be checked against server policy. May only be present if Usage Limits Byte Count is not present
Cryptographic Usage Mask	No	Specifies the Cryptographic Usage for which the client will use the object for
Lease Time	No	Specifies a Lease Time value that the Client is asking the server to validate against server policy

Response Payload		
Object	**Required**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object
Usage Limits Byte Count	No	Returned by the Server if the Usage Limits value specified in the Request Payload was larger than the value that the server policy would allow. May only be present if Usage Limits Object Count is not present
Usage Limits Object Count	No	Returned by the Server if the Usage Limits value specified in the Request Payload was larger than the value that the server policy would allow. May only be present if Usage Limits Byte Count is not present

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Cryptographic Usage Mask	No	Returned by the Server if the Cryptographic Usage Mask specified in the Request Payload was rejected by the server for policy violation
Lease Time	No	Returned by the Server if the Lease Time value in the Request Payload was larger than a valid Lease Time that the server would grant

963 The encodings of the Usage limits Byte and Object Counts is as shown in Section 3.14 .

964 4.10 Get

965 This operation requests that the server returns a Managed Object, which is specified in the request by its
966 Unique Identifier. The Unique Identifier field in the request may be omitted if the *Get* operation is in a
967 batched set of operations and follows an operation that sets the ID Placeholder variable.

968 Only a single object is returned. Only on-line objects can be specified. Archived objects must first be
969 moved back on-line through a Recover operation before they can be specified. The response contains the
970 Unique Identifier of the object, along with the object itself, which may be optionally wrapped using a
971 wrapping key specified in the request.

Request Payload		
Object	**Required**	**Description**
Unique Identifier	No	Determines the object being requested. If omitted, the ID Placeholder is substituted by the server
Key Wrapping Specification	No	Specifies keys and other information for wrapping the returned object. This field may not be specified if the returned object is a Template

972

Response Payload		
Object	**Required**	**Description**
Object Type	Yes	Type of object
Unique Identifier	Yes	The Unique Identifier of the object
Certificate, Symmetric Key, Private Key, Public Key, Split Key, Template, Secret Data, or Opaque Object	Yes	The cryptographic object being returned

973 4.11 Get Attributes

974 Return one or more attributes of a Managed Object. The object is specified by its Unique Identifier. The
975 desired attributes are specified by name in the request. If a specified attribute has multiple instances, all
976 instances are returned. If a specified attribute does not exist (i.e. has no value) it must not be present in
977 the returned response. If no requested attributes exist, the response should consist only of the Unique
978 Identifier.

979 Only on-line objects can be specified. Archived objects must first be moved back on-line through a
980 Recover operation before they can be specified.

Request Payload		
Object	**Required**	**Description**
Unique Identifier	No	Determines the object whose attributes are being requested. If omitted, the ID Placeholder is substituted by the server
Attribute Name	Yes, May be repeated	Specifies a desired attribute of the object

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Response Payload		
Object	**Required**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object
Attribute	No, May be repeated	The requested attribute for the object

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4.12 Get Attribute List

Returns a list of the attribute names associated with a specified Managed Object. The object is specified by its Unique Identifier.

Only on-line objects can be specified. Archived objects must first be moved back on-line through a Recover operation before they can be specified.

Request Payload		
Object	**Required**	**Description**
Unique Identifier	No	Determines the object whose attribute names are being requested. If omitted, the ID Placeholder is substituted by the server

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Response Payload		
Object	**Required**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object
Attribute Name	Yes, May be repeated	The requested attribute names for the object

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4.13 Add Attribute

This request adds a new attribute instance and sets its value. The request contains the Unique Identifier of the Managed Object which the attribute pertains to, and the attribute, with its name and new value. For non multi-instance attributes, this is how they are created. For multi-instance attributes, this is how the first and subsequent values are created. Existing attribute values must be changed by the Modify Attribute operation. Read-Only attributes may not be added using this operation. No Attribute Index may be specified in the request. The response will return a new Attribute Index if the attribute being added is allowed to have multiple instances. Multiple Add Attribute requests may be included in a single batched request to add multiple attributes.

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Only on-line objects can be specified. Archived objects must first be moved back on-line through a Recover operation before they can be specified.

Request Payload		
Object	**Required**	**Description**
Unique Identifier	No	The Unique Identifier of the object. If omitted, the ID Placeholder is substituted by the server
Attribute	Yes	Specifies the attribute of the object to be added

Response Payload		
Object	**Required**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object
Attribute	Yes	The added attribute

4.14 Modify Attribute

This request modifies the value of an existing attribute instance. The request contains the Unique Identifier of the Managed Object whose attribute is to be modified, and the attribute, with its name, optional index, and new value. Only existing attributes may be changed via this operation. New attributes must be added by the Add Attribute operation. Read-Only attributes may not be changed using this operation. If an attribute index is specified, only the specified instance is modified. If the attribute has multiple instances, and no index is specified in the request, then the index is assumed to be 0. If the attribute does not support multiple instances, the attribute index must not be specified. Using a non-existing attribute index in a modify operation will result in an error.

The Attribute returned in the response may have a value different from the one sent in the request, if the server policy so dictates. The value returned is the value set by the server.

Only on-line objects can be specified. Archived objects must first be moved back on-line through a Recover operation before they can be specified.

Request Payload		
Object	**Required**	**Description**
Unique Identifier	No	The Unique Identifier of the object. If omitted, the ID Placeholder is substituted by the server
Attribute	Yes	Specifies the attribute of the object to be modified

Response Payload		
Object	**Required**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object
Attribute	Yes	The modified attribute

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4.15 Delete Attribute

This request deletes an attribute. The request contains the Unique Identifier of the Managed Object whose attribute is to be deleted, the Attribute name, and optionally the Attribute Index of the attribute. Required attributes and Read-Only attributes may not be deleted by this operation. If no Attribute Index is specified, and the Attribute whose name is specified has multiple instances, the operation is rejected. Note that only a single attribute can be deleted at a time. Multiple delete operations (possibly batched) are necessary to delete several attributes. Deleting non-existing attributes will result in an error. Using a non-existing attribute index in a delete operation will also result in an error.

Only on-line objects can be specified. Archived objects must first be moved back on-line through a Recover operation before they can be specified.

Request Payload		
Object	**Required**	**Description**
Unique Identifier	No	Determines the object whose attributes are being deleted. If omitted, the ID Placeholder is substituted by the server
Attribute Name	Yes	Specifies the name of the attribute to be deleted
Attribute Index	No	Specifies the Index of the Attribute

Response Payload		
Object	**Required**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object
Attribute	Yes	The deleted attribute

4.16 Obtain Lease

This request is used to obtain a new *Lease Time* for a specified Managed Object. The Lease Time is an interval value that determines when the client's internal cache of information about the object expires and must be renewed. If the returned value of the lease time is zero, then the server is indicating that no lease interval is effective, and the client may use the object without any lease time limit. If a client's lease expires, the client must not use the associated cryptographic object until a new lease is obtained. If the server determines that a new lease should not be issued for the specified cryptographic object, then the server should respond to the Obtain Lease request with a Result Status of Failure, and a Result Reason of General Failure.

The response payload for the operation also contains the current value of the Last Changed Date attribute for the object. This may be used by the client to determine if any of the attributes cached by the client need to be refreshed, by comparing this time to the time when the attributes were previously obtained.

The Unique Identifier field in the request may be omitted if the operation is in a batched set of operations and follows an operation that sets the ID Placeholder variable.

Only on-line objects can be specified. Archived objects must first be moved back on-line through a Recover operation before they can be specified.

Request Payload		
Object	**Required**	**Description**
Unique Identifier	No	Determines the object for which the

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		lease is being obtained. If omitted, the *ID Placeholder* is substituted by the server

Response Payload		
Object	**Required**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object
Lease Time	Yes	An interval (in seconds) that specifies the amount of time that the object can be used until a new lease needs to be obtained
Last Changed Date	Yes	The date and time indicating when the latest change was made to the contents or any attribute of the specified object.

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4.17 Get Usage Allocation

This request is used to obtain an allocation from the current Usage Limits values, to allow the client to use the Managed Cryptographic Object for protection purposes. It only applies to Managed Cryptographic Objects that can be used for protection purposes (symmetric keys, private keys and public keys) and is only valid if the Managed Cryptographic Object has a Usage Limits attribute. Usage for process purposes (decryption, verification, etc.) is not limited and cannot be allocated. A Managed Cryptographic Object that has a Usage Limits attribute may not be used by a client for protection purposes unless an allocation has been obtained using this operation. The operation may only be issued during the time that protection is enabled for these objects, i.e. after the Activation Date and before the Protect Stop Date. If the operation is issued for an object that has no Usage Limits attribute, or is not an object that can be used for protection purposes, the server must return a response with a Result Reason of Operation Not Supported.

The fields in the request specify the number of bytes, or number of objects that the client needs to protect. Exactly one of the two count fields must be specified in the request. The corresponding field, containing the number of bytes, or number of objects that may be protected, is returned in the response. If the requested amount is not available, the server may return a smaller amount, or may return 0, indicating that the Managed Object may not be used for protection purposes at this time. The server must assume that the entire allocated amount has been consumed. Server policy may allow the value returned in the response to be different from the value requested. Once the entire allocated amount has been consumed, the client may not continue to use the Managed Cryptographic Object for protection purposes until a new allocation is obtained.

The Unique Identifier field in the request may be omitted if the operation is in a batched set of operations and follows an operation that sets the ID Placeholder variable.

Only on-line objects can be specified. Archived objects must first be moved back on-line through a Recover operation before they can be specified.

Request Payload		
Object	**Required**	**Description**
Unique Identifier	No	Determines the object whose usage allocation is being requested. If omitted, the ID Placeholder is substituted by the server
Usage Limits Byte Count	No	The number of bytes to be protected.

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		May only be present if Usage Limits Object Count is not present
Usage Limits Object Count	No	The number of objects to be protected. May only be present if Usage Limits Byte Count is not present

Response Payload		
Object	**Required**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object
Usage Limits Byte Count	No	The number of bytes that may be protected. May only be present if Usage Limits Object Count is not present
Usage Limits Object Count	No	The number of objects that may be protected. May only be present if Usage Limits Byte Count is not present

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The encodings of the Usage limits Byte and Object Counts is as shown in Section 3.14 .

