Key Management Interoperability Protocol Specification Version 2.0

OASIS Standard

31 October 2019

This version:
https://docs.oasis-open.org/kmip/kmip-spec/v2.0/os/kmip-spec-v2.0-os.docx (Authoritative)
https://docs.oasis-open.org/kmip/kmip-spec/v2.0/os/kmip-spec-v2.0-os.html
https://docs.oasis-open.org/kmip/kmip-spec/v2.0/os/kmip-spec-v2.0-os.pdf

Previous version:
https://docs.oasis-open.org/kmip/kmip-spec/v2.0/csd01/kmip-spec-v2.0-csd01.docx (Authoritative)
https://docs.oasis-open.org/kmip/kmip-spec/v2.0/csd01/kmip-spec-v2.0-csd01.html
https://docs.oasis-open.org/kmip/kmip-spec/v2.0/csd01/kmip-spec-v2.0-csd01.pdf

Latest version:
https://docs.oasis-open.org/kmip/kmip-spec/v2.0/kmip-spec-v2.0.docx (Authoritative)
https://docs.oasis-open.org/kmip/kmip-spec/v2.0/kmip-spec-v2.0.html
https://docs.oasis-open.org/kmip/kmip-spec/v2.0/kmip-spec-v2.0.pdf

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

Chairs:
Tony Cox (tony.cox@cryptsoft.com), Cryptsoft Pty Ltd.
Judith Furlong (Judith.Furlong@dell.com), Dell

Editors:
Tony Cox (tony.cox@cryptsoft.com), Cryptsoft Pty Ltd.
Charles White (chuck@fornetix.com), Fornetix

Related work:

This specification replaces or supersedes:

- *Key Management Interoperability Protocol Specification Version 1.4*. Edited by Tony Cox. OASIS Standard. Latest version: https://docs.oasis-open.org/kmip/spec/v1.4/kmip-spec-v1.4.html.

This specification is related to:

- *Key Management Interoperability Protocol Profiles Version 2.0.* Edited by Tim Hudson and Robert Lockhart. Latest version: https://docs.oasis-open.org/kmip/kmip-profiles/v2.0/kmip-profiles-v2.0.html.
- *Key Management Interoperability Protocol Test Cases Version 2.0. Edited by Tim Hudson* and Mark Joseph. Latest version: https://docs.oasis-open.org/kmip/kmip-testcases/v2.0/kmip-testcases-v2.0.html.
- *Key Management Interoperability Protocol Usage Guide Version 2.0.* Edited by Judith Furlong. Latest version: https://docs.oasis-open.org/kmip/kmip-ug/v2.0/kmip-ug-v2.0.html.

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 membership of OASIS on the above date. The level of approval is also listed above. Check the “Latest version” location noted above for possible later revisions of this document. Any other numbered Versions and other technical work produced by the Technical Committee (TC) are listed at https://www.oasis-open.org/committees/tc_home.php?wg_abbrev=kmip#technical.

TC members should send comments on this specification to the TC’s email list. Others should send comments to the TC’s public comment list, after subscribing to it by following the instructions at the “Send A Comment” button on the TC’s web page at https://www.oasis-open.org/committees/kmip/.

This specification is provided under the RF on RAND Terms Mode of the OASIS IPR Policy, the mode chosen when the Technical Committee was established. For information on whether any patents have been disclosed that may be essential to implementing this specification, and any offers of patent licensing terms, please refer to the Intellectual Property Rights section of the TC’s web page (https://www.oasis-open.org/committees/kmip/ipr.php).

Note that any machine-readable content (Computer Language Definitions) declared Normative for this Work Product is provided in separate plain text files. In the event of a discrepancy between any such plain text file and display content in the Work Product's prose narrative document(s), the content in the separate plain text file prevails.

Citation format:

When referencing this specification the following citation format should be used:

[kmip-spec-v2.0]

Key Management Interoperability Protocol Specification Version 2.0. Edited by Tony Cox and Charles White. 31 October 2019. OASIS Standard. https://docs.oasis-open.org/kmip/kmip-spec/v2.0/os/kmip-spec-v2.0-os.html. Latest version: https://docs.oasis-open.org/kmip/kmip-spec/v2.0/kmip-spec-v2.0.html.

Notices

All capitalized terms in the following text have the meanings assigned to them in the OASIS Intellectual Property Rights Policy (the "OASIS IPR Policy"). The full Policy may be found at the OASIS website.

This document and translations of it may be copied and furnished to others, and derivative works that comment on or otherwise explain it or assist in its implementation may be prepared, copied, published, and distributed, in whole or in part, without restriction of any kind, provided that the above copyright notice and this section are included on all such copies and derivative works. However, this document itself may not be modified in any way, including by removing the copyright notice or references to OASIS, except as needed for the purpose of developing any document or deliverable produced by an OASIS Technical Committee (in which case the rules applicable to copyrights, as set forth in the OASIS IPR Policy, must be followed) or as required to translate it into languages other than English.

The limited permissions granted above are perpetual and will not be revoked by OASIS or its successors or assigns.

This document and the information contained herein is provided on an "AS IS" basis and OASIS DISCLAIMS ALL WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY THAT THE USE OF THE INFORMATION HEREIN WILL NOT INFRINGE ANY OWNERSHIP RIGHTS OR ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

OASIS requests that any OASIS Party or any other party that believes it has patent claims that would necessarily be infringed by implementations of this OASIS Committee Specification or OASIS Standard, to notify OASIS TC Administrator and provide an indication of its willingness to grant patent licenses to such patent claims in a manner consistent with the IPR Mode of the OASIS Technical Committee that produced this specification.

OASIS invites any party to contact the OASIS TC Administrator if it is aware of a claim of ownership of any patent claims that would necessarily be infringed by implementations of this specification by a patent holder that is not willing to provide a license to such patent claims in a manner consistent with the IPR Mode of the OASIS Technical Committee that produced this specification. OASIS may include such claims on its website, but disclaims any obligation to do so.

OASIS takes no position regarding the validity or scope of any intellectual property or other rights that might be claimed to pertain to the implementation or use of the technology described in this document or the extent to which any license under such rights might or might not be available; neither does it represent that it has made any effort to identify any such rights. Information on OASIS' procedures with respect to rights in any document or deliverable produced by an OASIS Technical Committee can be found on the OASIS website. Copies of claims of rights made available for publication and any assurances of licenses to be made available, or the result of an attempt made to obtain a general license or permission for the use of such proprietary rights by implementers or users of this OASIS Committee Specification or OASIS Standard, can be obtained from the OASIS TC Administrator. OASIS makes no representation that any information or list of intellectual property rights will at any time be complete, or that any claims in such list are, in fact, Essential Claims.

The name "OASIS" is a trademark of OASIS, the owner and developer of this specification, and should be used only to refer to the organization and its official outputs. OASIS welcomes reference to, and implementation and use of, specifications, while reserving the right to enforce its marks against misleading uses. Please see https://www.oasis-open.org/policies-guidelines/trademark for above guidance.

Table of Contents

1 Introduction

This document is intended as a specification of the protocol used for the communication (request and response messages) between clients and servers to perform certain management operations on objects stored and maintained by a key management system. These objects are referred to as Managed Objects in this specification. They include symmetric and asymmetric cryptographic keys and digital certificates . 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 are obtained from the system via operations. Certain attributes are added, modified, or deleted by operations.

This specification is complemented by several other documents. The KMIP Usage Guide **[KMIP-UG]** provides illustrative information on using the protocol. The KMIP Profiles Specification **[KMIP-Prof]** provides a normative set of base level conformance profiles and authentication suites that include the specific tests used to test conformance with the applicable KMIP normative documents. The KMIP Test Cases **[KMIP-TC]** provides samples of protocol messages corresponding to a set of defined test cases that are also used in conformance testing.

This specification defines the KMIP protocol version major 2 and minor 0 (see 6.1).

1.1 IPR Policy

This specification is provided under the RF on RAND Terms Mode of the OASIS IPR Policy, the mode chosen when the Technical Committee was established. For information on whether any patents have been disclosed that may be essential to implementing this specification, and any offers of patent licensing terms, please refer to the Intellectual Property Rights section of the TC's web page (https://www.oasis-open.org/committees/kmip/ipr.php).

1.2 Terminology

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

For acronyms used in this document, see Appendix B. For definitions not found in this document, see **[SP800-57-1]**.

Term	Definition
Archive	To place information not accessed frequently into long-term storage.
Asymmetric key pair (key pair)	A public key and its corresponding private key; a key pair is used with a public key algorithm.
Authentication	A process that establishes the origin of information, or determines an entity's identity.
Authentication code	A cryptographic checksum based on a security function.
Authorization	Access privileges that are granted to an entity; conveying an "official" sanction to perform a security function or activity.
Certificate length	The length (in bytes) of an X.509 public key certificate.
Certification authority	The entity in a Public Key Infrastructure (PKI) that is responsible for issuing certificates, and exacting compliance to a PKI policy.

Term	Definition
Ciphertext	Data in its encrypted form.
Compromise	The unauthorized disclosure, modification, substitution or use of sensitive data (e.g., keying material and other security-related information).
Confidentiality	The property that sensitive information is not disclosed to unauthorized entities.
Cryptographic algorithm	A well-defined computational procedure that takes variable inputs, including a cryptographic key and produces an output.
Cryptographic key (key)	A parameter used in conjunction with a cryptographic algorithm that determines its operation in such a way that an entity with knowledge of the key can reproduce or reverse the operation, while an entity without knowledge of the key cannot. Examples include: 1. The transformation of plaintext data into ciphertext data, 2. The transformation of ciphertext data into plaintext data, 3. The computation of a digital signature from data, 4. The verification of a digital signature, 5. The computation of an authentication code from data, and 6. The verification of an authentication code from data and a received authentication code.
Decryption	The process of changing ciphertext into plaintext using a cryptographic algorithm and key.
Digest (or hash)	The result of applying a hashing algorithm to information.
Digital signature (signature)	The result of a cryptographic transformation of data that, when properly implemented with supporting infrastructure and policy, provides the services of: 1. origin authentication 2. data integrity, and 3. signer non-repudiation.
Digital Signature Algorithm	A cryptographic algorithm used for digital signature.
Encryption	The process of changing plaintext into ciphertext using a cryptographic algorithm and key.
Hashing algorithm (or hash algorithm, hash function)	An algorithm that maps a bit string of arbitrary length to a fixed length bit string. Approved hashing algorithms satisfy the following properties: 1. (One-way) It is computationally infeasible to find any input that maps to any pre-specified output, and 2. (Collision resistant) It is computationally infeasible to find any two distinct inputs that map to the same output.
Integrity	The property that sensitive data has not been modified or deleted in an unauthorized and undetected manner.

Term	Definition
Key derivation (derivation)	A function in the lifecycle of keying material; the process by which one or more keys are derived from: 1) Either a shared secret from a key agreement computation or a pre-shared cryptographic key, and 2) Other information.
Key management	The activities involving the handling of cryptographic keys and other related security parameters (e.g., IVs and passwords) during the entire life cycle of the keys, including their generation, storage, establishment, entry and output, and destruction.
Key wrapping (wrapping)	A method of encrypting and/or MACing/signing keys.
Message Authentication Code (MAC)	A cryptographic checksum on data that uses a symmetric key to detect both accidental and intentional modifications of data.
PGP Key	A RFC 4880-compliant container of cryptographic keys and associated metadata. Usually text-based (in PGP-parlance, ASCII-armored).
Private key	A cryptographic key used with a public key cryptographic algorithm that is uniquely associated with an entity and is not made public. The private key is associated with a public key. Depending on the algorithm, the private key MAY be used to: 1. Compute the corresponding public key, 2. Compute a digital signature that can be verified by the corresponding public key, 3. Decrypt data that was encrypted by the corresponding public key, or 4. Compute a piece of common shared data, together with other information.
Profile	A specification of objects, attributes, operations, message elements and authentication methods to be used in specific contexts of key management server and client interactions (see **[KMIP-Prof]**).
Public key	A cryptographic key used with a public key cryptographic algorithm that is uniquely associated with an entity and that MAY be made public. The public key is associated with a private key. The public key MAY be known by anyone and, depending on the algorithm, MAY be used to: 1. Verify a digital signature that is signed by the corresponding private key, 2. Encrypt data that can be decrypted by the corresponding private key, or 3. Compute a piece of shared data.
Public key certificate (certificate)	A set of data that uniquely identifies an entity, contains the entity's public key and possibly other information, and is digitally signed by a trusted party, thereby binding the public key to the entity.
Public key cryptographic algorithm	A cryptographic algorithm that uses two related keys, a public key and a private key. The two keys have the property that determining the private key from the public key is computationally infeasible.

Term	Definition
Public Key Infrastructure	A framework that is established to issue, maintain and revoke public key certificates.
Recover	To retrieve information that was archived to long-term storage.
Split Key	A process by which a cryptographic key is split into *n* multiple key components, individually providing no knowledge of the original key, which can be subsequently combined to recreate the original cryptographic key. If knowledge of *k* (where *k* is less than or equal to *n*) components is necessary to construct the original key, then knowledge of any *k*-1 key components provides no information about the original key other than, possibly, its length.
Symmetric key	A single cryptographic key that is used with a secret (symmetric) key algorithm.
Symmetric key algorithm	A cryptographic algorithm that uses the same secret (symmetric) key for an operation and its inverse (e.g., encryption and decryption).
X.509 certificate	The ISO/ITU-T X.509 standard defined two types of certificates – the X.509 public key certificate, and the X.509 attribute certificate. Most commonly (including this document), an X.509 certificate refers to the X.509 public key certificate.
X.509 public key certificate	The public key for a user (or device) and a name for the user (or device), together with some other information, rendered un-forgeable by the digital signature of the certification authority that issued the certificate, encoded in the format defined in the ISO/ITU-T X.509 standard.

Table 1: Terminology

1.3 Normative References

[AWS-SIGV4] *Authenticating Requests (AWS Signature Version 4)* https://docs.aws.amazon.com/AmazonS3/latest/API/sig-v4-authenticating-requests.htm

[CHACHA] D. J. Bernstein. ChaCha, a variant of Salsa20. https://cr.yp.to/chacha/chacha-20080128.pdf

[ECC-Brainpool] *ECC Brainpool Standard Curves and Curve Generation v. 1.0.19.10.2005*, http://www.ecc-brainpool.org/download/Domain-parameters.pdf**.**

[FIPS180-4] *Secure Hash Standard (SHS)*, FIPS PUB 186-4, March 2012, http://csrc.nist.gov/publications/fips/fips18-4/fips-180-4.pdf.

[FIPS186-4] *Digital Signature Standard (DSS)*, FIPS PUB 186-4, July 2013, http://nvlpubs.nist.gov/nistpubs/FIPS/NIST.FIPS.186-4.pdf.

[FIPS197] *Advanced Encryption Standard*, FIPS PUB 197, November 2001, http://csrc.nist.gov/publications/fips/fips197/fips-197.pdf.

[FIPS198-1] *The Keyed-Hash Message Authentication Code (HMAC)*, FIPS PUB 198-1, July 2008, http://csrc.nist.gov/publications/fips/fips198-1/FIPS-198-1_final.pdf.

[FIPS202] SHA-3 Standard: Permutation-Based Hash and Extendable-Output Functions, August 2015. http://nvlpubs.nist.gov/nistpubs/FIPS/NIST.FIPS.202.pdf

[IEEE1003-1] IEEE Std 1003.1, *Standard for information technology - portable operating system interface (POSIX). Shell and utilities*, 2004.

[ISO16609] ISO, *Banking -- Requirements for message authentication using symmetric techniques*, ISO 16609, 2012.

[ISO9797-1] ISO/IEC, *Information technology -- Security techniques -- Message Authentication Codes (MACs) -- Part 1: Mechanisms using a block cipher*, ISO/IEC 9797-1, 2011.

[KMIP-Prof] *Key Management Interoperability Protocol Profiles Version 2.0.* Edited by Tim Hudson and Robert Lockhart. Latest version: https://docs.oasis-open.org/kmip/kmip-profiles/v2.0/kmip-profiles-v2.0.html.

[PKCS#1] RSA Laboratories, *PKCS #1 v2.1: RSA Cryptography Standard*, June 14, 2002, http://www.preserveitall.org/emc-plus/rsa-labs/standards-initiatives/pkcs-rsa-cryptography-standard.htm.

[PKCS#5] RSA Laboratories, *PKCS #5 v2.1: Password-Based Cryptography Standard*, October 5, 2006, http://www.preserveitall.org/emc-plus/rsa-labs/standards-initiatives/pkcs-5-password-based-cryptography-standard.htm.

[PKCS#8] RSA Laboratories, *PKCS#8 v1.2: Private-Key Information Syntax Standard*, November 1, 1993, http://www.preserveitall.org/emc-plus/rsa-labs/standards-initiatives/pkcs-8-private-key-information-syntax-stand.htm.

[PKCS#10] RSA Laboratories, *PKCS #10 v1.7: Certification Request Syntax Standard*, May 26, 2000, http://www.preserveitall.org/emc-plus/rsa-labs/standards-initiatives/pkcs10-certification-request-syntax-standard.htm.

[PKCS#11] OASIS PKCS#11 Cryptographic Token Interface Base Specification Version 3.0

[POLY1305] Daniel J. Bernstein. *The Poly1305-AES Message-Authentication Code*. In Henri Gilbert and Helena Handschuh, editors, Fast Software Encryption: 12th International Workshop, FSE 2005, Paris, France, February 21-23, 2005, Revised Selected Papers, volume 3557 of Lecture Notes in Computer Science, pages 32–49. Springer, 2005.

[RFC1319] B. Kaliski, *The MD2 Message-Digest Algorithm*, IETF RFC 1319, Apr 1992, http://www.ietf.org/rfc/rfc1319.txt.

[RFC1320] R. Rivest, *The MD4 Message-Digest Algorithm*, IETF RFC 1320, April 1992, http://www.ietf.org/rfc/rfc1320.txt.

[RFC1321] R. Rivest, *The MD5 Message-Digest Algorithm*, IETF RFC 1321, April 1992, http://www.ietf.org/rfc/rfc1321.txt.

[RFC1421] J. Linn, *Privacy Enhancement for Internet Electronic Mail: Part I: Message Encryption and Authentication Procedures*, IETF RFC 1421, February 1993, http://www.ietf.org/rfc/rfc1421.txt.

[RFC1424] B. Kaliski, *Privacy Enhancement for Internet Electronic Mail: Part IV: Key Certification and Related Services*, IETF RFC 1424, Feb 1993, http://www.ietf.org/rfc/rfc1424.txt.

[RFC2104] H. Krawczyk, M. Bellare, R. Canetti, *HMAC: Keyed-Hashing for Message Authentication*, IETF RFC 2104, February 1997, http://www.ietf.org/rfc/rfc2104.txt.

[RFC2119] Bradner, S., “Key words for use in RFCs to Indicate Requirement Levels”, BCP 14, RFC 2119, March 1997. http://www.ietf.org/rfc/rfc2119.txt.

[RFC2898] B. Kaliski, *PKCS #5: Password-Based Cryptography Specification Version 2.0*, IETF RFC 2898, September 2000, http://www.ietf.org/rfc/rfc2898.txt.

[RFC2986] M. Nystrom and B. Kaliski, *PKCS #10: Certification Request Syntax Specification Version 1.7*, IETF RFC2986, November 2000, http://www.rfc-editor.org/rfc/rfc2986.txt.

[RFC3447] J. Jonsson, B. Kaliski, *Public-Key Cryptography Standards (PKCS) #1: RSA Cryptography Specifications Version 2.1*, IETF RFC 3447, Feb 2003, http://www.ietf.org/rfc/rfc3447.txt.

[RFC3629] F. Yergeau, *UTF-8, a transformation format of ISO 10646*, IETF RFC 3629, November 2003, http://www.ietf.org/rfc/rfc3629.txt.

[RFC3686] R. Housley, *Using Advanced Encryption Standard (AES) Counter Mode with IPsec Encapsulating Security Payload (ESP), IETF RFC 3686,* January 2004, http://www.ietf.org/rfc/rfc3686.txt.

[RFC4210] C. Adams, S. Farrell, T. Kause and T. Mononen, *Internet X.509 Public Key Infrastructure Certificate Management Protocol (CMP)*, IETF RFC 4210, September 2005, http://www.ietf.org/rfc/rfc4210.txt.

[RFC4211] J. Schaad, *Internet X.509 Public Key Infrastructure Certificate Request Message Format (CRMF)*, IETF RFC 4211, September 2005, http://www.ietf.org/rfc/rfc4211.txt.

[RFC4880] J. Callas, L. Donnerhacke, H. Finney, D. Shaw, and R. Thayer, *OpenPGP Message Format*, IETF RFC 4880, November 2007, http://www.ietf.org/rfc/rfc4880.txt.

[RFC4949] R. Shirey, *Internet Security Glossary, Version 2*, IETF RFC 4949, August 2007, http://www.ietf.org/rfc/rfc4949.txt.

[RFC5272] J. Schaad and M. Meyers, *Certificate Management over CMS (CMC)*, IETF RFC 5272, June 2008, http://www.ietf.org/rfc/rfc5272.txt.

[RFC5280] D. Cooper, S. Santesson, S. Farrell, S. Boeyen, R. Housley, W. Polk, *Internet X.509 Public Key Infrastructure Certificate*, IETF RFC 5280, May 2008, http://www.ietf.org/rfc/rfc5280.txt.

[RFC5639] M. Lochter, J. Merkle, *Elliptic Curve Cryptography (ECC) Brainpool Standard Curves and Curve Generation*, IETF RFC 5639, March 2010, http://www.ietf.org/rfc/rfc5639.txt.

[RFC5869] H. Krawczyk, *HMAC-based Extract-and-Expand Key Derivation Function (HKDF)*, IETF RFC5869, May 2010, https://tools.ietf.org/html/rfc5869

[RFC5958] S. Turner, *Asymmetric Key Packages*, IETF RFC5958, August 2010, https://tools.ietf.org/rfc/rfc5958.txt

[RFC6402] J. Schaad, *Certificate Management over CMS (CMC) Updates*, IETF RFC6402, November 2011, http://www.rfc-editor.org/rfc/rfc6402.txt.

[RFC6818] P. Yee, *Updates to the Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile*, IETF RFC6818, January 2013, http://www.rfc-editor.org/rfc/rfc6818.txt.

[RFC7778] A. Langley, M. Hamburg, S. Turner *Elliptic Curves for Security*, IETF RFC7748, January 2016, https://tools.ietf.org/html/rfc7748

[SEC2] SEC 2: Recommended Elliptic Curve Domain Parameters, http://www.secg.org/SEC2-Ver-1.0.pdf**.**

[SP800-38A] M. Dworkin, *Recommendation for Block Cipher Modes of Operation – Methods and Techniques*, NIST Special Publication 800-38A, December 2001, http://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-38a.pdf

[SP800-38B] M. Dworkin, *Recommendation for Block Cipher Modes of Operation: The CMAC Mode for Authentication*, NIST Special Publication 800-38B, May 2005, http://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-38b.pdf

[SP800-38C] M. Dworkin, *Recommendation for Block Cipher Modes of Operation: the CCM Mode for Authentication and Confidentiality*, NIST Special Publication 800-38C, May 2004, updated July 2007 http://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-38c.pdf

[SP800-38D] M. Dworkin, *Recommendation for Block Cipher Modes of Operation: Galois/Counter Mode (GCM) and GMAC*, NIST Special Publication 800-38D, Nov 2007, http://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-38d.pdf.

[SP800-38E] M. Dworkin, *Recommendation for Block Cipher Modes of Operation: The XTS-AES Mode for Confidentiality on Block-Oriented Storage Devices*, NIST Special Publication 800-38E, January 2010, http://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-38e.pdf**.**

[SP800-56A] E. Barker, L. Chen, A. Roginsky and M. Smid, *Recommendation for Pair-Wise Key Establishment Schemes Using Discrete Logarithm Cryptography*, NIST Special Publication 800-56A Revision 2, May 2013, http://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-56Ar2.pdf.

[SP800-57-1] E. Barker, W. Barker, W. Burr, W. Polk, and M. Smid, *Recommendations for Key Management - Part 1: General (Revision 3)*, NIST Special Publication 800-57 Part 1 Revision 3, July 2012, http://csrc.nist.gov/publications/nistpubs/800-57/sp800-57_part1_rev3_general.pdf.

[SP800-108] L. Chen, *Recommendation for Key Derivation Using Pseudorandom Functions (Revised)*, NIST Special Publication 800-108, Oct 2009, http://nvlpubs.nist.gov/nistpubs/Legacy/SP/nistspecialpublication800-108.pdf**.**

[X.509] International Telecommunication Union (ITU)–T, X.509: Information technology – Open systems interconnection – The Directory: Public-key and attribute certificate frameworks, November 2008, http://www.itu.int/rec/recommendation.asp?lang=en&parent=T-REC-X.509-200811-1.

[X9.24-1] ANSI, *X9.24 - Retail Financial Services Symmetric Key Management - Part 1: Using Symmetric Techniques*, 2009.

[X9.31] ANSI, *X9.31: Digital Signatures Using Reversible Public Key Cryptography for the Financial Services Industry (rDSA)*, September 1998.

[X9.42] ANSI, *X9.42: Public Key Cryptography for the Financial Services Industry: Agreement of Symmetric Keys Using Discrete Logarithm Cryptography*, 2003.

[X9.62] ANSI, *X9.62: Public Key Cryptography for the Financial Services Industry, The Elliptic Curve Digital Signature Algorithm (ECDSA)*, 2005.

[X9.63] ANSI, *X9.63: Public Key Cryptography for the Financial Services Industry, Key Agreement and Key Transport Using Elliptic Curve Cryptography*, 2011.

[X9.102] ANSI, *X9.102: Symmetric Key Cryptography for the Financial Services Industry - Wrapping of Keys and Associated Data*, 2008.

[X9 TR-31] ANSI, *X9 TR-31: Interoperable Secure Key Exchange Key Block Specification for Symmetric Algorithms*, 2010.

1.4 Non-Normative References

[ISO/IEC 9945-2] The Open Group, Regular Expressions, The Single UNIX Specification version 2, 1997, ISO/IEC 9945-2:1993, http://www.opengroup.org/onlinepubs/007908799/xbd/re.html.

[KMIP-UG] *Key Management Interoperability Protocol Usage Guide Version 2.0*. Work in progress.

[KMIP-TC] *Key Management Interoperability Protocol Test Cases Version 2.0*. Edited by Tim Hudson and Mark Joseph. Latest version: https://docs.oasis-open.org/kmip/kmip-testcases/v2.0/kmip-testcases-v2.0.html.

[RFC6151] S. Turner and L. Chen, *Updated Security Considerations for the MD5 Message-Digest and the HMAC-MD5 Algorithms*, IETF RFC6151, March 2011, http://www.rfc-editor.org/rfc/rfc6151.txt.

[w1979] A. Shamir, How to share a secret, Communications of the ACM, vol. 22, no. 11, pp. 612-613, November 1979.

[RFC7292] K. Moriarty, M. Nystrom, S. Parkinson, A. Rusch, M. Scott. *PKCS #12: Personal Information Exchange Syntax v1.1, July 2014,* https://tools.ietf.org/html/rfc7292

1.5 Item Data Types

The following are the data types of which all items (Objects, Attributes and Messages) are composed of Integer, Long Integer, Big Integer, Enumeration, Boolean, Text String, Byte String, Date Time, Interval, Date Time Extended, and Structure.

2 Objects

Managed Objects are objects that are the subjects of key management operations. *Managed Cryptographic Objects* are the subset of Managed Objects that contain cryptographic material.

2.1 Certificate

A Managed Cryptographic Object that is a digital certificate. It is a DER-encoded X.509 public key certificate.

Object	Encoding	REQUIRED
Certificate	Structure	
Certificate Type	Enumeration	Yes
Certificate Value	Byte String	Yes

Table 2: Certificate Object Structure

2.2 Certificate Request

A Managed Cryptographic Object containing the Certificate Request.

Object	Encoding	REQUIRED
Certificate Request	Structure	
Certificate Request Type	Enumeration	Yes
Certificate Request Value	Byte String	Yes

Table 3: Certificate Request Structure

2.3 Opaque Object

A Managed Object that the key management server is possibly not able to interpret. The context information for this object MAY be stored and retrieved using Custom Attributes.

An Opaque Object MAY be a Managed Cryptographic Object depending on the client context of usage and as such is treated in the same manner as a Managed Cryptographic Object for handling of attributes.

Object	Encoding	REQUIRED
Opaque Object	Structure	
Opaque Data Type	Enumeration	Yes
Opaque Data Value	Byte String	Yes

Table 4: Opaque Object Structure

2.4 PGP Key

A Managed Cryptographic Object that is a text-based representation of a PGP key. The Key Block field, indicated below, will contain the ASCII-armored export of a PGP key in the format as specified in RFC 4880. It MAY contain only a public key block, or both a public and private key block. Two different versions of PGP keys, version 3 and version 4, MAY be stored in this Managed Cryptographic Object.

KMIP implementers SHOULD treat the Key Block field as an opaque blob. PGP-aware KMIP clients SHOULD take on the responsibility of decomposing the Key Block into other Managed Cryptographic Objects (Public Keys, Private Keys, etc.).

Object	Encoding	REQUIRED
PGP Key	Structure	
PGP Key Version	Integer	Yes
Key Block	Object Data Structure	Yes

Table 5: PGP Key Object Structure

2.5 Private Key

A Managed Cryptographic Object that is the private portion of an asymmetric key pair.

Object	Encoding	REQUIRED
Private Key	Structure	
Key Block	Object Data Structure	Yes

Table 6: Private Key Object Structure

2.6 Public Key

A Managed Cryptographic Object that is the public portion of an asymmetric key pair. This is only a public key, not a certificate.

Object	Encoding	REQUIRED
Public Key	Structure	
Key Block	Object Data Structure	Yes

Table 7: Public Key Object Structure

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 Key Value of the Secret Data Type. The Key Value MAY be wrapped.

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

Table 8: Secret Data Object Structure

2.8 Split Key

A Managed Cryptographic Object that 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 MAY then be distributed to several key holders, for additional security. The *Split Key Parts* field indicates the total number of parts, and the

Split Key Threshold field indicates 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 SHALL be at least 1 and SHALL be less than or equal to Split Key Parts.

Object	Encoding	REQUIRED
Split Key	Structure	
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	Object Data Structure	Yes

Table 9: Split Key Object Structure

2.9 Symmetric Key

A Managed Cryptographic Object that is a symmetric key.

Object	Encoding	REQUIRED
Symmetric Key	Structure	
Key Block	Structure	Yes

Table 10: Symmetric Key Object Structure

3 Object Data Structures

3.1 Key Block

A *Key Block* object is a structure used to encapsulate all of the information that is closely associated with a cryptographic key.

The Key Block MAY contain the Key Compression Type, which indicates the format of the elliptic curve public key. By default, the public key is uncompressed.

The Key Block also has the Cryptographic Algorithm and the Cryptographic Length of the key contained in the Key Value field. Some example values are:

Value	Description
RSA keys	Typically 1024, 2048 or 3072 bits in length.
3DES keys	Typically from 112 to 192 bits (depending upon key length and the presence of parity bits).
AES keys	128, 192 or 256 bits in length

Table 11: Key Block Cryptographic Algorithm & Length Description

The Key Block SHALL contain a Key Wrapping Data structure if the key in the Key Value field is wrapped (i.e., encrypted, or MACed/signed, or both).

Object	Encoding	REQUIRED
Key Block	Structure	
Key Format Type	Enumeration	Yes
Key Compression Type	Enumeration	No
Key Value	Byte String: for wrapped Key Value; Structure: for plaintext Key Value	No
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 If present, the Cryptographic Length SHALL 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. If present, the Cryptographic Algorithm SHALL also be present.
Key Wrapping Data	Object Data Structure	No. SHALL only be present if the key is wrapped.

Table 12: Key Block Object Structure

3.2 Key Value

The *Key Value* is used only inside a Key Block and is either a Byte String or a:

- The Key Value structure contains the key material, either as a byte string or as a Transparent Key structure, and OPTIONAL attribute information that is associated and encapsulated with the key material. This attribute information differs from the attributes associated with Managed Objects, and is obtained via the Get Attributes operation, only by the fact that it is encapsulated with (and possibly wrapped with) the key material itself.
- The Key Value Byte String is either the wrapped TTLV-encoded Key Value structure, or the wrapped un-encoded value of the Byte String Key Material field.

Object	Encoding	REQUIRED
Key Value	Structure	
Key Material	Byte String: for Raw, Opaque, PKCS1, PKCS8, ECPrivateKey, or Extension Key Format types; Structure: for Transparent, or Extension Key Format Types	Yes
Attributes	Structure	No

Table 13: Key Value Object Structure

3.3 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. It is only used inside a Key Block.

This structure contains fields for:

Value	Description
Wrapping Method	Indicates the method used to wrap the Key Value.
Encryption Key Information	Contains the Unique Identifier value of the encryption key and associated cryptographic parameters.
MAC/Signature Key Information	Contains the Unique Identifier value of the MAC/signature key and associated cryptographic parameters.
MAC/Signature	Contains a MAC or signature of the Key Value
IV/Counter/Nonce	If REQUIRED by the wrapping method.
Encoding Option	Specifies the encoding of the Key Material within the Key Value structure of the Key Block that has been wrapped. If No Encoding is specified, then the Key Value structure SHALL NOT contain any attributes.

Table 14: Key Wrapping Data Structure Description

If wrapping is used, then the whole Key Value structure is wrapped unless otherwise specified by the Wrapping Method. The algorithms used for wrapping 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 for wrapping 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). Either the Encryption Key Information or the MAC/Signature Key Information (or both) in the Key Wrapping Data structure SHALL be specified.

Object	Encoding	REQUIRED
Key Wrapping Data	Structure	
Wrapping Method	Enumeration	Yes
Encryption Key Information	Structure, see below	No. Corresponds to the key that was used to encrypt the Key Value.
MAC/Signature Key Information	Structure, see below	No. Corresponds to the symmetric key used to MAC the Key Value or the private key used to sign the Key Value
MAC/Signature	Byte String	No
IV/Counter/Nonce	Byte String	No
Encoding Option	Enumeration	No. Specifies the encoding of the Key Value Byte String. If not present, the wrapped Key Value structure SHALL be TTLV encoded.

Table 15: Key Wrapping Data Object Structure

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

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

Table 16: Encryption Key Information Object Structure

Object	Encoding	REQUIRED
MAC/Signature Key Information	Structure	
Unique Identifier	Text string	Yes. It SHALL be either 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

Table 17: MAC/Signature Key Information Object Structure

3.4 Transparent Symmetric Key

If the Key Format Type in the Key Block is *Transparent Symmetric Key*, then Key Material is a structure.

