



Key Management Interoperability Protocol Usage Guide Version 1.0

Committee Draft 10

26 May 2010

Specification URIs:

This Version:

<http://docs.oasis-open.org/kmip/ug/v1.0/cd10/kmip-ug-1.0-cd-10.html>
<http://docs.oasis-open.org/kmip/ug/v1.0/cd10/kmip-ug-1.0-cd-10.doc> (Authoritative)
<http://docs.oasis-open.org/kmip/ug/v1.0/cd10/kmip-ug-1.0-cd-10.pdf>

Previous Version:

<http://docs.oasis-open.org/kmip/ug/v1.0/cd09/kmip-ug-1.0-cd-09.html>
<http://docs.oasis-open.org/kmip/ug/v1.0/cd09/kmip-ug-1.0-cd-09.doc>
<http://docs.oasis-open.org/kmip/ug/v1.0/cd09/kmip-ug-1.0-cd-09.pdf>

Latest Version:

<http://docs.oasis-open.org/kmip/ug/v1.0/kmip-ug-1.0.html>
<http://docs.oasis-open.org/kmip/ug/v1.0/kmip-ug-1.0.doc>
<http://docs.oasis-open.org/kmip/ug/v1.0/kmip-ug-1.0.pdf>

Technical Committee:

OASIS Key Management Interoperability Protocol (KMIP) TC

Chair(s):

Robert Griffin, EMC Corporation <robert.griffin@rsa.com>
Subhash Sankuratripati, NetApp <Subhash.Sankuratripati@netapp.com>

Editor(s):

Indra Fitzgerald, HP <indra.fitzgerald@hp.com>

Related work:

This specification replaces or supersedes:

- None

This specification is related to:

- [Key Management Interoperability Protocol Specification Version 1.0](#)
- [Key Management Interoperability Protocol Profiles Version 1.0](#)
- [Key Management Interoperability Protocol Use Cases Version 1.0](#)

Declared XML Namespace(s):

None

Abstract:

This document is intended to complement the Key Management Interoperability Protocol Specification by providing guidance on how to implement the Key Management Interoperability Protocol (KMIP) most effectively to ensure interoperability.

Status:

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

Technical Committee members should send comments on this specification to the Technical Committee's email list. Others should send comments to the Technical Committee by using the "Send A Comment" button on the Technical Committee's web page at <http://www.oasis-open.org/committees/kmip/>.

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 Technical Committee web page (<http://www.oasis-open.org/committees/kmip/ipr.php>.)

The non-normative errata page for this specification is located at <http://www.oasis-open.org/committees/kmip/>.

Notices

Copyright © OASIS® 2010. All Rights Reserved.

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 names "OASIS", "KMIP" are trademarks 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 <http://www.oasis-open.org/who/trademark.php> for above guidance.

Table of Contents

1	Introduction	6
1.1	Terminology	6
1.2	Normative References	6
1.3	Non-normative References	9
2	Assumptions	10
2.1	Island of Trust	10
2.2	Message Security	10
2.3	State-less Server	10
2.4	Extensible Protocol	10
2.5	Server Policy	10
2.6	Support for Cryptographic Objects	10
2.7	Client-Server Message-based Model	11
2.8	Synchronous and Asynchronous Messages	11
2.9	Support for “Intelligent Clients” and “Key Using Devices“	11
2.10	Batched Requests and Responses	11
2.11	Reliable Message Delivery	11
2.12	Large Responses	11
2.13	Key Life-cycle and Key State	11
3	Usage Guidelines	12
3.1	Authentication	12
3.1.1	Credential	12
3.2	Authorization for Revoke, Recover, Destroy and Archive Operations	13
3.3	Using Notify and Put Operations	13
3.4	Usage Allocation	13
3.5	Key State and Times	14
3.6	Template	15
3.6.1	Template Usage Examples	16
3.7	Archive Operations	17
3.8	Message Extensions	17
3.9	Unique Identifiers	17
3.10	Result Message Text	17
3.11	Query	17
3.12	Canceling Asynchronous Operations	17
3.13	Multi-instance Hash	17
3.14	Returning Related Objects	18
3.15	Reducing Multiple Requests through the Use of Batch	18
3.16	Maximum Message Size	18
3.17	Using Offset in Re-key and Re-certify Operations	18
3.18	Locate Queries	18
3.19	ID Placeholder	20
3.20	Key Block	20
3.21	Using Wrapped Keys with KMIP	21