4.18 Activate

This request is used to activate a Managed Cryptographic Object. The request may not specify a Template object. The request contains the unique identifier of the Managed Cryptographic Object . The operation can be performed only on an object in the Pre-Active state and has the effect of changing its state to Active, and its Activation Date will be set to the current date and time.

Only on-line objects can be specified. Archived objects must first be moved back on-line through a Recover operation before they can be specified.

Request Payload		
Object	**Required**	**Description**
Unique Identifier	No	Determines the object being activated. If omitted, the ID Placeholder is substituted by the server

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Response Payload		
Object	**Required**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object

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4.19 Revoke

This request is used to revoke a Managed Cryptographic Object or an Opaque Object. The request may not specify a Template object. The request contains the unique identifier of the Managed Cryptographic Object and a reason for the revocation, e.g. “compromised”, “no longer used”, etc. It is recommended that special authentication and authorization are enforced to perform this request (see Usage Guide). Only the object creator or an authorized security officer should be allowed to issue this request. The operation will have one of two effects. If the revocation reason is “compromised”, then the object will be placed into the “compromised” state, and the Compromise Date attribute will be set to the current date and time. Otherwise, the object will be placed into the “deactivated” state, and the Deactivation Date attribute will be set to the current date and time.

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Only on-line objects can be specified. Archived objects must first be moved back on-line through a Recover operation before they can be specified.

Request Payload		
Object	**Required**	**Description**
Unique Identifier	No	Determines the object being revoked. If omitted, the ID Placeholder is substituted by the server
Revocation Reason	Yes	Specifies the reason for revocation
Compromise Occurrence Date	No	Only specified, and required, if the Revocation Reason is 'compromised'

Response Payload		
Object	**Required**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object

4.20 Destroy

This request is used to indicate to the server that the key material for the specified Managed Object should be destroyed. The meta-data for the key material may be retained by the server. This is used for example, to ensure that an expired or revoked private signing key is no longer available. It is recommended that special authentication and authorization are enforced to perform this request (see Usage Guide). Only the object creator or an authorized security officer should be allowed to issue this request. If the Unique Identifier specifies a Template object, then the object itself, including all meta-data may be destroyed.

Only on-line objects can be specified. Archived objects must first be moved back on-line through a Recover operation before they can be specified.

Request Payload		
Object	**Required**	**Description**
Unique Identifier	No	Determines the object being destroyed. If omitted, the ID Placeholder is substituted by the server

Response Payload		
Object	**Required**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object

4.21 Archive

This request is used to specify that a Managed Object is now permitted to be placed in archival storage. The actual time when the object is placed in archival storage and the location of the archive or level of archive hierarchy is determined by the policies within the key management system, and is not specified by the client. The request contains the unique identifier of the object. It is recommended that special authentication and authorization are enforced to perform this request (see Usage Guide). Only the object creator or an authorized security officer should be allowed to issue this request. This request may be considered only a “hint” to the key management system, which may or may not choose to act upon this request.

Request Payload		
Object	**Required**	**Description**
Unique Identifier	No	Determines the object being archived. If omitted, the ID Placeholder is substituted by the server

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Response Payload		
Object	**Required**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object

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4.22 Recover

This request is used to obtain access to a Managed Object that has been placed in archival storage. Due to the fact that the object is located in archival storage, this request may require asynchronous polling to obtain the response. Once the response is received, the object is now on-line, and may be obtained via a normal Get operation, for instance. It is recommended that special authentication and authorization are enforced to perform this request (see Usage Guide).

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Request Payload		
Object	**Required**	**Description**
Unique Identifier	No	Determines the object being recovered. If omitted, the ID Placeholder is substituted by the server

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Response Payload		
Object	**Required**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object

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4.23 Validate

This requests that the server validate a certificate chain, and return information on its validity. Only a single certificate chain may be included in each request. Support for this operation at the server is optional.

The request may contain a list of certificate objects, and/or a list of Unique Identifiers which identify Managed Certificate objects. Together, the two lists comprise a certificate chain to be validated. The request may also optionally contain a date for which the certificate chain must be valid.

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The validation method or policy by which validation will be conducted is a decision of the server and is outside of the scope of this protocol. Likewise, the order in which the supplied certificate chain is validated and the specification of trust anchors used to terminate validation are also controlled by the server.

Only on-line objects can be specified. Archived objects must first be moved back on-line through a Recover operation before they can be specified.

Request Payload		
Object	**Required**	**Description**
Certificate	No, May be repeated	One or more Certificates
Unique Identifier	No, May be repeated	One or more Unique Identifiers of Certificate Objects
Validity Date	No	A Date-Time object indicating when the certificate chain must be valid

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Response Payload		
Object	**Required**	**Description**
Validity Indicator	Yes	An Enumeration object indicating whether the certificate chain is valid, invalid, or unknown

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4.24 Query

This request is used by the client to interrogate the server to determine its capabilities and/or protocol mechanisms. It is recommended that the *Query* operation, used to interrogate server features and functions, be invocable by unauthenticated clients. The *Query Function* field in the request may contain one of the following items:

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- Query Operations
- Query Objects
- Query Server Information

One, two, or all three of the above functions may be specified.

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The *Operation* fields in the response contain Operation enumerated values, which should list the optionally supported operations that the server supports. These fields should only be returned in the response if the request contains a Query Operations value in the Query Function field. The optional operations are:

- Validate
- Certify
- Re-Certify
- Notify
- Put

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The *Object Type* fields in the response contain Object Type enumerated values, which should list the object types that the server supports. These fields should only be returned in the response if the request contains a *Query Objects* value in the Query Function field. The object types (any of which are optional) are:

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- Certificate
- Symmetric Key
- Public Key
- Private Key
- Split Key
- Template

- Secret Data
- Opaque Object

The *Server Information* field in the response is a structure containing vendor-specific fields and/or substructures. This field should only be returned in the response if the request contains a *Query Server Information* value in the Query Function field.

Note that the response payload is empty if there are no values to return.

Request Payload		
Object	**Required**	**Description**
Query Function	Yes, May be Repeated	Determines the information being queried

Response Payload		
Object	**Required**	**Description**
Operation	No, May be repeated	Specifies an Operation that is supported by the server. Only optional operations should be listed
Object Type	No, May be repeated	Specifies a Managed Object Type that is supported by the server
Vendor Identification	No	Must be returned if Query Server Information is requested. The Vendor Identification must be a text string that uniquely identifies the vendor
Server Information	No	Contains vendor-specific information that may be of interest to the client

4.25 Cancel

This request is used to cancel an outstanding asynchronous operation. The correlation value (see Section 6.8) of the original operation must be specified in the request. The server must respond with a *Cancellation Result*, which contains one of the following values:

- *Canceled* – The cancel operation succeeded in canceling the pending operation.
- *Unable To Cancel* – The cancel operation is unable to cancel the pending operation.
- *Completed* – The pending operation completed successfully before the cancellation operation was able to cancel it.
- *Failed* – The pending operation completed with a failure before the cancellation operation was able to cancel it.
- *Unavailable* – The specified correlation value did not match any recently pending or completed asynchronous operations.

The response to this operation cannot be asynchronous.

Request Payload		
Object	**Required**	**Description**
Asynchronous Correlation Value	Yes	Specifies the request being canceled

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Response Payload		
Object	**Required**	**Description**
Asynchronous Correlation Value	Yes	Specified in the request
Cancellation Result	Yes	Enumeration indicating result of cancellation

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4.26 Poll

This request is used to poll the server in order to obtain the status of an outstanding asynchronous operation. The correlation value (see Section 6.8) of the original operation must be specified in the request. The response to this operation cannot be asynchronous.

Request Payload		
Object	**Required**	**Description**
Asynchronous Correlation Value.	Yes	Specifies the request being polled

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The server must reply with one of two responses:

A response containing no payload and a Result Status of Pending, if the operation has not completed

A response containing the appropriate payload for the operation, if the operation has completed. This response must be identical to the response that would have been sent if the operation had completed synchronously.

5 Server-to-Client Operations

Server-to-client operations are used by servers to send information or Managed Cryptographic Objects to clients outside of the normal client-server request-response mechanism. These operations are used to "push" Managed Cryptographic Objects directly to clients without a specific request from the client.

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5.1 Notify

This operation is used to notify a client of events that resulted in changes to attributes of an object. This operation is only ever sent by a server to a client outside the normal client request/response protocol, using information known to the server via unspecified configuration or administrative mechanisms. It contains the Unique Identifier of the object to which the notification applies, and a list of the attributes whose changed values have triggered the notification. The message is sent as a normal Request message, except that the Maximum Response Size, Asynchronous Indicator, Batch Error Continuation Option, and Batch Order Option fields are not allowed. The client must send a response in the form of a Response Message containing no payload, unless both the client and server have prior knowledge (obtained via out-of-band mechanisms) that the client cannot respond. Server and Client support for this message is optional.

Message Payload		
Object	**Required**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object
Attribute	Yes, May be repeated	The attributes which have changed. This includes at least the Last Changed Date attribute

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5.2 Put

This operation is used to "push" Managed Cryptographic Objects to clients. This operation is only ever sent by a server to a client outside the normal client request/response protocol, using information known

to the server via unspecified configuration or administrative mechanisms. It contains the Unique Identifier of the object which is being sent, and the object itself. The message is sent as a normal Request message, except that the Maximum Response Size, Asynchronous Indicator, Batch Error Continuation Option, and Batch Order Option fields are not allowed. The client must send a response in the form of a Response Message containing no payload, unless both the client and server have prior knowledge (obtained via out-of-band mechanisms) that the client cannot respond. Server and client support for this message is optional.

The *Put Function* field indicates whether the object being "pushed" is a new object, or a replacement for an object already known to the client. For example, when pushing a certificate to replace one that is about to expire, the Put Function field would be set to indicate replacement, and the Unique Identifier of the expiring certificate would be placed in the *Replaced Unique Identifier* field. The Put Function may contain one of the following values:

- *New* – which indicates that the object is not a replacement for another object.
- *Replace* – which indicates that the object is a replacement for another object, and that the Replaced Unique Identifier field is present, and contains the identification of the replaced object.

The Attribute field contains one or more attributes that the server wishes to be pushed along with the object. In particular, the server may include attributes with the object to specify how the object is to be used by the client. The server may include a Lease Time attribute which grants a lease to the client.

If the Managed Object is a wrapped key, the key wrapping specification must be exchanged prior to the transfer via out-of-band mechanisms.