Object	Encoding	REQUIRED
Key Material	Structure	
Key	Byte String	Yes

Table 18: Key Material Object Structure for Transparent Symmetric Keys

3.5 Transparent DSA Private Key

If the Key Format Type in the Key Block is *Transparent DSA Private Key*, then Key Material is a structure.

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

Table 19: Key Material Object Structure for Transparent DSA Private Keys

3.6 Transparent DSA Public Key

If the Key Format Type in the Key Block is *Transparent DSA Public Key*, then Key Material is a structure.

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

Table 20: Key Material Object Structure for Transparent DSA Public Keys

3.7 Transparent RSA Private Key

If the Key Format Type in the Key Block is *Transparent RSA Private Key*, then Key Material is a structure.

Object	Encoding	REQUIRED
Key Material	Structure	
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

Table 21: Key Material Object Structure for Transparent RSA Private Keys

One of the following SHALL be present (refer to **[PKCS#1]**):

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

3.8 Transparent RSA Public Key

If the Key Format Type in the Key Block is *Transparent RSA Public Key*, then Key Material is a structure.

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

Table 22: Key Material Object Structure for Transparent RSA Public Keys

3.9 Transparent DH Private Key

If the Key Format Type in the Key Block is *Transparent DH Private Key*, then Key Material is a structure.

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

Table 23: Key Material Object Structure for Transparent DH Private Keys

3.10 Transparent DH Public Key

If the Key Format Type in the Key Block is *Transparent DH Public Key*, then Key Material is a.

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

Table 24: Key Material Object Structure for Transparent DH Public Keys

3.11 Transparent EC Private Key

If the Key Format Type in the Key Block is *Transparent EC Private Key*, then Key Material is a structure.

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

Table 25: Key Material Object Structure for Transparent EC Private Keys

3.12 Transparent EC Public Key

If the Key Format Type in the Key Block is *Transparent EC Public Key*, then Key Material is a structure.

Object	Encoding	REQUIRED
Key Material	Structure	
Recommended Curve	Enumeration	Yes
Q String	Byte String	Yes

Table 26: Key Material Object Structure for Transparent EC Public Keys

4 Object Attributes

The following subsections describe the attributes that are associated with Managed Objects. Attributes that an object MAY have multiple instances of are referred to as *multi-instance attributes*. All instances of an attribute SHOULD have a different value. Similarly, attributes which an object SHALL only have at most one instance of are referred to as *single-instance attributes*. Attributes are able to be obtained by a client from the server using the Get Attribute operation. Some attributes are able to be set by the Add Attribute operation or updated by the Modify Attribute operation, and some are able to be deleted by the Delete Attribute operation if they no longer apply to the Managed Object. *Read-only attributes* are attributes that SHALL NOT be modified by either server or client, and that SHALL NOT be deleted by a client.

When attributes are returned by the server (e.g., via a Get Attributes operation), the attribute value returned SHALL NOT differ for different clients unless specifically noted against each attribute.

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

A server SHALL NOT delete attributes without receiving a request from a client until the object is destroyed. After an object is destroyed, the server MAY retain all, some or none of the object attributes, depending on the object type and server policy.

The second table in each subsection lists certain attribute characteristics (e.g., “SHALL always have a value. The server policy MAY further restrict these attribute characteristics.

SHALL always have a value	All Managed Objects that are of the Object Types for which this attribute applies, SHALL always have this attribute set once the object has been created or registered, up until the object has been destroyed.
Initially set by	Who is permitted to initially set the value of the attribute (if the attribute has never been set, or if all the attribute values have been deleted)?
Modifiable by server	Is the server allowed to change an existing value of the attribute without receiving a request from a client?
Modifiable by client	Is the client able to change an existing value of the attribute value once it has been set?
Deletable by client	Is the client able to delete an instance of the attribute?
Multiple instances permitted	Are multiple instances of the attribute permitted?
When implicitly set	Which operations MAY cause this attribute to be set even if the attribute is not

	specified in the operation request itself?
Applies to Object Types	Which Managed Objects MAY have this attribute set?

Table 27: Attribute Rules

There are default values for some mandatory attributes of Cryptographic Objects. The values in use by a particular server are available via Query. KMIP servers SHALL supply values for these attributes if the client omits them.

Object	Attribute
Symmetric Key	Cryptographic Algorithm Cryptographic Length Cryptographic Usage Mask
Private Key	Cryptographic Algorithm Cryptographic Length Cryptographic Usage Mask
Public Key	Cryptographic Algorithm Cryptographic Length Cryptographic Usage Mask
Certificate	Cryptographic Algorithm Cryptographic Length Digital Signature Algorithm
Split Key	Cryptographic Algorithm Cryptographic Length Cryptographic Usage Mask
Secret Data	Cryptographic Usage Mask

Table 28: Default Cryptographic Parameters

4.1 Activation Date

The *Activation Date* attribute contains the date and time when the Managed Object MAY begin to be used. This time corresponds to state transition. The object SHALL NOT be used for any cryptographic purpose before the *Activation Date* has been reached. Once the state transition from Pre-Active has occurred, then this attribute SHALL NOT be changed or deleted before the object is destroyed.

Item	Encoding
Activation Date	Date-Time

Table 29: Activation Date Attribute

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

Table 30: Activation Date Attribute Rules

4.2 Alternative Name

The *Alternative Name* attribute is used to identify and locate the object. This attribute is assigned by the client, and the *Alternative Name Value* is intended to be in a form that humans are able to interpret. The key management system MAY specify rules by which the client creates valid alternative names. Clients are informed of such rules by a mechanism that is not specified by this standard. Alternative Names MAY NOT be unique within a given key management domain.

Item	Encoding	REQUIRED
Alternative Name	Structure	
Alternative Name Value	Text String	Yes
Alternative Name Type	Enumeration	Yes

Table 31: Alternative Name Attribute Structure

SHALL always have a value	No
Initially set by	Client
Modifiable by server	Yes (Only if no value present)
Modifiable by client	Yes
Deletable by client	Yes
Multiple instances permitted	Yes
Applies to Object Types	All Objects

Table 32: Alternative Name Attribute Rules

4.3 Always Sensitive

The server SHALL create this attribute, and set it to True if the Sensitive attribute has always been True. The server SHALL set it to False if the Sensitive attribute has ever been set to False.

Item	Encoding
Sensitive	Boolean

Table 33: Always Sensitive Attribute

SHALL 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	When Sensitive attribute is set or changed
Applies to Object Types	All Objects

Table 34: Always Sensitive Attribute Rules

4.4 Application Specific Information

The *Application Specific Information* attribute is a structure used to store data specific to the application(s) using the Managed Object. It consists of the following fields: an *Application Namespace* and *Application Data* specific to that application namespace.

Clients MAY request to set (i.e., using any of the operations that result in new Managed Object(s) on the server or adding/modifying the attribute of an existing Managed Object an instance of this attribute with a particular *Application Namespace* while omitting *Application Data*. In that case, if the server supports this namespace (as indicated by the Query operation), then it SHALL return a suitable *Application Data* value. If the server does not support this namespace, then an error SHALL be returned.

Item	Encoding	REQUIRED
Application Specific Information	Structure	
Application Namespace	Text String	Yes
Application Data	Text String	No

Table 35: Application Specific Information Attribute

SHALL always have a value	No
Initially set by	Client or Server (only if the Application Data is omitted, in the client request)
Modifiable by server	Yes (only if the Application Data is omitted in the client request)
Modifiable by client	Yes
Deletable by client	Yes
Multiple instances permitted	Yes
When implicitly set	Re-key, Re-key Key Pair, Re-certify
Applies to Object Types	All Objects

Table 36: Application Specific Information Attribute Rules

4.5 Archive Date

The *Archive Date* attribute is the date and time when the Managed Object was placed in archival storage. This value is set by the server as a part of the Archive operation. The server SHALL delete this attribute whenever a Recover operation is performed.

Item	Encoding
Archive Date	Date-Time

Table 37: Archive Date Attribute

SHALL 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	Archive
Applies to Object Types	All Objects

Table 38: Archive Date Attribute Rules

4.6 Certificate Attributes

The Certificate Attributes are the various items included in a certificate. The following list is based on RFC2253.

Item	Encoding
Certificate Subject CN	Text String
Certificate Subject O	Text String
Certificate Subject OU	Text String
Certificate Subject Email	Text String
Certificate Subject C	Text String
Certificate Subject ST	Text String
Certificate Subject L	Text String
Certificate Subject UID	Text String
Certificate Subject Serial Number	Text String
Certificate Subject Title	Text String
Certificate Subject DC	Text String
Certificate Subject DN Qualifier	Text String
Certificate Issuer CN	Text String
Certificate Issuer O	Text String
Certificate Issuer OU	Text String
Certificate Issuer Email	Text String
Certificate Issuer C	Text String

Certificate Issuer ST	Text String
Certificate Issuer L	Text String
Certificate Issuer UID	Text String
Certificate Issuer Serial Number	Text String
Certificate Issuer Title	Text String
Certificate Issuer DC	Text String
Certificate Issuer DN Qualifier	Text String

Table 39: Certificate Attributes

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

Table 40: Certificate Attribute Rules

4.7 Certificate Type

The *Certificate Type* attribute is a type of certificate (e.g., X.509).

The *Certificate Type* value SHALL be set by the server when the certificate is created or registered and then SHALL NOT be changed or deleted before the object is destroyed.

Item	Encoding	
Certificate Type	Enumeration	

Table 41: Certificate Type Attribute

SHALL 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

Table 42: Certificate Type Attribute Rules

4.8 Certificate Length

The *Certificate Length* attribute is the length in bytes of the Certificate object. The *Certificate Length* SHALL be set by the server when the object is created or registered, and then SHALL NOT be changed or deleted before the object is destroyed.

Item	Encoding
Certificate Length	Integer

Table 43: Certificate Length Attribute

SHALL 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

Table 44: Certificate Length Attribute Rules

4.9 Comment

The Comment attribute is used for descriptive purposes only. It is not used for policy enforcement. The attribute is set by the client or the server.

Item	Encoding
Description	Text String

Table 45: Comment Attribute

SHALL 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
Applies to Object Types	All Objects

Table 46: Comment Rules

4.10 Compromise Date

The *Compromise Date* attribute contains the date and time when the Managed Cryptographic Object entered into the compromised state. This time corresponds to state transitions 3, 5, 8, or 10. 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* containing a *Revocation Reason Code* of Compromised code, or due to server policy or out-of-band administrative action.

Item	Encoding
Compromise Date	Date-Time

Table 47: Compromise Date Attribute

SHALL 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 Objects

Table 48: Compromise Date Attribute Rules

4.11 Compromise Occurrence Date

The *Compromise Occurrence Date* attribute is the date and time when the Managed Object was first believed to be compromised. If it is not possible to estimate when the compromise occurred, then this value SHOULD be set to the Initial Date for the object.

Item	Encoding
Compromise Occurrence Date	Date-Time

Table 49: Compromise Occurrence Date Attribute

SHALL 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 Objects

Table 50: Compromise Occurrence Date Attribute Rules

4.12 Contact Information

The *Contact Information* attribute is used for descriptive purposes only. It is not used for policy enforcement. The attribute is set by the client or the server.

Item	Encoding
Contact Information	Text String

Table 51: Contact Information Attribute

SHALL 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, Re-key Key Pair
Applies to Object Types	All Objects

Table 52: Contact Information Attribute Rules

4.13 Cryptographic Algorithm

The *Cryptographic Algorithm* of an object. The Cryptographic Algorithm of a Certificate object identifies the algorithm for the public key contained within the Certificate. The digital signature algorithm used to sign the Certificate is identified in the Digital Signature Algorithm attribute. This attribute SHALL be set by the server when the object is created or registered and then SHALL NOT be changed or deleted before the object is destroyed.

Item	Encoding
Cryptographic Algorithm	Enumeration

Table 53: Cryptographic Algorithm Attribute

SHALL always have a value	Yes (except for Secret Data and Opaque Object)
Initially set by	Server
Modifiable by server	No
Modifiable by client	No
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Certify, Create, Create Key Pair, Re-certify, Register, Derive Key, Re-key, Re-key Key Pair
Applies to Object Types	All Objects

Table 54: Cryptographic Algorithm Attribute Rules

4.14 Cryptographic Domain Parameters

The *Cryptographic Domain Parameters* attribute is a structure that contains fields that MAY need to be specified in the Create Key Pair Request Payload. Specific fields MAY only pertain to certain types of Managed Cryptographic Objects.

The domain parameter Qlength correponds to the bit length of parameter Q (refer to **[RFC7778]**, **[SEC2]** and **[SP800-56A]**).

Qlength applies to algorithms such as DSA and DH. The bit length of parameter P (refer to to **[RFC7778]**, **[SEC2]** and **[SP800-56A]**) is specified separately by setting the Cryptographic Length attribute.

Recommended Curve is applicable to elliptic curve algorithms such as ECDSA, ECDH, and ECMQV.

Item	Encoding	Required
Cryptographic Domain Parameters	Structure	Yes
Qlength	Integer	No
Recommended Curve	Enumeration	No

Table 55: Cryptographic Domain Parameters Attribute Structure

Shall always have a value	No
Initially set by	Client
Modifiable by server	No
Modifiable by client	No
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Re-key, Re-key Key Pair
Applies to Object Types	Public Keys, Private Keys

Table 56: Cryptographic Domain Parameters Attribute Rules

4.15 Cryptographic Length

For keys, *Cryptographic Length* is the length in bits of the clear-text cryptographic key material of the Managed Cryptographic Object. For certificates, *Cryptographic Length* is the length in bits of the public key contained within the Certificate. This attribute SHALL be set by the server when the object is created or registered, and then SHALL NOT be changed or deleted before the object is destroyed.

Item	Encoding
Cryptographic Length	Integer

Table 57: Cryptographic Length Attribute

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

Table 58: Cryptographic Length Attribute Rules

4.16 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 pertain only to certain types of Managed Objects. The Cryptographic Parameters attribute of a Certificate object identifies the cryptographic parameters of the public key contained within the Certificate.

The Cryptographic Algorithm is also used to specify the parameters for cryptographic operations. For operations involving digital signatures, either the Digital Signature Algorithm can be specified or the Cryptographic Algorithm and Hashing Algorithm combination can be specified.

Random IV can be used to request that the KMIP server generate an appropriate IV for a cryptographic operation that uses an IV. The generated Random IV is returned in the response to the cryptographic operation.

IV Length is the length of the Initialization Vector in bits. This parameter SHALL be provided when the specified Block Cipher Mode supports variable IV lengths such as CTR or GCM.

Tag Length is the length of the authenticator tag in bytes. This parameter SHALL be provided when the Block Cipher Mode is GCM.

The IV used with counter modes of operation (e.g., CTR and GCM) cannot repeat for a given cryptographic key. To prevent an IV/key reuse, the IV is often constructed of three parts: a fixed field, an invocation field, and a counter as described in **[SP800-38A]** and **[SP800-38D]**. The Fixed Field Length is the length of the fixed field portion of the IV in bits. The Invocation Field Length is the length of the invocation field portion of the IV in bits. The Counter Length is the length of the counter portion of the IV in bits.

Initial Counter Value is the starting counter value for CTR mode (for **[RFC3686]** it is 1).

Item	Encoding	REQUIRED
Cryptographic Parameters	Structure	
Block Cipher Mode	Enumeration	No
Padding Method	Enumeration	No
Hashing Algorithm	Enumeration	No
Key Role Type	Enumeration	No
Digital Signature Algorithm	Enumeration	No
Cryptographic Algorithm	Enumeration	No
Random IV	Boolean	No
IV Length	Integer	No unless Block Cipher Mode supports variable IV lengths
Tag Length	Integer	No unless Block Cipher Mode is GCM
Fixed Field Length	Integer	No
Invocation Field Length	Integer	No
Counter Length	Integer	No
Initial Counter Value	Integer	No
Salt Length	Integer	No (if omitted, defaults to the block size of the Mask Generator Hashing Algorithm)
Mask Generator	Enumeration	No (if omitted defaults to MGF1).
Mask Generator Hashing Algorithm	Enumeration	No. (if omitted defaults to SHA-1).
P Source	Byte String	No (if omitted, defaults to an empty byte string for encoding input P in OAEP padding)
Trailer Field	Integer	No (if omitted, defaults to the standard one-byte trailer in PSS padding)

Table 59: Cryptographic Parameters Attribute Structure

SHALL 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-key Key Pair, Re-certify
Applies to Object Types	All Objects

Table 60: Cryptographic Parameters Attribute Rules

4.17 Cryptographic Usage Mask

The *Cryptographic Usage Mask* attribute defines the cryptographic usage of a key. This is a bit mask that indicates to the client which cryptographic functions MAY be performed using the key, and which ones SHALL NOT be performed.

Item	Encoding
Cryptographic Usage Mask	Integer

Table 61: Cryptographic Usage Mask Attribute

SHALL always have a value	Yes (Except for Opaque Object)
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, Re-key Key Pair
Applies to Object Types	All Objects

Table 62: Cryptographic Usage Mask Attribute Rules

4.18 Deactivation Date

The *Deactivation Date* attribute is the date and time when the Managed Object SHALL NOT be used for any purpose, except for decryption, signature verification, or unwrapping, but only under extraordinary circumstances and only when special permission is granted. This time corresponds to state transition 6. This attribute SHALL NOT be changed or deleted before the object is destroyed, unless the object is in the Pre-Active or Active state.

Item	Encoding
Deactivation Date	Date-Time

Table 63: Deactivation Date Attribute

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

Table 64: Deactivation Date Attribute Rules

4.19 Description

The Description attribute is used for descriptive purposes only. It is not used for policy enforcement. The attribute is set by the client or the server.

Item	Encoding
Description	Text String

Table 65: Description Attribute

SHALL 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
Applies to Object Types	All Objects

Table 66: Description Attribute Rules

4.20 Destroy Date

The *Destroy Date* attribute is the date and time when the Managed Object was destroyed. This time corresponds to state transitions 2, 7, or 9 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.

Item	Encoding
Destroy Date	Date-Time

Table 67: Destroy Date Attribute

SHALL 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 Objects

Table 68: Destroy Date Attribute Rules

4.21 Digest

The *Digest* attribute is a structure that contains the digest value of the key or secret data (i.e., digest of the Key Material), certificate (i.e., digest of the Certificate Value), or opaque object (i.e., digest of the Opaque Data Value). If the Key Material is a Byte String, then the Digest Value SHALL be calculated on this Byte String. If the Key Material is a structure, then the Digest Value SHALL be calculated on the TTLV-encoded Key Material structure. The Key Format Type field in the Digest attribute indicates the format of the Managed Object from which the Digest Value was calculated. Multiple digests MAY be calculated using different algorithms and/or key format types. If this attribute exists, then it SHALL have a mandatory attribute instance computed with the SHA-256 hashing algorithm and the default Key Value Format for this object type and algorithm. Clients may request via supplying a non-default Key Format Value attribute on operations that create a Managed Object, and the server SHALL produce an additional Digest attribute for that Key Value Type. The digest(s) are static and SHALL be set by the server when the object is created or registered, provided that the server has access to the Key Material or the Digest Value (possibly obtained via out-of-band mechanisms).

Item	Encoding	REQUIRED
Digest	Structure	
Hashing Algorithm	Enumeration	Yes
Digest Value	Byte String	Yes, if the server has access to the Digest Value or the Key Material (for keys and secret data), the Certificate Value (for certificates) or the Opaque Data Value (for opaque objects).
Key Format Type	Enumeration	Yes, if the Managed Object is a key or secret data object.

Table 69: Digest Attribute Structure

SHALL always have a value	Yes, if the server has access to the Digest Value or the Key Material (for keys and secret data), the Certificate Value (for certificates) or the Opaque Data Value (for opaque objects).
Initially set by	Server
Modifiable by server	No
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, Re-key Key Pair
Applies to Object Types	All Objects

Table 70: Digest Attribute Rules

4.22 Digital Signature Algorithm

The *Digital Signature Algorithm* attribute identifies the digital signature algorithm associated with a digitally signed object (e.g., Certificate). This attribute SHALL be set by the server when the object is created or registered and then SHALL NOT be changed or deleted before the object is destroyed.

Item	Encoding
Digital Signature Algorithm	Enumeration

Table 71: Digital Signature Algorithm Attribute

SHALL always have a value	Yes
Initially set by	Server
Modifiable by server	No
Modifiable by client	No
Deletable by client	No
Multiple instances permitted	Yes for PGP keys. No for X.509 certificates.
When implicitly set	Certify, Re-certify, Register
Applies to Object Types	Certificates, PGP keys

Table 72: Digital Signature Algorithm Attribute Rules

4.23 Extractable

If False then the server SHALL prevent the object value being retrieved. The server SHALL set its value to True if not provided by the client.

Item	Encoding
Extractable	Boolean

Table 73: Extractable Attribute

SHALL always have a value	Yes
Initially set by	Client or Server
Modifiable by server	Yes
Modifiable by client	Yes
Deletable by client	No
Multiple instances permitted	No
When implicitly set	When object is created or registered
Applies to Object Types	All Objects

Table 74: Extractable Attribute Rules

4.24 Fresh

The *Fresh* attribute is a Boolean attribute that indicates that the object has not yet been served to a client using a Get operation. The Fresh attribute SHALL be set to True when a new object is created on the server unless the client provides a False value in Register or Import. The server SHALL change the attribute value to False as soon as the object has been served via the Get operation to a client.

Item	Encoding
Fresh	Boolean

Table 75: Fresh Attribute

SHALL always have a value	Yes
Initially set by	Client or 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, Re-key Key Pair, Re-key Key Pair
Applies to Object Types	All Objects

Table 76: Fresh Attribute Rules

4.25 Initial Date

The *Initial Date* attribute contains the date and time when the Managed Object was first created or registered at the server. This time corresponds to state transition 1. This attribute SHALL be set by the server when the object is created or registered, and then SHALL NOT be changed or deleted before the object is destroyed. This attribute is also set for non-cryptographic objects when they are first registered with the server.

Item	Encoding
Initial Date	Date-Time

Table 77: Initial Date Attribute

SHALL 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, Re-key Key Pair
Applies to Object Types	All Objects

Table 78: Initial Date Attribute Rules

4.26 Key Format Type

The Key Format Type attribute is a required attribute of a Cryptographic Object. It is set by the server, but a particular Key Format Type MAY be requested by the client if the cryptographic material is produced by the server (i.e., Create, Create Key Pair, Create Split Key, Re-key, Re-key Key Pair, Derive Key) on the client's behalf. The server SHALL comply with the client's requested format or SHALL fail the request. When the server calculates a Digest for the object, it SHALL compute the digest on the data in the assigned Key Format Type, as well as a digest in the default KMIP Key Format Type for that type of key and the algorithm requested (if a non-default value is specified).

Object	Encoding
Key Format Type	Enumeration

Table 79: Key Format Type Attribute

SHALL 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
Applies to Object Types	All Objects

Table 80: Key Format Type Attribute Rules

Keys have a default Key Format Type that SHALL be produced by KMIP servers. The default Key Format Type by object (and algorithm) is listed in the following table:

Object	Default Key Format Type
Certificate	X.509
Certificate Request	PKCS#10
Opaque Object	Opaque
PGP Key	Raw
Secret Data	Raw
Symmetric Key	Raw
Split Key	Raw
RSA Private Key	PKCS#1
RSA Public Key	PKCS#1
EC Private Key	Transparent EC Private Key
EC Public Key	Transparent EC Public Key
DSA Private Key	Transparent DSA Private Key
DSA Public Key	Transparent DSA Public Key

Table 81: Default Key Format Type, by Object

4.27 Key Value Location

Key Value Location MAY be specified by the client when the Key Value is omitted from the Key Block in a Register request. Key Value Location is used to indicate the location of the Key Value absent from the object being registered..

Object	Encoding	REQUIRED
Key Value Location	Structure	
Key Value Location Value	Text String	Yes
Key Value Location Type	Enumeration	Yes

Table 82: Key Value Location Attribute

SHALL 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	Never
Applies to Object Types	All Objects

`

4.28 Key Value Present

Key Value Present is an attribute of the managed object created by the server. It SHALL NOT be specified by the client in a Register request. *Key Value Present* SHALL be created by the server if the

Key Value is absent from the Key Block in a Register request. The value of Key Value Present SHALL NOT be modified by either the client or the server. *Key Value Present* attribute MAY be used as a part of the Locate operation.

Item	Encoding	REQUIRED
Key Value Present	Boolean	No

Table 83: Key Value Present Attribute

SHALL 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	During Register operation
Applies to Object Types	All Objects

Table 84: Key Value Present Attribute Rules

4.29 Last Change Date

The *Last Change Date* attribute contains the date and time of the last change of the specified object.

Item	Encoding
Last Change Date	Date-Time

Table 85: Last Change Date Attribute

SHALL 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, Re-key Key Pair, Add Attribute, Modify Attribute, Delete Attribute, Get Usage Allocation
Applies to Object Types	All Objects

Table 86: Last Change Date Attribute Rules

4.30 Lease Time

The *Lease Time* attribute defines a time interval for a Managed Object beyond which the client SHALL NOT use the object without obtaining another lease. This attribute always holds the initial length of time allowed for a lease, and not the actual remaining time. Once its lease expires, the client is only able to renew the lease by calling Obtain Lease. A server SHALL store in this attribute the maximum Lease Time

it is able to serve and a client obtains the lease time (with Obtain Lease) that is less than or equal to the maximum Lease Time. This attribute is read-only for clients. It SHALL be modified by the server only.

Item	Encoding
Lease Time	Interval

Table 87: Lease Time Attribute

SHALL 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, Re-key Key Pair
Applies to Object Types	All Objects

Table 88: Lease Time Attribute Rules

4.31 Link

The *Link* attribute is a structure used to create a link from one 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, as listed below. The *Linked Object Identifier* identifies the target Managed Cryptographic Object by its Unique Identifier. The link contains information about the association between the Managed Objects (e.g., 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).

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 it is possible for a Managed Object to have multiple instances of the Link attribute (e.g., a Private Key has links to the associated certificate, as well as the associated public key; a Certificate object has links to both the public key and to the certificate of the certification authority (CA) that signed the certificate).

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

Encoding	Description
Text String	Unique Identifier of a Managed Object.
Enumeration	Unique Identifier Enumeration
Integer	Zero based nth Unique Identifier in the response. If negative the count is backwards from the beginning of the current operation's batch item.

Table 89: Linked Object Identifier encoding descriptions

Item	Encoding	REQUIRED
Link	Structure	
Link Type	Enumeration	Yes
Linked Object Identifier	Text String/Enumeration/Integer	Yes

Table 90: Link Attribute Structure

SHALL 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 Key Pair, Derive Key, Certify, Re-certify, Re-key, Re-key Key Pair, Register
Applies to Object Types	All Objects

Table 91: Link Attribute Structure Rules

4.32 Name

The *Name* attribute is a structure used to identify and locate an object. This attribute is assigned by the client, and the *Name Value* is intended to be in a form that humans are able to interpret. The key management system MAY specify rules by which the client creates valid names. Clients are informed of such rules by a mechanism that is not specified by this standard. Names SHALL be unique within a given key management domain, but are NOT REQUIRED to be globally unique.

Item	Encoding	REQUIRED
Name	Structure	
Name Value	Text String	Yes
Name Type	Enumeration	Yes

Table 92: Name Attribute Structure

SHALL 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-key Key Pair, Re-certify
Applies to Object Types	All Objects

Table 93: Name Attribute Rules

4.33 Never Extractable

The server SHALL create this attribute, and set it to True if the Extractable attribute has always been False.

The server SHALL set it to False if the Extractable attribute has ever been set to True.

Item	Encoding
Never Extractable	Boolean

Table 94: Never Extractable Attribute

SHALL 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	When Never Extractable attribute is set or changed
Applies to Object Types	All Objects

Table 95: Never Extractable Attribute Rules

4.34 NIST Key Type

The NIST SP800-57 Key Type is an attribute of a Key (or Secret Data object). It MAY be set by the client, preferably when the object is registered or created. Although the attribute is optional, once set, MAY NOT be deleted or modified by either the client or the server. This attribute is intended to reflect the NIST SP-800-57 view of cryptographic material, so an object SHOULD have only one usage (see **[SP800-57-1]** for rationale), but this is not enforced at the server.

Item	**Encoding**
NIST Key Type	Enumeration

Table 96 SP800-57 Key Type Attribute

SHALL always have a value	No
Initially set by	Client
Modifiable by server	No
Modifiable by client	No
Deletable by client	No
Multiple instances permitted	Yes
Applies to Object Types	All Objects

Table 97 SP800-57 Key Type Attribute Rules

4.35 Object Group

A Managed Object MAY be part of a group of objects. An object MAY belong to more than one group of objects. To assign an object to a group of objects, the object group name SHOULD be set into this attribute.

Item	Encoding
Object Group	Text String

Table 98: Object Group Attribute

SHALL 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, Re-key Key Pair
Applies to Object Types	All Objects

Table 99: Object Group Attribute Rules

4.36 Object Type

The *Object Type* of a Managed Object (e.g., public key, private key, symmetric key, etc.) SHALL be set by the server when the object is created or registered and then SHALL NOT be changed or deleted before the object is destroyed.

Item	Encoding
Object Type	Enumeration

Table 100: Object Type Attribute

SHALL 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, Re-key Key Pair
Applies to Object Types	All Objects

Table 101: Object Type Attribute Rules

4.37 Opaque Data Type

The *Opaque Data Type* of an Opaque Object SHALL be set by the server when the object is registered and then SHALL NOT be changed or deleted before the object is destroyed.

Item	Encoding
Opaque Data Type	Enumeration

Table 102: Opaque Data Type Attribute

SHALL 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
Applies to Object Types	Opaque Objects

Table 103: Opaque Data Type Attribute Rules

4.38 Original Creation Date

The *Original Creation Date* attribute contains the date and time the object was originally created, which can be different from when the object is registered with a key management server.

It is OPTIONAL for an object being registered by a client. The *Original Creation Date* MAY be set by the client during a Register operation. If no *Original Creation Date* attribute was set by the client during a Register operation, it MAY do so at a later time through an Add Attribute operation for that object.

It is mandatory for an object created on the server as a result of a Create, Create Key Pair, Derive Key, Re-key, or Re-key Key Pair operation. In such cases the *Original Creation Date* SHALL be set by the server and SHALL be the same as the *Initial Date* attribute.

In all cases, once the *Original Creation Date* is set, it SHALL NOT be deleted or updated.

Item	Encoding
Original Creation Date	Date-Time

Table 104: Original Creation Date Attribute

SHALL always have a value	No
Initially set by	Client or Server (when object is generated 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, Derive Key, Re-key, Re-key Key Pair
Applies to Object Types	All Objects

Table 105: Original Creation Date Attribute Rules

4.39 PKCS#12 Friendly Name

PKCS#12 Friendly Name is an attribute used for descriptive purposes. If supplied on a Register Private Key with Key Format Type PKCS#12, it informs the server of the alias/friendly name (see [RFC7292]) under which the private key and its associated certificate chain SHALL be found in the Key Material. If no such alias/friendly name is supplied, the server SHALL record the alias/friendly name (if any) it finds for the first Private Key in the Key Material.

When a Get with Key Format Type PKCS#12 is issued, this attribute informs the server what alias/friendly name the server SHALL use when encoding the response. If this attribute is absent for the object on which the Get is issued, the server SHOULD use an alias/friendly name of “alias”. Since the PKCS#12 Friendly Name is defined in ASN.1 with an EQUALITY MATCHING RULE of caseIgnoreMatch, clients and servers SHOULD utilize a lowercase text string.

Item	Encoding
PKCS#12 Friendly Name	Text String

Table 106: PKCS#12 Friendly Name Attribute

SHALL always have a value	No
Initially set by	Client or Server
Modifiable by server	No
Modifiable by client	Yes
Deletable by client	Yes
Multiple instances permitted	No
Applies to Object Types	All Objects

Table 107: Friendly Name Attribute Rules

4.40 Process Start Date

The *Process Start Date* attribute is the date and time when a valid Managed Object MAY begin to be used to process cryptographically protected information (e.g., decryption or unwrapping), depending on the value of its Cryptographic Usage Mask attribute. The object SHALL NOT be used for these cryptographic purposes before the *Process Start Date* has been reached. This value MAY be equal to or later than, but SHALL NOT precede, the Activation Date. Once the Process Start Date has occurred, then this attribute SHALL NOT be changed or deleted before the object is destroyed.

Item	Encoding
Process Start Date	Date-Time

Table 108: Process Start Date Attribute

SHALL always have a value	No
Initially set by	Server or Client
Modifiable by server	Yes, only while in Pre-Active or Active state and as long as the Process Start Date has been not reached.
Modifiable by client	Yes, only while in Pre-Active or Active state and as long as the Process Start Date has been not reached.
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Create, Register, Derive Key, Re-key
Applies to Object Types	All Objects

Table 109: Process Start Date Attribute Rules

4.41 Protect Stop Date

The *Protect Stop Date* attribute is the date and time after which a valid Managed Object SHALL NOT be used for applying cryptographic protection (e.g., encryption or wrapping), depending on the value of its Cryptographic Usage Mask attribute. This value MAY be equal to or earlier than, but SHALL NOT be later than the Deactivation Date. Once the *Protect Stop Date* has occurred, then this attribute SHALL NOT be changed or deleted before the object is destroyed.

Item	Encoding
Protect Stop Date	Date-Time

Table 110: Protect Stop Date Attribute

SHALL always have a value	No
Initially set by	Server or Client
Modifiable by server	Yes, only while in Pre-Active or Active state and as long as the Protect Stop Date has not been reached.
Modifiable by client	Yes, only while in Pre-Active or Active state and as long as the Protect Stop Date has not been reached.
Deletable by client	No
Multiple instances permitted	No
When implicitly set	Create, Register, Derive Key, Re-key

Applies to Object Types	All Objects

Table 111: Protect Stop Date Attribute Rules

4.42 Protection Level

The *Protection Level* attribute is the Level of protection required for a given object.

Item	Encoding
Protection Level	Enumeration

Table 112: Protection Level Attribute

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

Table 113: Protection Level Attribute Rules

4.43 Protection Period

The *Protection Period* attribute is the period of time for which the output of an operation or a *Managed Cryptographic Object* SHALL remain safe. The *Protection Period* is specified as an *Interval*.

Item	Encoding
Protection Period	Interval

Table 114: Protection Period Attribute

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

Table 115: Protection Period Attribute Rules

4.44 Protection Storage Mask

The *Protection Storage Mask* attribute records which of the requested mask values have been used for protection storage.