3.21.1	Encrypt-only Example with a Symmetric Key as an Encryption Key for a Get Request and Response	22
3.21.2	Encrypt-only Example with a Symmetric Key as an Encryption Key for a Register Request and Response.....	22
3.21.3	Encrypt-only Example with an Asymmetric Key as an Encryption Key for a Get Request and Response	23
3.21.4	MAC-only Example with an HMAC Key as an Authentication Key for a Get Request and Response 23	
3.21.5	Registering a Wrapped Key as an Opaque Cryptographic Object	24
3.22	Object Group	24
3.23	Certify and Re-certify	24
3.24	Specifying Attributes during a Create Key Pair Operation	25
3.24.1	Example of Specifying Attributes during the Create Key Pair Operation	25
3.25	Registering a Key Pair	26
3.26	Non-Cryptographic Objects	27
3.27	Asymmetric Concepts with Symmetric Keys	27
3.28	Application Specific Information.....	28
3.29	Mutating Attributes.....	29
3.30	Interoperable Key Naming for Tape.....	30
3.30.1	Native Tape Encryption by a KMIP Client	30
3.31	Revocation Reason Codes	34
3.32	Certificate Renewal, Update, and Re-key.....	34
3.33	Key Encoding	34
3.33.1	AES Key Encoding.....	34
3.33.2	Triple-DES Key Encoding	35
3.34	Using the Same Asymmetric Key Pair in Multiple Algorithms	35
4	Deferred KMIP Functionality	36
5	Implementation Conformance	38
A.	Acronyms	39
B.	Acknowledgements	41
C.	Revision History	43

Tables

Table 1:	ID Placeholder Prior to and Resulting from a KMIP Operation	20
Table 2:	Cryptographic Usage Masks Pairs.....	28

1 Introduction

This Key Management Interoperability Protocol Usage Guide is intended to complement the Key Management Interoperability Protocol Specification **[KMIP-Spec]** by providing guidance on how to implement the Key Management Interoperability Protocol (KMIP) most effectively to ensure interoperability. In particular, it includes the following guidance:

- Clarification of assumptions and requirements that drive or influence the design of KMIP and the implementation of KMIP-compliant key management.
- Specific recommendations for implementation of particular KMIP functionality.
- Clarification of mandatory and optional capabilities for conformant implementations.
- Functionality considered for inclusion in KMIP V1.0, but deferred to subsequent versions of the standard.

A selected set of conformance profiles and authentication suites are defined in the KMIP Profiles specification **[KMIP-Prof]**.

Further assistance for implementing KMIP is provided by the KMIP Use Cases for Proof of Concept Testing document **[KMIP-UC]** that describes a set of recommended test cases and provides the TTLV (Tag/Type/Length/Value) format for the message exchanges defined by those use cases.

1.1 Terminology

For a list of terminologies refer to **[KMIP-Spec]**.

1.2 Normative References

- [FIPS186-3]** *Digital Signature Standard (DSS)*, FIPS PUB 186-3, June 2009, http://csrc.nist.gov/publications/fips/fips186-3/fips_186-3.pdf
- [FIPS197]** *Advanced Encryption Standard (AES)*, FIPS PUB 197, November 26, 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
- [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, 1991.
- [ISO9797-1]** ISO/IEC, *Information technology -- Security techniques -- Message Authentication Codes (MACs) -- Part 1: Mechanisms using a block cipher*, ISO/IEC 9797-1, 1999.
- [KMIP-Spec]** OASIS Committee Draft 12, *Key Management Interoperability Protocol Specification Version 1.0*, May 2010. <http://docs.oasis-open.org/kmip/spec/v1.0/cd12/kmip-spec-1.0-cd-12.doc>
- [KMIP-Prof]** OASIS Committee Draft 06, *Key Management Interoperability Protocol Profiles Version 1.0*, May 2010. <http://docs.oasis-open.org/kmip/profiles/v1.0/cd06/kmip-profiles-1.0-cd-06.doc>
- [PKCS#1]** RSA Laboratories, *PKCS #1 v2.1: RSA Cryptography Standard*, June 14, 2002, <http://www.rsa.com/rsalabs/node.asp?id=2125>
- [PKCS#5]** RSA Laboratories, *PKCS #5 v2.1: Password-Based Cryptography Standard*, October 5, 2006, <http://www.rsa.com/rsalabs/node.asp?id=2127>
- [PKCS#7]** RSA Laboratories, *PKCS#7 v1.5: Cryptographic Message Syntax Standard*. November 1, 1993, <http://www.rsa.com/rsalabs/node.asp?id=2129>