Message Payload

Object	Required	Description
Unique Identifier	Yes	The Unique Identifier of the object
Put Function	Yes	Indicates function for Put message
Replaced Unique Identifier	No	Unique Identifier of the replaced object. Must be present if the *Put Function* is *Replace*
Certificate, Symmetric Key, Private Key, Public Key, Split Key, Template, Secret Data, or Opaque Object	Yes	The object being sent to the client
Attribute	No, May be repeated	The additional attributes that the server wishes to push with the object

6 Message Contents

The messages in the protocol consist of a message header, one or more batch items which contain optional message payloads, and optional message extensions. The message headers contain fields whose presence is determined by the protocol features used, e.g. asynchronous responses. The field contents are also determined by whether the message is a request or a response. The message payload is determined by the specific operation being requested or replied to.

The message headers are structures which contain some of the following objects.

6.1 Protocol Version

This field contains the version number of the protocol, ensuring that the protocol is fully understood by both communicating parties. The version number is specified in two parts, major and minor. Servers and clients must support backward compatibility with versions of the protocol with the same major version but different minor versions. Support for backward compatibility with different major versions is optional.

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Object	Encoding	Required
Protocol Version	Structure	Yes
Protocol Version Major	Integer	Yes
Protocol Version Minor	Integer	Yes

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6.2 Operation

This field indicates the operation being requested or the operation for which the response is being returned. The operations are defined in Sections 4 and 5 .

Object	Encoding	Required
Operation	Enumeration	Yes

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6.3 Maximum Response Size

This field is optionally contained in a request message, and is used to indicate the maximum size of a response that the requester can handle. It need only be sent in requests that may return large replies.

Object	Encoding	Required
Maximum Response Size	Integer	No

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6.4 Unique Batch Item ID

This field is optionally contained in a request, and is used for correlation between requests and responses. If a request has a *Unique Batch Item ID*, then responses to that request must have the same Unique Batch Item ID.

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Object	Encoding	Required
Unique Batch Item ID	Octet String	No

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6.5 Time Stamp

This field is optionally contained in a request and required in a response, and is used for time stamping and may be used to enforce reasonable time usage at a client, e.g. a server may choose to reject a request if a client's time stamp contains a value that is too far off the known correct time. The time stamp may also be used by a client, which has no real-time clock but only a countdown timer, to obtain useful "seconds from now" values from all of the Date attributes, by performing a subtraction.

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Object	Encoding	Required
Time Stamp	Date-Time	No

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6.6 Authentication

This is used to authenticate the requester. It is an optional information item, depending on the type of request being issued and on server policies. Servers may require authentication on no requests, a subset of the requests, or all requests, depending on policy. It is recommended that the Query operation, used to interrogate server features and functions, not require authentication.

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The authentication mechanisms are described and discussed in Section 8 .

Object	Encoding	Required
Authentication	Structure	No
Credential	Structure	Yes

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The Credential structure is defined in Section 2.1.2 .

6.7 Asynchronous Indicator

This boolean flag indicates whether the client can accept an asynchronous response. It must have the boolean value True if the client can handle asynchronous responses, and the value False otherwise. If not present in a request, False is assumed. If a client indicates that it can't handle asynchronous responses (flag is set to False), and the server is not able to process the request synchronously, the server must respond to the request with a failure.

Object	Encoding	Required
Asynchronous Indicator	Boolean	No

6.8 Asynchronous Correlation Value

This is returned in the immediate response to an operation that will require asynchronous polling (the server decides which operations it wants to perform synchronously or asynchronously). It is a server generated correlation value that must be specified in any subsequent Poll, or Cancel operations that pertain to the original operation.

Object	Encoding	Required
Asynchronous Correlation Value	Octet String	No

6.9 Result Status

This is sent in a response message and indicates the success or failure of a request. The following values may be set in this field:

- *Success* – The requested operation completed successfully.
- *Pending* – The requested operation is in progress, and the actual result must be obtained via asynchronous polling. The asynchronous correlation value must be used for the subsequent polling of the result status.
- *Undone* – The requested operation was performed, but had to be undone (due to a failure in a batch for which the Error Continuation Option was set to Undo)
- *Failure* – The requested operation failed.

Object	Encoding	Required
Result Status	Enumeration	Yes

6.10 Result Reason

This field indicates a reason for failure or a modifier for a partially successful operation and must be present in responses that return a Result Status of Failure. It is optional in any response that returns a Result Status of Success. The following defined values may be set in this field:

- *Item Not Found* – A requested object was not found or did not exist.
- *Response too large* – The response to a request would exceed the *Maximum Response Size* in the request.
- *Authentication not successful* – The authentication information in the request could not be validated, or there was no authentication information in the request when there should have been.
- *Invalid Message* – The request message was not understood by the server.

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- *Operation Not Supported* – The operation requested by the request message is not supported by the server.
- *Missing Data* – The operation requires additional optional information in the request, which was not present.
- *Invalid Field* – Some data item in the request has an invalid value.
- *Feature not supported* – An optional feature specified in the request is not supported.
- *Operation canceled by requester* – The operation was asynchronous, and the operation was canceled by the Cancel operation before it completed successfully.
- *Cryptographic failure* – The operation failed due to a cryptographic error.
- *Illegal Operation* – The client requested an operation that could not be performed with the specified parameters.
- *Permission Denied* – The client does not have permission to perform the requested operation.
- *Object archived* – The object should be first recovered from the archive.
- *General Failure* – The request failed for a reason other than the defined reasons above.

Object	Encoding	Required
Result Reason	Enumeration	Yes

6.11 Result Message

This field may optionally be returned in a response. It contains a more descriptive error message, which may be used by the client to display to an end user or for logging/auditing purposes.

Object	Encoding	Required
Result Message	Text String	No

6.12 Batch Order Option

A Boolean value used in requests where the Batch Count is greater than 1. If true, then batched operations must be executed in the order in which they appear within the request. If false, the server may choose to execute the batched operations in any order. If not specified, false is assumed (i.e. no implied ordering). Server support for this feature is optional, but if the server does not support the feature, and a request is received with the batch order option set to true, the entire request must be rejected.

Object	Encoding	Required
Batch Order Option	Boolean	No

6.13 Batch Error Continuation Option

This option should only be present if the Batch Count is greater than 1. This option may have one of three values:

- *Undo* – If any operation in the request fails, the server must undo all the previous operations.
- *Stop* – If an operation fails, the server must not continue processing later operations in the request. Completed operations must be left intact.
- *Continue* – Return an error for the failed operation, and continue processing later operations in the request.

If not specified, Stop is assumed.

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Server support for this feature is optional, but if the server does not support the feature, and a request is received containing the *Batch Error Continuation* option, the entire request must be rejected.

Object	Encoding	Required
Batch Error Continuation Option	Enumeration	No

6.14 Batch Count

This field is required. It contains the number of Batch Items in a message. If only a single operation is being requested, the batch count must be set to 1. The Message Payload, which follows the Message Header, will contain one or more batch items.

Object	Encoding	Required
Batch Count	Integer	Yes

6.15 Batch Item

This field is required. It consists of a structure that holds the individual requests or responses in a batch. The contents of the batch items is described in Sections 7.2 and 7.3 .

Object	Encoding	Required
Batch Item	Structure	No

6.16 Message Extension

The *Message Extension* is an optional structure which may be appended to any Batch Item. It is used to extend protocol messages for the purpose of adding vendor specified extensions. The Message Extension is a structure containing a Vendor Identification, a Criticality Indicator, and vendor-specific extensions. The *Vendor Identification* must be a text string that uniquely identifies the vendor, allowing a client to determine if the extension can be parsed and understood. If a client or server receives a protocol message containing a message extension that it does not understand, its actions depend on the *Criticality Indicator*. If the indicator is True (Critical), and the receiver does not understand the extension, the receiver must reject the entire message. If the indicator is False (Non-Critical), and the receiver does not understand the extension, the receiver may process the rest of the message as if the extension were not present.

Object	Encoding	Required
Message Extension	Structure	No
Vendor Identification	Text String	Yes
Criticality Indicator	Boolean	Yes
Vendor Extension	Structure	Yes

7 Message Format

Messages contain the following objects and fields. All fields must appear in the order specified.

7.1 Message Structure

Object	Encoding	Required
Request Message	Structure	Yes
Request Header	Structure	Yes
Batch Item	Structure	Yes, May be repeated

Object	Encoding	Required
Response Message	Structure	Yes
Response Header	Structure	Yes
Batch Item	Structure	Yes, May be repeated

7.2 Synchronous Operations

Synchronous Request Header		
Object	**Required in Message**	**Comment**
Request Header	Yes	Structure
Protocol Version	Yes	
Maximum Response Size	No	
Authentication	No	
Batch Error Continuation Option	No	If omitted, Stop is assumed
Batch Order Option	No	If omitted, False is assumed
Time Stamp	No	
Batch Count	Yes	

Synchronous Request Batch Item		
Object	**Required in Message**	**Comment**
Batch Item	Yes	Structure
Operation	Yes	
Unique Batch Item ID	No	Required if *Batch Count* > 1
Request Payload	Yes	Structure, contents depend on the Operation
Message Extension	No	

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Synchronous Response Header		
Object	**Required in Message**	**Comment**
Response Header	Yes	Structure
Protocol Version	Yes	
Time Stamp	Yes	
Batch Count	Yes	

1354

Synchronous Response Batch Item		
Object	**Required in Message**	**Comment**
Batch Item	Yes	Structure
Operation	Yes, if not a failure	
Unique Batch Item ID	No	Required if *Batch Count* > 1
Result Status	Yes	
Result Reason	No	Only present, if Result Status is not *Success*
Result Message	No	Only present, if Result Status is not *Success*
Response Payload	Yes, if not a failure	Structure, contents depend on the Operation
Message Extension	No	

1355 ## 7.3 Asynchronous Operations

1356 If the client is capable of accepting asynchronous responses, it may set the *Asynchronous Indicator* in the
1357 header of a batched request. The batched responses may contain a mixture of synchronous and
1358 asynchronous responses.