Item	Encoding
Protection Storage Mask	Integer

Table 116: Protection Storage Mask

SHALL 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	When object is stored
Applies to Object Types	All Objects

Table 117: Protection Storage Mask Rules

4.45 Quantum Safe

The *Quantum Safe* attribute is a flag to be set to indicate an object is required to be Quantum Safe for the given *Protection Period* and *Protection Level.*

Item	Encoding
Quantum Safe	Boolean

Table 118: Quantum Safe Attribute

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

Table 119: Quantum Safe Attribute Rules

4.46 Random Number Generator

The *Random Number Generator* attribute contains the details of the random number generator used during the creation of the managed cryptographic object.

The *Random Number Generator* MAY be set by the client during a Register operation. If no *Random Number Generator* attribute was set by the client during a Register operation, it MAY do so at a later time through an Add Attribute operation for that object.

It is mandatory for an object created on the server as a result of a Create, Create Key Pair, Derive Key, Re-key, or Re-key Key Pair operation. In such cases the *Random Number Generator* SHALL be set by the server depending on which random number generator was used. If the specific details of the random

number generator are unknown then the RNG Algorithm within the RNG Parameters structure SHALL be set to *Unspecified*.

If one or more *Random Number Generator* attribute values are provided in the Attributes in a Create, Create Key Pair, Derive Key, Re-key, or Re-key Key Pair operation then the server SHALL use a random number generator that matches one of the *Random Number Generator* attributes. If the server does not support or is otherwise unable to use a matching random number generator then it SHALL fail the request.

The *Random Number Generator* attribute SHALL NOT be copied from the original object in a Re-key or Re-key Key Pair operation.

In all cases, once the *Random Number Generator* attribute is set, it SHALL NOT be deleted or updated.

Note: the encoding is the same as the RNG Parameters structure using a different tag; it does not contain a nested RNG Parameters structure.

Item	Encoding
Random Number Generator	RNG Parameters

Table 120: Random Number Generator Attribute

SHALL always have a value	No
Initially set by	Client (when the object is generated by the Client and registered) or Server (when object is generated 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, Derive Key, Re-key, Re-key Key Pair
Applies to Object Types	All Objects

Table 121: Random Number Generator Attribute Rules

4.47 Revocation Reason

The *Revocation Reason* attribute is a structure used to indicate why the Managed Cryptographic Object was revoked (e.g., “compromised”, “expired”, “no longer used”, etc.). This attribute is only set by the server as a part of the Revoke Operation.

The *Revocation Message* is an OPTIONAL field that is used exclusively for audit trail/logging purposes and MAY contain additional information about why the object was revoked (e.g., “Laptop stolen”, or “Machine decommissioned”).

Item	Encoding	REQUIRED
Revocation Reason	Structure	
Revocation Reason Code	Enumeration	Yes
Revocation Message	Text String	No

Table 122: Revocation Reason Attribute Structure

SHALL 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 Objects

Table 123: Revocation Reason Attribute Rules

4.48 Sensitive

If True then the server SHALL prevent the object value being retrieved (via the Get operation) unless it is wrapped by another key. The server SHALL set the value to False if the value is not provided by the client.

Item	Encoding
Sensitive	Boolean

Table 124: Sensitive Attribute

SHALL always have a value	Yes
Initially set by	Client or Server
Modifiable by server	Yes
Modifiable by client	Yes
Deletable by client	No
Multiple instances permitted	No
When implicitly set	When object is created or registered
Applies to Object Types	All Objects

Table 125: Sensitive Attribute Rules

4.49 Short Unique Identifier

The *Short Unique Identifier* is generated by the key management system to uniquely identify a Managed Object using a shorter identifier. It is only REQUIRED to be unique within the identifier space managed by a single key management system, however this identifier SHOULD be globally unique in order to allow for a key management domain export of such objects. This attribute SHALL be assigned by the key management system upon creation or registration of a *Unique Identifier*, and then SHALL NOT be changed or deleted before the object is destroyed.

The *Short Unique Identifier* SHOULD be generated as a SHA-256 hash of the *Unique Identifier* and SHALL be a 32 byte *byte string*.

Item	Encoding
Short Unique Identifier	Byte String

Table 126: Unique Identifier Attribute

SHALL 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, Re-key Key Pair
Applies to Object Types	All Objects

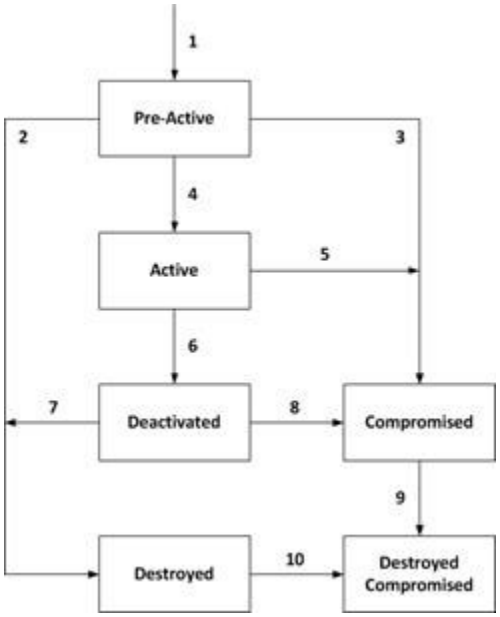
Table 127: Short Unique Identifier Attribute Rules

4.50 State

This attribute is an indication of the *State* of an object as known to the key management server. The State SHALL NOT be changed by using the Modify Attribute operation on this attribute. The State SHALL only be changed by the server as a part of other operations or other server processes. An object SHALL be in one of the following states at any given time.

Note: The states correspond to those described in **[SP800-57-1]**.

Figure 1: Cryptographic Object States and Transitions



- *Pre-Active*: The object exists and SHALL NOT be used for any cryptographic purpose.
- *Active*: The object SHALL be transitioned to the *Active* state prior to being used for any cryptographic purpose. The object SHALL only be used for all cryptographic purposes that are allowed by its Cryptographic Usage Mask attribute. If a Process Start Date attribute is set, then the object SHALL NOT be used for cryptographic purposes prior to the Process Start Date. If a

Protect Stop attribute is set, then the object SHALL NOT be used for cryptographic purposes after the Process Stop Date.

- *Deactivated*: The object SHALL NOT be used for applying cryptographic protection (e.g., encryption, signing, wrapping, MACing, deriving) . The object SHALL only be used for cryptographic purposes permitted by the Cryptographic Usage Mask attribute. The object SHOULD only be used to process cryptographically-protected information (e.g., decryption, signature verification, unwrapping, MAC verification under extraordinary circumstances and when special permission is granted.
- *Compromised*: The object SHALL NOT be used for applying cryptographic protection (e.g., encryption, signing, wrapping, MACing, deriving). The object SHOULD only be used to process cryptographically-protected information (e.g., decryption, signature verification, unwrapping, MAC verification in a client that is trusted to use managed objects that have been compromised. The object SHALL only be used for cryptographic purposes permitted by the Cryptographic Usage Mask attribute.
- *Destroyed*: The object SHALL NOT be used for any cryptographic purpose.
- *Destroyed Compromised*: The object SHALL NOT be used for any cryptographic purpose; however its compromised status SHOULD 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 caused 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, then the state immediately transitions from Pre-Active to Active. In this case, the server SHALL set the Activation Date attribute to the value specified in the request, or fail the request attempting to create or register the object, depending on server policy. If the operation contains an Activation Date attribute that is in the future, or contains no Activation Date, then the Cryptographic Object is initialized in the key management system in the Pre-Active state.
2. The transition from Pre-Active to Destroyed is caused by a client issuing a Destroy operation. The server destroys the object when (and if) server policy dictates.
3. The transition from Pre-Active to Compromised is caused by a client issuing a Revoke operation with a Revocation Reason containing a *Revocation Reason Code* of Compromised.
4. The transition from Pre-Active to Active SHALL occur in one of three ways:
    - The Activation Date is reached,
    - A client successfully issues a Modify Attribute operation, modifying the Activation Date to a date in the past, or the current date, or
    - A client issues an Activate operation on the object. The server SHALL set the Activation Date to the time the Activate operation is received.
5. The transition from Active to Compromised is caused by a client issuing a Revoke operation with a Revocation Reason containing a *Revocation Reason Code* of Compromised.
6. The transition from Active to Deactivated SHALL occur in one of three ways:
    - The object's Deactivation Date is reached,
    - A client issues a Revoke operation, with a Revocation Reason containing a *Revocation Reason Code* other than Compromised, or
    - The client successfully issues a Modify Attribute operation, modifying the Deactivation Date to a date in the past, or the current date.
7. The transition from Deactivated to Destroyed is caused by a client issuing a Destroy operation, or by a server, both in accordance with server policy. The server destroys the object when (and if) server policy dictates.

8. The transition from Deactivated to Compromised is caused by a client issuing a Revoke operation with a Revocation Reason containing a *Revocation Reason Code* of Compromised.
9. The transition from Compromised to Destroyed Compromised is caused by a client issuing a Destroy operation, or by a server, both in accordance with server policy. The server destroys the object when (and if) server policy dictates.
10. The transition from Destroyed to Destroyed Compromised is caused by a client issuing a *R*evoke operation with a Revocation Reason containing a *Revocation Reason Code* of Compromised.

Only the transitions described above are permitted.

Item	Encoding
State	Enumeration

Table 128: State Attribute

SHALL always have a value	Yes
Initially set by	Server
Modifiable by server	Yes
Modifiable by client	No, but only by the server in response to certain requests (see above)
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, Re-key Key Pair
Applies to Object Types	All Objects

Table 129: State Attribute Rules

4.51 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 this identifier SHOULD be globally unique in order to allow for a key management domain export of such objects. This attribute SHALL be assigned by the key management system at creation or registration time, and then SHALL NOT be changed or deleted before the object is destroyed.

Encoding	Description
Text String	Unique Identifier of a Managed Object.
Enumeration	Unique Identifier Enumeration
Integer	Zero based nth Unique Identifier in the response. If negative the count is backwards from the beginning of the current operation's batch item.

Table 130: Unique Identifier encoding descriptions

Item	Encoding
Unique Identifier	Text String, Enumeration or Integer

Table 131: Unique Identifier Attribute

SHALL 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, Re-key Key Pair
Applies to Object Types	All Objects

Table 132: Unique Identifier Attribute Rules

4.52 Usage Limits

The *Usage Limits* attribute is a mechanism for limiting the usage of a Managed Object. It only applies to Managed Objects that are able to be used for applying cryptographic protection and it SHALL only reflect their usage for applying that protection (e.g., encryption, signing, etc.). This attribute does not necessarily exist for all Managed Cryptographic Objects, since some objects are able to be used without limit for cryptographically protecting data, depending on client/server policies. Usage for processing cryptographically protected data (e.g., decryption, verification, etc.) is not limited. The Usage Limits attribute contains the Usage Limit structure which has the three following fields:

Value	Description
Usage Limits Total	The total number of Usage Limits Units allowed to be protected. This is the total value for the entire life of the object and SHALL NOT be changed once the object begins to be used for applying cryptographic protection.
Usage Limits Count	The currently remaining number of Usage Limits Units allowed to be protected by the object.
Usage Limits Unit	The type of quantity for which this structure specifies a usage limit (e.g., byte, object).

Table 133;: Usage Limits Descriptions

When the attribute is initially set (usually during object creation or registration), the Usage Limits Count is set to the Usage Limits Total value allowed for the useful life of the object, and are decremented when the object is used. The server SHALL ignore the Usage Limits Count value if the attribute is specified in an operation that creates a new object. Changes made via the Modify Attribute operation reflect corrections to the Usage Limits Total value, but they SHALL NOT be changed once the Usage Limits Count value has changed by a Get Usage Allocation operation. The Usage Limits Count value SHALL NOT be set or modified by the client via the Add Attribute or Modify Attribute operations.

SHALL always have a value	No
Initially set by	Server (Usage Limits Total, Usage Limits Count, and Usage Limits Unit) or Client (Usage Limits Total and/or Usage Limits Unit only)
Modifiable by server	Yes
Modifiable by client	Yes (Usage Limits Total and/or Usage Limits Unit only, as long as Get Usage Allocation has not been performed)
Deletable by client	Yes, as long as Get Usage Allocation has not been performed
Multiple instances permitted	No
When implicitly set	Create, Create Key Pair, Register, Derive Key, Re-key, Re-key Key Pair, Get Usage Allocation
Applies to Object Types	All Objects

Table 134: Usage Limits Attribute Rules

4.53 Vendor Attribute

A vendor specific Attribute is a structure used for sending and receiving a Managed Object attribute. The *Vendor Identification* and *Attribute Name* are text-strings that are used to identify the attribute. The *Attribute Value* is either a primitive data type or structured object, depending on the attribute. Vendor identification values “x” and “y” are reserved for KMIP v2.0 and later implementations referencing KMIP v1.x Custom Attributes.

Vendor Attributes created by the client with Vendor Identification “x” are not created (provided during object creation), set, added, adjusted, modified or deleted by the server.

Vendor Attributes created by the server with Vendor Identification “y” are not created (provided during object creation), set, added, adjusted, modified or deleted by the client.

Item	Encoding	REQUIRED
Attribute	Structure	
Vendor Identification	Text String (with usage limited to alphanumeric, underscore and period – i.e. [A-Za-z0-9_.])	Yes
Attribute Name	Text String	Yes
Attribute Value	Varies, depending on attribute.	Yes, except for the Notify operation

Table 135: Attribute Object Structure

4.54 X.509 Certificate Identifier

The *X.509 Certificate Identifier* attribute is a structure used to provide the identification of an X.509 public key certificate. The X.509 Certificate Identifier contains the Issuer Distinguished Name (i.e., from the Issuer field of the X.509 certificate) and the Certificate Serial Number (i.e., from the Serial Number field of the X.509 certificate). The X.509 Certificate Identifier SHALL be set by the server when the X.509 certificate is created or registered and then SHALL NOT be changed or deleted before the object is destroyed.

Item	Encoding	REQUIRED
X.509 Certificate Identifier	Structure	
Issuer Distinguished Name	Byte String	Yes
Certificate Serial Number	Byte String	Yes

Table 136: X.509 Certificate Identifier Attribute Structure

SHALL 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	X.509 Certificates

Table 137: X.509 Certificate Identifier Attribute Rules

4.55 X.509 Certificate Issuer

The *X.509 Certificate Issuer* attribute is a structure used to identify the issuer of a X.509 certificate, containing the Issuer Distinguished Name (i.e., from the Issuer field of the X.509 certificate). It MAY include one or more alternative names (e.g., email address, IP address, DNS name) for the issuer of the certificate (i.e., from the Issuer Alternative Name extension within the X.509 certificate). The server SHALL set these values based on the information it extracts from a X.509 certificate that is created as a result of a Certify or a Re-certify operation or is sent as part of a Register operation. These values SHALL NOT be changed or deleted before the object is destroyed.

Item	Encoding	REQUIRED
X.509 Certificate Issuer	Structure	
Issuer Distinguished Name	Byte String	Yes
Issuer Alternative Name	Byte String, MAY be repeated	No

Table 138: X.509 Certificate Issuer Attribute Structure

SHALL 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	X.509 Certificates

Table 139: X.509 Certificate Issuer Attribute Rules

4.56 X.509 Certificate Subject

The *X.509 Certificate Subject* attribute is a structure used to identify the subject of a X.509 certificate. The X.509 Certificate Subject contains the Subject Distinguished Name (i.e., from the Subject field of the X.509 certificate). It MAY include one or more alternative names (e.g., email address, IP address, DNS name) for the subject of the X.509 certificate (i.e., from the Subject Alternative Name extension within the X.509 certificate). The X.509 Certificate Subject SHALL be set by the server based on the information it extracts from the X.509 certificate that is created (as a result of a Certify or a Re-certify operation) or registered (as part of a Register operation) and SHALL NOT be changed or deleted before the object is destroyed.

If the Subject Alternative Name extension is included in the X.509 certificate and is marked critical within the X.509 certificate itself, then an X.509 certificate MAY be issued with the subject field left blank. Therefore an empty string is an acceptable value for the Subject Distinguished Name.

Item	Encoding	REQUIRED
X.509 Certificate Subject	Structure	
Subject Distinguished Name	Byte String	Yes, but MAY be the empty string
Subject Alternative Name	Byte String, MAY be repeated	Yes, if the Subject Distinguished Name is an empty string.

Table 140: X.509 Certificate Subject Attribute Structure

SHALL 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	X.509 Certificates

Table 141: X.509 Certificate Subject Attribute Rules

5 Attribute Data Structures

5.1 Attributes

This structure is used in various operations to provide the desired attribute values in the request and to return the actual attribute values in the response.

The *Attributes* structure is defined as follows:

Item	Encoding	REQUIRED
Attributes	Structure	
Any attribute in §4 - Object Attributes	*Any*, MAY be repeated	No

Table 142: Attributes Definition

5.2 Common Attributes

This structure is used in various operations to provide the desired attribute values in the request and to return the actual attribute values in the response.

The *Common Attributes* structure is defined as follows:

Item	Encoding	REQUIRED
Common Attributes	Structure	
Any attribute in §4 - Object Attributes	*Any*, MAY be repeated	No

Table 143: Common Attributes Definition

5.3 Private Key Attributes

This structure is used in various operations to provide the desired attribute values in the request and to return the actual attribute values in the response.

The *Private Key Attributes* structure is defined as follows:

Item	Encoding	REQUIRED
Private Key Attributes	Structure	
Any attribute in §4 - Object Attributes	*Any*, MAY be repeated	No

Table 144: Private Key Attributes Definition

5.4 Public Key Attributes

This structure is used in various operations to provide the desired attribute values in the request and to return the actual attribute values in the response.

The *Public Key Attributes* structure is defined as follows:

Item	Encoding	REQUIRED
Public Key Attributes	Structure	
Any attribute in §4 - Object Attributes	*Any*, MAY be repeated	No

Table 145: Public Key Attributes Definition

5.5 Attribute Reference

These structures are used in various operations to provide reference to an attribute by name or by tag in a request or response.

The *Attribute Reference* definition is as follows:

Object	Encoding	REQUIRED
Attribute Reference	Structure	
Vendor Identification	Text String (with usage limited to alphanumeric, underscore and period – i.e. [A-Za-z0-9_.])	Yes
Attribute Name	*Text String*	Yes

OR

Object	Encoding	REQUIRED
Attribute Reference	Enumeration (Tag)	Yes

Table 146: Attribute Reference Definition

5.6 Current Attribute

Structure used in various operations to provide the *Current Attribute* value in the request.

The *Current Attribute* structure is defined identically as follows:

Item	Encoding	REQUIRED
Current Attribute	Structure	
Any attribute in §4 - Object Attributes	*Any*	Yes

Table 147: Current Attribute Definition

5.7 New Attribute

Structure used in various operations to provide the *New Attribute* value in the request.

The *New Attribute* structure is defined identically as follows:

Item	Encoding	REQUIRED
New Attribute	Structure	
Any attribute in §4 - Object Attributes	*Any*	Yes

Table 148: New Attribute Definition

6 Operations

6.1 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 SHALL be capable of understanding the response to the request. All Object Management operations are issued in requests from clients to servers, and results obtained in responses from servers to clients. Multiple operations MAY be combined within a batch, resulting 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 SHALL 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 SHALL be discarded and/or invalidated by the server, so that subsequent requests do not find this previous ID Placeholder available.

The ID Placeholder is obtained from the Unique Identifier returned in response to the Create, Create Pair, Register, Derive Key, Re-key, Re-key Key Pair, Certify, Re-Certify, Locate, and Recover operations. If any of these operations successfully completes and returns a Unique Identifier, then the server SHALL copy this Unique Identifier into the ID Placeholder variable, where it is held until the completion of the operations remaining in the batched request or until a subsequent operation in the batch causes the ID Placeholder to be replaced. If the Batch Order Option is set to true (or unspecified), then subsequent operations in the batched request MAY make use of the ID Placeholder by omitting the Unique Identifier field from the request payloads for these operations.

Requests MAY contain attribute values to be assigned to the object. This information is specified with zero or more individual attributes.

For any operations that operate on Managed Objects already stored on the server, any archived object SHALL first be made available by a Recover operation before they MAY be specified (i.e., as on-line objects).

Multi-part cryptographic operations (operations where a stream of data is provided across multiple requests from a client to a server) are optionally supported by those cryptographic operations that include the Correlation Value, Init Indicator and Final Indicator request parameters.

For multi-part cryptographic operations the following sequence is performed

1. On the first request
   a. Provide an Init Indicator with a value of True
   b. Provide any other required parameters
   c. Preserve the Correlation Value returned in the response for use in subsequent requests
   d. Use the Data output (if any) from the response
2. On subsequent requests
   a. Provide the Correlation Value from the response to the first request
   b. Provide any other required parameters
   c. Use the next block of Data output (if any) from the response
3. On the final request
   a. Provide the Correlation Value from the response to the first request
   b. Provide a Final Indicator with a value of True
   c. Use the final block of Data output (if any) from the response

Single-part cryptographic operations (operations where a single input is provided and a single response returned) the following sequence is performed:

1. On each request
   a. Do not provide an Init Indicator, Final Indicator or Correlation Value or provide an Init indicator and Final Indicator but no Correlation Value.
   b. Provide any other required parameters
   c. Use the Data output from the response

Data is always required in cryptographic operations except when either Init Indicator or Final Indicator is true.

6.1.1 Activate

This operation requests the server to activate a Managed Object. The operation SHALL only be performed on an object in the Pre-Active state and has the effect of changing its state to Active, and setting its Activation Date to the current date and time.

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	Determines the object being activated. If omitted, then the ID Placeholder value is used by the server as the Unique Identifier.

Table 149: Activate Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object.

Table 150: Activate Response Payload

6.1.1.1 Error Handling – Activate

This section details the specific Result Reasons that SHALL be returned for errors detected in a Activate Operation.

Result Status	Result Reason
Operation Failed	Invalid Object Type, Object Not Found, Wrong Key Lifecycle State, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 151: Activate Errors

6.1.2 Add Attribute

This operation requests the server to add a new attribute instance to be associated with a Managed Object and set its value. The request contains the Unique Identifier of the Managed Object to which the attribute pertains, along with the attribute name and value. For single-instance attributes, this creates the attribute value. For multi-instance attributes, this is how the first and subsequent values are created. Existing attribute values SHALL NOT be changed by this operation. Read-Only attributes SHALL NOT be added using the Add Attribute operation.

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	The Unique Identifier of the object. If omitted, then the ID Placeholder value is used by the server as the Unique Identifier.
New Attribute	Yes	Specifies the attribute to be added to the object.

Table 152: Add Attribute Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object.

Table 153: Add Attribute Response Payload

6.1.2.1 Error Handling - Add Attribute

This section details the specific Result Reasons that SHALL be returned for errors detected in a Add Attribute Operation.

Result Status	Result Reason
Operation Failed	Attribute Single Valued, Invalid Attribute, Invalid Message, Non Unique Name Attribute, Object Not Found, Read Only Attribute, Server Limit Exceeded, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 154: Add Attribute Errors

6.1.3 Adjust Attribute

This operation requests the server to adjust the value of an attribute. The request contains the Unique Identifier of the Managed Object to which the attribute pertains, along with the attribute reference and value. If the object did not have value for the attribute, the previous value is assumed to be a 0 for numeric types and intervals, or false for Boolean, otherwise an error is raised. If the object had exactly one instance, then it is modified. If it has more than one instance an error is raised. Read-Only attributes SHALL NOT be added or modified using this operation.

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	The Unique Identifier of the object. If omitted, then the ID Placeholder value is used by the server as the Unique Identifier.
Attribute Reference	Yes	The attribute to be adjusted.
Adjustment Type	Yes	The adjustment to be made.
Adjustment Value	No	The value for the adjustment

Table 155: Adjust Attribute Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object.

Table 156: Adjust Attribute Response Payload

6.1.3.1 Error Handling - Adjust Attribute

This section details the specific Result Reasons that SHALL be returned for errors detected in a Adjust Attribute Operation.

Result Status	Result Reason
Operation Failed	Invalid Data Type, Item Not Found, Multi Valued Attribute, Numeric Range, Object Archived, Read Only Attribute, Unsupported Attribute, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 157: Adjust Attribute Errors

6.1.4 Archive

This operation is used to specify that a Managed Object MAY be archived. The actual time when the object is archived, 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 Managed Object. This request is only an indication from a client that, from its point of view, the key management system MAY archive the object.

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	Determines the object being archived. If omitted, then the ID Placeholder value is used by the server as the Unique Identifier.

Table 158: Archive Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object.

Table 159: Archive Response Payload

6.1.4.1 Error Handling – Archive

This section details the specific Result Reasons that SHALL be returned for errors detected in a Archive Operation.

Result Status	Result Reason
Operation Failed	Object Archived, Object Not Found, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 160: Archive Errors

6.1.5 Cancel

This operation requests the server to cancel an outstanding asynchronous operation. The correlation value of the original operation SHALL be specified in the request. The server SHALL respond with a *Cancellation Result.* The response to this operation is not able to be asynchronous.

Request Payload		
Item	**REQUIRED**	**Description**
Asynchronous Correlation Value	Yes	Specifies the request being canceled.

Table 161: Cancel Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Asynchronous Correlation Value	Yes	Specified in the request.
Cancellation Result	Yes	Enumeration indicating the result of the cancellation.

Table 162: Cancel Response Payload

This section details the specific Result Reasons that SHALL be returned for errors detected in a Cancel Operation.

Result Status	Result Reason
Operation Failed	Invalid Asynchronous Correlation Value, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 163: Cancel Errors

6.1.6 Certify

This request is used to generate a Certificate object for a public key. This request supports the certification of a new public key, as well as the certification of a public key that has already been certified (i.e., certificate update). Only a single certificate SHALL be requested at a time.

The Certificate Request object MAY be omitted, in which case the public key for which a Certificate object is generated SHALL be specified by its Unique Identifier only. If the Certificate Request Type and the Certificate Request objects are omitted from the request, then the Certificate Type SHALL be specified using the Attributes object.

The Certificate Request is passed as a Byte String, which allows multiple certificate request types for X.509 certificates (e.g., PKCS#10, PEM, etc.) to be submitted to the server.

The generated 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.

For the public key, the server SHALL create a Link attribute of Link Type Certificate pointing to the generated certificate. For the generated certificate, the server SHALL create a Link attribute of Link Type Public Key pointing to the Public Key.

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

If the information in the Certificate Request conflicts with the attributes specified in the Attributes, then the information in the Certificate Request takes precedence.

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	The Unique Identifier of the Public Key or the Certificate Request being certified. If omitted and Certificate Request is not present, then the ID Placeholder value is used by the server as the Unique Identifier.
Certificate Request Type	No	An Enumeration object specifying the type of certificate request. It is REQUIRED if the Certificate Request is present.
Certificate Request Value	No	A Byte String object with the certificate request.
Attributes	No	Specifies desired object attributes.
Protection Storage Masks	No	Specifies all permissible Protection Storage Mask selections for the new object

Table 164: Certify Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the generated Certificate object.

Table 165: Certify Response Payload

6.1.6.1 Error Handling – Certify

This section details the specific Result Reasons that SHALL be returned for errors detected in a Certify Operation.

Result Status	Result Reason
Operation Failed	Invalid CSR, Invalid Object Type, Item Not Found, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Protection Storage Unavailable, Response Too Large

Table 166: Certify Errors

6.1.7 Check

This operation requests that the server check 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, Re-key or Re-key Key Pair operation, and followed by a Get operation.

If the server determines that the client is allowed to use the object according to the specified attributes, then the server returns the Unique Identifier of the object.

If the server determines that the client is not allowed to use the object according to the specified attributes, then the server empties the ID Placeholder and does not return the Unique Identifier, and the operation returns the set of attributes specified in the request that caused the server policy denial. The only attributes returned are those that resulted in the server determining that the client is not allowed to use the object, thus allowing the client to determine how to proceed.

In a batch containing a Check operation the Batch Order Option SHOULD be set to true. Only STOP or UNDO Batch Error Continuation Option values SHOULD be used by the client in such a batch. Additional attributes that MAY be specified in the request are limited to:

Value	Description
Usage Limits Count	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.
Cryptographic Usage Mask	This is used to specify the cryptographic operations for which the client intends to use the object (see Section 3.19). 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 MAY be used for both Encryption and Decryption, but the value in the Check operation MAY specify that the client is only using the key for Encryption at this time.
Lease Time	This specifies a desired lease time (see Section 3.20). The client MAY use this to determine if the server allows 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 MAY be granted if requested by a subsequent, batched Obtain Lease operation.

Table 167: Check value description

Note that these objects are not encoded in an Attribute structure.

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	Determines the object being checked. If omitted, then the ID Placeholder value is used by the server as the Unique Identifier.
Usage Limits Count	No	Specifies the number of Usage Limits Units to be protected to be checked against server policy.
Cryptographic Usage Mask	No	Specifies the Cryptographic Usage for which the client intends to use the object.
Lease Time	No	Specifies a Lease Time value that the Client is asking the server to validate against server policy.

Table 168: Check Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes, unless a failure,	The Unique Identifier of the object.
Usage Limits Count	No	Returned by the Server if the Usage Limits value specified in the Request Payload is larger than the value that the server policy allows.
Cryptographic Usage Mask	No	Returned by the Server if the Cryptographic Usage Mask specified in the Request Payload is rejected by the server for policy violation.
Lease Time	No	Returned by the Server if the Lease Time value in the Request Payload is larger than a valid Lease Time that the server MAY grant.

Table 169: Check Response Payload

6.1.7.1 Error Handling – Check

This section details the specific Result Reasons that SHALL be returned for errors detected in a Check Operation.

Result Status	Result Reason
Operation Failed	Illegal Object Type, Incompatible Cryptographic Usage Mask, Object Not Found, Usage Limit Exceeded, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 170: Check Errors

6.1.8 Create

This operation requests the server to generate a new symmetric key or generate Secret Data as a Managed Cryptographic Object.

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.).

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

Request Payload		
Item	**REQUIRED**	**Description**
Object Type	Yes	Determines the type of object to be created.
Attributes	Yes	Specifies desired attributes to be associated with the new object.
Protection Storage Masks	No	Specifies all permissible Protection Storage Mask selections for the new object

Table 171: Create Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Object Type	Yes	Type of object created.
Unique Identifier	Yes	The Unique Identifier of the newly created object.

Table 172: Create Response Payload

6.1.8.1 Error Handling - Create

This section details the specific Result Reasons that SHALL be returned for errors detected in a Create operation.

Result Status	Result Reason
Operation Failed	Attribute Read Only, Attribute Single Valued, Cryptographic Failure, Invalid Attribute, Invalid Attribute Value, Invalid Object Type, Non Unique Name Attribute, Read Only Attribute, Server Limit Exceeded, Unsupported Attribute, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Protection Storage Unavailable, Response Too Large

Table 173: Create Errors

6.1.9 Create Key Pair

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

The request contains attributes to be assigned to the objects (e.g., Cryptographic Algorithm, Cryptographic Length, etc.). Attributes MAY be specified for both keys at the same time by specifying a Common Attributes object in the request. Attributes not common to both keys (e.g., Name, Cryptographic Usage Mask) MAY be specified using the Private Key Attributes and Public Key Attributes objects in the request, which take precedence over the Common Attributes object.

For the Private Key, the server SHALL create a Link attribute of Link Type Public Key pointing to the Public Key. For the Public Key, the server SHALL create a Link attribute of Link Type Private Key pointing to the Private Key. The response contains the Unique Identifiers of both created objects. The ID Placeholder value SHALL be set to the Unique Identifier of the Private Key.

Request Payload		
Item	**REQUIRED**	**Description**
Common Attributes	No	Specifies desired attributes to be associated with the new object that apply to both the Private and Public Key Objects.
Private Key Attributes	No	Specifies the attributes to be associated with the new object that apply to the Private Key Object.
Public Key Attributes	No	Specifies the attributes to be associated with the new object that apply to the Public Key Object.
Common Protection Storage Masks	No	Specifies all Protection Storage Mask selections that are permissible for the new Private Key and Public Key objects.
Private Protection Storage Masks	No	Specifies all Protection Storage Mask selections that are permissible for the new Private Key object.
Public Protection Storage Masks	No	Specifies all Protection Storage Mask selections that are permissible for the new Public Key object.

Table 174: Create Key Pair Request Payload

For multi-instance attributes, the union of the values found in the attributes of the Common, Private, and Public Key Attributes SHALL be used.

Response Payload		
Item	**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.

Table 175: Create Key Pair Response Payload

Table 176 indicates which attributes SHALL have the same value for the Private and Public Key.

Attribute	SHALL contain the same value for both Private and Public Key
Cryptographic Algorithm	Yes
Cryptographic Length	Yes
Cryptographic Domain Parameters	Yes
Cryptographic Parameters	Yes

Table 176: Create Key Pair Attribute Requirements

Setting the same Cryptographic Length value for both private and public key does not imply that both keys are of equal length. For RSA, Cryptographic Length corresponds to the bit length of the Modulus. For DSA and DH algorithms, Cryptographic Length corresponds to the bit length of parameter P, and the bit length of Q is set separately in the Cryptographic Domain Parameters attribute. For ECDSA, ECDH, and ECMQV algorithms, Cryptographic Length corresponds to the bit length of parameter Q.

6.1.9.1 Error Handling - Create Key Pair

This section details the specific Result Reasons that SHALL be returned for errors detected in a Create Key Pair Operation.

Result Status	Result Reason
Operation Failed	Attribute Read Only, Attribute Single Valued, Cryptographic Failure, Invalid Attribute, Invalid Attribute Value, Non Unique Name Attribute, Server Limit Exceeded, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Private Protection Storage Unavailable, Public Protection Storage Unavailable, Response Too Large

Table 177: Create Key Pair Errors

6.1.10 Create Split Key

This operation requests the server to generate a new split key and register all the splits as individual new Managed Cryptographic Objects.

The request contains attributes to be assigned to the objects (e.g., Split Key Parts, Split Key Threshold, Split Key Method, Cryptographic Algorithm, Cryptographic Length, etc.). The request MAY contain the Unique Identifier of an existing cryptographic object that the client requests be split by the server. If the attributes supplied in the request do not match those of the key supplied, the attributes of the key take precedence.

The response contains the Unique Identifiers of all created objects. The ID Placeholder value SHALL be set to the Unique Identifier of the split whose Key Part Identifier is 1.

Request Payload		
Item	**REQUIRED**	**Description**
Object Type	Yes	Determines the type of object to be created.
Unique Identifier	No	The Unique Identifier of the key to be split (if applicable).
Split Key Parts	Yes	The total number of parts.
Split Key Threshold	Yes	The minimum number of parts needed to reconstruct the entire key.
Split Key Method	Yes	
Prime Field Size	No	
Attributes	Yes	Specifies desired object attributes.
Protection Storage Masks	No	Specifies all permissible Protection Storage Mask selections for the new object

Table 178: Create Split Key Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes, MAY be repeated	The list of Unique Identifiers of the newly created objects.

Table 179: Create Split Key Response Payload

6.1.10.1 Error Handling - Create Split Key

This section details the specific Result Reasons that SHALL be returned for errors detected in a Create Split Key Operation.

Result Status	Result Reason
Operation Failed	Bad Cryptographic Parameters, Cryptographic Failure, Invalid Attribute, Invalid Attribute Value, Invalid Object type, Item Not Found, Non Unique Name Attribute, Server Limit Exceeded, Unsupported Cryptographic Parameters, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Protection Storage Unavailable, Response Too Large

Table 180: Create Split Key Errors

6.1.11 Decrypt

This operation requests the server to perform a decryption operation on the provided data using a Managed Cryptographic Object as the key for the decryption operation.

The request contains information about the cryptographic parameters (mode and padding method), the data to be decrypted, and the IV/Counter/Nonce to use. The cryptographic parameters MAY be omitted from the request as they can be specified as associated attributes of the Managed Cryptographic Object.

The initialization vector/counter/nonce MAY also be omitted from the request if the algorithm does not use an IV/Counter/Nonce.

The response contains the Unique Identifier of the Managed Cryptographic Object used as the key and the result of the decryption operation.

The success or failure of the operation is indicated by the Result Status (and if failure the Result Reason) in the response header.

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	The Unique Identifier of the Managed Cryptographic Object that is the key to use for the decryption operation. If omitted, then the ID Placeholder value SHALL be used by the server as the Unique Identifier.
Cryptographic Parameters	No	The Cryptographic Parameters (Block Cipher Mode, Padding Method) corresponding to the particular decryption method requested. If there are no Cryptographic Parameters associated with the Managed Cryptographic Object and the algorithm requires parameters then the operation SHALL return with a Result Status of Operation Failed.
Data	Yes for single-part. No for multi-part.	The data to be decrypted.
IV/Counter/Nonce	No	The initialization vector, counter or nonce to be used (where appropriate).
Correlation Value	No	Specifies the existing stream or by-parts cryptographic operation (as returned from a previous call to this operation).
Init Indicator	No	Initial operation as Boolean
Final Indicator	No	Final operation as Boolean
Authenticated Encryption Additional Data	No	Additional data to be authenticated via the Authenticated Encryption Tag. If supplied in multi-part decryption, this data MUST be supplied on the initial Decrypt request
Authenticated Encryption Tag	No	Specifies the tag that will be needed to authenticate the decrypted data and the additional authenticated data. If supplied in multi-part decryption, this data MUST be supplied on the initial Decrypt request

Table 181: Decrypt Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the Managed Cryptographic Object that is the key used for the decryption operation.
Data	No.	The decrypted data (as a Byte String).
Correlation Value	No	Specifies the stream or by-parts value to be provided in subsequent calls to this operation for performing cryptographic operations.

Table 182: Decrypt Response Payload

6.1.11.1 Error Handling - Decrypt

This section details the specific Result Reasons that SHALL be returned for errors detected in a Decrypt Operation.

Result Status	Result Reason
Operation Failed	Bad Cryptographic Parameters, Cryptographic Failure, Cryptographic Failure, Incompatible Cryptographic Usage Mask, Invalid Correlation Value, Invalid Object Type, Key Value Not Present, Missing Initialization Vector, Object Not Found, Unsupported Cryptographic Parameters, Wrong Key Lifecycle State, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 183: Decrypt Errors

6.1.12 Delegated Login

This operation requests the server to allow future requests to be authenticated using Ticket data that is returned by this operation. Requests using the ticket MUST only be permitted to perform the operations specified in the Rights section.

Request Payload		
Item	**REQUIRED**	**Description**
Lease Time	No	The lease time Interval or Date Time for the ticket.
Request Count	No	The integer count of the number of requests that can be made with the ticket
Usage Limits	No	The usage limits for operations performed.
Rights	Yes	List of Rights granted to the ticket holder which may only perform operations allowed by at least one of the contained Right structures.

Table 184: Delegated Login Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Ticket	Yes	The Ticket that is returned

Table 185: Delegated Login Response Payload

6.1.12.1 Error Handling – Delegated Login

This section details the specific Result Reasons that SHALL be returned for errors detected in a Delegated Login Operation

Result Status	Result Reason
Operation Failed	Invalid Field, Permission Denied, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 186: Delegated Login Errors

6.1.13 Delete Attribute

This operation requests the server to delete an attribute associated with a Managed Object. The request contains the Unique Identifier of the Managed Object whose attribute is to be deleted, the Current Attribute of the attribute. Attributes that are always REQUIRED to have a value SHALL never be deleted by this operation. Attempting to delete a non-existent attribute or specifying an Current Attribute for which there exists no attribute value SHALL result in an error. If no Current Attribute is specified in the request, and an Attribute Reference is specified, then all instances of the specified attribute SHALL be deleted.

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	Determines the object whose attributes are being deleted. If omitted, then the ID Placeholder value is used by the server as the Unique Identifier.
Current Attribute	No	Specifies the attribute associated with the object to be deleted.
Attribute Reference	No	Specifies the reference for the attribute associated with the object to be deleted.

Table 187: Delete Attribute Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object.

Table 188: Delete Attribute Response Payload

6.1.13.1 Error Handling - Delete Attribute

This section details the specific Result Reasons that SHALL be returned for errors detected in a Delete Attribute Operation.

Result Status	Result Reason
Operation Failed	Attribute Instance Not Found, Attribute Not Found, Attribute Read Only, Invalid Attribute, Object Not Found, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 189: Delete Attribute Errors

6.1.14 Derive Key

This request is used to derive a Symmetric Key or Secret Data object from keys or Secret Data objects that are already known to the key management system. The request SHALL only apply to Managed Objects that have the Derive Key bit set in the Cryptographic Usage Mask attribute of the specified Managed Object (i.e., are able to be used for key derivation). If the operation is issued for an object that does not have this bit set, then the server SHALL return an error. For all derivation methods, the client SHALL specify the desired length of the derived key or Secret Data object using the Cryptographic Length attribute. If a key is created, then the client SHALL specify both its Cryptographic Length and Cryptographic Algorithm. If the specified length exceeds the output of the derivation method, then the server SHALL return an error. Clients MAY derive multiple keys and IVs by requesting the creation of a Secret Data object and specifying a Cryptographic Length that is the total length of the derived object. If the specified length exceeds the output of the derivation method, then the server SHALL return an error.

The fields in the Derive Key request specify the Unique Identifiers of the keys or Secret Data objects to be used for derivation (e.g., some derivation methods MAY use multiple keys or Secret Data objects to derive the result), the method to be used to perform the derivation, and any parameters needed by the specified method.

The server SHALL 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 SHALL copy the Unique Identifier returned by this operation into the ID Placeholder variable.

For the keys or Secret Data objects from which the key or Secret Data object is derived, the server SHALL create a Link attribute of Link Type Derived Key pointing to the Symmetric Key or Secret Data object derived as a result of this operation. For the Symmetric Key or Secret Data object derived as a result of this operation, the server SHALL create a Link attribute of Link Type Derivation Base Object pointing to the keys or Secret Data objects from which the key or Secret Data object is derived.

Request Payload		
Item	**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. Note that the current value of the ID Placeholder SHALL NOT be used in place of a Unique Identifier in this operation.
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.
Attributes	Yes	Specifies desired attributes to be associated with the new object; the length and algorithm SHALL always be specified for the creation of a symmetric key.

Table 190: Derive Key Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the newly derived key or Secret Data object.

Table 191: Derive Key Response Payload

6.1.14.1 Error Handling - Derive Key

This section details the specific Result Reasons that SHALL be returned for errors detected in a Derive Key Operation.

Result Status	Result Reason
Operation Failed	Bad Cryptographic parameters, Cryptographic Failure, Incompatible Cryptographic Usage Mask, Invalid Attribute, Invalid Field, Invalid Message, Invalid Object Type, Key Value Not Present, Non Unique Name Attribute, Object Not Found, Unsupported Cryptographic Parameters, Wrong Key Lifecycle State, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 192: Derive Key Errors

6.1.15 Destroy

This operation is used to indicate to the server that the key material for the specified Managed Object SHALL be destroyed or rendered inaccessible. The meta-data for the key material SHALL be retained by the server. Objects SHALL only be destroyed if they are in either Pre-Active or Deactivated state.

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	Determines the object being destroyed. If omitted, then the ID Placeholder value is used by the server as the Unique Identifier.

Table 193: Destroy Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object.

Table 194: Destroy Response Payload

6.1.15.1 Error Handling – Destroy

This section details the specific Result Reasons that SHALL be returned for errors detected in a Destroy Operation.

Result Status	Result Reason
Operation Failed	Object Destroyed, Object Not Found, Wrong Key Lifecycle State, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 195: Destroy Errors

6.1.16 Discover Versions

This operation is used by the client to determine a list of protocol versions that is supported by the server. The request payload contains an OPTIONAL list of protocol versions that is supported by the client. The protocol versions SHALL be ranked in decreasing order of preference.

The response payload contains a list of protocol versions that are supported by the server. The protocol versions are ranked in decreasing order of preference. If the client provides the server with a list of supported protocol versions in the request payload, the server SHALL return only the protocol versions that are supported by both the client and server. The server SHOULD list all the protocol versions supported by both client and server. If the protocol version specified in the request header is not specified in the request payload and the server does not support any protocol version specified in the request payload, the server SHALL return an empty list in the response payload. If no protocol versions are specified in the request payload, the server SHOULD return all the protocol versions that are supported by the server.

Request Payload		
Item	**REQUIRED**	**Description**
Protocol Version	No, MAY be Repeated	The list of protocol versions supported by the client ordered in decreasing order of preference.

Table 196: Discover Versions Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Protocol Version	No, MAY be repeated	The list of protocol versions supported by the server ordered in decreasing order of preference.

Table 197: Discover Versions Response Payload

6.1.16.1 Error Handling - Discover Versions

This section details the specific Result Reasons that SHALL be returned for errors detected in a Discover Versions Operation.

Result Status	Result Reason
Operation Failed	Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 198: Discover Versions Errors

6.1.17 Encrypt

This operation requests the server to perform an encryption operation on the provided data using a Managed Cryptographic Object as the key for the encryption operation.

The request contains information about the cryptographic parameters (mode and padding method), the data to be encrypted, and the IV/Counter/Nonce to use. The cryptographic parameters MAY be omitted from the request as they can be specified as associated attributes of the Managed Cryptographic Object. The IV/Counter/Nonce MAY also be omitted from the request if the cryptographic parameters indicate that the server shall generate a Random IV on behalf of the client or the encryption algorithm does not need an IV/Counter/Nonce. The server does not store or otherwise manage the IV/Counter/Nonce.

If the Managed Cryptographic Object referenced has a Usage Limits attribute then the server SHALL obtain an allocation from the current Usage Limits value prior to performing the encryption operation. If the allocation is unable to be obtained the operation SHALL return with a result status of Operation Failed and result reason of Permission Denied.

The response contains the Unique Identifier of the Managed Cryptographic Object used as the key and the result of the encryption operation.

The success or failure of the operation is indicated by the Result Status (and if failure the Result Reason) in the response header.

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	The Unique Identifier of the Managed Cryptographic Object that is the key to use for the encryption operation. If omitted, then the ID Placeholder value SHALL be used by the server as the Unique Identifier.
Cryptographic Parameters	No	The Cryptographic Parameters (Block Cipher Mode, Padding Method, RandomIV) corresponding to the particular encryption method requested. If there are no Cryptographic Parameters associated with the Managed Cryptographic Object and the algorithm requires parameters then the operation SHALL return with a Result Status of Operation Failed.
Data	Yes for single-part. No for multi-part.	The data to be.
IV/Counter/Nonce	No	The initialization vector, counter or nonce to be used (where appropriate).
Correlation Value	No	Specifies the existing stream or by-parts cryptographic operation (as returned from a previous call to this operation).
Init Indicator	No	Initial operation as Boolean
Final Indicator	No	Final operation as Boolean

Authenticated Encryption Additional Data	No	Any additional data to be authenticated via the Authenticated Encryption Tag. If supplied in multi-part encryption, this data MUST be supplied on the initial Encrypt request

Table 199: Encrypt Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the Managed Cryptographic Object that was the key used for the encryption operation.
Data	No.	The encrypted data (as a Byte String).
IV/Counter/Nonce	No	The value used if the Cryptographic Parameters specified Random IV and the IV/Counter/Nonce value was not provided in the request and the algorithm requires the provision of an IV/Counter/Nonce.
Correlation Value	No	Specifies the stream or by-parts value to be provided in subsequent calls to this operation for performing cryptographic operations.
Authenticated Encryption Tag	No	Specifies the tag that will be needed to authenticate the decrypted data (and any “additional data”). Only returned on completion of the encryption of the last of the plaintext by an authenticated encryption cipher.

Table 200: Encrypt Response Payload

6.1.17.1 Error Handling – Encrypt

This section details the specific Result Reasons that SHALL be returned for errors detected in a Encrypt Operation.

Result Status	Result Reason
Operation Failed	Bad Cryptographic Parameters, Cryptographic Failure, Incompatible Cryptographic Usage Mask, Invalid Correlation Value, Invalid Object Type, Key Value Not Present, Missing Initialization Vector, Object Not Found, Unsupported Cryptographic Parameters, Usage Limit Exceeded, Wrong Key Lifecycle State, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 201: Encrypt Errors

6.1.18 Export

This operation requests that the server returns a Managed Object specified by its Unique Identifier, together with its attributes.

The Key Format Type, Key Wrap Type, Key Compression Type and Key Wrapping Specification SHALL have the same semantics as for the Get operation. If the Managed Object has been Destroyed then the key material for the specified managed object SHALL not be returned in the response.

The server SHALL copy the Unique Identifier returned by this operations into the ID Placeholder variable.

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	Determines the object being requested. If omitted, then the IDPlaceholder value is used by the server as the Unique Identifier.
Key Format Type	No	Determines the key format type to be returned.
Key Wrap Type	No	Determines the Key Wrap Type of the returned key value.
Key Compression Type	No	Determines the compression method for elliptic curve public keys.
Key Wrapping Specification	No	Specifies keys and other information for wrapping the returned object.

Table 202: Export Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Object Type	Yes	Type of object
Unique Identifier	Yes	The Unique Identifier of the object.
Attributes	Yes	All of the object's Attributes.
Any Object (Section 2)	Yes	The object value being returned, in the same manner as the Get operation.

Table 203: Export Response Payload

6.1.18.1 Error Handling – Export

This section details the specific Result Reasons that SHALL be returned for errors detected in a Export Operation.

Result Status	Result Reason
Operation Failed	Bad Cryptographic Parameters, Encoding Option Error, Encoding Option Error, Incompatible Cryptographic Usage Mask, Invalid Object Type, Key Compression Type Not Supported, Key Format Type Not Supported, Key Value Not Present, Key Wrap Type Not Supported, Object Not Found, Wrapping Object Archived, Wrapping Object Destroyed, Wrapping Object Not Found, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 204: Export Errors

6.1.19 Get

This operation requests that the server returns the Managed Object specified by its Unique Identifier.

Only a single object is returned. The response contains the Unique Identifier of the object, along with the object itself, which MAY be wrapped using a wrapping key as specified in the request.

The following key format capabilities SHALL be assumed by the client; restrictions apply when the client requests the server to return an object in a particular format:

- If a client registered a key in a given format, the server SHALL be able to return the key during the Get operation in the same format that was used when the key was registered.
- Any other format conversion MAY be supported by the server.

If Key Format Type is specified to be PKCS#12 then the response payload shall be a PKCS#12 container as specified by [RFC7292]. The Unique Identifier shall be either that of a private key or certificate to be included in the response. The container shall be protected using the Secret Data object specified via the private key or certificate's PKCS#12 Password Link. The current certificate chain shall also be included as determined by using the private key's Public Key link to get the corresponding public key (where relevant), and then using that public key's PKCS#12 Certificate Link to get the base certificate, and then using each certificate's Certificate Link to build the certificate chain. It is an error if there is more than one valid certificate chain.

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	Determines the object being requested. If omitted, then the ID Placeholder value is used by the server as the Unique Identifier.
Key Format Type	No	Determines the key format type to be returned.
Key Wrap Type	No	Determines the Key Wrap Type of the returned key value.
Key Compression Type	No	Determines the compression method for elliptic curve public keys.
Key Wrapping Specification	No	Specifies keys and other information for wrapping the returned object.

Table 205: Get Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Object Type	Yes	Type of object.
Unique Identifier	Yes	The Unique Identifier of the object.
Any Object (Section 2)	Yes	The object being returned.

Table 206: Get Response Payload

6.1.19.1 Error Handling – Get

This section details the specific Result Reasons that SHALL be returned for errors detected in a Get Operation.

Result Status	Result Reason
Operation Failed	Bad Cryptographic Parameters, Encoding Option Error, Encoding Option Error, Incompatible Cryptographic Usage Mask, Incompatible Cryptographic Usage Mask, Invalid Object Type, Key Compression Type Not Supported, Key Format Type Not Supported, Key Value Not Present, Key Wrap Type Not Supported, Not Extractable, Object Not Found, Sensitive, Wrapping Object Archived, Wrapping Object Destroyed, Wrapping Object Not Found, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 207: Get Errors

6.1.20 Get Attributes

This operation requests one or more attributes associated with a Managed Object. The object is specified by its Unique Identifier, and the attributes are specified by their name in the request. If a specified attribute has multiple instances, then all instances are returned. If a specified attribute does not exist (i.e., has no value), then it SHALL NOT be present in the returned response. If none of the requested attributes exist, then the response SHALL consist only of the Unique Identifier. The same Attribute Reference SHALL NOT be present more than once in a request.

If no Attribute Reference is provided, the server SHALL return all attributes.

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	Determines the object whose attributes are being requested. If omitted, then the ID Placeholder value is used by the server as the Unique Identifier.
Attribute Reference	No, MAY be repeated	Specifies an attribute associated with the object.

Table 208: Get Attributes Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object.
Attributes	Yes	The requested attributes associated with the object.

Table 209: Get Attributes Response Payload

6.1.20.1 Error Handling - Get Attributes

This section details the specific Result Reasons that SHALL be returned for errors detected in a Get Attributes Operation.

Result Status	Result Reason
Operation Failed	Invalid Attribute, Object Not Found, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 210: Get Attributes Errors

6.1.21 Get Attribute List

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

If no Attribute Reference is provided, the server SHALL return all attributes.

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	Determines the object whose attribute names are being requested. If omitted, then the ID Placeholder value is used by the server as the Unique Identifier.

Table 211: Get Attribute List Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object.
Attribute Reference	Yes, MAY be repeated	The attributes associated with the object.

Table 212: Get Attribute List Response Payload

6.1.21.1 Error Handling - Get Attribute List

This section details the specific Result Reasons that SHALL be returned for errors detected in a Get Attribute List Operation.

Result Status	Result Reason
Operation Failed	Object Not Found, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 213: Get Attribute List Errors

6.1.22 Get Usage Allocation

This operation requests the server to obtain an allocation from the current Usage Limits value to allow the client to use the Managed Cryptographic Object for applying cryptographic protection. The allocation only applies to Managed Objects that are able to be used for applying protection (e.g., symmetric keys for encryption, private keys for signing, etc.) and is only valid if the Managed Object has a Usage Limits attribute. Usage for processing cryptographically protected information (e.g., decryption, verification, etc.) is not limited and is not able to be allocated. A Managed Object that has a Usage Limits attribute SHALL NOT be used by a client for applying cryptographic protection unless an allocation has been obtained using this operation. The operation SHALL only be requested 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 requested for an object that has no Usage Limits attribute, or is not an object that MAY be used for applying cryptographic protection, then the server SHALL return an error.

The field in the request specifies the number of units that the client needs to protect. If the requested amount is not available or if the Managed Object is not able to be used for applying cryptographic protection at this time, then the server SHALL return an error. The server SHALL assume that the entire allocated amount is going to be consumed. Once the entire allocated amount has been consumed, the client SHALL NOT continue to use the Managed Object for applying cryptographic protection until a new allocation is obtained.

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	Determines the object whose usage allocation is being requested. If omitted, then the ID Placeholder is substituted by the server.
Usage Limits Count	Yes	The number of Usage Limits Units to be protected.

Table 214: Get Usage Allocation Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object.

Table 215: Get Usage Allocation Response Payload

6.1.22.1 Error Handling - Get Usage Allocation

This section details the specific Result Reasons that SHALL be returned for errors detected in a Get Usage Allocation Operation.

Result Status	Result Reason
Operation Failed	Attribute Not Found, Invalid Message, Invalid Object Type, Object Not Found, Usage Limit Exceeded, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 216: Get Usage Allocation Errors

6.1.23 Hash

This operation requests the server to perform a hash operation on the data provided.

The request contains information about the cryptographic parameters (hash algorithm) and the data to be hashed.

The response contains the result of the hash operation.

The success or failure of the operation is indicated by the Result Status (and if failure the Result Reason) in the response header.

Request Payload		
Item	**REQUIRED**	**Description**
Cryptographic Parameters	Yes	The Cryptographic Parameters (Hashing Algorithm) corresponding to the particular hash method requested.
Data	Yes for single-part. No for multi-part.	The data to be hashed .
Correlation Value	No	Specifies the existing stream or by-parts cryptographic operation (as returned from a previous call to this operation).
Init Indicator	No	Initial operation as Boolean
Final Indicator	No	Final operation as Boolean

Table 217: Hash Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Data	Yes for single-part. No for multi-part.	The hashed data (as a Byte String).
Correlation Value	No	Specifies the stream or by-parts value to be provided in subsequent calls to this operation for performing cryptographic operations.

Table 218: Hash Response Payload

6.1.23.1 Error Handling - HASH

This section details the specific Result Reasons that SHALL be returned for errors detected in a Hash Operation.

Result Status	Result Reason
Operation Failed	Cryptographic Failure, Invalid Correlation Value, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 219: HASH Errors

6.1.24 Import

This operation requests the server to Import a Managed Object specified by its Unique Identifier. The request specifies the object being imported and all the attributes to be assigned to the object. The attribute rules for each attribute for “Initially set by” and “When implicitly set” SHALL NOT be enforced as all attributes MUST be set to the supplied values rather than any server generated values.

The response contains the Unique Identifier provided in the request or assigned by the server. The server SHALL copy the Unique Identifier returned by this operations into the ID Placeholder variable.

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object to be imported
Object Type	Yes	Determines the type of object being imported.
Replace Existing	No	A Boolean. If specified and true then any existing object with the same Unique Identifier SHALL be replaced by this operation. If absent or false and an object exists with the same Unique Identifier then an error SHALL be returned.
Key Wrap Type	If and only if the key object is wrapped.	If Not Wrapped then the server SHALL unwrap the object before storing it, and return an error if the wrapping key is not available. Otherwise the server SHALL store the object as provided.
Attributes	Yes	Specifies object attributes to be associated with the new object.
Any Object (Section 2)	Yes	The object being imported. The object and attributes MAY be wrapped.

Table 220: Import Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the newly imported object.

Table 221: Import Response Payload

6.1.24.1 Error Handling – Import

This section details the specific Result Reasons that SHALL be returned for errors detected in a Import Operation.

Result Status	Result Reason
Operation Failed	Attribute Read Only, Attribute Single Valued, Encoding Option Error, Invalid Attribute, Invalid Attribute Value, Invalid Field, Non Unique Name Attribute, Object Already Exists, Server Limit Exceeded, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Protection Storage Unavailable, Response Too Large

Table 222: Import Errors

6.1.25 Interop

This operation informs the server about the status if interop tests. It SHALL NOT be available in a production server. The Interop Operation uses three Interop Functions (Begin, End and Reset).

Request Payload		
Item	**REQUIRED**	**Description**
Interop Function	Yes	The function to be performed
Interop Identifier	Yes	The identifier if the test case to be submitted.

Table 223: Interop Request Payload

Response Payload		
Item	**REQUIRED**	**Description**

Table 224: Interop Response Payload

6.1.25.1 Error Handling – Interop

This section details the specific Result Reasons that SHALL be returned for errors detected in an Interop Operation.

Result Status	Result Reason
Operation Failed	Invalid Field, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 225: Interop Errors

6.1.26 Join Split Key

This operation requests the server to combine a list of Split Keys into a single Managed Cryptographic Object. The number of Unique Identifiers in the request SHALL be at least the value of the Split Key Threshold defined in the Split Keys.

The request contains the Object Type of the Managed Cryptographic Object that the client requests the Split Key Objects be combined to form. If the Object Type formed is Secret Data, the client MAY include the Secret Data Type in the request.

The response contains the Unique Identifier of the object obtained by combining the Split Keys. The server SHALL copy the Unique Identifier returned by this operation into the ID Placeholder variable.

Request Payload		
Item	**REQUIRED**	**Description**
Object Type	Yes	Determines the type of object to be created.
Unique Identifier	Yes, MAY be repeated	Determines the Split Keys to be combined to form the object returned by the server. The minimum number of identifiers is specified by the Split Key Threshold field in each of the Split Keys.
Secret Data Type	No	Determines which Secret Data type the Split Keys form.
Attributes	No	Specifies desired object attributes.
Protection Storage Masks	No	Specifies all permissible Protection Storage Mask selections for the new object

Table 226: Join Split Key Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object obtained by combining the Split Keys.

Table 227: Join Split Key Response Payload

6.1.26.1 Error Handling - Join Split Key

This section details the specific Result Reasons that SHALL be returned for errors detected in a Join Split Key Operation.

Result Status	Result Reason
Operation Failed	Attribute Read Only, Attribute Single Valued, Bad Cryptographic Parameters, Cryptographic Failure, Cryptographic Failure, Invalid Attribute, Invalid Attribute Value, Invalid Object Type, Non Unique Name Attribute, Object Not Found, Server Limit Exceeded, Unsupported Cryptographic Parameters, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Protection Storage Unavailable, Response Too Large

Table 228: Join Split Key Errors

6.1.27 Locate

This operation requests that the server search for one or more Managed Objects, depending on the attributes specified in the request. All attributes are allowed to be used. The request MAY contain a *Maximum Items* field, which specifies the maximum number of objects to be returned. 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 request MAY contain an *Offset Items* field, which specifies the number of objects to skip that satisfy the identification criteria specified in the request. An *Offset Items* field of 0 is the same as omitting the *Offset Items* field. If both *Offset Items* and *Maximum Items* are specified in the request, the server skips *Offset Items* objects and returns up to *Maximum Items* objects.

If more than one object satisfies the identification criteria specified in the request, then the response MAY contain Unique Identifiers for multiple Managed Objects. Responses containing Unique Identifiers for multiple objects SHALL be returned in descending order of object creation (most recently created object first). Returned objects SHALL match all of the attributes in the request. If no objects match, then an empty response payload is returned. If no attribute is specified in the request, any object SHALL be deemed to match the Locate request. The response MAY include *Located Items* which is the count of all objects that satisfy the identification criteria.

The server returns a list of Unique Identifiers of the found objects, which then MAY be retrieved using the Get operation. If the objects are archived, then the Recover and Get operations are REQUIRED to be used to obtain those objects. If a single Unique Identifier is returned to the client, then the server SHALL 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 SHALL empty the ID Placeholder, causing any subsequent operations that are batched with the Locate, and which do not specify a Unique Identifier explicitly, to fail. This ensures that these batched operations SHALL proceed only if a single object is returned by Locate.

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

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

When the Usage Limits attribute is specified in the request, matching candidate objects SHALL have a Usage Limits Count and Usage Limits Total equal to or larger than the values specified in the request.

When an attribute that is defined as a structure is specified, all of the structure fields are not REQUIRED to be specified. For instance, for the Link attribute, if the Linked Object Identifier value is specified without the Link Type value, then matching candidate objects have the Linked Object Identifier as specified, irrespective of their Link Type.

When the Object Group attribute and the Object Group Member flag are specified in the request, and the value specified for Object Group Member is ‘Group Member Fresh’, matching candidate objects SHALL be fresh objects from the object group. If there are no more fresh objects in the group, the server MAY choose to generate a new object on-the-fly, based on server policy. If the value specified for Object Group Member is ‘Group Member Default’, the server locates the default object as defined by server policy.

The Storage Status Mask field is used to indicate whether on-line objects (not archived or destroyed), archived objects, destroyed objects or any combination of the above are to be searched.The server SHALL NOT return unique identifiers for objects that are destroyed unless the Storage Status Mask field includes the Destroyed Storage indicator. The server SHALL NOT return unique identifiers for objects that are archived unless the Storage Status Mask field includes the Archived Storage indicator.

Request Payload		
Item	**REQUIRED**	**Description**
Maximum Items	No	An Integer object that indicates the maximum number of object identifiers the server MAY return.
Offset Items	No	An Integer object that indicates the number of object identifiers to skip that satisfy the identification criteria specified in the request.
Storage Status Mask	No	An Integer object (used as a bit mask) that indicates whether only on-line objects, only archived objects, destroyed objects or any combination of these, are to be searched. If omitted, then only on-line objects SHALL be returned.
Object Group Member	No	An Enumeration object that indicates the object group member type.
Attributes	Yes	Specifies an attribute and its value(s) that are REQUIRED to match those in a candidate object (according to the matching rules defined above). Note: the Attributes structure MAY be empty indicating all objects should match.

Table 229: Locate Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Located Items	No	An Integer object that indicates the number of object identifiers that satisfy the identification criteria specified in the request. A server MAY elect to omit this value from the Response if it is unable or unwilling to determine the total count of matched items. A server MAY elect to return the Located Items value even if Offset Items is not present in the Request.
Unique Identifier	No, MAY be repeated	The Unique Identifier of the located objects.

Table 230: Locate Response Payload

6.1.27.1 Error Handling – Locate

This section details the specific Result Reasons that SHALL be returned for errors detected in a Locate Operation.

Result Status	Result Reason
Operation Failed	Invalid Attribute, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 231: Locate Errors

6.1.28 Log

This operation requests the server to log a message to the server log. The response payload returned is empty.

Request Payload		
Item	**REQUIRED**	**Description**
Log Message	Yes	The message to log

Table 232: Log Request Payload

Response Payload		
Item	**REQUIRED**	**Description**

Table 233: Log Response Payload

6.1.28.1 Error Handling – Log

This section details the specific Result Reasons that SHALL be returned for errors detected in a Query Operation.

Result Status	Result Reason
Operation Failed	Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 234: Log Errors

6.1.29 Login

This operation requests the server to allow future requests ti be authenticated using a ticket that is returned by this operation.

Request Payload		
Item	**REQUIRED**	**Description**
Lease Time	No	The lease time Interval or Date Time for the ticket
Request Count	No	The integer count of the number of requests that can be made with the ticket
Usage Limits	No	The usage limits for the operations performed

Table 235: Login Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Ticket	Yes	The ticket that is returned

Table 236: Login Response Payload

6.1.29.1 Error Handling - Login

This section details the specific Result Reasons that SHALL be returned for errors detected in an Login Operation.

Result Status	Result Reason
Operation Failed	Invalid Field, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 237: Login Errors

6.1.30 Logout

This operation requests the server to terminate the Login and prevent future unauthenticated sessions being created without the ticket.

Request Payload		
Item	**REQUIRED**	**Description**
Ticket	Yes	The ticket to be invalidated

Table 238: Logout Request Payload

Response Payload		
Item	**REQUIRED**	**Description**

Table 239: Logout Response Payload

6.1.30.1 Error Handling - Logout

This section details the specific Result Reasons that SHALL be returned for errors detected in an Logout Operation.

Result Status	Result Reason
Operation Failed	Invalid Ticket, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 240: Logout Errors

6.1.31 MAC

This operation requests the server to perform message authentication code (MAC) operation on the provided data using a Managed Cryptographic Object as the key for the MAC operation.

The request contains information about the cryptographic parameters (cryptographic algorithm) and the data to be MACed. The cryptographic parameters MAY be omitted from the request as they can be specified as associated attributes of the Managed Cryptographic Object.

The response contains the Unique Identifier of the Managed Cryptographic Object used as the key and the result of the MAC operation.

The success or failure of the operation is indicated by the Result Status (and if failure the Result Reason) in the response header.

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	The Unique Identifier of the Managed Cryptographic Object that is the key to use for the MAC operation. If omitted, then the ID Placeholder value SHALL be used by the server as the Unique Identifier.
Cryptographic Parameters	No	The Cryptographic Parameters (Cryptographic Algorithm) corresponding to the particular MAC method requested. If there are no Cryptographic Parameters associated with the Managed Cryptographic Object and the algorithm requires parameters then the operation SHALL return with a Result Status of Operation Failed.
Data	Yes for single-part. No for multi-part.	The data to be MACed .
Correlation Value	No	Specifies the existing stream or by-parts cryptographic operation (as returned from a previous call to this operation).
Init Indicator	No	Initial operation as Boolean
Final Indicator	No	Final operation as Boolean

Table 241: MAC Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the Managed Cryptographic Object that is the key used for the MAC operation.
MAC Data	Yes for single-part. No for multi-part	The data MACed (as a Byte String).
Correlation Value	No	Specifies the stream or by-parts value to be provided in subsequent calls to this operation for performing cryptographic operations.

Table 242: MAC Response Payload

6.1.31.1 Error Handling - MAC

This section details the specific Result Reasons that SHALL be returned for errors detected in a MAC Operation.

Result Status	Result Reason
Operation Failed	Bad Cryptographic Parameters, Cryptographic Failure, Incompatible Cryptographic Usage Mask, Invalid Correlation Value, Invalid Object Type, Key Value Not Present, Object Not Found, Usage Limit Exceeded, Wrong Key Lifecycle State, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 243: MAC Errors

6.1.32 MAC Verify

This operation requests the server to perform message authentication code (MAC) verify operation on the provided data using a Managed Cryptographic Object as the key for the MAC verify operation.

The request contains information about the cryptographic parameters (cryptographic algorithm) and the data to be MAC verified and MAY contain the data that was passed to the MAC operation (for those algorithms which need the original data to verify a MAC). The cryptographic parameters MAY be omitted from the request as they can be specified as associated attributes of the Managed Cryptographic Object.

The response contains the Unique Identifier of the Managed Cryptographic Object used as the key and the result of the MAC verify operation. The validity of the MAC is indicated by the Validity Indicator field.

The response message SHALL include the Validity Indicator for single-part MAC Verify operations and for the final part of a multi-part MAC Verify operation. Non-Final parts of multi-part MAC Verify operations SHALL NOT include the Validity Indicator.

The success or failure of the operation is indicated by the Result Status (and if failure the Result Reason) in the response header.