Asynchronous Request Header		
Object	**Required in Message**	**Comment**
Request Header	Yes	Structure
Protocol Version	Yes	
Maximum Response Size	No	
Asynchronous Indicator	Yes	Must be set to True
Authentication	No	
Batch Error Continuation Option	No	If omitted, Stop is assumed
Batch Order Option	No	If omitted, False is assumed
Time Stamp	No	
Batch Count	Yes	

1359

Asynchronous Request Batch Item		
Object	**Required in Message**	**Comment**
Batch Item	Yes	Structure
Operation	Yes	
Unique Batch Item ID	No	Required if *Batch Count* > 1
Request Payload	Yes	Structure, contents depend on the Operation
Message Extension	No	

1360

Asynchronous Response Header		
Object	**Required in Message**	**Comment**
Response Header	Yes	Structure
Protocol Version	Yes	
Time Stamp	Yes	
Batch Count	Yes	

1361

Asynchronous Response Batch Item		
Object	**Required in Message**	**Comment**
Batch Item	Yes	Structure
Operation	Yes, if not a failure	
Unique Batch Item ID	No	Required if *Batch Count* > 1
Result Status	Yes	
Result Reason	No	Only present, if Result Status is not *Pending* or *Success*
Result Message	No	Only present, if Result Status is not *Pending* or *Success*
Asynchronous Correlation Value	Yes	Only present, if Result Status is *Pending*
Response Payload	Yes, if not a failure	Structure, contents depend on the Operation
Message Extension	No	

8 Authentication

The mechanisms used to authenticate the client to the server and the server to the client are not part of the message definitions, and are external to the protocol. The *Authentication* field contained in Request Headers is used to identify the client and to provide linkage between this identification and the external authentication mechanism.

The Usage Guide describes authentication profiles appropriate to this protocol, as well as the relationship of those mechanisms to the credentials that are optionally included in the Authentication field. The authentication profiles described are:

- SSL/TLS authentication. If the transport protocol uses a normal TCP stream, then that stream should use an SSL/TLS encryption layer, and the client and server authentication features must be enabled unless otherwise specified in the operation. The Credential object contained in the Authentication field in all request messages will contain the client's certificate. The server should use this certificate to identify the client for policy enforcement purposes, and should verify that this certificate matches the one used for SSL/TLS authentication.
- HTTPS authentication. If the transport protocol is HTTP over TCP, then the HTTPS protocol should be used, and the client and server authentication features enabled unless otherwise specified in the operation. The contents and use of the *Credential* object are the same as in the bullet above.

All server implementations should, at a minimum, support the SSL/TLS and HTTPS profiles described in the Usage Guide.

Other mechanisms, such as Kerberos, are potentially usable, with the identity established in the mechanism, such as the Kerberos token, expressed as the Credential object. Profiles for these mechanisms are not currently described in the Usage Guide.

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9 Message Encoding

To support different transport protocols and different client capabilities, a number of message-encoding mechanisms are supported.

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9.1 TTLV Encoding

In order to minimize the resource impact on potentially low-function clients, one encoding mechanism to be used for protocol messages is a simplified TTLV (Tag, Type, Length, Value) scheme.

The scheme is designed to minimize the CPU cycle and memory requirements of clients that must encode or decode protocol messages, and to provide optimal alignment for both 32-bit and 64-bit processors. Minimizing bandwidth over the transport mechanism is considered to be of lesser importance.

9.1.1 TTLV Encoding Fields

Every Data object encoded by the TTLV scheme consists of 4 items, in order:

9.1.1.1 Item Tag

An Item Tag is a 3-byte binary unsigned integer, transmitted big endian, which contains a number that designates the specific Protocol Field or Object that the TTLV object represents. To ease debugging, and to ensure that malformed messages are detected more easily, all tags must contain either the value 42 in hex or the value 54 in hex as the high order (first) byte. Tags defined by this specification contain hex 42 in the first byte. Extensions, which are permitted, but not defined in this specification, contain the value 54 hex in the first byte. A list of defined Item Tags is in Section 9.1.3.1 .

9.1.1.2 Item Type

An Item Type is a byte containing a coded value that indicates the data type of the data object. The allowed values are:

Data Type	Coded Value in Hex
Structure	01
Integer	02
Long Integer	03
Big Integer	04
Enumeration	05
Boolean	06
Text String	07
Octet String	08
Date-Time	09
Interval	0A

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9.1.1.3 Item Length

An Item Length is a 32-bit binary integer, transmitted big-endian, containing the number of bytes in the Item Value.

Allowed values are:

Data Type	Length
Structure	Varies, multiple of 8
Integer	4
Long Integer	8
Big Integer	Varies, multiple of 8
Enumeration	4
Boolean	8
Text String	Varies
Octet String	Varies
Date-Time	8
Interval	4

If the Item Type is Structure, then the Item Length is the total length of all of the sub-items contained in the structure, including any padding. If the Item Type is Integer, Enumeration, Text String, Octet String, or Interval, then the Item Length is the number of bytes excluding the padding bytes. Text Strings and Octet

Strings must be padded with the minimal number of bytes following the Item Value to obtain a multiple of 8 bytes. Integers, Enumerations, and Intervals must be padded with 4 bytes following the Item Value.

9.1.1.4 Item Value

The item value is a sequence of bytes containing the value of the data item, depending on the type:

- Integers are encoded as 4-byte long (32 bit) binary signed numbers in 2's complement notation, transmitted big-endian.
- Long Integers are encoded as 8-byte long (64 bit) binary signed numbers in 2's complement notation, transmitted big-endian.
- Big Integers are encoded as a sequence of 8-bit bytes, in 2's complement notation, transmitted big-endian. If the length of the sequence is not a multiple of 8 bytes, then Big Integers shall be padded with the minimal number of leading sign-extended bytes to make the length a multiple of 8 bytes. These padding bytes are part of the Item Value and must be counted in the Item Length.
- Enumerations are encoded as 4-byte long (32 bit) binary unsigned numbers transmitted big-endian. Extensions, which are permitted, but not defined in this specification, contain the value 8 hex in the first nibble of the first byte.
- Booleans are encoded as an 8-byte value that must either contain the hex value 0000000000000000, indicating the boolean value *False,* or the hex value 0000000000000001, transmitted big-endian, indicating the boolean value *True.*
- Text Strings are sequences of bytes encoding character values according to the UTF-8 encoding standard. There must be no null-termination at the end of such strings.
- Octet Strings are sequences of bytes containing individual unspecified 8 bit binary values.
- Date-Time values are encoded as 8-byte long (64 bit) binary signed numbers, transmitted big-endian. They are POSIX Time values (described in IEEE Standard 1003.1) extended to a 64 bit value to eliminate the "Year 2038 problem" (problem that will affect Unix systems that store time as a signed 32-bit integer). The value is expressed as the number of seconds from a time epoch, which is 00:00:00 GMT January 1st, 1970. This value has a resolution of 1 second. All Date-Time values are expressed as UTC values.
- Intervals are encoded as 4-byte long (32 bit) binary unsigned numbers, transmitted big-endian. They have a resolution of 1 second.
- Structure Values are encoded as the concatenated encodings of the elements of the structure. All structures defined in this specification must have all of their fields encoded in the order in which they appear in their respective structure descriptions.

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9.1.2 Examples

These examples are assumed to be encoding a Protocol Object whose tag is 420020. The examples are shown as a sequence of bytes in hexadecimal notation:

- An Integer containing the decimal value 8:

```
42 00 20 | 02 | 00 00 00 04 | 00 00 00 08 00 00 00 00
```

- A Long Integer containing the decimal value 123456789000000000:

```
42 00 20 | 03 | 00 00 00 08 | 01 B6 9B 4B A5 74 92 00
```

- A Big Integer containing the decimal value 1234567890000000000000000000:

```
42 00 20 | 04 | 00 00 00 10 | 00 00 00 00 03 FD 35 EB 6B C2 DF 46 18 08
00 00
```

- An Enumeration with value 255:

```
42 00 20 | 05 | 00 00 00 04 | 00 00 00 FF 00 00 00 00
```

- A Boolean with the value *True*:

```
42 00 20 | 06 | 00 00 00 08 | 00 00 00 00 00 00 00 01
```

- A Text String:

```
42 00 20 | 07 | 00 00 00 0B | 48 65 6C 6C 6F 20 57 6F 72 6C 64 00 00 00
00 00
```

- An Octet String:

```
42 00 20 | 08 | 00 00 00 03 | 01 02 03 00 00 00 00 00
```

- A Date-Time, containing the value for Friday, March 14, 2008, 11:56:40 GMT:

```
42 00 20 | 09 | 00 00 00 08 | 00 00 00 00 47 DA 67 F8
```

- An Interval, containing the value for 10 days:

```
42 00 20 | 0A | 00 00 00 04 | 00 0D 2F 00 00 00 00 00
```

- A Structure containing an Enumeration, value 254, followed by an Integer, value 255, having tags 420004 and 420005 respectively:

```
42 00 20 | 01 | 00 00 00 20 | 42 00 04 | 05 | 00 00 00 04 | 00 00 00 FE
00 00 00 00| 42 00 05 | 02 | 00 00 00 04 | 00 00 00 FF 00 00 00 00
```

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9.1.3 Defined Values

This section specifies the values that are defined by this specification. In all cases where an extension mechanism is allowed, this extension mechanism may only be used for communication between parties that have pre-agreed understanding of the specific extensions.

9.1.3.1 Tags

The following table defines the tag values for the objects and primitive data values for the protocol messages.