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	The Unique Identifier of the Managed Cryptographic Object that is the key to use for the MAC verify operation. If omitted, then the ID Placeholder value SHALL be used by the server as the Unique Identifier.
Cryptographic Parameters	No	The Cryptographic Parameters (Cryptographic Algorithm) corresponding to the particular MAC method requested. If there are no Cryptographic Parameters associated with the Managed Cryptographic Object and the algorithm requires parameters then the operation SHALL return with a Result Status of Operation Failed.
Data	No	The data that was MACed .
MAC Data	Yes for single-part. No for multi-part.	The data to be MAC verified (as a Byte String).
Correlation Value	No	Specifies the existing stream or by-parts cryptographic operation (as returned from a previous call to this operation).
Init Indicator	No	Initial operation as Boolean
Final Indicator	No	Final operation as Boolean

Table 244: MAC Verify Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the Managed Cryptographic Object that is the key used for the verification operation.
Validity Indicator	Yes for single-part. No for multi-part.	An Enumeration object indicating whether the MAC is valid, invalid, or unknown.
Correlation Value	No	Specifies the stream or by-parts value to be provided in subsequent calls to this operation for performing cryptographic operations.

Table 245: MAC Verify Response Payload

6.1.32.1 Error Handling - MAC Verify

This section details the specific Result Reasons that SHALL be returned for errors detected in a MAC Verify Operation.

Result Status	Result Reason
Operation Failed	Bad Cryptographic Parameters, Cryptographic Failure, Incompatible Cryptographic Usage Mask, Invalid Correlation Value, Invalid Object Type, Key Value Not Present, Object Not Found, Permission Denied, Wrong Key Lifecycle State, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 246: MAC Verify Errors

6.1.33 Modify Attribute

This operation requests the server to modify the value of an existing attribute instance associated with a Managed Object. The request contains the Unique Identifier of the Managed Object whose attribute is to be modified, the OPTIONAL Current Attribute existing value and the New Attribute new value. If no Current Attribute is specified in the request, then if there is only a single instance of the Attribute it SHALL be selected as the attribute instance to be modified to the New Attribute value, and if there are multiple instances of the Attribute an error SHALL be returned (as the specific instance of the attribute is unable to be determined).. Only existing attributes MAY be changed via this operation. Only the specified instance of the attribute SHALL be modified. Specifying a Current Attribute for which there exists no Attribute associated with the object SHALL result in an error.

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	The Unique Identifier of the object. If omitted, then the ID Placeholder value is used by the server as the Unique Identifier.
Current Attribute	No	Specifies the existing attribute value associated with the object to be modified.
New Attribute	Yes	Specifies the new value for the attribute associated with the object .

Table 247: Modify Attribute Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object.

Table 248: Modify Attribute Response Payload

6.1.33.1 Error Handling - Modify Attribute

This section details the specific Result Reasons that SHALL be returned for errors detected in a Modify Attribute Operation.

Result Status	Result Reason
Operation Failed	Attribute Instance Not Found, Attribute Not Found, Attribute Read Only, Non Unique Name Attribute, Object Not Found, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 249: Modify Attribute Errors

6.1.34 Obtain Lease

This operation requests the server 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 needs to 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, then the client SHALL NOT use the associated cryptographic object until a new lease is obtained. If the server determines that a new lease SHALL NOT be issued for the specified cryptographic object, then the server SHALL respond to the Obtain Lease request with an error.

The response payload for the operation contains the current value of the Last Change 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.

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	Determines the object for which the lease is being obtained. If omitted, then the ID Placeholder value is used by the server as the Unique Identifier.

Table 250: Obtain Lease Request Payload

Response Payload		
Item	**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 MAY be used until a new lease needs to be obtained.
Last Change Date	Yes	The date and time indicating when the latest change was made to the contents or any attribute of the specified object.

Table 251: Obtain Lease Response Payload

6.1.34.1 Error Handling - Obtain Lease

This section details the specific Result Reasons that SHALL be returned for errors detected in a Obtain Lease Operation.

Result Status	Result Reason
Operation Failed	Object Not Found, Usage Limit Exceeded, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 252: Obtain Lease Errors

6.1.35 PKCS#11

This operation enables the server to perform a PKCS#11 operation.

Request Payload		
Item	**REQUIRED**	**Description**
PKCS#11 Interface	No	The name of the interface. If absent, the default V3.0 interface which defines the functions supported.
PKCS#11 Function	Yes	The function to perform. An Enumeration for PKCS#11 defined functions or an Integer for vendor defined function.
Correlation Value	No	Must be returned to the server if provided in a previous response.
PKCS#11 Input Parameters	No	The parameters to the function. The format is specified in the PKCS#11 Profile and the **[PKCS#11]** standard document

Table 253: PKCS#11 Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
PKCS#11 Interface	No	The name of the interface. If absent, the default V3.0 interface is used.
PKCS#11 Function	Yes	The function that was performed. An Enumeration for PKCS#11 defined functions or an Integer for vendor defined function.
Correlation Value	No	Server defined Byte String that the client must provide in the next request.
PKCS#11 Output Parameters	No	The parameters output from the function. The format is specified in the PKCS#11 Profile [KMIP-Prof] and the **[PKCS#11]** standard document.
PKCS#11 Return Code	Yes	The PKCS#11 return code as specified in the CK_RV values in **[PKCS#11]**

Table 254: PKCS#11 Response Payload

6.1.35.1 Error Handling – PKCS#11

This section details the specific Result Reasons that SHALL be returned for errors detected in a PKCS#11 Operation.

Result Status	Result Reason
Operation Failed	Invalid Asynchronous Correlation Value, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large, PKCS#11 Codec Error, PKCS#11 Invalid Function, PKCS#11 Invalid Interface

Table 255: PKCS#11 Errors

6.1.36 Poll

This operation is used to poll the server in order to obtain the status of an outstanding asynchronous operation. The correlation value of the original operation SHALL be specified in the request. The response to this operation SHALL NOT be asynchronous.

Request Payload		
Item	**REQUIRED**	**Description**
Asynchronous Correlation Value	Yes	Specifies the request being polled.

Table 256: Poll Request Payload

The server SHALL reply with one of two responses:

If the operation has not completed, the response SHALL contain no payload and a Result Status of Pending.

If the operation has completed, the response SHALL contain the appropriate payload for the operation. This response SHALL be identical to the response that would have been sent if the operation had completed synchronously.

6.1.36.1 Error Handling – Poll

This section details the specific Result Reasons that SHALL be returned for errors detected in a Poll Operation.

Result Status	Result Reason
Operation Failed	Invalid Asynchronous Correlation Value, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 257: Poll Errors

6.1.37 Query

This operation is used by the client to interrogate the server to determine its capabilities and/or protocol mechanisms.

For each Query Function specified in the request, the corresponding items SHALL be returned in the response.

Value	Description
Operations	Contains Operation enumerated values, which SHALL list all the operations that the server supports.
Object Type	Contains Object Type enumerated values, which SHALL list all the object types that the server supports.
Server Information	A structure containing vendor-specific fields and/or substructures.
Application Namespace	Contains the namespaces that the server SHALL generate values for if requested by the client.
Extension List	Contains the descriptions of Objects with Item Tag values in the Extensions range that are supported by the server. If the request contains a Query Extension List and/or Query Extension Map value in the Query Function field, then the Extensions Information fields SHALL be returned in the response.
Extension Map	
Attestation Type	Contains Attestation Type enumerated values, which SHALL list all the attestation types that the server supports.
RNG Parameters	Contains a listing of the RNGs supported. The response SHALL list all the Random Number Generators that the server supports. If the request contains a Query RNGs value in the Query Function field, then this field SHALL be returned in the response.
Validation Information	A structure containing details of each formal validation which the server asserts. If the request contains a Query Validations value, then zero or more Validation Information fields SHALL be returned in the response. A server MAY elect to return no validation information in the response.
Profile Information	A structure containing details of the profiles that a server supports including potentially how it supports that profile. If the request contains a *Query Profiles* value in the *Query Function* field, then this field SHALL be returned in the response if the server supports any Profiles.
Capability Information	Contains details of the capability of the server.
Client Registration Method	Contains *Client Registration Method* enumerated values, which SHALL list all the client registration methods that the server supports. If the request contains a *Query Client Registration Method* value in the Query Function field, then this field SHALL be returned in the response if the server supports any *Client Registration Methods*.
Defaults Information	A structure containing Object Defaults structures, which list the default values that the server SHALL use on Cryptographic Objects if the client omits them.
Protection Storage Masks	Contains ProtectionStorageMask attribute(s) for the alternatives that a server supports

Table 258: Query Functions

If both Query Extension List and Query Extension Map are specified in the request, then only the response to Query Extension Map SHALL be returned and the Query Extension List SHALL be ignored.

If the Query Function RNG Parameters is specified in the request and If the server is unable to specify details of the RNG then it SHALL return an RNG Parameters with the RNG Algorithm enumeration of Unspecified.

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

The Query Function field in the request SHALL contain one or more of the following items:

Request Payload		
Item	**REQUIRED**	**Description**
Query Function	Yes, MAY be Repeated	Determines the information being queried.

Table 259: Query Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Operation	No, MAY be repeated	Specifies an Operation that is supported by the server.
Object Type	No, MAY be repeated	Specifies a Managed Object Type that is supported by the server.
Vendor Identification	No	SHALL be returned if Query Server Information is requested. The Vendor Identification SHALL be a text string that uniquely identifies the vendor.
Server Information	No	Contains vendor-specific information possibly be of interest to the client.
Application Namespace	No, MAY be repeated	Specifies an Application Namespace supported by the server.
Extension Information	No, MAY be repeated	SHALL be returned if Query Extension List or Query Extension Map is requested and supported by the server.
Attestation Type	No, MAY be repeated	Specifies an Attestation Type that is supported by the server.
RNG Parameters	No, MAY be repeated	Specifies the RNG that is supported by the server.
Profile Information	No, MAY be repeated	Specifies the Profiles that are supported by the server.
Validation Information	No, MAY be repeated	Specifies the validations that are supported by the server.
Capability Information	No, MAY be repeated	Specifies the capabilities that are supported by the server.
Client Registration Method	No, MAY be repeated	Specifies a Client Registration Method that is supported by the server.
Defaults Information	No	Specifies the defaults that the server will use if the client omits them.
Protection Storage Masks	Yes	Specifies the list of Protection Storage Mask values supported by the server. A server MAY elect to provide an empty list in the Response if it is unable or unwilling to provide this information.

Table 260: Query Response Payload

6.1.37.1

6.1.37.2 Error Handling – Query

This section details the specific Result Reasons that SHALL be returned for errors detected in a Query Operation.

Result Status	Result Reason
Operation Failed	Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 261: Query Errors

6.1.38 Recover

This operation is used to obtain access to a Managed Object that has been archived. This request MAY need asynchronous polling to obtain the response due to delays caused by retrieving the object from the archive. Once the response is received, the object is now on-line, and MAY be obtained (e.g., via a Get operation). Special authentication and authorization SHOULD be enforced to perform this request (see **[KMIP-UG]**).

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	Determines the object being recovered. If omitted, then the ID Placeholder value is used by the server as the Unique Identifier.

Table 262: Recover Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object.

Table 263: Recover Response Payload

6.1.38.1 Error Handling – Recover

This section details the specific Result Reasons that SHALL be returned for errors detected in a Recover Operation.

Result Status	Result Reason
Operation Failed	Object Not Found, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 264: Recover Errors

6.1.39 Register

This operation requests the server to register a Managed Object that was 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 contain the object itself for storage by the server.

The request contains information about the type of object being registered and attributes to be assigned to the object (e.g., Cryptographic Algorithm, Cryptographic Length, etc.). This information SHALL be specified by the use of a Attributes object.

If the Managed Object being registered is wrapped, the server SHALL create a Link attribute of Link Type Wrapping Key Link pointing to the Managed Object with which the Managed Object being registered is wrapped.

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

Request Payload		
Item	**REQUIRED**	**Description**
Object Type	Yes	Determines the type of object being registered.
Attributes	Yes	Specifies desired object attributes to be associated with the new object.
Any Object (Section 2)	Yes	The object being registered. The object and attributes MAY be wrapped.
Protection Storage Masks	No	Specifies all permissible Protection Storage Mask selections for the new object

Table 265: Register Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the newly registered object.

Table 266: Register Response Payload

If a Managed Cryptographic Object is registered, then the following attributes SHALL be included in the Register request.

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, then Cryptographic Length below SHALL 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, then Cryptographic Algorithm above SHALL also be present.
Certificate Length	Yes. Only applies to Certificates.
Cryptographic Usage Mask	Yes.
Digital Signature Algorithm	Yes, MAY be omitted only if this information is encapsulated in the Certificate object. Only applies to Certificates.

Table 267: Register Attribute Requirements

6.1.39.1 Error Handling – Register

This section details the specific Result Reasons that SHALL be returned for errors detected in a Register Operation.

Result Status	Result Reason
Operation Failed	Attribute Read Only, Attribute Single Valued, Bad Password, Encoding Option Error, Invalid Attribute, Invalid Attribute Value, Invalid Object Type, Non Unique Name Attribute, Server Limit Exceeded, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Protection Storage Unavailable, Response Too Large

Table 268: Register Errors

6.1.40 Revoke

This operation requests the server to revoke a Managed Cryptographic Object or an Opaque Object. The request contains a reason for the revocation (e.g., “key compromise”, “cessation of operation”, etc.). The operation has one of two effects. If the revocation reason is “key compromise” or “CA compromise”, then the object is placed into the “compromised” state; the Date is set to the current date and time; and the Compromise Occurrence Date is set to the value (if provided) in the Revoke request and if a value is not provided in the Revoke request then Compromise Occurrence Date SHOULD be set to the Initial Date for the object. If the revocation reason is neither “key compromise” nor “CA compromise”, the object is placed into the “deactivated” state, and the Deactivation Date is set to the current date and time.

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	Determines the object being revoked. If omitted, then the ID Placeholder value is used by the server as the Unique Identifier.
Revocation Reason	Yes	Specifies the reason for revocation.
Compromise Occurrence Date	No	SHOULD be specified if the Revocation Reason is 'key compromise' or ‘CA compromise’ and SHALL NOT be specified for other Revocation Reason enumerations.

Table 269: Revoke Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object.

Table 270: Revoke Response Payload

6.1.40.1 Error Handling – Revoke

This section details the specific Result Reasons that SHALL be returned for errors detected in a Revoke Operation.

Result Status	Result Reason
Operation Failed	Invalid Field, Invalid Object Type, Object Not Found, Wrong Key Lifecycle State, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 271: Revoke Errors

6.1.41 Re-certify

This request is used to renew an existing certificate for the same key pair. Only a single certificate SHALL be renewed at a time.

The Certificate Request object MAY be omitted, in which case the public key for which a Certificate object is generated SHALL be specified by its Unique Identifier only. If the Certificate Request Type and the Certificate Request objects are omitted and the Certificate Type is not specified using the Attributes object in the request, then the Certificate Type of the new certificate SHALL be the same as that of the existing certificate.

The Certificate Request is passed as a Byte String, which allows multiple certificate request types for X.509 certificates (e.g., PKCS#10, PEM, etc.) to be submitted to the server.

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

If the information in the Certificate Request field in the request conflicts with the attributes specified in the Attributes, 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 (existing) certificate.

For the existing certificate, the server SHALL create a Link attribute of Link Type Replacement pointing to the new certificate. For the new certificate, the server SHALL create a Link attribute of Link Type Replaced pointing to the existing certificate. For the public key, the server SHALL change the Link attribute of Link Type Certificate to point to the new certificate.

An *Offset* MAY be used to indicate the difference between the Initial Date and the Activation Date of the new certificate. If no Offset is specified, the Activation Date and Deactivation Date values are copied from the existing certificate. If Offset is set and dates exist for the existing certificate, then the dates of the new certificate SHALL be set based on the dates of the existing certificate as follows:

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)

Table 272: Computing New Dates from Offset during Re-certify

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

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 are removed from the existing certificate.
State	Set based on attributes values, such as dates.
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.

Table 273: Re-certify Attribute Requirements

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	The Unique Identifier of the Certificate being renewed. If omitted, then the ID Placeholder value is used by the server as the Unique Identifier.
Certificate Request Unique Identifier	No	The Unique Identifier of the Certificate Request.
Certificate Request Type	No	An Enumeration object specifying the type of certificate request. It is REQUIRED if the Certificate Request is present.
Certificate Request Value	No	A Byte String object with the certificate request.
Offset	No	An Interval object indicating the difference between the Initial Date of the new certificate and the Activation Date of the new certificate.
Attributes	No	Specifies desired object attributes.
Protection Storage Masks	No	Specifies all permissible Protection Storage Mask selections for the new object

Table 274: Re-certify Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the new certificate.

Table 275: Re-certify Response Payload

6.1.41.1 Error Handling - Re-certify

This section details the specific Result Reasons that SHALL be returned for errors detected in a Re-certify Operation.

Result Status	Result Reason
Operation Failed	Invalid CSR, Invalid Message, Invalid Object Type, Object Not Found, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Protection Storage Unavailable, Response Too Large

Table 276: Re-certify Errors

6.1.42 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 attributes of the replacement key are copied from the existing key, with the exception of the attributes listed in *Re-key Attribute Requirements*.

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

For the existing key, the server SHALL create a Link attribute of Link Type Replacement Object pointing to the replacement key. For the replacement key, the server SHALL create a Link attribute of Link Type Replaced Key pointing to the existing key.

An *Offset* MAY be used to indicate the difference between the Initial Date and the Activation Date of the replacement key. If no Offset is specified, the Activation Date, Process Start Date, Protect Stop Date and Deactivation Date values are copied from the existing key. If Offset is set and dates exist for the existing key, then the dates of the replacement key SHALL be set based on the dates of the existing key as follows:

Attribute in Existing Key	Attribute in Replacement Key
Initial Date (IT_1)	Initial Date (IT_2) > IT_1
Activation Date (AT_1)	Activation Date (AT2) = IT2+ 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)

Table 277: Computing New Dates from Offset during Re-key

Attributes requiring special handling when creating the replacement key are:

Attribute	Action
Initial Date	Set to the 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 value is copied from the existing key, and the Count value in the existing key is set to the Total value.
Name	Set to the name(s) of the existing key; all name attributes are removed from the existing key.
State	Set based on attributes values, such as dates.
Digest	Recomputed from the replacement key value
Link	Set to point to the existing key as the replaced key
Last Change Date	Set to current time
Random Number Generator	Set to the random number generator used for creating the new managed object. Not copied from the original object.

Table 278: Re-key Attribute Requirements

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	Determines the existing Symmetric Key being re-keyed. If omitted, then the ID Placeholder value is used by the server as the Unique Identifier.
Offset	No	An Interval object indicating the difference between the Initial Date and the Activation Date of the replacement key to be created.
Attributes	No	Specifies desired object attributes.
Protection Storage Masks	No	Specifies all permissible Protection Storage Mask selections for the new object

Table 279: Re-key Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the newly-created replacement Symmetric Key.

Table 280: Re-key Response Payload

6.1.42.1 Error Handling - Re-key

This section details the specific Result Reasons that SHALL be returned for errors detected in a Re-key Operation.

Result Status	Result Reason
Operation Failed	Cryptographic Failure, Invalid Field, Invalid Message, Invalid Object Type, Key Value Not Present, Object Not Found, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Protection Storage Unavailable, Response Too Large

Table 281: Re-key Errors

6.1.43 Re-key Key Pair

This request is used to generate a replacement key pair for an existing public/private key pair. It is analogous to the Create Key Pair operation, except that attributes of the replacement key pair are copied from the existing key pair, with the exception of the attributes listed in *Re-key Key Pair Attribute Requirements tor.*

As the replacement of the key pair takes over the name attribute for the existing public/private key pair, Re-key Key Pair SHOULD only be performed once on a given key pair.

For both the existing public key and private key, the server SHALL create a Link attribute of Link Type Replacement Key pointing to the replacement public and private key, respectively. For both the replacement public and private key, the server SHALL create a Link attribute of Link Type Replaced Key pointing to the existing public and private key, respectively.

The server SHALL copy the Private Key Unique Identifier of the replacement private key returned by this operation into the ID Placeholder variable.

An *Offset* MAY be used to indicate the difference between the Initial Date and the Activation Date of the replacement key pair. If no Offset is specified, the Activation Date and Deactivation Date values are copied from the existing key pair. If Offset is set and dates exist for the existing key pair, then the dates of the replacement key pair SHALL be set based on the dates of the existing key pair as follows

Attribute in Existing Key Pair	Attribute in Replacement Key Pair
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)

Table 282: Computing New Dates from Offset during Re-key Key Pair

Attributes for the replacement key pair that are not copied from the existing key pair and which are handled in a specific way are:

Attribute	Action
Private Key Unique Identifier	New value generated
Public Key Unique Identifier	New value generated
Name	Set to the name(s) of the existing public/private keys; all name attributes of the existing public/private keys are removed.
Digest	Recomputed for both replacement public and private keys from the new public and private key values
Usage Limits	The Total Bytes/Total Objects value is copied from the existing key pair, while the Byte Count/Object Count values are set to the Total Bytes/Total Objects.
State	Set based on attributes values, such as dates.
Initial Date	Set to the current time
Destroy Date	Not set
Compromise Occurrence Date	Not set
Compromise Date	Not set
Revocation Reason	Not set
Link	Set to point to the existing public/private keys as the replaced public/private keys
Last Change Date	Set to current time
Random Number Generator	Set to the random number generator used for creating the new managed object. Not copied from the original object.

Table 283: Re-key Key Pair Attribute Requirements

Request Payload		
Item	**REQUIRED**	**Description**
Private Key Unique Identifier	No	Determines the existing Asymmetric key pair to be re-keyed. If omitted, then the ID Placeholder is substituted by the server.
Offset	No	An Interval object indicating the difference between the Initial Date and the Activation Date of the replacement key pair to be created.
Common Attributes	No	Specifies desired attributes that apply to both the Private and Public Key Objects.
Private Key Attributes	No	Specifies attributes that apply to the Private Key Object.
Public Key Attributes	No	Specifies attributes that apply to the Public Key Object.
Common Protection Storage Masks	No	Specifies all Protection Storage Mask selections that are permissible for the new Private Key and new Public Key objects
Private Protection Storage Masks	No	Specifies all Protection Storage Mask selections that are permissible for the new Private Key object.
Public Protection Storage Masks	No	Specifies all Protection Storage Mask selections that are permissible for the new Public Key object.

Table 284: Re-key Key Pair Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Private Key Unique Identifier	Yes	The Unique Identifier of the newly created replacement Private Key object.
Public Key Unique Identifier	Yes	The Unique Identifier of the newly created replacement Public Key object.

Table 285: Re-key Key Pair Response Payload

6.1.43.1 Error Handling - Re-key Key Pair

This section details the specific Result Reasons that SHALL be returned for errors detected in a Re-key Key Pair Operation.

Result Status	Result Reason
Operation Failed	Cryptographic Failure, Invalid Field, Invalid Message, Invalid Object Type, Key Value Not Present, Object Not Found, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Private Protection Storage Unavailable, Public Protection Storage Unavailable, Response Too Large

Table 286: Re-key Key Pair Errors

6.1.44 Re-Provision

This request is used to generate a replacement client link level credential from an existing client link level credential. The client requesting re-provisioning SHALL provide a certificate signing request, or a certificate, or no parameters if the server will create the client credential .

If the client provides a certificate signing request, the server SHALL process the certificate signing request and assign the new certificate to the be the client link level credential. The server SHALL return the unique identifier for the signed certificate stored on the server.

If the client provides a certificate, the server SHALL associate the certificate with the client as the client's link level credential. The server SHALL return the unique identifier for the certificate stored on the server.

Where no parameters are provided, the server shall generate a key pair and certificate associated with the client. The server SHALL return the unique identifier for the private key. The client may then subsequently retrieve the private key via a Get operation.

The current client credential SHALL be made invalid and cannot be used in future KMIP requests.

Re-Provision SHALL be called by the client that requires new credentials

Re-Provision SHOULD fail if the certificate that represents the client credential has expired.

Re-Provision SHALL fail if the certificate that represents the client credential has been Revoked.

Re-Provision SHALL fail if the certificate that represents the client credential has been compromised.

Request Payload		
Item	**REQUIRED**	**Description**
Certificate Request	No	The certificate request to be signed
Certificate	No	The certificate to replace the existing certificate

Table 287: Re-Provision Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	The Certificate or Private Key unique identifier

Table 288: Re-Provision Response Payload

6.1.44.1 Error Handling – Re-Provision

This section details the specific Result Reasons that SHALL be returned for errors detected in a Re-Provision Operation.

Result Status	Result Reason
Operation Failed	Cryptographic Failure, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 289: RNG Retrieve Errors

6.1.45 RNG Retrieve

This operation requests the server to return output from a Random Number Generator (RNG).

The request contains the quantity of output requested.

The response contains the RNG output.

The success or failure of the operation is indicated by the Result Status (and if failure the Result Reason) in the response header.

Request Payload		
Item	**REQUIRED**	**Description**
Data Length	Yes	The amount of random number generator output to be returned (in bytes).

Table 290: RNG Retrieve Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Data	Yes	The random number generator output.

Table 291: RNG Retrieve Response Payload

6.1.45.1 Error Handling - RNG Retrieve

This section details the specific Result Reasons that SHALL be returned for errors detected in a RNG Retrieve Operation.

Result Status	Result Reason
Operation Failed	Cryptographic Failure, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 292: RNG Retrieve Errors

6.1.46 RNG Seed

This operation requests the server to seed a Random Number Generator.

The request contains the seeding material.

The response contains the amount of seed data used.

The success or failure of the operation is indicated by the Result Status (and if failure the Result Reason) in the response header.

The server MAY elect to ignore the information provided by the client (i.e. not accept the seeding material) and MAY indicate this to the client by returning zero as the value in the Data Length response. A client SHALL NOT consider a response from a server which does not use the provided data as an error.

Request Payload		
Item	**REQUIRED**	**Description**
Data	Yes	The data to be provided as a seed to the random number generator.

Table 293: RNG Seed Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Data Length	Yes	The amount of seed data used (in bytes).

Table 294: RNG Seed Response Payload

6.1.46.1 Error Handling - RNG Seed

This section details the specific Result Reasons that SHALL be returned for errors detected in a RNG Seed Operation.

Result Status	Result Reason
Operation Failed	Cryptographic Failure, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 295: RNG Seed Errors

6.1.47 Set Attribute

This operation requests the server to either add or modify an attribute. The request contains the Unique Identifier of the Managed Object to which the attribute pertains, along with the attribute and value. If the object did not have any instances of the attribute, one is created. If the object had exactly one instance, then it is modified. If it has more than one instance an error is raised. Read-Only attributes SHALL NOT be added or modified using this operation.

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	The Unique Identifier of the object. If omitted, then the ID Placeholder value is used by the server as the Unique Identifier.
New Attribute	Yes	Specifies the new value for the attribute associated with the object.

Table 296: Set Attribute Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the Object.

Table 297: Set Attribute Response Payload

6.1.47.1 Error Handling - Set Attribute

This section details the specific Result Reasons that SHALL be returned for errors detected in a Add Attribute Operation.

Result Status	Result Reason
Operation Failed	Invalid Attribute Value, Invalid Attribute Value, Multi Valued Attribute, Non Unique Name Attribute, Object Not Found, Read Only Attribute, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 298: Set Attribute Errors

6.1.48 Set Endpoint Role

This operation requests specifying the role of server for subsequent requests and responses over the current client-to-server communication channel. After successful completion of the operation the server assumes the client role, and the client assumes the server role, but the communication channel remains as established.

Request Payload		
Item	**REQUIRED**	**Description**
Endpoint Role	Yes	The endpoint role for the server to apply.

Table 299: Set Endpoint Role Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Endpoint Role	Yes	The accepted endpoint role as applied by the server.

Table 300: Set Endpoint Role Response Payload

6.1.48.1 Error Handling - Set Endpoint Role

This section details the specific Result Reasons that SHALL be returned for errors detected in a Set Endpoint Role Operation.

Result Status	Result Reason
Operation Failed	Permission Denied, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 301: Set Endpoint Role Errors

6.1.49 Sign

This operation requests the server to perform a signature operation on the provided data using a Managed Cryptographic Object as the key for the signature operation.

The request contains information about the cryptographic parameters (digital signature algorithm or cryptographic algorithm and hash algorithm) and the data to be signed. The cryptographic parameters MAY be omitted from the request as they can be specified as associated attributes of the Managed Cryptographic Object.

If the Managed Cryptographic Object referenced has a Usage Limits attribute then the server SHALL obtain an allocation from the current Usage Limits value prior to performing the signing operation. If the allocation is unable to be obtained the operation SHALL return with a result status of Operation Failed and result reason of Permission Denied.

The response contains the Unique Identifier of the Managed Cryptographic Object used as the key and the result of the signature operation.

The success or failure of the operation is indicated by the Result Status (and if failure the Result Reason) in the response header.

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	The Unique Identifier of the Managed Cryptographic Object that is the key to use for the signature operation. If omitted, then the ID Placeholder value SHALL be used by the server as the Unique Identifier.
Cryptographic Parameters	No	The Cryptographic Parameters (Digital Signature Algorithm or Cryptographic Algorithm and Hashing Algorithm) corresponding to the particular signature generation method requested. If there are no Cryptographic Parameters associated with the Managed Cryptographic Object and the algorithm requires parameters then the operation SHALL return with a Result Status of Operation Failed.

Data	Yes for single-part, unless Digested Data is supplied.. No for multi-part.	The data to be.
Digested Data	No	The digested data to be signed (as a Byte String).
Correlation Value	No	Specifies the existing stream or by-parts cryptographic operation (as returned from a previous call to this operation).
Init Indicator	No	Initial operation as Boolean
Final Indicator	No	Final operation as Boolean

Table 302: Sign Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the Managed Cryptographic Object that is the key used for the signature operation.
Signature Data	Yes for single-part. No for multi-part.	The signed data (as a Byte String).
Correlation Value	No	Specifies the stream or by-parts value to be provided in subsequent calls to this operation for performing cryptographic operations.

Table 303: Sign Response Payload

6.1.49.1 Error Handling - Sign

This section details the specific Result Reasons that SHALL be returned for errors detected in a sign Operation.

Result Status	Result Reason
Operation Failed	Bad Cryptographic Parameters, Cryptographic Failure, Incompatible Cryptographic Usage Mask, Invalid Correlation Value, Invalid Object Type, Invalid Object Type, Key Value Not Present, Object Not Found, Unsupported Cryptographic Parameters, Usage Limit Exceeded, Wrong Key Lifecycle State, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 304: Sign Errors

6.1.50 Signature Verify

This operation requests the server to perform a signature verify operation on the provided data using a Managed Cryptographic Object as the key for the signature verification operation.

The request contains information about the cryptographic parameters (digital signature algorithm or cryptographic algorithm and hash algorithm) and the signature to be verified and MAY contain the data that was passed to the signing operation (for those algorithms which need the original data to verify a signature).

The cryptographic parameters MAY be omitted from the request as they can be specified as associated attributes of the Managed Cryptographic Object.

The response contains the Unique Identifier of the Managed Cryptographic Object used as the key and the OPTIONAL data recovered from the signature (for those signature algorithms where data recovery from the signature is supported). The validity of the signature is indicated by the Validity Indicator field.

The response message SHALL include the Validity Indicator for single-part Signature Verify operations and for the final part of a multi-part Signature Verify operation. Non-Final parts of multi-part Signature Verify operations SHALL NOT include the Validity Indicator.

The success or failure of the operation is indicated by the Result Status (and if failure the Result Reason) in the response header.

Request Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	No	The Unique Identifier of the Managed Cryptographic Object that is the key to use for the signature verify operation. If omitted, then the ID Placeholder value SHALL be used by the server as the Unique Identifier.
Cryptographic Parameters	No	The Cryptographic Parameters (Digital Signature Algorithm or Cryptographic Algorithm and Hashing Algorithm) corresponding to the particular signature verification method requested. If there are no Cryptographic Parameters associated with the Managed Cryptographic Object and the algorithm requires parameters then the operation SHALL return with a Result Status of Operation Failed.
Data	No	The data that was.
Digested Data	No	The digested data to be verified (as a Byte String)
Signature Data	Yes for single-part. No for multi-part.	The signature to be verified (as a Byte String).
Correlation Value	No	Specifies the existing stream or by-parts cryptographic operation (as returned from a previous call to this operation).
Init Indicator	No	Initial operation as Boolean
Final Indicator	No	Final operation as Boolean

Table 305: Signature Verify Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the Managed Cryptographic Object that is the key used for the verification operation.
Validity Indicator	Yes for single-part. No for multi-part.	An Enumeration object indicating whether the signature is valid, invalid, or unknown.
Data	No	The OPTIONAL recovered data (as a Byte String) for those signature algorithms where data recovery from the signature is supported.
Correlation Value	No	Specifies the stream or by-parts value to be provided in subsequent calls to this operation for performing cryptographic operations.

Table 306: Signature Verify Response Payload

6.1.50.1 Error Handling - Signature Verify

This section details the specific Result Reasons that SHALL be returned for errors detected in a signature Verify Operation.

Result Status	Result Reason
Operation Failed	Bad Cryptographic Parameters, Cryptographic Failure, Incompatible Cryptographic Usage Mask, Invalid Correlation Value, Invalid Object Type, Invalid Object Type, Key Value Not Present, Object Not Found, Unsupported Cryptographic Parameters, Wrong Key Lifecycle State, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 307: Signature Verify Errors

6.1.51 Validate

This operation requests the server to validate a certificate chain and return information on its validity. Only a single certificate chain SHALL be included in each request.

The request MAY contain a list of certificate objects, and/or a list of Unique Identifiers that identify Managed Certificate objects. Together, the two lists compose a certificate chain to be validated. The request MAY also contain a date for which all certificates in the certificate chain are REQUIRED to be valid.

The method or policy by which validation is 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.

Request Payload		
Item	**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 needs to be valid. If omitted, the current date and time SHALL be assumed.

Table 308: Validate Request Payload

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

Table 309: Validate Response Payload

6.1.51.1 Error Handling – Validate

This section details the specific Result Reasons that SHALL be returned for errors detected in a Validate Operation.

Result Status	Result Reason
Operation Failed	Invalid Field, Invalid Object Type, Object Not Found, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 310: Validate Errors

6.2 Server-to-Client Operations

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

6.2.1 Discover Versions

This operation is used by the server to determine a list of protocol versions that is supported by the client. The request payload contains an OPTIONAL list of protocol versions that is supported by the server. The protocol versions SHALL be ranked in decreasing order of preference.

The response payload contains a list of protocol versions that are supported by the client. The protocol versions are ranked in decreasing order of preference. If the server provides the client with a list of supported protocol versions in the request payload, the client SHALL return only the protocol versions that are supported by both the client and server. The client SHOULD list all the protocol versions supported by both client and server. If the protocol version specified in the request header is not specified in the request payload and the client does not support any protocol version specified in the request

payload, the client SHALL return an empty list in the response payload. If no protocol versions are specified in the request payload, the client SHOULD return all the protocol versions that are supported by the client.

Request Payload		
Item	**REQUIRED**	**Description**
Protocol Version	No, MAY be Repeated	The list of protocol versions supported by the server ordered in decreasing order of preference.

Table 311: Discover Versions Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Protocol Version	No, MAY be repeated	The list of protocol versions supported by the client ordered in decreasing order of preference.

6.2.1.1 Error Handling – Discover Versions

This section details the specific Result Reasons that SHALL be returned for errors detected in a Discover Versions Operation.

Result Status	Result Reason
Operation Failed	Permission Denied, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 312: Discover Versions Errors

6.2.2 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 via means outside of 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 or deletion have triggered the notification. The client SHALL send a response in the form of a Response containing no payload, unless both the client and server have prior knowledge (obtained via out-of-band mechanisms) that the client is not able to respond.

Message Payload		
Item	**REQUIRED**	**Description**
Unique Identifier	Yes	The Unique Identifier of the object.
Attributes	No	The attributes that have changed. This includes at least the Last Change Date attribute.
Attribute Reference	No, may be repeated	The attributes that have been deleted.

6.2.2.1 Error Handling – Notify

This section details the specific Result Reasons that SHALL be returned for errors detected in a Notify Operation.

Result Status	Result Reason
Operation Failed	Permission Denied, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 313: Notify Message Errors

6.2.3 Put

This operation is used to "push" Managed Objects to clients. This operation is only ever sent by a server to a client via means outside of 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 that is being sent, and the object itself. The client SHALL 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 is not able to respond.

The *Put Function* field indicates whether the object being "pushed" is a new object, or is a replacement for an object already known to the client (e.g., 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 SHALL 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. In case the object with the Replaced Unique Identifier does not exist at the client, the client SHALL interpret this as if the Put Function contained the value New.

The Attribute field contains one or more attributes that the server is sending along with the object. The server MAY include the attributes associated with the object.

Message Payload		
Item	**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. SHALL be present if the *Put Function* is *Replace.*
All Objects	Yes	The object being sent to the client.
Attributes	No	The additional attributes that the server wishes to send with the object.

6.2.3.1 Error Handling – Put

This section details the specific Result Reasons that SHALL be returned for errors detected in a Put Operation.

Result Status	Result Reason
Operation Failed	Permission Denied, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 314: Put Errors

6.2.4 Query

This operation is used by the server to interrogate the client to determine its capabilities and/or protocol mechanisms. The *Query Function* field in the request SHALL contain one or more of the following items:

- Query Operations
- Query Objects
- Query Server Information
- Query Extension List
- Query Extension Map
- Query Attestation Types
- Query RNGs
- Query Validations
- Query Profiles
- Query Capabilities
- Query Client Registration Methods

The *Operation* fields in the response contain Operation enumerated values, which SHALL list all the operations that the client supports. If the request contains a Query Operations value in the Query Function field, then these fields SHALL be returned in the response.

The *Object Type* fields in the response contain Object Type enumerated values, which SHALL list all the object types that the client supports. If the request contains a *Query Objects* value in the Query Function field, then these fields SHALL be returned in the response.

The *Server Information* field in the response is a structure containing vendor-specific fields and/or substructures. If the request contains a *Query Server Information* value in the Query Function field, then this field SHALL be returned in the response.

The *Extension Information* fields in the response contain the descriptions of Objects with Item Tag values in the Extensions range that are supported by the server. If the request contains a *Query Extension List* and/or *Query Extension Map* value in the Query Function field, then the Extensions Information fields SHALL be returned in the response. If the Query Function field contains the Query Extension Map value, then the Extension Tag and Extension Type fields SHALL be specified in the Extension Information values. If both Query Extension List and Query Extension Map are specified in the request, then only the response to Query Extension Map SHALL be returned and the Query Extension List SHALL be ignored.

The *Attestation Type* fields in the response contain Attestation Type enumerated values, which SHALL list all the attestation types that the client supports. If the request contains a *Query Attestation Types* value in the Query Function field, then this field SHALL be returned in the response if the server supports any Attestation Types.

The *RNG Parameters* fields in the response SHALL list all the Random Number Generators that the client supports. If the request contains a *Query RNGs* value in the Query Function field, then this field SHALL be returned in the response. If the server is unable to specify details of the RNG then it SHALL return an *RNG Parameters* with the *RNG Algorithm* enumeration of *Unspecified*.

The *Validation Information* field in the response is a structure containing details of each formal validation which the client asserts. If the request contains a *Query Validations* value, then zero or more *Validation Information* fields SHALL be returned in the response. A client MAY elect to return no validation information in the response.

A *Profile Information* field in the response is a structure containing details of the profiles that a client supports including potentially how it supports that profile. If the request contains a *Query Profiles* value in the Query Function field, then this field SHALL be returned in the response if the client supports any Profiles.

The *Capability Information* fields in the response contain details of the capability of the client.

The *Client Registration Method* fields in the response contain Client Registration Method enumerated values, which SHALL list all the client registration methods that the client supports. If the request contains a *Query Client Registration Methods* value in the Query Function field, then this field SHALL be returned in the response if the server supports any Client Registration Methods.

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

Request Payload		
Item	**REQUIRED**	**Description**
Query Function	Yes, MAY be Repeated	Determines the information being queried.

Table 315: Query Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Operation	No, MAY be repeated	Specifies an Operation that is supported by the client.
Object Type	No, MAY be repeated	Specifies a Managed Object Type that is supported by the client.
Vendor Identification	No	SHALL be returned if Query Server Information is requested. The Vendor Identification SHALL be a text string that uniquely identifies the vendor.
Server Information	No	Contains vendor-specific information in response to the Query.
Extension Information	No, MAY be repeated	SHALL be returned if Query Extension List or Query Extension Map is requested and supported by the client.
Attestation Type	No, MAY be repeated	Specifies an Attestation Type that is supported by the client.
RNG Parameters	No, MAY be repeated	Specifies the RNG that is supported by the client.
Profile Information	No, MAY be repeated	Specifies the Profiles that are supported by the client.
Validation Information	No, MAY be repeated	Specifies the validations that are supported by the client.
Capability Information	No, MAY be repeated	Specifies the capabilities that are supported by the client.

Client Registration Method	No, MAY be repeated	Specifies a Client Registration Method that is supported by the client.

6.2.4.1 Error Handling – Query

This section details the specific Result Reasons that SHALL be returned for errors detected in a Query Operation.

Result Status	Result Reason
Operation Failed	Permission Denied, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 316: Query Errors

6.2.5 Set Endpoint Role

This operation requests specifying the role of server for subsequent requests and responses over the current client-to-server communication channel. After successful completion of the operation the server assumes the client role, and the client assumes the server role, but the communication channel remains as established.

Request Payload		
Item	**REQUIRED**	**Description**
Endpoint Role	Yes	The endpoint role for the client to apply.

Table 317: Set Endpoint Role Request Payload

Response Payload		
Item	**REQUIRED**	**Description**
Endpoint Role	Yes	The accepted endpoint role as applied by the client.

Table 318: Set Endpoint Role Response Payload

6.2.5.1 Error Handling - Set Endpoint Role

This section details the specific Result Reasons that SHALL be returned for errors detected in a Set Endpoint Role Operation.

Result Status	Result Reason
Operation Failed	Permission Denied, Attestation Failed, Attestation Required, Feature Not Supported, Invalid Field, Invalid Message, Operation Not Supported, Permission Denied, Response Too Large

Table 319: Set Endpoint Role Errors

7 Operations Data Structures

Common structure used across multiple operations

7.1 Authenticated Encryption Additional Data

The Authenticated Encryption Additional Data object is used in authenticated encryption and decryption operations that require the transmission of that data between client and server.

Object	Encoding	REQUIRED
Authenticated Encryption Additional Data	Byte String	No

Table 320 Authenticated Encryption Additional Data

7.2 Authenticated Encryption Tag

The Authenticated Encryption Tag object is used to validate the integrity of the data encrypted and decrypted in “Authenticated Encryption” mode. See **[SP800-38D]**.

Object	Encoding	REQUIRED
Authenticated Encryption Tag	Byte String	No

Table 321 Authenticated Encryption Tag

7.3 Capability Information

The *Capability Information* base object is a structure that contains details of the supported capabilities.

Object	Encoding	REQUIRED
Capability Information	Structure	
Streaming Capability	Boolean	No
Asynchronous Capability	Boolean	No
Attestation Capability	Boolean	No
Batch Undo Capability	Boolean	No
Batch Continue Capability	Boolean	No
Unwrap Mode	Enumeration	No
Destroy Action	Enumeration	No
Shredding Algorithm	Enumeration	No
RNG Mode	Enumeration	No
Quantum Safe Capability	Boolean	No

Table 322: Capability Information Structure

7.4 Correlation Value

The *Correlation Value* is used in requests and responses in cryptographic operations that support multi-part (streaming) operations. This is generated by the server and returned in the first response to an operation that is being performed across multiple requests. Note: the server decides which operations are supported for multi-part usage. A server-generated correlation value SHALL be specified in any subsequent cryptographic operations that pertain to the original operation.

Object	Encoding
Correlation Value	Byte String

Table 323: Correlation Value Structure

7.5 Data

The *Data* object is used in requests and responses in cryptographic operations that pass data between the client and the server.

Encoding	Description
Byte String	The Data
Enumeration	Data Enumeration
Integer	Zero based nth Data in the response. If negative the count is backwards from the beginning of the current operation's batch item.

Table 324: Data encoding descriptions

Object	Encoding
Data	Byte String, Enumeration or Integer

Table 325: Data

7.6 Data Length

The *Data Length* is used in requests in cryptographic operations to indicate the amount of data expected in a response.

Object	Encoding
Data Length	Integer

Table 326: Data Length Structure

7.7 Defaults Information

The *Defaults Information* is a structure used in Query responses for values that servers will use if clients omit them from factory operations requests.

Object	Encoding	REQUIRED
Defaults Information	Structure	
Object Defaults	Structure, may be repeated	Yes

Table 327: Defaults Information Structure

7.8 Derivation Parameters

The Derivation Parameters for all derivation methods consist of the following parameters.

Object	Encoding	REQUIRED
Derivation Parameters	Structure	Yes.
Cryptographic Parameters,	Structure	No, depends on the PRF.
Initialization Vector	Byte String	No, depends on the PRF (if different than those defined in **[PKCS#5]**) and mode of operation: an empty IV is assumed if not provided.
Derivation Data	Byte String	Yes, unless the Unique Identifier of a Secret Data object is provided. May be repeated.
Salt	Byte String	Yes if Derivation method is PBKDF2.
Iteration Count	Integer	Yes if Derivation method is PBKDF2.

Table 328: Derivation Parameters Structure

Cryptographic Parameters identify the Pseudorandom Function (PRF) or the mode of operation of the PRF (e.g., if a key is to be derived using the HASH derivation method, then clients are REQUIRED to indicate the hash algorithm inside Cryptographic Parameters; similarly, if a key is to be derived using AES in CBC mode, then clients are REQUIRED to indicate the Block Cipher Mode).

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

Derivation Data is either the data to be encrypted, hashed, or HMACed. For the NIST SP 800-108 methods **[SP800-108]**, Derivation Data is Label||{0x00}||Context, where the all-zero byte is optional.

Most derivation methods (e.g., Encrypt) REQUIRE a derivation key and the derivation data to be used. The HASH derivation method REQUIRES either a derivation key or derivation data. Derivation data MAY either be explicitly provided by the client with the Derivation Data field or implicitly provided by providing the Unique Identifier of a Secret Data object. If both are provided, then an error SHALL be returned.

For the AWS Signature Version 4 derivation method, the Derivation Data is (in order) the Date, Region, and Service.

For the HKDF derivation method, the Input Key Material is provided by the specified managed object, the salt is provided in the Salt field of the Derivation Parameters, the optional information is provided in the Derivation Data field of the Derivation Parameters, the output length is specified in the Cryptographic Length attribute provided in the Attributes request parameter. The default hash function is SHA-256 and may be overriden by specifying a Hashing Algorithm in the Cryptographic Parameters field of the Derivation Parameters.

7.9 Extension Information

An *Extension Information* object is a structure describing Objects with Item Tag values in the Extensions range. The Extension Name is a Text String that is used to name the Object. The Extension Tag is the Item Tag Value of the Object. The Extension Type is the Item Type Value of the Object.

Object	Encoding	REQUIRED
Extension Information	Structure	
Extension Name	Text String	Yes
Extension Tag	Integer	No
Extension Type	Enumeration (Item Type)	No
Extension Enumeration	Integer	No
Extension Attribute	Boolean	No
Extension Parent Structure Tag	Integer	No
Extension Description	Text String	No

Table 329: Extension Information Structure

7.10 Final Indicator

The *Final Indicator* is used in requests in cryptographic operations that support multi-part (streaming) operations. This is provided in the final (last) request with a value of True to an operation that is being performed across multiple requests.

Object	Encoding
Final Indicator	Boolean

Table 330: Final Indicator Structure

7.11 Interop Function

The *IInterop Functrion* is used in requests and responses in to indicate the commencement or completion of an interop operation.

Object	Encoding
Interop Function	Enumeration

Table 331: Interop Function Structure

7.12 Interop Identifier

The *IInterop Functrion* is used in requests and responses in to indicate that which interop test is being performed.

Object	Encoding
Interop identifier	TextString

Table 332: Interop Function Structure

7.13 Init Indicator

The *Init Indicator* is used in requests in cryptographic operations that support multi-part (streaming) operations. This is provided in the first request with a value of True to an operation that is being performed across multiple requests.

Object	Encoding
Init Indicator	Boolean

Table 333: Init Indicator Structure

7.14 Key Wrapping Specification

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

This structure contains:

- A Wrapping Method that indicates the method used to wrap the Key Value.
- Encryption Key Information with the Unique Identifier value of the encryption key and associated cryptographic parameters.
- 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.
- An Encoding Option, specifying the encoding of the Key Value before wrapping. If No Encoding is specified, then the Key Value SHALL NOT contain any attributes

Object	Encoding	REQUIRED
Key Wrapping Specification	Structure	
Wrapping Method	Enumeration	Yes
Encryption Key Information	Structure	No, SHALL be present if MAC/Signature Key Information is omitted
MAC/Signature Key Information	Structure	No, SHALL be present if Encryption Key Information is omitted
Attribute Name	Text String, MAY be repeated	No
Encoding Option	Enumeration	No. If Encoding Option is not present, the wrapped Key Value SHALL be TTLV encoded.

Table 334: Key Wrapping Specification Object Structure

7.15 Log Message

The *Log Message* is used in the Log operation.

Object	Encoding
Log Message	Text String

Table 335: Log Message Structure

7.16 MAC Data

The *MAC Data* is used in requests and responses in cryptographic operations that pass MAC data between the client and the server.

Object	Encoding
MAC Data	Byte String

Table 336: MAC Data Structure

7.17 Objects

A list of Object Unique Identifiers.

Object	Encoding	REQUIRED
Objects	Structure	
Unique Identifier	Text String, Enumeration or Integer	No, May be repeated.

Table 337: Objects Structure

7.18 Object Defaults

The *Object Defaults* is a structure that details the values that the server will use if the client omits them on factory methods for objects. The structure list the Attributes and their values by Object Type enumeration.

Object	Encoding	REQUIRED
Object Defaults	Structure	
Object Type	Enumeration	Yes
Attributes	Structure	Yes

Table 338: Object Defaults Structure

7.19 Operations

A list of Operations.

Object	Encoding	REQUIRED
Operations	Structure	
Operation	Enumeration	No, May be repeated.

Table 339: Operations Structure

7.20 PKCS#11 Function

The *PKCS#11 Function* structure contains details of the PKCS#11 Function. Specific fields MAY pertain only to certain types of profiles.

Item	Encoding	REQUIRED
PKCS#11 Function	Structure	
PKCS#11 Function	Enumeration	Yes

Table 340: PKCS#11 Function Structure

7.21 PKCS#11 Input Parameters

The *PKCS#11 Input Parameters* structure contains details of the PKCS#11 Input Parameters. Specific fields MAY pertain only to certain types of profiles.

Item	Encoding	REQUIRED
PKCS#11 Input Parameters	Structure	
PKCS#11 Input Parameters	ByteString	No

Table 341: PKCS#11 Input Parameters Structure

7.22 PKCS#11 Interface

The *PKCS#11 Interface* structure contains details of the PKCS#11 Interface. Specific fields MAY pertain only to certain types of profiles.

Item	Encoding	REQUIRED
PKCS#11 Interface	Structure	
PKCS#11 Interface	TextString	No

Table 342: PKCS#11 Interface Structure

7.23 PKCS#11 Output Parameters

The *PKCS#11 Output Parameters* structure contains details of the PKCS#11 Output Parameters. Specific fields MAY pertain only to certain types of profiles.

Item	Encoding	REQUIRED
PKCS#11 Output Parameters	Structure	
PKCS#11 Output Parameters	ByteString	No

Table 343: PKCS#11 Output Parameters Structure

7.24 PKCS#11 Return Code

The *PKCS#11 Return Code* structure contains details of the PKCS#11 Return Code. Specific fields MAY pertain only to certain types of profiles.

Item	Encoding	REQUIRED
PKCS#11 Return Code	Structure	
PKCS#11 Return Code	Enumeration	Yes

Table 344: PKCS#11 Return Code Structure

7.25 Profile Information

The *Profile Information* structure contains details of the supported profiles. Specific fields MAY pertain only to certain types of profiles.

Item	Encoding	REQUIRED
Profile Information	Structure	
Profile Name	Enumeration	Yes
Profile Version	Structure	No
Server URI	Text String	No
Server Port	Integer	No

Table 345: Profile Information Structure

7.26 Profile Version

The *Profile Version* structure contains the version number of the profile, ensuring that the profile is fully understood by both communicating parties. The version number SHALL be specified in two parts, major and minor.

Item	Encoding	REQUIRED
Profile Version	Structure	
Profile Version Major	Integer	Yes
Profile Version Minor	Integer	Yes

Table 346: Profile Version Structure

7.27 Protection Storage Masks

The Protection Storage Masks operations data object is a structure that contains an ordered collection of *Protection Storage Mask* selections acceptable to the client. The server MAY service the request with ANY *Storage Protection Mask* that the client passes, but SHALL return an error if no single *Storage Protection Mask* can be satisfied in its entirety (all bits match). When more than one *Protection Storage Mask* is specified by a Client, then all are acceptable alternatives. Note that there are also variants of *Protection Storage Masks* to deal with the operations that deal with asymmetric pairs (*Common Protection Storage Masks*, *Private Protection Storage Masks* and *Public Protection Storage Masks*), as the client may have different requirements on the parts of the pair, but the layout of those variants is identical to the one expressed here.

Item	Encoding	REQUIRED
Protection Storage Masks	Structure	

Table 347: Protection Storage Mask Structure

7.28 Right

The Right base object is a structure that defines a right to perform specific numbers of specific operations on specific managed objects. If any field is omitted, then that aspect is unrestricted..

Object	Encoding	REQUIRED
Right	Structure	
Usage Limits	Structure	No
Operations	Structure	No
Objects	Structure	No

Table 348: Right Structure

7.29 Rights

A list of Rights.

Object	Encoding	REQUIRED
Rights	Structure	
Right	Structure	No, May be repeated.

Table 349: Rights Structure

7.30 RNG Parameters

The *RNG Parameters* base object is a structure that contains a mandatory RNG Algorithm and a set of OPTIONAL fields that describe a Random Number Generator. Specific fields pertain only to certain types of RNGs.

The RNG Algorithm SHALL be specified and if the algorithm implemented is unknown or the implementation does not want to provide the specific details of the RNG Algorithm then the Unspecified enumeration SHALL be used.

If the cryptographic building blocks used within the RNG are known they MAY be specified in combination of the remaining fields within the RNG Parameters structure.

Object	Encoding	REQUIRED
RNG Parameters	Structure	
RNG Algorithm	Enumeration	Yes
Cryptographic Algorithm	Enumeration	No
Cryptographic Length	Integer	No
Hashing Algorithm	Enumeration	No
DRBG Algorithm	Enumeration	No
Recommended Curve	Enumeration	No
FIPS186 Variation	Enumeration	No
Prediction Resistance	Boolean	No

Table 350: RNG Parameters Structure

7.31 Server Information

The *Server Information* base object is a structure that contains a set of OPTIONAL fields that describe server information. Where a server supports returning information in a vendor-specific field for which there is an equivalent field within the structure, the server SHALL provide the standardized version of the field.

Object	Encoding	REQUIRED
Server Information	Structure	
Server name	Text String	No
Server serial number	Text String	No
Server version	Text String	No
Server load	Text String	No
Product name	Text String	No
Build level	Text String	No
Build date	Text String	No
Cluster info	Text String	No
Alternative failover endpoints	Text String, MAY be repeated	No
Vendor-Specific	*Any*, MAY be repeated	No

Table 351: Server Information Structure

7.32 Signature Data

The *Signature Data* is used in requests and responses in cryptographic operations that pass signature data between the client and the server.

Object	Encoding
Signature Data	Byte String

Table 352: Signature Data Structure

7.33 Ticket

The ticket structure used to specify a *Ticket*

Item	Encoding	REQUIRED
Ticket	Structure	
Ticket Type	Enumeration	Yes
Ticket Value	Byte String	Yes

Table 353: Ticket Structure

7.34 Usage Limits

The *Usage Limits* structure is used to limit the number of operations that may be performed.

Item	Encoding	REQUIRED
Usage Limits	Structure	
Usage Limits Total	Long Integer	Yes
Usage Limits Count	Long Integer	Yes
Usage Limits Unit	Enumeration	Yes

Table 354: Usage limits Structure

7.35 Validation Information

The *Validation Information* base object is a structure that contains details of a formal validation. Specific fields MAY pertain only to certain types of validations.

Object	Encoding	REQUIRED
Validation Information	Structure	
Validation Authority Type	Enumeration	Yes
Validation Authority Country	Text String	No
Validation Authority URI	Text String	No
Validation Version Major	Integer	Yes
Validation Version Minor	Integer	No
Validation Type	Enumeration	Yes
Validation Level	Integer	Yes
Validation Certificate Identifier	Text String	No
Validation Certificate URI	Text String	No
Validation Vendor URI	Text String	No
Validation Profile	Text String, MAY be repeated	No

Table 355: Validation Information Structure

The Validation Authority along with the Validation Version Major, Validation Type and Validation Level SHALL be provided to uniquely identify a validation for a given validation authority. If the Validation Certificate URI is not provided the server SHOULD include a Validation Vendor URI from which information related to the validation is available.

The Validation Authority Country is the two letter ISO country code.

8 Messages

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 to which is being replied.

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

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

If the client is capable of accepting asynchronous responses, then it MAY set the Asynchronous Indicator in the header of a batched request. The batched responses MAY contain a mixture of synchronous and asynchronous responses only if the Asynchronous Indicator is present in the header.

8.1 Request Message

Object	Encoding	REQUIRED
Request Message	Structure	
Request Header	Structure	Yes
Batch Item	Structure, MAY be repeated	Yes

Table 356: Request Message Structure

8.2 Request Header

Request Header		
Object	**REQUIRED in Message**	**Comment**
Request Header	Yes	Structure
Protocol Version	Yes	
Maximum Response Size	No	
Client Correlation Value	No	
Server Correlation Value	No	
Asynchronous Indicator	No	
Attestation Capable Indicator	No	
Attestation Type	No, MAY be repeated	
Authentication	No	
Batch Error Continuation Option	No	If omitted, then Stop is assumed
Batch Order Option	No	If omitted, then True is assumed

Time Stamp	No	
Batch Count	Yes	

Table 357: Request Header Structure

8.3 Request Batch Item

Request Batch Item		
Object	**REQUIRED in Message**	**Comment**
Batch Item	Yes	Structure
Operation	Yes	
Ephemeral	No	Indicates that the Data output of the operation should not be returned to the client. Boolean.
Unique Batch Item ID	No	REQUIRED if *Batch Count* > 1
Request Payload	Yes	Structure, contents depend on the Operation
Message Extension	No, MAY be repeated	

Table 358: Request Batch Item Structure

8.4 Response Message

Object	Encoding	REQUIRED
Response Message	Structure	
Response Header	Structure	Yes
Batch Item	Structure, MAY be repeated	Yes

Table 359: Response Message Structure

8.5 Response Header

Response Header		
Object	**REQUIRED in Message**	**Comment**
Response Header	Yes	Structure
Protocol Version	Yes	
Time Stamp	Yes	
Nonce	No	
Server Hashed Password	Yes, if Hashed Password credential was used	Hash(Timestamp || S1 || Hash(S2)), where S1, S2 and the Hash algorithm are defined in the Hashed Password credential.

Attestation Type	No, MAY be repeated	REQUIRED in *Attestation Required* error message if client set Attestation Capable Indicator to True in the request
Client Correlation Value	No	
Server Correlation Value	No	
Batch Count	Yes	

Table 360: Response Header Structure

8.6 Response Batch Item

Response Batch Item		
Object	**REQUIRED in Message**	**Comment**
Batch Item	Yes	Structure
Operation	Yes, if specified in Request Batch Item	
Unique Batch Item ID	No	REQUIRED if present in Request Batch Item
Result Status	Yes	
Result Reason	Yes, if Result Status is *Failure*	REQUIRED if Result Status is *Failure*, otherwise OPTIONAL
Result Message	No	OPTIONAL if Result Status is not *Pending* or *Success*
Asynchronous Correlation Value	No	REQUIRED if Result Status is *Pending*
Response Payload	Yes, if not a failure	Structure, contents depend on the Operation
Message Extension	No	

Table 361: Response Batch Item Structure

9 Message Data Structures

Data structures passed within request and response messages.

9.1 Asynchronous Correlation Value

This is returned in the immediate response to an operation that is pending and that requires asynchronous polling. Note: the server decides which operations are performed synchronously or asynchronously. A server-generated correlation value SHALL be specified in any subsequent Poll or Cancel operations that pertain to the original operation.

Object	Encoding
Asynchronous Correlation Value	Byte String

Table 362: Asynchronous Correlation Value in Response Batch Item

9.2 Asynchronous Indicator

This Enumeration indicates whether the client is able to accept an asynchronous response. If not present in a request, then Prohibited is assumed. If the value is Prohibited, the server SHALL process the request synchronously.

Object	Encoding
Asynchronous Indicator	Enumeration

Table 363: Asynchronous Indicator in Message Request Header

9.3 Attestation Capable Indicator

The *Attestation Capable Indicator* flag indicates whether the client is able to create an Attestation Credential object. It SHALL have Boolean value True if the client is able to create an Attestation Credential object, and the value False otherwise. If not present, the value False is assumed. If a client indicates that it is not able to create an Attestation Credential Object, and the client has issued an operation that requires attestation such as Get, then the server SHALL respond to the request with a failure.

Object	Encoding
Attestation Capable Indicator	Boolean

Table 364: Attestation Capable Indicator in Message Request Header

9.4 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. Query operations used to interrogate server features and functions SHOULD NOT require authentication. The Authentication structure SHALL contain one or more Credential structures. If multiple Credential structures are provided then they must ALL be satisfied.

The authentication mechanisms are described and discussed in Section 12.

Object	Encoding
Authentication	Structure
Credential, MAY be repeated	Structure

Table 365: Authentication Structure in Message Header

9.5 Batch Count

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

Object	Encoding
Batch Count	Integer

Table 366: Batch Count in Message Header

9.6 Batch Error Continuation Option

This option SHALL only be present if the Batch Count is greater than 1. This option SHALL have one of three values (*Undo*, *Stop* or *Continue).* If not specified, then Stop is assumed.

Object	Encoding
Batch Error Continuation Option	Enumeration

Table 367: Batch Error Continuation Option in Message Request Header

9.7 Batch Item

This field consists of a structure that holds the individual requests or responses in a batch, and is REQUIRED. The contents of the batch items are described in Section 12.

Object	Encoding
Batch Item	Structure

Table 368: Batch Item in Message

9.8 Batch Order Option

A Boolean value used in requests where the Batch Count is greater than 1. If True, then batched operations SHALL be executed in the order in which they appear within the request. If False, then the server MAY choose to execute the batched operations in any order. If not specified, then True is assumed.

Object	Encoding
Batch Order Option	Boolean

Table 369: Batch Order Option in Message Request Header

9.9 Correlation Value (Client)

The Client Correlation Value is a string that MAY be added to messages by clients to provide additional information to the server. It need not be unique. The server SHOULD log this information.

For client to server operations, the Client Correlation Value is provided in the request. For server to client operations the Client Correlation Value is provided in the response.

Object	Encoding
Client Correlation Value	Text String

Table 370: Client Correlation Value in Message Request Header

9.10 Correlation Value (Server)

The Server Correlation Value SHOULD be provided by the server and SHOULD be globally unique, and SHOULD be logged by the server with each request.

For client to server operations the Server Correlation Value is provided in the response. For server to client operations, the Server Correlation Value is provided in the request.

Object	Encoding
Server Correlation Value	Text String

Table 371: Server Correlation Value in Message Request Header

9.11 Credential

A *Credential* is a structure used for client identification purposes and is not managed by the key management system (e.g., user id/password pairs, Kerberos tokens, etc.). It MAY be used for authentication purposes as indicated in **[KMIP-Prof]**.

Object	Encoding	REQUIRED
Credential	Structure	
Credential Type	Enumeration	Yes
Credential Value	Varies based on Credential Type.	Yes

Table 372: Credential Object Structure

If the Credential Type in the Credential is *Username and Password*, then Credential Value is a structure. The Username field identifies the client, and the Password field is a secret that authenticates the client.

Object	Encoding	REQUIRED
Credential Value	Structure	
Username	Text String	Yes
Password	Text String	No

Table 373: Credential Value Structure for the Username and Password Credential

If the Credential Type in the Credential is *Device*, then Credential Value is a. One or a combination of the *Device Serial Number*, *Network Identifier*, *Machine Identifier*, and *Media Identifier* SHALL be unique. Server implementations MAY enforce policies on uniqueness for individual fields. A shared secret or password MAY also be used to authenticate the client. The client SHALL provide at least one field.

Object	Encoding	REQUIRED
Credential Value	Structure	
Device Serial Number	Text String	No
Password	Text String	No
Device Identifier	Text String	No

Network Identifier	Text String	No
Machine Identifier	Text String	No
Media Identifier	Text String	No

Table 374: Credential Value Structure for the Device Credential

If the Credential Type in the Credential is *Attestation*, then Credential Value is a structure. The *Nonce Value* is obtained from the key management server in a Nonce Object. The Attestation Credential Object can contain a measurement from the client or an assertion from a third party if the server is not capable or willing to verify the attestation data from the client. Neither type of attestation data (*Attestation Measurement* or *Attestation Assertion*) is necessary to allow the server to accept either. However, the client SHALL provide attestation data in either the *Attestation Measurement* or *Attestation Assertion* fields.

Object	Encoding	REQUIRED
Credential Value	Structure	
Nonce	Structure	Yes
Attestation Type	Enumeration	Yes
Attestation Measurement	Byte String	No
Attestation Assertion	Byte String	No

Table 375: Credential Value Structure for the Attestation Credential

If the Credential Type in the Credential is One Time Password, then Credential Value is a structure. The Username field identifies the client, and the Password field is a secret that authenticates the client. The One Time Password field contains a one time password (OTP) which may only be used for a single authentication.

Object	Encoding	REQUIRED
Credential Value	Structure	
Username	Text String	Yes
Password	Text String	No
One Time Password	Text String	Yes

Table 376: Credential Value Structure for the One Time Password Credential

If the Credential Type in the Credential is Hashed Password, then Credential Value is a structure. The Username field identifies the client. The timestamp is the current timestamp used to produce the hash and SHALL monotonically increase. The Hashing Algorithm SHALL default to SHA 256. The Hashed Password is define as

Hashed Password = Hash(S1 || Timestamp) || S2

Where

S1 = Hash(Username || Password)

S2 = Hash(Password || Username)

Object	Encoding	REQUIRED
Credential Value	Structure	
Username	Text String	Yes
Timestamp	Date Time Extended	Yes
Hashing Algorithm	Enumeration	No
Hashed Password	Byte String	Yes

Table 377: Credential Value Structure for the Hashed Password Credential

If the Credential Type in the Credential is Ticket, then Credential Value is a structure.

Object	Encoding	REQUIRED
Credential Value	Structure	
Ticket	Structure	Yes

Table 378: Credential Value Structure for the Ticket

9.12 Maximum Response Size

This is an OPTIONAL field contained in a request message, and is used to indicate the maximum size of a response, in bytes, that the requester SHALL be able to handle. It SHOULD only be sent in requests that possibly return large replies.

Object	Encoding
Maximum Response Size	Integer

Table 379: Maximum Response Size in Message Request Header

9.13 Message Extension

The *Message Extension* is an OPTIONAL structure that 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 that SHALL contain the Vendor Identification, Criticality Indicator, and Vendor Extension fields. The *Vendor Identification* SHALL be a text string that uniquely identifies the vendor, allowing a client to determine if it is able to parse and understand the extension. If a client or server receives a protocol message containing a message extension that it does not understand, then its actions depend on the *Criticality Indicator*. If the indicator is True (i.e., Critical), and the receiver does not understand the extension, then the receiver SHALL reject the entire message. If the indicator is False (i.e., Non-Critical), and the receiver does not understand the extension, then the receiver MAY process the rest of the message as if the extension were not present. The *Vendor Extension* structure SHALL contain vendor-specific extensions.

Object	Encoding
Message Extension	Structure
Vendor Identification	Text String (with usage limited to alphanumeric, underscore and period – i.e. [A-Za-z0-9_.])
Criticality Indicator	Boolean
Vendor Extension	Structure

Table 380: Message Extension Structure in Batch Item

9.14 Nonce

A *Nonce* object is a structure used by the server to send a random value to the client. The Nonce Identifier is assigned by the server and used to identify the Nonce object. The Nonce Value consists of the random data created by the server.

Object	Encoding	REQUIRED
Nonce	Structure	
Nonce ID	Byte String	Yes
Nonce Value	Byte String	Yes

Table 381: Nonce Structure

9.15 Operation

This field indicates the operation being requested or the operation for which the response is being returned.

Object	Encoding
Operation	Enumeration

Table 382: Operation in Batch Item

9.16 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 SHALL be specified in two parts, major and minor. Servers and clients SHALL support backward compatibility with versions of the protocol with the same major version. Support for backward compatibility with different major versions is OPTIONAL.