Formatted Table

Tag	
Object	**Tag Value**
(Unused)	000000 – 420000
Activation Date	420001
Application Identifier	420002
Application Name Space	420003
Application Specific Identification	420004
Archive Date	420005
Asynchronous Correlation Value	420006
Asynchronous Indicator	420007
Attribute	420008
Attribute Index	420009
Attribute Name	42000A
Attribute Value	42000B
Authentication	42000C
Batch Count	42000D

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Tag	
Object	**Tag Value**
Batch Error Continuation Option	42000E
Batch Item	42000F
Batch Order Option	420010
Block Cipher Mode	420011
Cancellation Result	420012
Certificate	420013
Certificate Issuer	420014
Certificate Request	420015
Certificate Request Type	420016
Certificate Subject	420017
Certificate Subject Alternative Name	420018
Certificate Subject Distinguished Name	420019
Certificate Type	42001A
Certificate Value	42001B
Common Template-Attribute	42001C
Compromise Date	42001D
Compromise Occurrence Date	42001E
Contact Information	42001F
Credential	420020
Credential Type	420021
Credential Value	420022
Criticality Indicator	420023
CRT Coefficient	420024
Cryptographic Algorithm	420025
Cryptographic Length	420026
Cryptographic Parameters	420027
Cryptographic Usage Mask	420028
Custom Attribute	420029
D	42002A
Deactivation Date	42002B
Derivation Data	42002C
Derivation Method	42002D
Derivation Parameters	42002E
Destroy Date	42002F

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Tag	
Object	**Tag Value**
Digest	420030
Digest Value	420031
Encryption Key Information	420032
G	420033
Hashing Algorithm	420034
Initial Date	420035
Initialization Vector	420036
Issuer	420037
Iteration Count	420038
IV/Counter/Nonce	420039
J	42003A
Key	42003B
Key Block	42003C
Key Material	42003D
Key Part Identifier	42003E
Key Value	42003F
Key Value Type	420040
Key Wrapping Data	420041
Key Wrapping Specification	420042
Last Changed Date	420043
Lease Time	420044
Link	420045
Link Type	420046
Linked Object Identifier	420047
MAC/Signature	420048
MAC/Signature Key Information	420049
Maximum Items	42004A
Maximum Response Size	42004B
Message Extension	42004C
Modulus	42004D
Name	42004E
Name Type	42004F
Name Value	420050
Object Group	420051
Object Type	420052
Offset	420053

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Tag	
Object	**Tag Value**
Opaque Data Type	420054
Opaque Data Value	420055
Opaque Object	420056
Operation	420057
Operation Policy Name	420058
P	420059
Padding Method	42005A
Prime Exponent P	42005B
Prime Exponent Q	42005C
Prime Field Size	42005D
Private Exponent	42005E
Private Key	42005F
Private Key Template-Attribute	420060
Private Key Unique Identifier	420061
Process Start Date	420062
Protect Stop Date	420063
Protocol Version	420064
Protocol Version Major	420065
Protocol Version Minor	420066
Public Exponent	420067
Public Key	420068
Public Key Template-Attribute	420069
Public Key Unique Identifier	42006A
Put Function	42006B
Q	42006C
Q String	42006D
Query Function	42006E
Recommended Curve	42006F
Replaced Unique Identifier	420070
Request Header	420071
Request Message	420072
Request Payload	420073
Response Header	420074
Response Message	420075
Response Payload	420076
Result Message	420077

Tag	
Object	**Tag Value**
Result Reason	420078
Result Status	420079
Revocation Message	42007A
Revocation Reason	42007B
Revocation Reason Code	42007C
Role Type	42007D
Salt	42007E
Secret Data	42007F
Secret Data Type	420080
Serial Number	420081
Server Information	420082
Split Key	420083
Split Key Method	420084
Split Key Parts	420085
Split Key Threshold	420086
State	420087
Storage Status Mask	420088
Symmetric Key	420089
Template	42008A
Template-Attribute	42008B
Time Stamp	42008C
Unique Identifier	42008D
Unique Batch Item ID	42008E
Usage Limits	42008F
Usage Limits Byte Count	420090
Usage Limits Object Count	420091
Usage Limits Total Bytes	420092
Usage Limits Total Objects	420093
Validity Date	420094
Validity Indicator	420095
Vendor Extension	420096
Vendor Identification	420097
Wrapping Method	420098
X	420099
Y	42009A
(Reserved)	42009B - 42FFFF

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Tag	
Object	**Tag Value**
(Unused)	430000 – 53FFFF
Extensions	540000 – 54FFFF
(Unused)	550000 – FFFFFF

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9.1.3.2 Enumerations

The following tables define the values for enumerated lists.

9.1.3.2.1 Credential Type Enumeration

Credential Type	
Name	**Value**
Username & Password	00000001
Token	00000002
Biometric Measurement	00000003
Certificate	00000004
Extensions	8XXXXXXX

9.1.3.2.2 Key Value Type Enumeration

Key Value Type	
Name	**Value**
Raw	00000001
Opaque	00000002
PKCS#1	00000003
PKCS#8	00000004
X.509	00000005
Transparent Symmetric Key	00000006
Transparent DSA Private Key	00000007
Transparent DSA Public Key	00000008
Transparent RSA Private Key	00000009
Transparent RSA Public Key	0000000A
Transparent DH Private Key	0000000B
Transparent DH Public Key	0000000C
Transparent ECDSA Private Key	0000000D
Transparent ECDSA Public Key	0000000E
Transparent ECDH Private Key	0000000F
Transparent ECDH Public Key	00000010
Extensions	8XXXXXXX

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9.1.3.2.3 Wrapping Method Enumeration

Wrapping Method	
Name	**Value**
Encrypt	00000001
MAC/sign	00000002
Encrypt then MAC/sign	00000003
MAC/sign then encrypt	00000004
TR-31	00000005
Extensions	8XXXXXXX

9.1.3.2.4 Recommended Curves for ECDSA and ECDH

Recommended curves are defined in NIST FIPS PUB 186-3.

Recommended Curve Enumeration	
Name	**Value**
P-192	00000001
K-163	00000002
B-163	00000003
P-224	00000004
K-233	00000005
B-233	00000006
P-256	00000007
K-283	00000008
B-283	00000009
P-384	0000000A
K-409	0000000B
B-409	0000000C
P-521	0000000D
K-571	0000000E
B-571	0000000F
Extensions	8XXXXXXX

9.1.3.2.5 Certificate Type Enumeration

Certificate Type	
Name	**Value**
X.509	00000001
PGP	00000002
Extensions	8XXXXXXX

9.1.3.2.6 Split Key Method Enumeration

Split Key Method	
Name	**Value**
XOR	00000001
Polynomial Sharing GF(2^{16})	00000002
Polynomial Sharing Prime Field	00000003
Extensions	8XXXXXXX

9.1.3.2.7 Secret Data Type Enumeration

Secret Data Type	
Name	**Value**
Password	00000001
Seed	00000002
Extensions	8XXXXXXX

9.1.3.2.8 Opaque Data Type Enumeration

Opaque Data Type	
Name	**Value**
Extensions	8XXXXXXX

9.1.3.2.9 Name Type Enumeration

Name Type	
Name	**Value**
Uninterpreted Text String	00000001
URI	00000002
Extensions	8XXXXXXX

9.1.3.2.10 Object Type Enumeration

Object Type	
Name	**Value**
Certificate	00000001
Symmetric Key	00000002
Public Key	00000003
Private Key	00000004
Split Key	00000005
Template	00000006
Secret Data	00000007
Opaque Object	00000008
Extensions	8XXXXXXX

9.1.3.2.11 Cryptographic Algorithm Enumeration

Cryptographic Algorithm	
Name	**Value**
DES	00000001
3DES	00000002
AES	00000003
RSA	00000004
DSA	00000005
ECDSA	00000006
HMAC-SHA1	00000007
HMAC-SHA256	00000008
HMAC-SHA512	00000009
HMAC-MD5	0000000A
DH	0000000B
ECDH	0000000C
Extensions	8XXXXXXX

9.1.3.2.12 Block Cipher Mode Enumeration

Block Cipher Mode	
Name	**Value**
CBC	00000001
ECB	00000002
PCBC	00000003
CFB	00000004
OFB	00000005
CTR	00000006
CMAC	00000007
CCM	00000008
GCM	00000009
CBC-MAC	0000000A
NISTKeyWrap	0000000B
X9.102 AESKW	0000000C
X9.102 TDKW	0000000D
X9.102 AKW1	0000000E
X9.102 AKW2	0000000F
Extensions	8XXXXXXX

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9.1.3.2.13 Padding Method Enumeration

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Padding Method	
Name	**Value**
None	00000001
OAEP	00000002
PKCS5	00000003
SSL3	00000004
Zeros	00000005
ANSI X9.23	00000006
ISO 10126	00000007
PKCS1 v1.5	00000008
X9.31	00000009
PSS	0000000A
Extensions	8XXXXXXX

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9.1.3.2.14 Hashing Algorithm Enumeration

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Hashing Algorithm	
Name	**Value**
MD2	00000001
MD4	00000002
MD5	00000003
SHA-1	00000004
SHA-256	00000005
SHA-384	00000006
SHA-512	00000007
SHA-224	00000008
Extensions	8XXXXXXX

9.1.3.2.15 Role Type Enumeration

Role Type	
Name	**Value**
ZMK	00000001
ZPK	00000002
MAC	00000003
CVK	00000004
CSC	00000005
PVKIBM	00000006
PVKPVV	00000007
MKCVC	00000008
MKSMI	00000009
MKSMC	0000000A
MKIDN	0000000B
MKAC	0000000C
MKCAP	0000000D
BDK	0000000E
Extensions	8XXXXXXX

9.1.3.2.16 State Enumeration

State	
Name	**Value**
Pre-Active	00000001
Active	00000002
Deactivated	00000003
Compromised	00000004
Destroyed	00000005
Destroyed Compromised	00000006
Extensions	8XXXXXXX

9.1.3.2.17 Revocation Reason Code Enumeration

Revocation Reason Code

Name	Value
Key Compromise	00000001
CA Compromise	00000002
Affiliation Changed	00000003
Superseded	00000004
Cessation of Operation	00000005
Certificate Hold	00000006
Privilege Withdrawn	00000007
Revoked By creator	00000008
Revoked By Administrator	00000009
Extensions	8XXXXXXX

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1500 #### 9.1.3.2.18 Link Type Enumeration

Formatted Table

Link Type	
Name	**Value**
Certificate Link	00000101
Public Key Link	00000102
Private Key Link	00000103
Derivation Base Object Link	00000104
Derived Key Link	00000105
Replacement Object Link	00000106
Replaced Object Link	00000107
Extensions	8XXXXXXX

1501 Note: Link Types start at 101 to avoid any confusion with Object Types.

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1502 #### 9.1.3.2.19 Derivation Method Enumeration

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Derivation Method	
Name	**Value**
PBKDF2	00000001
HASH	00000002
HMAC	00000003
ENCRYPT	00000004
NIST800-108-C	00000005
NIST800-108-F	00000006
NIST800-108-DPI	00000007
Extensions	8XXXXXXX

9.1.3.2.20 Certificate Request Type Enumeration

Certificate Request Type	
Name	**Value**
PCKS#10	00000001
PEM	00000002
PGP	00000003
Extensions	8XXXXXXX

9.1.3.2.21 Validity Indicator Enumeration

Validity Indicator	
Name	**Value**
Valid	00000001
Invalid	00000002
Unknown	00000003
Extensions	8XXXXXXX