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

Table 383: Protocol Version Structure in Message Header

9.17 Result Message

This field MAY be returned in a response. It contains a more descriptive error message, which MAY be provided to an end user or used for logging/auditing purposes.

Object	Encoding
Result Message	Text String

Table 384: Result Message in Response Batch Item

9.18 Result Reason

This field indicates a reason for failure or a modifier for a partially successful operation and SHALL be present in responses that return a Result Status of Failure. In such a case, the Result Reason SHALL be set as specified. It SHALL NOT be present in any response that returns a Result Status of Success.

Object	Encoding
Result Reason	Enumeration

Table 385: Result Reason in Response Batch Item

9.19 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.
- *Operation Pending* – The requested operation is in progress, and it is necessary to obtain the actual result via asynchronous polling. The asynchronous correlation value SHALL be used for the subsequent polling of the result status.
- *Operation Undone* – The requested operation was performed, but had to be undone (i.e., due to a failure in a batch for which the Error Continuation Option was set to Undo).
- *Operation Failed* – The requested operation failed.

Object	Encoding
Result Status	Enumeration

Table 386: Result Status in Response Batch Item

9.20 Time Stamp

This is an OPTIONAL field contained in a client request. It is REQUIRED in a server request and response. It 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 server's time). Note that the time stamp MAY be used by a client that has no real-time clock, but has a countdown timer, to obtain useful "seconds from now" values from all of the Date attributes by performing a subtraction.

Object	Encoding
Time Stamp	Date-Time

Table 387: Time Stamp in Message Header

9.21 Unique Batch Item ID

This is an OPTIONAL field 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 SHALL have the same Unique Batch Item ID.

Object	Encoding
Unique Batch Item ID	Byte String

Table 388: Unique Batch Item ID in Batch Item

10 Message Protocols

10.1 TTLV

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 need to 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.

10.1.1 Tag

An Item Tag is a three-byte binary unsigned integer, transmitted big endian, which contains the *Tag Enumeration Value (using only the three least significant bytes of the enumeration)*.

10.1.2 Type

An Item Type is a byte containing a coded value that indicates the data type of the data object using the specified *Item Type Enumeration* (using only the least significant byte of the enumeration).

Value	Description
Structure	Encoded as the concatenated encodings of the elements of the structure. All structures defined in this specification SHALL have all of their fields encoded in the order in which they appear in their respective structure descriptions
Integer	Encoded as four-byte long (32 bit) binary signed numbers in 2's complement notation, transmitted big-endian.
Long Integer	Encoded as eight-byte long (64 bit) binary signed numbers in 2's complement notation, transmitted big-endian.
Big Integer	Encoded as a sequence of eight-bit bytes, in two's complement notation, transmitted big-endian. If the length of the sequence is not a multiple of eight bytes, then Big Integers SHALL be padded with the minimal number of leading sign-extended bytes to make the length a multiple of eight bytes. These padding bytes are part of the Item Value and SHALL be counted in the Item Length.
Enumeration	Encoded as four-byte long (32 bit) binary unsigned numbers transmitted big-endian. Extensions, which are permitted, but are not defined in this specification, contain the value 8 hex in the first nibble of the first byte.
Boolean	Encoded as an eight-byte hex value 0000000000000000, indicating the Boolean value False, or the hex value 0000000000000001, indicating the Boolean value True, transmitted big-endian.
Text String	Sequences of bytes that encode character values according to **[RFC3629]** the UTF-8 encoding standard.
Byte String	Sequences of bytes containing individual eight-bit binary values.
Date Time	Encoded as eight-byte long (64 bit) binary signed numbers in 2's complement notation, transmitted big-endian.
Interval	Encoded as four-byte long (32 bit) binary unsigned numbers, transmitted big-endian.
Date Time Extended	Encoded as eight-byte long (64 bit) binary signed numbers in 2's complement notation, transmitted big-endian.

10.1.3 Length

An Item Length is a 32-bit binary integer, transmitted big-endian, containing the number of bytes in the Item Value. The 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
Byte String	Varies
Date Time	8
Interval	4
Date Time Extended	8

Table 389: Allowed Item Length Values

10.1.4 Value

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

10.1.5 Padding

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, Byte String, or Interval, then the Item Length is the number of bytes excluding the padding bytes. Text Strings and Byte Strings SHALL be padded with the minimal number of bytes following the Item Value to obtain a multiple of eight bytes. Integers, Enumerations, and Intervals SHALL be padded with four bytes following the Item Value.

10.2 Other Message Protocols

In addition to the mandatory TTLV messaging protocol, a number of optional message-encoding mechanisms to support different transport protocols and different client capabilities.

10.2.1 HTTPS

The HTTPs messaging protocol is specified in **[KMIP-Prof]**.

10.2.2 JSON

The JSON messaging protocol is specified in **[KMIP-Prof]**.

10.2.3 XML

The XML messaging protocol is specified in **[KMIP-Prof]**.

10.3 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 KMIP Server SHALL support authentication as defined in **[KMIP-Prof]**.

10.4 Transport

KMIP Servers and Clients SHALL establish and maintain channel confidentiality and integrity, and provide assurance of authenticity for KMIP messaging as specified in **[KMIP-Prof]**.

11 Enumerations

The following tables define the values for enumerated lists. Values not listed (outside the range 80000000 to 8FFFFFFF) are reserved for future KMIP versions.

Implementations SHALL NOT use Tag Values marked as Reserved.

11.1 Adjustment Type Enumeration

The *Adjustment Type* enumerations are:

Value	Description
Increment	Add the Adjustment Parameter to the value. Applies to Integer, Long Integers, Big Integer, Interval, Date Time, and Date Time Extended. The default is parameter is 1 for numeric types, 1 second for Date Time, and 1 microsecond for Date Time Extended.
Decrement	Subtract the Adjustment Parameter to the value. Applies to Integer, Long Integers, Big Integer, Interval, Date Time, and Date Time Extended. The default is parameter is 1 for numeric types, 1 second for Date Time, and 1 microsecond for Date Time Extended.
Negate	Negate the value. Applies to Integer, Long Integers, Big Integer and Boolean types.

Table 390: Adjustment Type Descriptions

Adjustment Type	
Name	**Value**
Increment	00000001
Decrement	00000002
Negate	00000003
Extensions	8XXXXXXX

Table 391: Adjustment Type Enumeration

11.2 Alternative Name Type Enumeration

Alternative Name Type	
Name	**Value**
Uninterpreted Text String	00000001
URI	00000002
Object Serial Number	00000003
Email Address	00000004
DNS Name	00000005
X.500 Distinguished Name	00000006
IP Address	00000007
Extensions	8XXXXXXX

Table 392: Alternative Name Type Enumeration

11.3 Asynchronous Indicator Enumeration

Asynchronous Indicator enumerations are:

Value	Description
Mandatory	The server SHALL process all batch items in the request asynchronously (returning an Asynchronous Correlation Value for each batch item).
Optional	The server MAY process each batch item in the request either asynchronously (returning an Asynchronous Correlation Value for a batch item) or synchronously. The method or policy by which the server determines whether or not to process an individual batch item asynchronously is a decision of the server and is outside of the scope of this protocol.
Prohibited	The server SHALL NOT process any batch item asynchronously. All batch items SHALL be processed synchronously.

Table 393: Asynchronous Indicator Descriptions

Asynchronous Indicator	
Name	**Value**
Mandatory	00000001
Optional	00000002
Prohibited	00000003
Extensions	8XXXXXXX

Table 394: Asynchronous Indicator Enumeration

11.4 Attestation Type Enumeration

Attestation Type	
Name	**Value**
TPM Quote	00000001
TCG Integrity Report	00000002
SAML Assertion	00000003
Extensions	8XXXXXXX

Table 395: Attestation Type Enumeration

11.5 Batch Error Continuation Option Enumeration

Batch Error Continuation Option enumerations are:

Value	Description
Undo	If any operation in the request fails, then the server SHALL undo all the previous operations. Batch item fails and Result Status is set to Operation Failed. Responses to batch items that have already been processed are returned normally. Responses to batch items that have not been processed are not returned.
Stop	If an operation fails, then the server SHALL NOT continue processing subsequent operations in the request. Completed operations SHALL NOT be undone. Batch item fails and Result Status is set to Operation Failed. Responses to other batch items are returned normally.
Continue	Return an error for the failed operation, and continue processing subsequent operations in the request. Batch item fails and Result Status is set to Operation Failed. Batch items that had been processed have been undone and their responses are returned with Undone result status.

Table 396: Batch Error Continuation Option Descriptions

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

Table 397: Batch Error Continuation Option Enumeration

11.6 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
XTS	0000000B
AESKeyWrapPadding	0000000C

NISTKeyWrap	0000000D
X9.102 AESKW	0000000E
X9.102 TDKW	0000000F
X9.102 AKW1	00000010
X9.102 AKW2	00000011
AEAD	00000012
Extensions	8XXXXXXX

Table 398: Block Cipher Mode Enumeration

11.7 Cancellation Result Enumeration

A *Cancellation Result* enumerations are:

Value	Description
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	Unavailable – The specified correlation value did not match any recently pending or completed asynchronous operations.

Table 399: Cancellation Result Enumeration Descriptions

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

Table 400: Cancellation Result Enumeration

11.8 Certificate Request Type Enumeration

.

Certificate Request Type	
Name	**Value**
CRMF	00000001
PKCS#10	00000002
PEM	00000003
(Reserved)	00000004
Extensions	8XXXXXXX

Table 401: Certificate Request Type Enumeration

11.9 Certificate Type Enumeration

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

Table 402: Certificate Type Enumeration

11.10 Client Registration Method Enumeration

Client Registration Method enumerations are:

Value	Description
Server Pre-Generated	The server has pre-generated the client's private key. The returned PKCS#12 is protected with HEX(SHA256(Username || Password)).
Server On-Demand	The server generates the client's private key on demand. The returned PKCS#12 is protected with HEX(SHA256(Username || Password)).
Client Generated	The client generates the private key and sends a Certificate Signing Request to the server to generate the certificate. The returned PKCS#12 is protected with HEX(SHA256(Username || Password)).
Client Registered	The client generates the private key and the certificates and registers the certificate with the server.

Table 403: Client Registration Method Enumeration Descriptions

Client Registration Method	
Name	**Value**
Unspecified	00000001
Server Pre-Generated	00000002
Server On-Demand	00000003
Client Generated	00000004
Client Registered	00000005
Extensions	8XXXXXXX

11.11 Credential Type Enumeration

Credential Type	
Name	**Value**
Username and Password	00000001
Device	00000002
Attestation	00000003
One Time Password	00000004
Hashed Password	00000005
Ticket	00000006
Extensions	8XXXXXXX

Table 404: Credential Type Enumeration

11.12 Cryptographic Algorithm Enumeration

Cryptographic Algorithm	
Name	**Value**
DES	00000001
3DES	00000002
AES	00000003
RSA	00000004
DSA	00000005
ECDSA	00000006
HMAC-SHA1	00000007
HMAC-SHA224	00000008
HMAC-SHA256	00000009
HMAC-SHA384	0000000A
HMAC-SHA512	0000000B
HMAC-MD5	0000000C
DH	0000000D

ECDH	0000000E
ECMQV	0000000F
Blowfish	00000010
Camellia	00000011
CAST5	00000012
IDEA	00000013
MARS	00000014
RC2	00000015
RC4	00000016
RC5	00000017
SKIPJACK	00000018
Twofish	00000019
EC	0000001A
One Time Pad	0000001B
ChaCha20	0000001C
Poly1305	0000001D
ChaCha20Poly1305	0000001E
SHA3-224	0000001F
SHA3-256	00000020
SHA3-384	00000021
SHA3-512	00000022
HMAC-SHA3-224	00000023
HMAC-SHA3-256	00000024
HMAC-SHA3-384	00000025
HMAC-SHA3-512	00000026
SHAKE-128	00000027
SHAKE-256	00000028
ARIA	00000029
SEED	0000002A
SM2	0000002B
SM3	0000002C
SM4	0000002D
GOST R 34.10-2012	0000002E
GOST R 34.11-2012	0000002F
GOST R 34.13-2015	00000030
GOST 28147-89	00000031
XMSS	00000032
SPHINCS-256	00000033

McEliece	00000034
McEliece-6960119	00000035
McEliece-8192128	00000036
Ed25519	00000037
Ed448	00000038
Extensions	8XXXXXXX

Table 405: Cryptographic Algorithm Enumeration

11.13 Data Enumeration

Data	
Name	**Value**
Decrypt	00000001
Encrypt	00000002
Hash	00000003
MAC MAC Data	00000004
RNG Retrieve	00000005
Sign Signature Data	00000006
Signature Verify	00000007
Extensions	8XXXXXXX

Table 406: Data Enumeration

11.14 Derivation Method Enumeration

The *Derivation Method* enumerations are:

Item	Description	Mapping
PBKDF2	This method is used to derive a symmetric key from a password or pass phrase.	**[PKCS#5]** and **[RFC2898]**
HASH	This method derives a key by computing a hash over the derivation key or the derivation data.	
HMAC	This method derives a key by computing an HMAC over the derivation data.	
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	**[SP800-108]**
NIST800-108-F	This method derives a key by computing the KDF in Feedback Mode	**[SP800-108]**
NIST800-108-DPI	This method derives a key by computing the KDF in Double-Pipeline Iteration Mode	**[SP800-108]**
Asymmetric Key	This method derives a key using asymmetric key agreement between a private and public key.	
AWS Signature Version 4	As defined in Amazon Web Services Signature Version 4.	**[AWS-SIGV4]**
HKDF	HMAC-based Extract-and-Expand Key Derivation Function	**[RFC5869]**

Table 407: Derivation Method Enumeration Descriptions

Derivation Method	
Name	**Value**
PBKDF2	00000001
HASH	00000002
HMAC	00000003
ENCRYPT	00000004
NIST800-108-C	00000005
NIST800-108-F	00000006
NIST800-108-DPI	00000007
Asymmetric Key	00000008
AWS Signature Version 4	00000009
HKDF	0000000A
Extensions	8XXXXXXX

Table 408: Derivation Method Enumeration

11.15 Destroy Action Enumeration

Destroy Action Type	
Name	**Value**
Unspecified	00000001
Key Material Deleted	00000002
Key Material Shredded	00000003
Meta Data Deleted	00000004
Meta Data Shredded	00000005
Deleted	00000006
Shredded	00000007
Extensions	8XXXXXXX

11.16 Digital Signature Algorithm Enumeration

Digital Signature Algorithm	
Name	**Value**
MD2 with RSA Encryption	00000001
MD5 with RSA Encryption	00000002
SHA-1 with RSA Encryption	00000003
SHA-224 with RSA Encryption	00000004
SHA-256 with RSA Encryption	00000005
SHA-384 with RSA Encryption	00000006
SHA-512 with RSA Encryption	00000007
RSASSA-PSS	00000008
DSA with SHA-1	00000009
DSA with SHA224	0000000A
DSA with SHA256	0000000B
ECDSA with SHA-1	0000000C
ECDSA with SHA224	0000000D
ECDSA with SHA256	0000000E
ECDSA with SHA384	0000000F
ECDSA with SHA512	00000010
SHA3-256 with RSA Encryption	00000011
SHA3-384 with RSA Encryption	00000012
SHA3-512 with RSA Encryption	00000013
Extensions	8XXXXXXX

Table 409: Digital Signature Algorithm Enumeration

11.17 DRBG Algorithm Enumeration

DRBG Algorithm	
Name	**Value**
Unspecified	00000001
Dual-EC	00000002
Hash	00000003
HMAC	00000004
CTR	00000005
Extensions	8XXXXXXX

Table 410: DRGB Algorithm Enumeration

11.18 Encoding Option Enumeration

The following encoding options are currently defined:

Value	Description
No Encoding	the wrapped un-encoded value of the Byte String Key Material field in the Key Value structure
TTLV Encoding	the wrapped TTLV-encoded Key Value structure

Table 411: Encoding Option Description

Encoding Option	
Name	**Value**
No Encoding	00000001
TTLV Encoding	00000002
Extensions	8XXXXXXX

Table 412: Encoding Option Enumeration

11.19 Endpoint Role Enumeration

The following endpoint roles are currently defined:

Value	Description
Client	The endpoint that sends requests and receives responses.
Server	The endpoint that receives requests and sends responses.

Table 413: Endpoint Role Description

Encoding Option	
Name	**Value**
Client	00000001
Server	00000002
Extensions	8XXXXXXX

Table 414: Endpoint Role Enumeration

11.20 FIPS186 Variation Enumeration

FIPS186 Variation	
Name	**Value**
Unspecified	00000001
GP x-Original	00000002
GP x-Change Notice	00000003
x-Original	00000004
x-Change Notice	00000005
k-Original	00000006
k-Change Notice	00000007
Extensions	8XXXXXXX

Table 415: FIPS186 Variation Enumeration

Note: the user should be aware that a number of these algorithms are no longer recommended for general use and/or are deprecated. They are included for completeness.

11.21 Hashing Algorithm Enumeration

Hashing Algorithm	
Name	**Value**
MD2	00000001
MD4	00000002
MD5	00000003
SHA-1	00000004
SHA-224	00000005
SHA-256	00000006
SHA-384	00000007
SHA-512	00000008
RIPEMD-160	00000009
Tiger	0000000A
Whirlpool	0000000B
SHA-512/224	0000000C
SHA-512/256	0000000D
SHA3-224	0000000E
SHA3-256	0000000F
SHA3-384	00000010
SHA3-512	00000011
Extensions	8XXXXXXX

Table 416: Hashing Algorithm Enumeration

11.22 Interop Function Enumeration

Interop Function enumerations are:

Function	Description
Begin	A specified test is about to begin
End	A specified test has ended
Reset	Resets the server to the state it would be in at the beginning of an interop session

Table 417: Interop Function Descriptions

Interop Function	
Name	**Value**
Begin	00000001
End	00000002
Reset	00000003
Extensions	8XXXXXXX

Table 418: Interop Function Enumeration

11.23 Item Type Enumeration

Item Type enumerations are:

Value	Description
Structure	The ordered concatenation of items.
Integer	Four-byte long (32 bit) signed numbers
Long Integer	Eight-byte long (64 bit) signed numbers.
Big Integer	A sequence of eight-bit bytes
Enumeration	Four-byte long (32 bit) unsigned numbers
Boolean	The value True or False.
Text String	Sequences of character values.
Byte String	Sequences of bytes containing individual unspecified eight-bit binary values
Date Time	Eight-byte long (64 bit) POSIX Time values in seconds. .
Interval	Four-byte long (32 bit) unsigned numbers in seconds
Date Time Extended	Eight-byte long (64 bit) POSIX Time values in micro-seconds.

Table 419: Item Type Descriptions

Item Type	
Name	**Value**
Structure	00000001
Integer	00000002

Long Integer	00000003
Big Integer	00000004
Enumeration	00000005
Boolean	00000006
Text String	00000007
Byte String	00000008
Date Time	00000009
Interval	0000000A
Date Time Extended	0000000B

Table 420: Item Type Enumeration

11.24 Key Compression Type Enumeration

Key Compression Type	
Name	**Value**
EC Public Key Type Uncompressed	00000001
EC Public Key Type X9.62 Compressed Prime	00000002
EC Public Key Type X9.62 Compressed Char2	00000003
EC Public Key Type X9.62 Hybrid	00000004
Extensions	8XXXXXXX

Table 421: Key Compression Type Enumeration values

11.25 Key Format Type Enumeration

A *Key Block* contains a Key Value of one of the following *Key Format Types*:

Value	Description
Raw	A key that contains only cryptographic key material, encoded as a string of bytes.

Opaque	an encoded key for which the encoding is unknown to the key management system. It is encoded as a string of bytes.
PKCS1	an encoded private key, expressed as a DER-encoded ASN.1 PKCS#1 object.
PKCS8	An encoded private key, expressed as a DER-encoded ASN.1 PKCS#8 object, supporting both the RSAPrivateKey syntax and EncryptedPrivateKey
X.509	An encoded object, expressed as a DER-encoded ASN.1 X.509 object.
ECPrivateKey	An ASN.1 encoded elliptic curve private key.
Several Transparent Key types	algorithm-specific structures containing defined values for the various key types.
Extensions	Vendor-specific extensions to allow for proprietary or legacy key formats.

Table 422: Key Format Types Description

Key Format Type	
Name	**Value**
Raw	00000001
Opaque	00000002
PKCS#1	00000003
PKCS#8	00000004
X.509	00000005
ECPrivateKey	00000006
Transparent Symmetric Key	00000007
Transparent DSA Private Key	00000008
Transparent DSA Public Key	00000009
Transparent RSA Private Key	0000000A
Transparent RSA Public Key	0000000B
Transparent DH Private Key	0000000C
Transparent DH Public Key	0000000D
(Reserved)	0000000E
(Reserved)	0000000F
(Reserved)	00000010
(Reserved)	00000011
(Reserved)	00000012
(Reserved)	00000013
Transparent EC Private Key	00000014
Transparent EC Public Key	00000015
PKCS#12	00000016
PKCS#10	00000017

Extensions	8XXXXXXX

Table 423: Key Format Type Enumeration

11.26 Key Role Type Enumeration

Key Role Type	
Name	**Value**
BDK	00000001
CVK	00000002
DEK	00000003
MKAC	00000004
MKSMC	00000005
MKSMI	00000006
MKDAC	00000007
MKDN	00000008
MKCP	00000009
MKOTH	0000000A
KEK	0000000B
MAC16609	0000000C
MAC97971	0000000D
MAC97972	0000000E
MAC97973	0000000F
MAC97974	00000010
MAC97975	00000011
ZPK	00000012
PVKIBM	00000013
PVKPVV	00000014
PVKOTH	00000015
DUKPT	00000016
IV	00000017
TRKBK	00000018
Extensions	8XXXXXXX

Table 424: Key Role Type Enumeration

Note that while the set and definitions of key role types are chosen to match **[X9 TR-31]** there is no necessity to match binary representations.

11.27 Key Value Location Type Enumeration

Key Value Location Type

Name	Value
Uninterpreted Text String	00000001
URI	00000002
Extensions	8XXXXXXX

Table 425: Key Value Location Type Enumeration

11.28 Link Type Enumeration

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

Value	Description
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 contained in 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 or Secret Data object: the object(s) from which the current symmetric key was derived.
Derived Key Link	The symmetric key(s) or Secret Data object(s) that were derived from the current object.
Replacement Object Link	For a Symmetric Key, an Asymmetric Private Key, or an Asymmetric 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 SHALL be only one such replacement object per Managed Object.
Replaced Object Link	For a Symmetric Key, an Asymmetric Private Key, or an Asymmetric 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.
Parent Link	For all object types: the container or other parent object corresponding to the object.
Child Link	For all object types: the subordinate, derived or other child object corresponding to the object.
Previous Link	For all object types: the previous object to this object.
Next Link	For all object types: the next object to this object.
PKCS#12 Certificate Link	
PKCS#12 Password Link	
Wrapping Key Link	For wrapped objects: the object that was used to wrap this object.

Table 426: Link Type Enumeration Descriptions

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
Parent Link	00000108
Child Link	00000109
Previous Link	0000010A
Next Link	0000010B
PKCS#12 Certificate Link	0000010C
PKCS#12 Password Link	0000010D
Wrapping Key Link	0000010E
Extensions	8XXXXXXX

Table 427: Link Type Enumeration

11.29 Key Wrap Type Enumeration

Key Wrap Type	
Name	**Value**
Not Wrapped	00000001
As Registered	00000002
Extensions	8XXXXXXX

11.30 Mask Generator Enumeration

Mask Generator	
Name	**Value**
MFG1	00000001
Extensions	8XXXXXXX

11.31 Name Type Enumeration

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

Table 428: Name Type Enumeration

11.32 NIST Key Type Enumeration

NIST Key Type Enumeration	
Name	**Value**
Private signature key	00000001
Public signature verification key	00000002
Symmetric authentication key	00000003
Private authentication key	00000004
Public authentication key	00000005
Symmetric data encryption key	00000006
Symmetric key wrapping key	00000007
Symmetric random number generation key	00000008
Symmetric master key	00000009
Private key transport key	0000000A
Public key transport key	0000000B
Symmetric key agreement key	0000000C
Private static key agreement key	0000000D
Public static key agreement key	0000000E
Private ephemeral key agreement key	0000000F
Public ephemeral key agreement key	00000010
Symmetric authorization key	00000011
Private authorization key	00000012
Public authorization key	00000013
Extensions	8XXXXXXX

11.33 Object Group Member Enumeration

Object Group Member Option	
Name	**Value**
Group Member Fresh	00000001
Group Member Default	00000002
Extensions	8XXXXXXX

Table 429: Object Group Member Enumeration

11.34 Object Type Enumeration

Object Type	
Name	**Value**
Certificate	00000001
Symmetric Key	00000002
Public Key	00000003
Private Key	00000004
Split Key	00000005
(Reserved)	00000006
Secret Data	00000007
Opaque Object	00000008
PGP Key	00000009
Certificate Request	0000000A
Extensions	8XXXXXXX

Table 430: Object Type Enumeration

11.35 Opaque Data Type Enumeration

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

Table 431: Opaque Data Type Enumeration

11.36 Operation Enumeration

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
Re-key Key Pair	0000001D
Discover Versions	0000001E
Encrypt	0000001F
Decrypt	00000020
Sign	00000021
Signature Verify	00000022
MAC	00000023
MAC Verify	00000024
RNG Retrieve	00000025
RNG Seed	00000026
Hash	00000027
Create Split Key	00000028
Join Split Key	00000029

Import	0000002A
Export	0000002B
Log	0000002C
Login	0000002D
Logout	0000002E
Delegated Login	0000002F
Adjust Attribute	00000030
Set Attribute	00000031
Set Endpoint Role	00000032
PKCS#11	00000033
Interop	00000034
Re-Provision	00000035
Extensions	8XXXXXXX

Table 432: Operation Enumeration

11.37 Padding Method Enumeration

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

Table 433: Padding Method Enumeration

11.38 PKCS#11 Function Enumeration

The PKCS#11 Function enumerations are the 1-based offset count of the function in the CK_FUNCTION_LIST_3_0 structure as specified in [PKCS#11]

11.39 PKCS#11 Return Code Enumeration

The PKCS#11 Return Codes enumerations representing PKCS#11 return codes as specified in the CK_RV values in [PKCS#11]

11.40 Profile Name Enumeration

Profile Name	
Name	**Value**
(Reserved)	00000001-00000103
Complete Server Basic	00000104
Complete Server TLS v1.2	00000105
Tape Library Client	00000106
Tape Library Server	00000107
Symmetric Key Lifecycle Client	00000108
Symmetric Key Lifecycle Server	00000109
Asymmetric Key Lifecycle Client	0000010A
Asymmetric Key Lifecycle Server	0000010B
Basic Cryptographic Client	0000010C
Basic Cryptographic Server	0000010D
Advanced Cryptographic Client	0000010E
Advanced Cryptographic Server	0000010F
RNG Cryptographic Client	00000110
RNG Cryptographic Server	00000111
Basic Symmetric Key Foundry Client	00000112
Intermediate Symmetric Key Foundry Client	00000113
Advanced Symmetric Key Foundry Client	00000114
Symmetric Key Foundry Server	00000115
Opaque Managed Object Store Client	00000116
Opaque Managed Object Store Server	00000117
(Reserved)	00000118
(Reserved)	00000119
(Reserved)	0000011A
(Reserved)	0000011B
Storage Array with Self Encrypting Drive Client	0000011C
Storage Array with Self Encrypting Drive Server	0000011D
HTTPS Client	0000011E
HTTPS Server	0000011F
JSON Client	00000120
JSON Server	00000121
XML Client	00000122
XML Server	00000123
AES XTS Client	00000124
AES XTS Server	00000125

Quantum Safe Client	00000126
Quantum Safe Server	00000127
PKCS#11 Client	00000128
PKCS#11 Server	00000129
Baseline Client	0000012A
Baseline Server	0000012B
Complete Server	0000012C
Extensions	8XXXXXXX

Table 434: Profile Name Enumeration

11.41 Protection Level Enumeration

Protection Level	
Name	**Value**
High	00000001
Low	00000002
Extensions	8XXXXXXX

Table 435: Protection Level Enumeration

11.42 Put Function Enumeration

Put Function	
Name	**Value**
New	00000001
Replace	00000002
Extensions	8XXXXXXX

Table 436: Put Function Enumeration

11.43 Query Function Enumeration

Query Function	
Name	**Value**
Query Operations	00000001
Query Objects	00000002
Query Server Information	00000003
Query Application Namespaces	00000004
Query Extension List	00000005
Query Extension Map	00000006
Query Attestation Types	00000007
Query RNGs	00000008
Query Validations	00000009
Query Profiles	0000000A

Query Capabilities	0000000B
Query Client Registration Methods	0000000C
Query Defaults Information	0000000D
Query Storage Protection Masks	0000000E
Extensions	8XXXXXXX

Table 437: Query Function Enumeration

11.44 Recommended Curve Enumeration

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
SECP112R1	00000010
SECP112R2	00000011
SECP128R1	00000012
SECP128R2	00000013
SECP160K1	00000014
SECP160R1	00000015
SECP160R2	00000016
SECP192K1	00000017
SECP224K1	00000018
SECP256K1	00000019
SECT113R1	0000001A

SECT113R2	0000001B
SECT131R1	0000001C
SECT131R2	0000001D
SECT163R1	0000001E
SECT193R1	0000001F
SECT193R2	00000020
SECT239K1	00000021
ANSIX9P192V2	00000022
ANSIX9P192V3	00000023
ANSIX9P239V1	00000024
ANSIX9P239V2	00000025
ANSIX9P239V3	00000026
ANSIX9C2PNB163V1	00000027
ANSIX9C2PNB163V2	00000028
ANSIX9C2PNB163V3	00000029
ANSIX9C2PNB176V1	0000002A
ANSIX9C2TNB191V1	0000002B
ANSIX9C2TNB191V2	0000002C
ANSIX9C2TNB191V3	0000002D
ANSIX9C2PNB208W1	0000002E
ANSIX9C2TNB239V1	0000002F
ANSIX9C2TNB239V2	00000030
ANSIX9C2TNB239V3	00000031
ANSIX9C2PNB272W1	00000032
ANSIX9C2PNB304W1	00000033
ANSIX9C2TNB359V1	00000034
ANSIX9C2PNB368W1	00000035
ANSIX9C2TNB431R1	00000036
BRAINPOOLP160R1	00000037
BRAINPOOLP160T1	00000038
BRAINPOOLP192R1	00000039
BRAINPOOLP192T1	0000003A
BRAINPOOLP224R1	0000003B
BRAINPOOLP224T1	0000003C
BRAINPOOLP256R1	0000003D
BRAINPOOLP256T1	0000003E
BRAINPOOLP320R1	0000003F
BRAINPOOLP320T1	00000040

BRAINPOOLP384R1	00000041
BRAINPOOLP384T1	00000042
BRAINPOOLP512R1	00000043
BRAINPOOLP512T1	00000044
CURVE25519	00000045
CURVE448	00000046
Extensions	8XXXXXXX

Table 438: Recommended Curve Enumeration for ECDSA, ECDH, and ECMQV

11.45 Result Reason Enumeration

Following are the Result Reason enumerations.

Value	Description
Application Namespace Not Supported	The particular Application Namespace is not supported, and the server was not able to generate the Application Data field of an Application Specific Information attribute if the field was omitted from the client request
Attestation Failed	Operation requires attestation data and the attestation data provided by the client does not validate
Attestation Required	Operation requires attestation data which was not provided by the client, and the client has set the Attestation Capable indicator to True
Attribute Instance Not Found	A referenced attribute was found, but the specific instance was not found
Attribute Not Found	A referenced attribute was not found at all on an object
Attribute Read Only	Attempt to set a Read Only Attribute
Attribute Single Instance	Attempt to provide multiple values for a single instance attribute
Authentication not successful	The authentication information in the request could not be validated, or was not found
Bad Cryptographic Parameters	Bad Cryptographic Parameters
Bad Password	Key Format Type is PKCS#12, but missing or multiple PKCS#12 Password Links, or not Secret Data, or not Active
Codec Error	The low level TTLV, XML, JSON etc. was badly formed and not understood by the server.TTLV connections should be closed as future requests might not be correctly separated
Cryptographic Failure	The operation failed due to a cryptographic error
Encoding Option Error	The Encoding Option is not supported as specified by the Encoding Option Enumeration

Feature Not Supported	The operation is supported, but not a specific feature specified in the request is not supported
General failure	The request failed for a reason other than the defined reasons above
Illegal Object Type	Check cannot be performed on this object type
Incompatible Cryptographic Usage Mask	The cryptographic algorithm or other parameters is not valid for the requested operation
Internal Server Error	The server had an internal error and could not process the request at this time.
Invalid Asynchronous Correlation Value	No outstanding operation with the specified Asynchronous Correlation Value exists
Invalid Attribute	An attribute is invalid for this object for this operation
Invalid Attribute Value	The value supplied for an attribute is invalid
Invalid Correlation Value	For streaming cryptographic operations
Invalid CSR	Invalid Certifcate Signing Request
Invalid Data Type	A data type was invalid for the requested operation
Invalid Field	The request is syntactically valid but some data in the request (other than an attribute value) has an invalid value
Invalid Message	The request message was not syntactically understood by the server. For example - the invalid use of a known tag
Invalid Object Type	Specificed object is not valid for the requested operation
Invalid Password	
Invalid Ticket	The ticket was invalid
Item Not Found	No object with the specified Unique Identifier exists
Key Compression Type Not Supported	The object exists, but the server is unable to provide it in the desired Key Compression Type
Key Format Type Not Supported	The object exists, but the server is unable to provide it in the desired Key Format Type
Key Value Not Present	A meta data only object. The key value is not present on the server
Key Wrap Type Not Supported	Key Wrap Type Type is not supported by the server
Missing data	The operation REQUIRED additional information in the request, which was not present
Missing Initialization Vector	Missing IV when required for crypto operation
Multi Valued Attribute	Attempt to Set or Adjust an attribute that has multiple values
Non Unique Name Attribute	Trying to perform an operation that requests the server to break the constraint on Name attribute being unique
Not Extractable	Object is not Extractable

Numeric Range	An operation produced a number that is to large or too small to be stored in the specified data type
Object Already Exists	for operations such as Import that require that no object with a specific unique identifier exists on a server
Object Archived	The object SHALL be recovered from the archive before performing the operation
Object Destroyed	Object exists, but has already been destroyed
Object Not Found	A requested managed object was not found or did not exist
Object Type	Invalid object type for the operation
Operation canceled by requester	The operation was asynchronous, and the operation was canceled by the Cancel operation before it completed successfully
Operation Not Supported	The operation requested by the request message is not supported by the server
Permission Denied	Client is not allowed to perform the specified operation
PKCS#11 Codec Error	There is a Codec error in the Input parameter
PKCS#11 Invalid Function	The PKCS function is not in the interface
PKCS#11 Invalid Interface	The interface is unknown or unavailable in the server
Protection Storage Unavailable, Private Protection Storage Unavailable, Public Protection Storage Unavailable	The operation could not be completed with the protections requested (or defaulted).
Read Only Attribute	Attempt to set a Read Only Attribute
Response Too Large	Maximum Response Size has been exceeded
Sensitive	Sensitive keys may not be retrieved unwrapped
Server Limit Exceeded	Some limit on the server such as database size has been exceeded
Unknown Enumeration	An enumerated value is not known by the server
Unknown Message Extension	The server does not support the supplied Message Extension
Unknown Tag	A tag is not known by the server
Unsupported Attribute	Attribute is valid in the specification but unsupported by the Server
Unsupported Cryptographic Parameters	Cryptographic Parameters are valid in the specification but unsupported by the Server
Unsupported Protocol Version	The operation cannot be performed with the provided protocol version
Usage Limit Exceeded	The usage limits or request count has been exceeded
Wrapping Object Archived	Wrapping Object is archived
Wrapping Object Destroyed	The object exists, but is destroyed

Wrapping Object Not Found	Wrapping object does not exist
Wrong Key Lifecycle State	The key lifecycle state is invalid for the operation, for example not Active for an Encrypt operation
General failure	The request failed for a reason other than any other reason enumeration value.