9.1.3.2.22 Query Function Enumeration

Query Function	
Name	**Value**
Query Operations	00000001
Query Objects	00000002
Query Server Information	00000003
Extensions	8XXXXXXX

9.1.3.2.23 Cancellation Result Enumeration

Cancellation Result	
Name	**Value**
Canceled	00000001
Unable to Cancel	00000002
Completed	00000003
Failed	00000004
Unavailable	00000005
Extensions	8XXXXXXX

9.1.3.2.24 Put Function Enumeration

Put Function	
Name	**Value**
New	00000001
Replace	00000002

Extensions	8XXXXXXX

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9.1.3.2.25 Operations Enumeration

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Operation	
Name	**Value**
Create	00000001
Create Key Pair	00000002
Register	00000003
Re-key	00000004
Derive Key	00000005
Certify	00000006
Re-certify	00000007
Locate	00000008
Check	00000009
Get	0000000A
Get Attributes	0000000B
Get Attribute List	0000000C
Add Attribute	0000000D
Modify Attribute	0000000E
Delete Attribute	0000000F
Obtain Lease	00000010
Get Usage Allocation	00000011
Activate	00000012
Revoke	00000013
Destroy	00000014
Archive	00000015
Recover	00000016
Validate	00000017
Query	00000018
Cancel	00000019
Poll	0000001A
Notify	0000001B
Put	0000001C
Extensions	8XXXXXXX

9.1.3.2.26 Result Status Enumeration

Result Status	
Name	**Value**
Success	00000000
Operation Failed	00000001
Operation Pending	00000002
Operation Undone	00000003
Extensions	8XXXXXXX

9.1.3.2.27 Result Reason Enumeration

Result Reason	
Name	**Value**
Item Not Found	00000001
Response Too Large	00000002
Authentication Not Successful	00000003
Invalid Message	00000004
Operation Not Supported	00000005
Missing Data	00000006
Invalid Field	00000007
Feature Not Supported	00000008
Operation Canceled By Requester	00000009
Cryptographic Failure	0000000A
Illegal Operation	0000000B
Permission Denied	0000000C
Object archived	0000000D
Index Out of Bounds	0000000E
General Failure	00000100
Extensions	8XXXXXXX

9.1.3.2.28 Batch Error Continuation Enumeration

Batch Error Continuation	
Name	**Value**
Continue	00000001
Stop	00000002
Undo	00000003
Extensions	8XXXXXXX

9.1.3.3 Bit Masks

9.1.3.3.1 Cryptographic Usage Mask Values

Cryptographic Usage Mask	
Name	**Value**
Sign	00000001
Verify	00000002
Encrypt	00000004
Decrypt	00000008
Wrap Key	00000010
Unwrap Key	00000020
Export	00000040
MAC Generate	00000080
MAC Verify	00000100
Derive Key	00000200
Content Commitment (Non Repudiation)	00000400
Key Agreement	00000800
Certificate Sign	00001000
CRL Sign	00002000
Extensions	XXXX0000

This list takes into consideration values which may appear in the Key Usage extension in an X.509 certificate.

9.1.3.3.2 Storage Status Mask

Storage Status Values	
Name	**Value**
On-line storage	00000001
Archival storage	00000002
Extensions	XXXXXXX0

9.2 XML Encoding

An XML Encoding has not yet been defined.

10 Transport

Transport protocols are not part of the message definitions, and are external to this protocol. The Usage Guide, however, describes two profiles for implementation of this protocol over secure transport protocols, namely:

- SSL/TLS over TCP. This profile describes the implementation of this protocol using SSL/TLS encryption, with client and server authentication features enabled, over a normal TCP stream.

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- HTTPS over TCP. This profile describes the implementation of this protocol using HTTPS, with client and server authentication features enabled, over a normal TCP stream.

To ensure a base level of interoperability, all server implementations should, at least, support the SSL/TLS and HTTPS transport protocols as described in the Usage Guide.

11 Error Handling

This section details the specific Result Reasons that should be returned for errors detected. Note that this is not an exhaustive list of possible errors for each operation (allowing other Result Reasons to be returned if an implementation needs to do so).

11.1 General

These errors may occur when any protocol message is received by the server.

Error Definition	Action	Result Reason
Protocol major version mismatch	Response message containing a header and a Batch Item without Operation, but with the Result Status field set to Operation Failed	Invalid Message
Error parsing batch item or payload within batch item (required fields missing, etc.)	Batch item fails; Result Status is Operation Failed	Invalid Message
The same field is contained in a header/batch item/payload more than once	Result Status is Operation Failed	Invalid Message
Same major version, different minor versions (client is newer): unknown fields/fields the server does not understand	Ignore unknown fields, process rest normally	N/A
Same major & minor version, unknown field	Result Status is Operation Failed	Invalid Field
Client is not allowed to perform the specified operation	Result Status is Operation Failed	Permission Denied
Operation cannot be completed synchronously and client does not support asynchronous requests	Result Status is Operation Failed	Operation Not Supported
Maximum Response Size has been exceeded	Result Status is Operation Failed	Response Too Large

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11.2 Create

Error Definition	Result Status	Result Reason
Object Type is not recognized	Operation Failed	Invalid Field
Templates that do not exist are given in request	Operation Failed	Item Not Found
Incorrect attribute value(s) specified (e.g. initial date 5 years ago)	Operation Failed	Invalid Field
Error creating cryptographic object (key material generation issue)	Operation Failed	Cryptographic Failure
Trying to set more instances than the server supports of an attribute that can have multiple instances	Operation Failed	Index Out of Bounds
Trying to create a new object with the same Name attribute value as an existing object	Operation Failed	Invalid Field
Template object is archived	Operation Failed	Object archived

11.3 Create Key Pair

Error Definition	Result Status	Result Reason
Templates that do not exist are given in request	Operation Failed	Item Not Found
Incorrect attribute value(s) specified	Operation Failed	Invalid Field
Error creating cryptographic object (key material generation issue)	Operation Failed	Cryptographic Failure
Trying to create a new object with the same Name attribute value as an existing object	Operation Failed	Invalid Field

Trying to set more instances than the server supports of an attribute that can have multiple instances	Operation Failed	Index Out of Bounds
Required field(s) missing	Operation Failed	Invalid Message
Template object is archived	Operation Failed	Object archived

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11.4 Register

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Error Definition	Result Status	Result Reason
Object Type is not recognized	Operation Failed	Invalid Field
Object Type does not match type of cryptographic object provided	Operation Failed	Invalid Field
Templates that do not exist are given in request	Operation Failed	Item Not Found
Incorrect attribute value(s) specified (e.g. initial date 5 years ago)	Operation Failed	Invalid Field
Trying to register a new object with the same Name attribute value as an existing object	Operation Failed	Invalid Field
Trying to set more instances than the server supports of an attribute that can have multiple instances	Operation Failed	Index Out of Bounds
Template object is archived	Operation Failed	Object archived

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11.5 Re-key

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Error Definition	Result Status	Result Reason
No object with the specified Unique Identifier exists	Operation Failed	Item Not Found
Object specified cannot be re-keyed (not a symmetric key, or the permissions do not allow it)	Operation Failed	Permission Denied
Offset field cannot be specified at the same time as any of the Activation Date, Process Start Date, Protect Stop Date, or Deactivation Date attributes	Operation Failed	Invalid Message
Cryptographic error during re-key	Operation Failed	Cryptographic Failure
Object is archived	Operation Failed	Object archived

11.6 Derive Key

Error Definition	Result Status	Result Reason
One or more of the objects specified do not exist	Operation Failed	Item Not Found
One or more of the objects specified are not of the correct type	Operation Failed	Invalid Field
Templates that do not exist are given in request	Operation Failed	Item Not Found
Invalid Derivation Method	Operation Failed	Invalid Field
Invalid Derivation Parameters	Operation Failed	Invalid Field
Ambiguous derivation data provided both with Derivation Data and Secret Data object.	Operation Failed	Invalid Message
Incorrect attribute value(s) specified (e.g. initial date 5 years ago)	Operation Failed	Invalid Field
One or more of the specified objects cannot be used to derive a new key	Operation Failed	Invalid Field
Trying to derive a new key with the same Name attribute value as an existing object	Operation Failed	Invalid Field
One or more of the objects is archived	Operation Failed	Object archived

11.7 Certify

Error Definition	Result Status	Result Reason
No object with the specified Unique Identifier exists	Operation Failed	Item Not Found
Object specified cannot be certified (not a public key or the permissions do not allow it)	Operation Failed	Permission Denied
The Certificate Request does not contain a signed certificate request of the specified Certificate Request Type	Operation Failed	Invalid Field
Server does not support operation	Operation Failed	Operation Not Supported
Object is archived	Operation Failed	Object archived

11.8 Re-certify

Error Definition	Result Status	Result Reason
No object with the specified Unique Identifier exists	Operation Failed	Item Not Found
Object specified cannot be certified (not a certificate or the permissions do not allow it)	Operation Failed	Permission Denied
The Certificate Request does not contain a signed certificate request of the specified Certificate Request Type	Operation Failed	Invalid Field
Server does not support operation	Operation Failed	Operation Not Supported
Offset field cannot be specified at the same time as any of the Activation Date or Deactivation Date attributes	Operation Failed	Invalid Message
Object is archived	Operation Failed	Object archived

11.9 Locate

Error Definition	Result Status	Result Reason
Non-existing attributes, attributes that the server does not understand or templates that do not exist are given in request	Operation Failed	Invalid Field

11.10 Check

Error Definition	Result Status	Result Reason
Object does not exist	Operation Failed	Item Not Found
Object is archived	Operation Failed	Object archived

11.11 Get

Error Definition	Result Status	Result Reason
Object does not exist	Operation Failed	Item Not Found
Wrapping key does not exist	Operation Failed	Item Not Found
Object with Wrapping Key ID exists, but it is not a key	Operation Failed	Illegal Operation
Object with Wrapping Key ID exists, but it cannot be used for wrapping	Operation Failed	Permission Denied
Object with MAC/Signature Key ID exists, but it is not a key	Operation Failed	Illegal Operation
Object with MAC/Signature Key ID exists, but it cannot be used for	Operation Failed	Permission Denied

MACing/signing		
Object exists and is not a Template, but the server only has attributes for this object	Operation Failed	Illegal Operation
Cryptographic Parameters associated with object do not exist or do not match with those provided in the Encryption Key Information and/or Signature Key Information	Operation Failed	Item Not Found
Object is archived	Operation Failed	Object archived

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11.12 Get Attributes

Error Definition	Result Status	Result Reason
No object with the specified Unique Identifier exists	Operation Failed	Item Not Found
An Attribute Index is specified but no matching instance exists.	Operation Failed	Item Not Found
Object is archived	Operation Failed	Object archived

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11.13 Get Attribute List

Error Definition	Result Status	Result Reason
No object with the specified Unique Identifier exists	Operation Failed	Item Not Found
Object is archived	Operation Failed	Object archived

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11.14 Add Attribute

Error Definition	Result Status	Result Reason
No object with the specified Unique Identifier exists	Operation Failed	Item Not Found
Attempt to add read-only attribute	Operation Failed	Permission Denied
The specified attribute already exists	Operation Failed	Illegal Operation
New attribute contains index	Operation Failed	Invalid Field
Trying to add a Name attribute with the same value that another object already has	Operation Failed	Illegal Operation
Trying to add a new instance to an attribute with multiple instances but the server limit on instances is reached	Operation Failed	Index Out of Bounds
Object is archived	Operation Failed	Object archived

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11.15 Modify Attribute

Error Definition	Result Status	Result Reason
No object with the specified Unique Identifier exists	Operation Failed	Item Not Found
A specified attribute does not exist (must first be added)	Operation Failed	Invalid Field
An Attribute Index is specified, but no matching instance exists.	Operation Failed	Item Not Found
The specified attribute is read-only	Operation Failed	Permission Denied
Trying to set the Name attribute value to a value already used by another object	Operation Failed	Illegal Operation
Object is archived	Operation Failed	Object archived

11.16 Delete Attribute

Error Definition	Result Status	Result Reason
No object with the specified Unique Identifier exists	Operation Failed	Item Not Found
Attempt to delete read-only/required attribute	Operation Failed	Permission Denied
Attribute index is specified, but attribute does not have multiple instances (i.e., no index should be specified)	Operation Failed	Item Not Found
No attribute with specified name exists	Operation Failed	Item Not Found
Object is archived	Operation Failed	Object archived

11.17 Obtain Lease

Error Definition	Result Status	Result Reason
No object with the specified Unique Identifier exists	Operation Failed	Item Not Found
The server determines that a new lease should not be issued for the specified cryptographic object	Operation Failed	Permission Denied
Object is archived	Operation Failed	Object archived

11.18 Get Usage Allocation

Error Definition	Result Status	Result Reason
No object with the specified Unique Identifier exists	Operation Failed	Item Not Found
Object has no Usage Limits attribute or object cannot be used for protection purposes	Operation Failed	Illegal Operation
Both Usage Limits Byte Count and Usage Limits Object Count fields are specified	Operation Failed	Invalid Message
Neither Byte Count or Object Count is specified	Operation Failed	Invalid Message
A usage type (Byte Count or Object Count) is specified in the request, but the usage allocation for the object can only be given for the other type	Operation Failed	Operation Not Supported
Object is archived	Operation Failed	Object archived

11.19 Activate

Error Definition	Result Status	Result Reason
No object with the specified Unique Identifier exists	Operation Failed	Item Not Found
Unique Identifier specifies template or other object that cannot be activated	Operation Failed	Illegal Operation
Object is not in Pre-Active state	Operation Failed	Permission Denied
Object is archived	Operation Failed	Object archived

11.20 Revoke

Error Definition	Result Status	Result Reason
No object with the specified Unique Identifier exists	Operation Failed	Item Not Found
Revocation Reason is not recognized	Operation Failed	Invalid Field
Unique Identifier specifies template or other object that cannot be revoked	Operation Failed	Illegal Operation
Object is archived	Operation Failed	Object archived

11.21 Destroy

Error Definition	Result Status	Result Reason
No object with the specified Unique Identifier exists	Operation Failed	Item Not Found

Object exists, but has already been destroyed	Operation Failed	Permission Denied
Object is not in Deactivated state	Operation Failed	Permission Denied
Object is archived	Operation Failed	Object archived

11.22 Archive

Error Definition	Result Status	Result Reason
No object with the specified Unique Identifier exists	Operation Failed	Item Not Found
Object is already archived	Operation Failed	Object archived

11.23 Recover

Error Definition	Result Status	Result Reason
No object with the specified Unique Identifier exists	Operation Failed	Item Not Found

11.24 Validate

Error Definition	Result Status	Result Reason
The combination of Certificate Objects and Unique Identifiers do not specify a certificate list	Operation Failed	Invalid Message
One or more of the objects is archived	Operation Failed	Object archived

11.25 Query

N/A

11.26 Cancel

N/A

11.27 Poll

Error Definition	Result Status	Result Reason
No outstanding operation with the specified Asynchronous Correlation Value exists	Operation Failed	Item Not Found

11.28 Batch Items

These errors may occur when a protocol message with one or more batch items is processed by the server. If a message with one or more batch items was parsed correctly, the response message should include response(s) to the batch item(s) in the request according to the table below.

Error Definition	Result Status	Result Reason
Processing of batch item fails with Batch Error Continuation Option set to Stop	Batch item fails. Responses to batch items that have already been processed are returned normally. Responses to batch items that have not been processed are not returned.	See tables above, referring to the operation being performed in the batch item that failed
Processing of batch item fails with Batch Error Continuation Option set to Continue	Batch item fails. Responses to other batch items are returned normally.	See tables above, referring to the operation being performed in the batch item that failed
Processing of batch item fails with Batch Error Continuation Option set to Undo	Batch item fails. Batch items that had been processed have been undone and their responses are returned with Undone result status.	See tables above, referring to the operation being performed in the batch item that failed

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12 Security Considerations

TBD

A. Attribute Cross-reference

The following table of Attribute names indicates the Managed Object(s) for which each attribute applies.
This table is not normative.

Attribute Name	Managed Object							
	Certificate	Symmetric Key	Public Key	Private Key	Split Key	Template	Secret Data	Opaque Object
Unique Identifier	x	x	x	x	x	x	x	x
Name	x	x	x	x	x	x	x	x
Object Type	x	x	x	x	x	x	x	x
Cryptographic Algorithm	x	x	x	x	x	x		
Cryptographic Length	x	x	x	x	x	x		
Cryptographic Parameters	x	x	x	x	x	x		
Certificate Type	x							
Certificate Issuer	x							
Certificate Subject	x							
Digest	x	x	x	x	x		x	
Operation Policy Name	x	x	x	x	x	x	x	x
Cryptographic Usage Mask	x	x	x	x	x	x	x	
Lease Time	x	x	x	x	x		x	x
Usage Limits		x	x	x	x	x		
State	x	x	x	x	x		x	
Initial Date	x	x	x	x	x	x	x	x
Activation Date	x	x	x	x	x	x	x	
Process Start Date		x			x	x		
Protect Stop Date		x			x	x		
Deactivation Date	x	x	x	x	x	x	x	x
Destroy Date	x	x	x	x	x		x	x
Compromise Occurrence Date	x	x	x	x	x		x	x
Compromise Date	x	x	x	x	x		x	x
Revocation Reason	x	x	x	x	x		x	x
Archive Date	x	x	x	x	x	x	x	x
Object Group	x	x	x	x	x	x	x	x
Link	x	x	x	x	x		x	
Application Specific Identification	x	x	x	x	x	x	x	x

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	Managed Object							
Contact Information	x	x	x	x	x	x	x	x
Last Changed Date	x	x	x	x	x	x	x	x
Custom Attribute	x	x	x	x	x	x	x	x

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B. Tag Cross-reference

This table is not normative.

Object	Defined	Type	Notes
Activation Date	3.17	Date-Time	
Application Identifier	3.28	Text String	
Application Name Space	3.28	Text String	
Application Specific Identification	3.28	Structure	
Archive Date	3.25	Date-Time	
Asynchronous Correlation Value	6.8	Octet String	
Asynchronous Indicator	6.7	Boolean	
Attribute	2.1.1	Structure	
Attribute Index	2.1.1	Integer	
Attribute Name	2.1.1	Text String	
Attribute Value	2.1.1	*	type varies
Authentication	6.6	Structure	
Batch Count	6.14	Integer	
Batch Error Continuation Option	6.13 , 9.1.3.2.28	Enumeration	
Batch Item	6.15	Structure	
Batch Order Option	6.12	Boolean	
Block Cipher Mode	3.6 , 9.1.3.2.12	Enumeration	
Cancellation Result	4.25 , 9.1.3.2.23	Enumeration	
Certificate	2.2.1	Structure	
Certificate Issuer	3.8	Structure	
Certificate Request	4.6 , 4.7	Octet String	
Certificate Request Type	4.6 , 4.7 , 9.1.3.2.20	Enumeration	
Certificate Subject	3.9	Structure	
Certificate Subject Alternative Name	3.9	Text String	
Certificate Subject Distinguished Name	3.9	Text String	
Certificate Type	2.2.1 , 3.7 , 9.1.3.2.5	Enumeration	
Certificate Value	2.2.1	Octet String	
Common Template-Attribute	2.1.8	Structure	
Compromise Occurrence Date	3.22	Date-Time	
Compromise Date	3.23	Date-Time	
Contact Information	3.29	Text String	
Credential	2.1.2	Structure	
Credential Type	2.1.2 , 9.1.3.2.1	Enumeration	
Credential Value	2.1.2	Octet String	
Criticality Indicator	6.16	Boolean	

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Object	Defined	Type	Notes
CRT Coefficient	2.1.7	Big Integer	
Cryptographic Algorithm	3.4 , 9.1.3.2.11	Enumeration	
Cryptographic Length	3.5	Integer	
Cryptographic Parameters	3.6	Structure	
Cryptographic Usage Mask	3.12 , 9.1.3.3.1	Integer	Bit mask
Custom Attribute	3.31	*	type varies
D	2.1.7	Big Integer	
Deactivation Date	3.20	Date-Time	
Derivation Data	4.5	Octet String	
Derivation Method	4.5 , 9.1.3.2.19	Enumeration	
Derivation Parameters	4.5	Structure	
Destroy Date	3.21	Date-Time	
Digest	3.10	Structure	
Digest Value	3.10	Octet String	
Encryption Key Information	2.1.5	Structure	
Extensions	9.1.3		
G	2.1.7	Big Integer	
Hashing Algorithm	3.6 , 3.10 , 9.1.3.2.14	Enumeration	
Initial Date	3.16	Date-Time	
Initialization Vector	4.5	Octet String	
Issuer	3.8	Text String	
Iteration Count	4.5	Integer	
IV/Counter/Nonce	2.1.5	Octet String	
J	2.1.7	Big Integer	
Key	2.1.7	Octet String	
Key Block	2.1.3	Structure	
Key Material	2.1.4 , 2.1.7	Octet String / Structure	
Key Part Identifier	2.2.5	Integer	
Key Value	2.1.4	Octet String / Structure	
Key Value Type	2.1.4 , 9.1.3.2.2	Enumeration	
Key Wrapping Data	2.1.5	Structure	
Key Wrapping Specification	2.1.6	Structure	
Last Changed Date	3.30	Date-Time	
Lease Time	3.13	Interval	
Link	3.27	Structure	
Link Type	3.27 , 9.1.3.2.18	Enumeration	
Linked Object Identifier	3.27	Text String	
MAC/Signature	2.1.5	Octet String	