Table 439: Result Reason Encoding Descriptions

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
(Reserved)	0000000B
Permission Denied	0000000C
Object Archived	0000000D
(Reserved)	0000000E
Application Namespace Not Supported	0000000F
Key Format Type Not Supported	00000010
Key Compression Type Not Supported	00000011
Encoding Option Error	00000012
Key Value Not Present	00000013
Attestation Required	00000014
Attestation Failed	00000015
Sensitive	00000016
Not Extractable	00000017
Object Already Exists	00000018
Invalid Ticket	00000019
Usage Limit Exceeded	0000001A
Numeric Range	0000001B
Invalid Data Type	0000001C

Read Only Attribute	0000001D
Multi Valued Attribute	0000001E
Unsupported Attribute	0000001F
Attribute Instance Not Found	00000020
Attribute Not Found	00000021
Attribute Read Only	00000022
Attribute Single Valued	00000023
Bad Cryptographic Parameters	00000024
Bad Password	00000025
Codec Error	00000026
(Reserved)	00000027
Illegal Object Type	00000028
Incompatible Cryptographic Usage Mask	00000029
Internal Server Error	0000002A
Invalid Asynchronous Correlation Value	0000002B
Invalid Attribute	0000002C
Invalid Attribute Value	0000002D
Invalid Correlation Value	0000002E
Invalid CSR	0000002F
Invalid Object Type	00000030
(Reserved)	00000031
Key Wrap Type Not Supported	00000032
(Reserved)	00000033
Missing Initialization Vector	00000034
Non Unique Name Attribute	00000035
Object Destroyed	00000036
Object Not Found	00000037
(Reserved)	00000038
Not Authorised	00000039
Server Limit Exceeded	0000003A
Unknown Enumeration	0000003B
Unknown Message Extension	0000003C
Unknown Tag	0000003D
Unsupported Cryptographic Parameters	0000003E
Unsupported Protocol Version	0000003F
Wrapping Object Archived	00000040

Wrapping Object Destroyed	00000041
Wrapping Object Not Found	00000042
Wrong Key Lifecycle State	00000043
Protection Storage Unavailable	00000044
PKCS#11 Codec Error	00000045
PKCS#11 Invalid Function	00000046
PKCS#11 Invalid Interface	00000047
Private Protection Storage Unavailable	00000048
Public Protection Storage Unavailable	00000049
General Failure	00000100
Extensions	8XXXXXXX

Table 440: Result Reason Enumeration

11.46 Result Status Enumeration

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

Table 441: Result Status Enumeration

11.47 Revocation Reason Code Enumeration

Revocation Reason Code	
Name	**Value**
Unspecified	00000001
Key Compromise	00000002
CA Compromise	00000003
Affiliation Changed	00000004
Superseded	00000005
Cessation of Operation	00000006
Privilege Withdrawn	00000007
Extensions	8XXXXXXX

Table 442: Revocation Reason Code Enumeration

11.48 RNG Algorithm Enumeration

RNG Algorithm	
Name	**Value**
Unspecified	00000001
FIPS 186-2	00000002
DRBG	00000003
NRBG	00000004
ANSI X9.31	00000005
ANSI X9.62	00000006
Extensions	8XXXXXXX

Note: the user should be aware that a number of these algorithms are no longer recommended for general use and/or are deprecated. They are included for completeness.

11.49 RNG Mode Enumeration

RNG Mode	
Name	**Value**
Unspecified	00000001
Shared Instantiation	00000002
Non-Shared Instantiation	00000003
Extensions	8XXXXXXX

11.50 Secret Data Type Enumeration

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

Table 443: Secret Data Type Enumeration

11.51 Shredding Algorithm Enumeration

Shredding Algorithm	
Name	**Value**
Unspecified	00000001
Cryptographic	00000002
Unsupported	00000003
Extensions	8XXXXXXX

11.52 Split Key Method Enumeration

Split Key Method	
Name	**Value**
XOR	00000001
Polynomial Sharing GF (2^{16})	00000002
Polynomial Sharing Prime Field	00000003
Polynomial Sharing GF (2^{8})	00000004
Extensions	8XXXXXXX

Table 444: Split Key Method Enumeration

11.53 State Enumeration

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

Table 445: State Enumeration

11.54 Tag Enumeration

All tags SHALL contain either the value 42 in hex or the value 54 in hex as the first byte of a three (3) byte enumeration value. Tags defined by this specification contain hex 42 in the first byte. Extensions contain the value 54 hex in the first byte.

Tag	
Name	**Value**
(Unused)	000000 – 420000
Activation Date	420001

Tag	
Name	**Value**
Application Data	420002
Application Namespace	420003
Application Specific Information	420004
Archive Date	420005
Asynchronous Correlation Value	420006
Asynchronous Indicator	420007
Attribute	420008
(Reserved)	420009
Attribute Name	42000A
Attribute Value	42000B
Authentication	42000C
Batch Count	42000D
Batch Error Continuation Option	42000E
Batch Item	42000F
Batch Order Option	420010
Block Cipher Mode	420011
Cancellation Result	420012
Certificate	420013
(Reserved)	420014
(Reserved)	420015
(Reserved)	420016
(Reserved)	420017
Certificate Request	420018
Certificate Request Type	420019
(Reserved)	42001A
(Reserved)	42001B
(Reserved)	42001C
Certificate Type	42001D
Certificate Value	42001E
(Reserved)	42001F
Compromise Date	420020
Compromise Occurrence Date	420021
Contact Information	420022
Credential	420023
Credential Type	420024
Credential Value	420025

Tag	
Name	**Value**
Criticality Indicator	420026
CRT Coefficient	420027
Cryptographic Algorithm	420028
Cryptographic Domain Parameters	420029
Cryptographic Length	42002A
Cryptographic Parameters	42002B
Cryptographic Usage Mask	42002C
(Reserved)	42002D
D	42002E
Deactivation Date	42002F
Derivation Data	420030
Derivation Method	420031
Derivation Parameters	420032
Destroy Date	420033
Digest	420034
Digest Value	420035
Encryption Key Information	420036
G	420037
Hashing Algorithm	420038
Initial Date	420039
Initialization Vector	42003A
(Reserved)	42003B
Iteration Count	42003C
IV/Counter/Nonce	42003D
J	42003E
Key	42003F
Key Block	420040
Key Compression Type	420041
Key Format Type	420042
Key Material	420043
Key Part Identifier	420044
Key Value	420045
Key Wrapping Data	420046
Key Wrapping Specification	420047
Last Change Date	420048

Tag	
Name	**Value**
Lease Time	420049
Link	42004A
Link Type	42004B
Linked Object Identifier	42004C
MAC/Signature	42004D
MAC/Signature Key Information	42004E
Maximum Items	42004F
Maximum Response Size	420050
Message Extension	420051
Modulus	420052
Name	420053
Name Type	420054
Name Value	420055
Object Group	420056
Object Type	420057
Offset	420058
Opaque Data Type	420059
Opaque Data Value	42005A
Opaque Object	42005B
Operation	42005C
(Reserved)	42005D
P	42005E
Padding Method	42005F
Prime Exponent P	420060
Prime Exponent Q	420061
Prime Field Size	420062
Private Exponent	420063
Private Key	420064
(Reserved)	420065
Private Key Unique Identifier	420066
Process Start Date	420067
Protect Stop Date	420068
Protocol Version	420069
Protocol Version Major	42006A
Protocol Version Minor	42006B
Public Exponent	42006C

Tag	
Name	**Value**
Public Key	42006D
(Reserved)	42006E
Public Key Unique Identifier	42006F
Put Function	420070
Q	420071
Q String	420072
Qlength	420073
Query Function	420074
Recommended Curve	420075
Replaced Unique Identifier	420076
Request Header	420077
Request Message	420078
Request Payload	420079
Response Header	42007A
Response Message	42007B
Response Payload	42007C
Result Message	42007D
Result Reason	42007E
Result Status	42007F
Revocation Message	420080
Revocation Reason	420081
Revocation Reason Code	420082
Key Role Type	420083
Salt	420084
Secret Data	420085
Secret Data Type	420086
(Reserved)	420087
Server Information	420088
Split Key	420089
Split Key Method	42008A
Split Key Parts	42008B
Split Key Threshold	42008C
State	42008D
Storage Status Mask	42008E
Symmetric Key	42008F
(Reserved)	420090

Tag	
Name	**Value**
(Reserved)	420091
Time Stamp	420092
Unique Batch Item ID	420093
Unique Identifier	420094
Usage Limits	420095
Usage Limits Count	420096
Usage Limits Total	420097
Usage Limits Unit	420098
Username	420099
Validity Date	42009A
Validity Indicator	42009B
Vendor Extension	42009C
Vendor Identification	42009D
Wrapping Method	42009E
X	42009F
Y	4200A0
Password	4200A1
Device Identifier	4200A2
Encoding Option	4200A3
Extension Information	4200A4
Extension Name	4200A5
Extension Tag	4200A6
Extension Type	4200A7
Fresh	4200A8
Machine Identifier	4200A9
Media Identifier	4200AA
Network Identifier	4200AB
Object Group Member	4200AC
Certificate Length	4200AD
Digital Signature Algorithm	4200AE
Certificate Serial Number	4200AF
Device Serial Number	4200B0
Issuer Alternative Name	4200B1
Issuer Distinguished Name	4200B2
Subject Alternative Name	4200B3
Subject Distinguished Name	4200B4

Tag	
Name	**Value**
X.509 Certificate Identifier	4200B5
X.509 Certificate Issuer	4200B6
X.509 Certificate Subject	4200B7
Key Value Location	4200B8
Key Value Location Value	4200B9
Key Value Location Type	4200BA
Key Value Present	4200BB
Original Creation Date	4200BC
PGP Key	4200BD
PGP Key Version	4200BE
Alternative Name	4200BF
Alternative Name Value	4200C0
Alternative Name Type	4200C1
Data	4200C2
Signature Data	4200C3
Data Length	4200C4
Random IV	4200C5
MAC Data	4200C6
Attestation Type	4200C7
Nonce	4200C8
Nonce ID	4200C9
Nonce Value	4200CA
Attestation Measurement	4200CB
Attestation Assertion	4200CC
IV Length	4200CD
Tag Length	4200CE
Fixed Field Length	4200CF
Counter Length	4200D0
Initial Counter Value	4200D1
Invocation Field Length	4200D2
Attestation Capable Indicator	4200D3
Offset Items	4200D4
Located Items	4200D5
Correlation Value	4200D6
Init Indicator	4200D7
Final Indicator	4200D8

Tag	
Name	**Value**
RNG Parameters	4200D9
RNG Algorithm	4200DA
DRBG Algorithm	4200DB
FIPS186 Variation	4200DC
Prediction Resistance	4200DD
Random Number Generator	4200DE
Validation Information	4200DF
Validation Authority Type	4200E0
Validation Authority Country	4200E1
Validation Authority URI	4200E2
Validation Version Major	4200E3
Validation Version Minor	4200E4
Validation Type	4200E5
Validation Level	4200E6
Validation Certificate Identifier	4200E7
Validation Certificate URI	4200E8
Validation Vendor URI	4200E9
Validation Profile	4200EA
Profile Information	4200EB
Profile Name	4200EC
Server URI	4200ED
Server Port	4200EE
Streaming Capability	4200EF
Asynchronous Capability	4200F0
Attestation Capability	4200F1
Unwrap Mode	4200F2
Destroy Action	4200F3
Shredding Algorithm	4200F4
RNG Mode	4200F5
Client Registration Method	4200F6
Capability Information	4200F7
Key Wrap Type	4200F8
Batch Undo Capability	4200F9
Batch Continue Capability	4200FA
PKCS#12 Friendly Name	4200FB
Description	4200FC

Tag	
Name	**Value**
Comment	4200FD
Authenticated Encryption Additional Data	4200FE
Authenticated Encryption Tag	4200FF
Salt Length	420100
Mask Generator	420101
Mask Generator Hashing Algorithm	420102
P Source	420103
Trailer Field	420104
Client Correlation Value	420105
Server Correlation Value	420106
Digested Data	420107
Certificate Subject CN	420108
Certificate Subject O	420109
Certificate Subject OU	42010A
Certificate Subject Email	42010B
Certificate Subject C	42010C
Certificate Subject ST	42010D
Certificate Subject L	42010E
Certificate Subject UID	42010F
Certificate Subject Serial Number	420110
Certificate Subject Title	420111
Certificate Subject DC	420112
Certificate Subject DN Qualifier	420113
Certificate Issuer CN	420114
Certificate Issuer O	420115
Certificate Issuer OU	420116
Certificate Issuer Email	420117
Certificate Issuer C	420118
Certificate Issuer ST	420119
Certificate Issuer L	42011A
Certificate Issuer UID	42011B
Certificate Issuer Serial Number	42011C
Certificate Issuer Title	42011D
Certificate Issuer DC	42011E
Certificate Issuer DN Qualifier	42011F

Tag	
Name	**Value**
Sensitive	420120
Always Sensitive	420121
Extractable	420122
Never Extractable	420123
Replace Existing	420124
Attributes	420125
Common Attributes	420126
Private Key Attributes	420127
Public Key Attributes	420128
Extension Enumeration	420129
Extension Attribute	42012A
Extension Parent Structure Tag	42012B
Extension Description	42012C
Server Name	42012D
Server Serial Number	42012E
Server Version	42012F
Server Load	420130
Product Name	420131
Build Level	420132
Build Date	420133
Cluster Info	420134
Alternate Failover Endpoints	420135
Short Unique Identifier	420136
Reserved	420137
Tag	420138
Certificate Request Unique Identifier	420139
NIST Key Type	42013A
Attribute Reference	42013B
Current Attribute	42013C
New Attribute	42013D
(Reserved)	42013E
(Reserved)	42013F
Certificate Request Value	420140
Log Message	420141
Profile Version	420142

Tag	
Name	**Value**
Profile Version Major	420143
Profile Version Minor	420144
Protection Level	420145
Protection Period	420146
Quantum Safe	420147
Quantum Safe Capability	420148
Ticket	420149
Ticket Type	42014A
Ticket Value	42014B
Request Count	42014C
Rights	42014D
Objects	42014E
Operations	42014F
Right	420150
Endpoint Role	420151
Defaults Information	420152
Object Defaults	420153
Ephemeral	420154
Server Hashed Password	420155
One Time Password	420156
Hashed Password	420157
Adjustment Type	420158
PKCS#11 Interface	420159
PKCS#11 Function	42015A
PKCS#11 Input Parameters	42015B
PKCS#11 Output Parameters	42015C
PKCS#11 Return Code	42015D
Protection Storage Mask	42015E
Protection Storage Masks	42015F
Interop Function	420160
Interop Identifier	420161
Adjustment Value	420162
Common Protection Storage Masks	420163
Private Protection Storage Masks	420164
Public Protection Storage Masks	420165

Tag	
Name	**Value**
(Reserved)	420XXX – 42FFFF
(Unused)	430000 – 53FFFF
Extensions	540000 – 54FFFF
(Unused)	550000 – FFFFFF

Table 446: Tag Enumeration

11.55 Ticket Type Enumeration

State	
Name	**Value**
Login	00000001
Extensions	8XXXXXXX

Table 447: Ticket Type Enumeration

11.56 Unique Identifier Enumeration

The following values may be specified in an operation request for a Unique Identifier: If multiple unique identifiers would be referenced then the operation is repeated for each of them. If an operation appears multiple times in a request, it is the most recent that is referred to.

Unique Identifier Enumerations	
Name	**Value**
ID Placeholder	00000001
Certify	00000002
Create	00000003
Create Key Pair	00000004
Create Key Pair Private Key	00000005
Create Key Pair Public Key	00000006
Create Split Key	00000007
Derive Key	00000008
Import	00000009
Join Split Key	0000000A
Locate	0000000B
Register	0000000C
Re-key	0000000D
Re-certify	0000000E
Re-key Key Pair	0000000F
Re-key Key Pair Private Key	00000010
Re-key Key Pair Public Key	00000011
Extensions	8XXXXXXX

Table 448: Unique Identifier Enumeration

11.57 Unwrap Mode Enumeration

Unwrap Mode	
Name	**Value**
Unspecified	00000001
Processed	00000002
Not Processed	00000003
Extensions	8XXXXXXX

Table 449: Unwrap Mode Enumeration

11.58 Usage Limits Unit Enumeration

Usage Limits Unit	
Name	**Value**
Byte	00000001
Object	00000002
Extensions	8XXXXXXX

Table 450: Usage Limits Unit Enumeration

11.59 Validity Indicator Enumeration

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

Table 451: Validity Indicator Enumeration

11.60 Wrapping Method Enumeration

The following wrapping methods are currently defined:

Value	Description
Encrypt only	encryption using a symmetric key or public key, or authenticated encryption algorithms that use a single key
MAC/sign only	either MACing 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	

Table 452: Key Wrapping Methods Description

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

Table 453: Wrapping Method Enumeration

11.61 Validation Authority Type Enumeration

Validation Authority Type	
Name	**Value**
Unspecified	00000001
NIST CMVP	00000002
Common Criteria	00000003
Extensions	8XXXXXXX

11.62 Validation Type Enumeration

Validation Type	
Name	**Value**
Unspecified	00000001
Hardware	00000002
Software	00000003
Firmware	00000004
Hybrid	00000005
Extensions	8XXXXXXX

12 Bit Masks

All mask values SHALL be encoded as Integers in TTLV encoding and SHALL be encoded as Integers but in symbolic form in XML and JSON encodings.

12.1 Cryptographic Usage Mask

The following Cryptographic Usage Masks are currently defined:

Value	Description	Valid KMIP Server Operation
Sign	Allow for signing. Applies to Sign operation. Valid for PGP Key, Private Key	Yes
Verify	Allow for signature verification. Applies to Signature Verify and Validate operations. Valid for PGP Key, Certificate and Public Key.	Yes
Encrypt	Allow for encryption. Applies to Encrypt operation. Valid for PGP Key, Private Key, Public Key and Symmetric Key. Encryption for the purpose of wrapping is separate Wrap Key value.	Yes
Decrypt	Allow for decryption. Applies to Decrypt operation. Valid for PGP Key, Private Key, Public Key and Symmetric Key. Decryption for the purpose of unwrapping is separate Unwrap Key value.	Yes
Wrap Key	Allow for key wrapping. Applies to Get operation when wrapping is required by Wrapping Specification is provided on the object used to Wrap. Valid for PGP Key, Private Key and Symmetric Key. Note: even if the underlying wrapping mechanism is encryption, this value is logically separate.	Yes
Unwrap Key	Allow for key unwrapping. Applies to Get operation when unwrapping is required on the object used to Unwrap. Valid for PGP Key, Private Key, Public Key and Symmetric Key. Not interchangeable with Decrypt. Note: even if the underlying unwrapping mechanism is decryption, this value is logically separate.	Yes
(Reserved)		
MAC Generate	Allow for MAC generation. Applies to MAC operation. Valid for Symmetric Keys	Yes
MAC Verify	Allow for MAC verification. Applies to MAC Verify operation. Valid for Symmetric Keys	Yes
Derive Key	Allow for key derivation. Applied to Derive Key operation. Valid for PGP Keys, Private Keys, Public Keys, Secret Data and Symmetric Keys.	Yes
Key Agreement	Allow for Key Agreement. Valid for PGP Keys, Private Keys, Public Keys, Secret Data and Symmetric Keys	No
Certificate Sign	Allow for Certificate Signing. Applies to Certify operation on a private key. Valid for Private Keys.	Yes
CRL Sign	Allow for CRL Sign. Valid for Private Keys	Yes
Authenticate	Allow for Authentication. Valid for Secret Data.	Yes
Unrestricted	Cryptographic Usage Mask contains no Usage Restrictions.	Yes
FPE Encrypt	Allow for Format Preserving Encrypt. Valid for Symmetric Keys, Public Keys and Private Keys	Yes

FPE Decrypt	Allow for Format Preserving Decrypt. Valid for Symmetric Keys, Public Keys and Private Keys	Yes
Extensions	Extensions	

Table 454: Cryptographic Usage Masks Description

Cryptographic Usage Mask	
Name	**Value**
Sign	00000001
Verify	00000002
Encrypt	00000004
Decrypt	00000008
Wrap Key	00000010
Unwrap Key	00000020
(Reserved)	00000040
MAC Generate	00000080
MAC Verify	00000100
Derive Key	00000200
(Reserved)	00000400
Key Agreement	00000800
Certificate Sign	00001000
CRL Sign	00002000
(Reserved)	00004000
(Reserved)	00008000
(Reserved)	00010000
(Reserved)	00020000
(Reserved)	00040000
(Reserved)	00080000
Authenticate	00100000
Unrestricted	00200000
FPE Encrypt	00400000
FPE Decrypt	00800000
Extensions	XXX00000

Table 455: Cryptographic Usage Mask enumerations

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

12.2 Protection Storage Mask

Protection Storage Mask	
Name	**Value**
Software	00000001
Hardware	00000002
On Processor	00000004
On System	00000008
Off System	00000010
Hypervisor	00000020
Operating System	00000040
Container	00000080
On Premises	00000100
Off Premises	00000200
Self Managed	00000400
Outsourced	00000800
Validated	00001000
Same Jurisdiction	00002000
Extensions	XXXXXXX0

Table 456: Protection Storage Mask enumerations

12.3 Storage Status Mask

Storage Status Mask	
Name	**Value**
On-line storage	00000001
Archival storage	00000002
Destroyed storage	00000004
Extensions	XXXXXXX0

Table 457: Storage Status Mask enumerations

13 Algorithm Implementation

13.1 Split Key Algorithms

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 **[w1979]**.

Let *L* be the minimum number of bits needed to represent all values of the secret.

- When the Split Key Method is XOR, then 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 XORing all of the parts.
- When the Split Key Method is Polynomial Sharing Prime Field, then 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}), then 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 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 **[FIPS197]**, Sections 3 and 4. The field GF(2^8) is as described in a format consistent with **[FIPS197]**,

  GF(2^8) ≈ 285 - $x^8+x^4+x^3+x^2+1$.

  An element of GF(2^8) is represented as a byte. Addition and subtraction in GF(2^8) is performed as a bit-wise XOR of the bytes. Multiplication and inversion are more complex (see **[FIPS197]** Section 4.1 and 4.2 for details).

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

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

  which is represented by the byte 0x3A (or {3A} in notation according to **[FIPS197]**).

  Addition and subtraction in GF(2^{16}) both correspond to simply XORing the bytes. 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 $d = (u + v)v + mu^2$.

14 KMIP Client and Server Implementation Conformance

14.1 KMIP Client Implementation Conformance

An implementation is a conforming KMIP Client if the implementation meets the conditions specified in one or more client profiles specified in **[KMIP-Prof]**.

A KMIP client implementation SHALL be a conforming KMIP Client.

If a KMIP client implementation claims support for a particular client profile, then the implementation SHALL conform to all normative statements within the clauses specified for that profile and for any subclauses to each of those clauses.

14.2 KMIP Server Implementation Conformance

An implementation is a conforming KMIP Server if the implementation meets the conditions specified in one or more server profiles specified in **[KMIP-Prof]**.

A KMIP server implementation SHALL be a conforming KMIP Server.

If a KMIP server implementation claims support for a particular server profile, then the implementation SHALL conform to all normative statements within the clauses specified for that profile and for any subclauses to each of those clauses.

Appendix A. Acknowledgments

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

Participants:

Rinkesh Bansal - IBM
Jeff Bartell - Individual
Gabriel Becker - KRYPTUS
Andre Bereza - KRYPTUS
Anthony Berglas - Cryptsoft Pty Ltd.
Mathias Bjorkqvist - IBM
Joseph Brand - Semper Fortis Solutions
Alan Brown - Thales e-Security
Andrew Byrne - Dell
Tim Chevalier - NetApp
Kenli Chong - QuintessenceLabs Pty Ltd.
Justin Corlett - Cryptsoft Pty Ltd.
Tony Cox - Cryptsoft Pty Ltd.
James Crossland - Northrop Grumman
Stephen Edwards - Semper Fortis Solutions
Stan Feather - Hewlett Packard Enterprise (HPE)
Indra Fitzgerald - Utimaco IS GmbH
Judith Furlong - Dell
Gary Gardner - Fornetix
Susan Gleeson - Oracle
Steve He - Thales e-Security
Christopher Hillier - Hewlett Packard Enterprise (HPE)
Tim Hudson - Cryptsoft Pty Ltd.
Nitin Jain - SafeNet, Inc.
Gershon Janssen - Individual
Mark Joseph - P6R, Inc
Paul Lechner - KeyNexus Inc
John Leiseboer - QuintessenceLabs Pty Ltd.
Jarrett Lu - Oracle
Jeff MacMillan - KeyNexus Inc
John Major - QuintessenceLabs Pty Ltd.
Cecilia Majorel - Quintessence Labs
Gabriel Mandaji - KRYPTUS
Jon Mentzell - Fornetix
Prashant Mestri - IBM
Kevin Mooney - Fornetix
Ladan Nekuii - Thales e-Security
Jason Novecosky - KeyNexus Inc
Matt O'reilly - Fornetix
Sanjay Panchal - IBM
Mahesh Paradkar - IBM
Steve Pate - Thales e-Security
Greg Pepus - Semper Fortis Solutions
Bruce Rich - Cryptsoft Pty Ltd.
Thad Roemer - Dyadic Security Ltd.
Thad Roemer - Unbound Tech
Greg Scott - Cryptsoft Pty Ltd.
Martin Shannon - QuintessenceLabs Pty Ltd.
Gerald Stueve - Fornetix

Jim Susoy - P6R, Inc
Jason Thatcher - Cryptsoft Pty Ltd.
Peter Tsai - Thales e-Security
Charles White - Fornetix
Steven Wierenga - Utimaco IS GmbH
Kyle Wuolle - KeyNexus Inc

Appendix B. Acronyms

The following abbreviations and acronyms are used in this document:

Item	Description
3DES	Triple Data Encryption Standard specified in ANSI X9.52
AES	Advanced Encryption Standard specified in **[FIPS197]**FIPS 197
ASN.1	Abstract Syntax Notation One specified in ITU-T X.680
BDK	Base Derivation Key specified in ANSI X9 TR-31
CA	Certification Authority
CBC	Cipher Block Chaining
CCM	Counter with CBC-MAC specified in **[SP800-38C]**
CFB	Cipher Feedback specified in **[SP800-38A]**
CMAC	Cipher-based MAC specified in **[SP800-38B]**
CMC	Certificate Management Messages over CMS specified in **[RFC5272]**
CMP	Certificate Management Protocol specified in **[RFC4210]**
CPU	Central Processing Unit
CRL	Certificate Revocation List specified in **[RFC5280]**
CRMF	Certificate Request Message Format specified in **[RFC4211]**
CRT	Chinese Remainder Theorem
CTR	Counter specified in **[SP800-38A]**
CVK	Card Verification Key specified in ANSI X9 TR-31
DEK	Data Encryption Key
DER	Distinguished Encoding Rules specified in ITU-T X.690
DES	Data Encryption Standard specified in FIPS 46-3
DH	Diffie-Hellman specified in ANSI X9.42
DNS	Domain Name Server
DSA	Digital Signature Algorithm specified in FIPS 186-3
DSKPP	Dynamic Symmetric Key Provisioning Protocol
ECB	Electronic Code Book
ECDH	Elliptic Curve Diffie-Hellman specified in **[X9.63][SP800-56A]**
ECDSA	Elliptic Curve Digital Signature Algorithm specified in **[X9.62]**
ECMQV	Elliptic Curve Menezes Qu Vanstone specified in **[X9.63][SP800-56A]**
FFC	Finite Field Cryptography
FIPS	Federal Information Processing Standard
GCM	Galois/Counter Mode specified in **[SP800-38D]**
GF	Galois field (or finite field)
HKDF	HMAC-based Extract-and-Expand Key Derivation Function (HKDF) **[RFC5869]**
HMAC	Keyed-Hash Message Authentication Code specified in **[FIPS198-1][RFC2104]**
HTTP	Hyper Text Transfer Protocol

Item	Description
HTTP(S)	Hyper Text Transfer Protocol (Secure socket)
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IP	Internet Protocol
IPsec	Internet Protocol Security
IV	Initialization Vector
KEK	Key Encryption Key
KMIP	Key Management Interoperability Protocol
MAC	Message Authentication Code
MKAC	EMV/chip card Master Key: Application Cryptograms specified in ANSI X9 TR-31
MKCP	EMV/chip card Master Key: Card Personalization specified in ANSI X9 TR-31
MKDAC	EMV/chip card Master Key: Data Authentication Code specified in ANSI X9 TR-31
MKDN	EMV/chip card Master Key: Dynamic Numbers specified in ANSI X9 TR-31
MKOTH	EMV/chip card Master Key: Other specified in ANSI X9 TR-31
MKSMC	EMV/chip card Master Key: Secure Messaging for Confidentiality specified in X9 TR-31
MKSMI	EMV/chip card Master Key: Secure Messaging for Integrity specified in ANSI X9 TR-31
MD2	Message Digest 2 Algorithm specified in **[RFC1319]**
MD4	Message Digest 4 Algorithm specified in **[RFC1320]**
MD5	Message Digest 5 Algorithm specified in **[RFC1321]**
NIST	National Institute of Standards and Technology
OAEP	Optimal Asymmetric Encryption Padding specified in **[PKCS#1]**
OFB	Output Feedback specified in **[SP800-38A]**
PBKDF2	Password-Based Key Derivation Function 2 specified in **[RFC2898]**
PCBC	Propagating Cipher Block Chaining
PEM	Privacy Enhanced Mail specified in **[RFC1421]**
PGP	OpenPGP specified in **[RFC4880]**
PKCS	Public-Key Cryptography Standards
PKCS#1	RSA Cryptography Specification Version 2.1 specified in **[RFC3447]**
PKCS#5	Password-Based Cryptography Specification Version 2 specified in **[RFC2898]**
PKCS#8	Private-Key Information Syntax Specification Version 1.2 specified in **[RFC5958]**
PKCS#10	Certification Request Syntax Specification Version 1.7 specified in **[RFC2986]**
PKCS#11	Cryptographic Token Interface Standard
PKCS#12	Personal Information Exchange Syntax
POSIX	Portable Operating System Interface
RFC	Request for Comments documents of IETF
RSA	Rivest, Shamir, Adelman (an algorithm)
RNG	Random Number Generator
SCEP	Simple Certificate Enrollment Protocol
SCVP	Server-based Certificate Validation Protocol
SHA	Secure Hash Algorithm specified in FIPS 180-2

Item	Description
SP	Special Publication
SSL/TLS	Secure Sockets Layer/Transport Layer Security
S/MIME	Secure/Multipurpose Internet Mail Extensions
TDEA	see 3DES
TCP	Transport Control Protocol
TTLV	Tag, Type, Length, Value
URI	Uniform Resource Identifier
UTC	Coordinated Universal Time
UTF-8	Universal Transformation Format 8-bit specified in **[RFC3629]**
XKMS	XML Key Management Specification
XML	Extensible Markup Language
XTS	XEX Tweakable Block Cipher with Ciphertext Stealing specified in **[SP800-38E]**
X.509	Public Key Certificate specified in **[RFC5280]**
ZPK	PIN Block Encryption Key specified in ANSI X9 TR-31

Appendix C. List of Figures and Tables

Appendix D. Revision History

Revision	Date	Editor	Changes Made
WD01	December 6, 2017	Tony Cox	Initial Draft incorporating items approved at the February 2017 Face to Face Technical Committee meeting.
WD02	January 9, 2018	Tony Cox	Updated following initial feedback on WD01. See KMIP TC archives and change bar pdf for details. Mainly editorial corrections.
WD03	February 15, 2018	Tony Cox & Chuck White	- Rolled in PQC items - Added and amended enumerations - Corrected Put Operation behavior - Completed addition of Certificate Request as an Object - Updated Mac Verify and Signature Verify for multi-part operations
WD04	October 18, 2018	Tony Cox & Chuck White	- OTP - Key Format Type - Cryptographic Usage Mask - Export - Cryptographic Usage Mask - Other - Hashed Passwords - Login - Delegated Login - Client Provisioning - Multiple ID Placeholders - Add Attribute - Current Attribute - Set Attribute - AdjustAttribute - Full Async - AWS Signature - Flow Control - Default Crypto Params - Re-Encrypt
WD05	November 01, 2018	Tony Cox & Chuck White	- Result Reasons
WD06	November 08, 2018	Tony Cox & Chuck White	- Storage Protection Mask - PKCS#11 Encapsulation - HKDF
WD07	November 18, 2018	Tony Cox & Chuck White	- Amended Process Start Date and Protect Stop Date - Client Reprovisioning - Multiple changes Result Reason enums & content - Range of editorial changes - Added Certificate Attributes
WD07r2	December 20, 2018	Tony Cox & Chuck White	- Minor corrections

WD08	December 21, 2018	Tony Cox & Chuck White	- Minor corrections
CSD01	December 21, 2018	Tony Cox & Chuck White	-Publication of CSD
WD09	9 April 2019	Tony Cox & Chuck White	--Editorial cleanup - Added missing Protection Storage Mask proposal content