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Object	Defined	Type	Notes
MAC/Signature Key Information	2.1.5	Text String	
Maximum Items	4.8	Integer	
Maximum Response Size	6.3	Integer	
Message Extension	6.16	Structure	
Modulus	2.1.7	Big Integer	
Name	3.2	Structure	
Name Type	3.2 , 9.1.3.2.9	Enumeration	
Name Value	3.2	Text String	
Object Group	3.26	Text String	
Object Type	3.3 , 9.1.3.2.10	Enumeration	
Offset	4.4 , 4.7	Interval	
Opaque Data Type	2.2.8 , 9.1.3.2.8	Enumeration	
Opaque Data Value	2.2.8	Octet String	
Opaque Object	2.2.8	Structure	
Operation	6.2 , 9.1.3.2.25	Enumeration	
Operation Policy Name	3.11	Text String	
P	2.1.7	Big Integer	
Padding Method	3.6 , 9.1.3.2.13	Enumeration	
Prime Exponent P	2.1.7	Big Integer	
Prime Exponent Q	2.1.7	Big Integer	
Prime Field Size	2.2.5	Big Integer	
Private Exponent	2.1.7	Big Integer	
Private Key	2.2.4	Structure	
Private Key Template-Attribute	2.1.8	Structure	
Private Key Unique Identifier	4.2	Text String	
Process Start Date	3.18	Date-Time	
Protect Stop Date	3.19	Date-Time	
Protocol Version	6.1	Structure	
Protocol Version Major	6.1	Integer	
Protocol Version Minor	6.1	Integer	
Public Exponent	2.1.7	Big Integer	
Public Key	2.2.3	Structure	
Public Key Template-Attribute	2.1.8	Structure	
Public Key Unique Identifier	4.2	Text String	
Put Function	5.2 , 9.1.3.2.24	Enumeration	
Q	2.1.7	Big Integer	
Q String	2.1.7	Octet String	
Query Function	4.24 , 9.1.3.2.22	Enumeration	
Recommended Curve	2.1.7 , 9.1.3.2.4	Enumeration	

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Object	Defined	Type	Notes
Replaced Unique Identifier	5.2	Text String	
Request Header	7.2 , 7.3	Structure	
Request Message	7.1	Structure	
Request Payload	4 , 5 , 7.2 , 7.3	Structure	
Response Header	7.2 , 7.3	Structure	
Response Message	7.1	Structure	
Response Payload	4 , 7.2 , 7.3	Structure	
Result Message	6.11	Text String	
Result Reason	6.10 , 9.1.3.2.27	Enumeration	
Result Status	6.9 , 9.1.3.2.26	Enumeration	
Revocation Message	3.24	Text String	
Revocation Reason	3.24	Structure	
Revocation Reason Code	3.24 , 9.1.3.2.17	Enumeration	
Role Type	3.6 , 9.1.3.2.15	Enumeration	
Salt	4.5	Octet String	
Secret Data	2.2.7	Structure	
Secret Data Type	2.2.7 , 9.1.3.2.7	Enumeration	
Serial Number	3.8	Text String	
Server Information	4.24	Structure	contents vendor-specific
Split Key	2.2.5	Structure	
Split Key Method	2.2.5 , 9.1.3.2.6	Enumeration	
Split Key Parts	2.2.5	Integer	
Split Key Threshold	2.2.5	Integer	
State	3.15 , 9.1.3.2.16	Enumeration	
Storage Status Mask	4.8 , 9.1.3.3.2	Integer	Bit mask
Symmetric Key	2.2.2	Structure	
Template	2.2.6	Structure	
Template-Attribute	2.1.8	Structure	
Time Stamp	6.5	Date-Time	
Transparent*	2.1.7	Structure	
Unique Identifier	3.1	Text String	
Unique Batch Item ID	6.4	Octet String	
Usage Limits	3.14	Structure	
Usage Limits Byte Count	3.14	Big Integer	
Usage Limits Object Count	3.14	Big Integer	
Usage Limits Total Bytes	3.14	Big Integer	
Usage Limits Total Objects	3.14	Big Integer	
Validity Date	4.23	Date-Time	

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Object	Defined	Type	Notes
Validity Indicator	4.23 , 9.1.3.2.21	Enumeration	
Vendor Extension	6.16	Structure	contents vendor-specific
Vendor Identification	4.24 , 6.16	Text String	
Wrapping Method	2.1.5 , 9.1.3.2.3	Enumeration	
X	2.1.7	Big Integer	
Y	2.1.7	Big Integer	

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C. Operation and Object Cross-reference

The following table indicates the types of Managed Object(s) that each Operation can take as input or provide as output. This table is not normative.

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Operation	Managed Objects							
	Certificate	Symmetric Key	Public Key	Private Key	Split Key	Template	Secret Data	Opaque Object
Create	N/A	Y	N/A	N/A	N/A	Y	N/A	N/A
Create Key Pair	N/A	N/A	Y	Y	N/A	N/A	N/A	N/A
Register	Y	Y	Y	Y	Y	Y	Y	Y
Re-Key	N/A	Y	N/A	N/A	N/A	Y	N/A	N/A
Derive Key	N/A	Y	N/A	N/A	N/A	Y	Y	N/A
Certify	Y	N/A	Y	N/A	N/A	Y	N/A	N/A
Re-certify	Y	N/A	N/A	N/A	N/A	Y	N/A	N/A
Locate	Y	Y	Y	Y	Y	Y	Y	Y
Check	Y	Y	Y	Y	Y	N/A	Y	Y
Get	Y	Y	Y	Y	Y	Y	Y	Y
Get Attributes	Y	Y	Y	Y	Y	Y	Y	Y
Get Attribute List	Y	Y	Y	Y	Y	Y	Y	Y
Add Attribute	Y	Y	Y	Y	Y	Y	Y	Y
Modify Attribute	Y	Y	Y	Y	Y	Y	Y	Y
Delete Attribute	Y	Y	Y	Y	Y	Y	Y	Y
Obtain Lease	Y	Y	Y	Y	Y	N/A	Y	N/A
Get Usage Allocation	N/A	Y	Y	Y	N/A	N/A	N/A	N/A
Activate	Y	Y	Y	Y	Y	N/A	Y	N/A
Revoke	Y	Y	N/A	Y	Y	N/A	Y	Y
Destroy	Y	Y	Y	Y	Y	Y	Y	Y
Archive	Y	Y	Y	Y	Y	Y	Y	Y
Recover	Y	Y	Y	Y	Y	Y	Y	Y
Validate	Y	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Query	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cancel	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Poll	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Notify	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Put	Y	Y	Y	Y	Y	Y	Y	Y

D. Acronyms

The following abbreviations and acronyms are used in this document:

3DES - Three key Data Encryption Standard

AES - Advanced Encryption Standard specified in FIPS 197

ASN.1 - Abstract Syntax Notation One

CA - Certification Authority

CBC - Cipher Block Chaining

CPU - Central Processing Unit

CRL - Certificate Revocation List

CRT - Chinese Remainder Theorem

DER - Distinguished Encoding Rules

DES - Data Encryption Standard

DH - Diffie-Hellman

DSA - Digital Signature Algorithm specified in FIPS 186-3

DSKPP - Dynamic Symmetric Key Provisioning Protocol

ECB - Electronic Code Book

ECDH - Elliptic Curve Diffie-Hellman

ECDSA - Elliptic Curve Digital Signature Algorithm specified in ANSX9.62

HMAC - Keyed-Hash Message Authentication Code specified in FIPS 198

HTTP - Hyper Text Transfer Protocol

HTTP(S) - Hyper Text Transfer Protocol (Secure socket)

IEEE - Institute of Electrical and Electronics Engineers

IETF - Internet Engineering Task Force

IPsec - Internet Protocol Security

IV - Initialization Vector

KMIP - Key Management Interoperability Protocol

MAC - Message Authentication Code

MD5 - Message Digest 5 Algorithm

PBKDF2 - Password-Based Key Derivation Function 2

PGP - Pretty Good Privacy

PKCS - Public Key Cryptography Standards

POSIX - Portable Operating System Interface

RFC - Request for Comments documents of IETF

RSA - Rivest, Shamir, Adelman (an algorithm)

SHA-1 - Secure Hash Algorithm Revision One

SSL/TLS - Secure Sockets Layer/Transport Layer Security

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1616 S/MIME - Secure/Multipurpose Internet Mail Extensions
1617 TCP - Transport Control Protocol
1618 TTLV - Tag, Type, Length, Value
1619 URI - Unique Resource Identifier
1620 UTF - Universal Transformation Format
1621 XML - Extensible Markup Language

E. Acknowledgements

The following individuals have participated in the creation of this specification and are gratefully acknowledged:

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TBD

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F. Revision History

Revision	Date	Editor	Changes Made
ed-0.98	2009-05-21	Robert Haas	Changes to TTLV format for 64-bit alignment. Appendices indicated as non normative.
ed-0.98	2009-04-24	Robert Haas	Initial conversion of input document to OASIS format together with clarifications.
ed-0.98	2009-06-25	Robert Haas, Indra Fitzgerald	Multiple editorial and technical changes, including merge of Template and Policy Template.
ed-0.98	2009-07-23	Robert Haas, Indra Fitzgerald	Multiple editorial and technical changes, mainly based on comments from Elaine Barker and Judy Furlong. Fix of Template Name.

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Template-Attribute	Yes, May be repeated	Specifies the attributes of the new Template using templates and/or as individual attributes

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