- 45 [PKCS#8] RSA Laboratories, PKCS#8 v1.2: Private-Key Information Syntax Standard,
46 November 1, 1993, <http://www.rsa.com/rsalabs/node.asp?id=2130>
- 47 [PKCS#10] RSA Laboratories, PKCS #10 v1.7: Certification Request Syntax Standard, May
48 26, 2000, <http://www.rsa.com/rsalabs/node.asp?id=2132>
- 49 [RFC1319] B. Kaliski, *The MD2 Message-Digest Algorithm*, IETF RFC 1319, Apr 1992,
50 <http://www.ietf.org/rfc/rfc1319.txt>
- 51 [RFC1320] R. Rivest, *The MD4 Message-Digest Algorithm*, IETF RFC 1320, Apr 1992,
52 <http://www.ietf.org/rfc/rfc1320.txt>
- 53 [RFC1321] R. Rivest, *The MD5 Message-Digest Algorithm*, IETF RFC 1321, Apr 1992,
54 <http://www.ietf.org/rfc/rfc1321.txt>
- 55 [RFC1421] J. Linn, *Privacy Enhancement for Internet Electronic Mail: Part I: Message*
56 *Encryption and Authentication Procedures*, IETF RFC 1421, Feb 1993,
57 <http://www.ietf.org/rfc/rfc1421.txt>
- 58 [RFC1424] B. Kaliski, *Privacy Enhancement for Internet Electronic Mail: Part IV: Key*
59 *Certification and Related Services*, IETF RFC 1424, February 1993,
60 <http://www.ietf.org/rfc/rfc1424.txt>
- 61 [RFC2104] H. Krawczyk, M. Bellare, R. Canetti, *HMAC: Keyed-Hashing for Message*
62 *Authentication*, IETF RFC 2104, Feb 1997, <http://www.ietf.org/rfc/rfc2104.txt>
- 63 [RFC2119] S. Bradner, *Key words for use in RFCs to Indicate Requirement Levels*,
64 <http://www.ietf.org/rfc/rfc2119.txt>, IETF RFC 2119, March 1997.
- 65 [RFC2898] B. Kaliski, *PKCS #5: Password-Based Cryptography Specification Version 2.0*,
66 IETF RFC 2898, Sep 2000, <http://www.ietf.org/rfc/rfc2898.txt>
- 67 [RFC3394] J. Schaad, R. Housley, *Advanced Encryption Standard (AES) Key Wrap*
68 *Algorithm*, IETF RFC 3394, Sep 2002, <http://www.ietf.org/rfc/rfc3394.txt>
- 69 [RFC3447] J. Jonsson, B. Kaliski, *Public-Key Cryptography Standards (PKCS) #1: RSA*
70 *Cryptography Specifications Version 2.1*, IETF RFC 3447 Feb 2003,
71 <http://www.ietf.org/rfc/rfc3447.txt>
- 72 [RFC3629] F. Yergeau, *UTF-8, a transformation format of ISO 10646*, IETF RFC 3629, Nov
73 2003, <http://www.ietf.org/rfc/rfc3629.txt>
- 74 [RFC3647] S. Chokhani, W. Ford, R. Sabett, C. Merrill, and S. Wu, *RFC3647: Internet*
75 *X.509 Public Key Infrastructure Certificate Policy and Certification Practices*
76 *Framework*, November 2003, <http://www.ietf.org/rfc/rfc3647.txt>
- 77 [RFC4210] C. Adams, S. Farrell, T. Kause and T. Mononen, *RFC2510: Internet X.509*
78 *Public Key Infrastructure Certificate Management Protocol (CMP)*, September
79 2005, <http://www.ietf.org/rfc/rfc4210.txt>
- 80 [RFC4211] J. Schaad, *RFC 4211: Internet X.509 Public Key Infrastructure Certificate*
81 *Request Message Format (CRMF)*, September 2005,
82 <http://www.ietf.org/rfc/rfc4211.txt>
- 83 [RFC4868] S. Kelly, S. Frankel, *Using HMAC-SHA-256, HMAC-SHA-384, and HMAC-SHA-*
84 *512 with IPsec*, IETF RFC 4868, May 2007, <http://www.ietf.org/rfc/rfc4868.txt>
- 85 [RFC4880] J. Callas, L. Donnerhackle, H. Finney, D. Shaw, and R. Thayer, *OpenPGP*
86 *Message Format*, IETF RFC 4880, Nov 2007, <http://www.ietf.org/rfc/rfc4880.txt>
- 87 [RFC4949] R. Shirey, *RFC4949: Internet Security Glossary, Version 2*, August 2007,
88 <http://www.ietf.org/rfc/rfc4949.txt>
- 89 [RFC5272] J. Schaad and M. Meyers, *RFC5272: Certificate Management over CMS (CMC)*,
90 June 2008, <http://www.ietf.org/rfc/rfc5272.txt>
- 91 [RFC5280] D. Cooper, S. Santesson, S. Farrell, S. Boeyen, R. Housley and W. Polk, *RFC*
92 *5280: Internet X.509 Public Key Infrastructure Certificate and Certificate*
93 *Revocation List (CRL) Profile*, May 2008, <http://www.ietf.org/rfc/rfc5280.txt>
- 94 [RFC5649] R. Housley, *Advanced Encryption Standard (AES) Key Wrap with Padding*
95 *Algorithm*, IETF RFC 5649, Aug 2009, <http://www.ietf.org/rfc/rfc5649.txt>

96 [SP800-38A] M. Dworkin, *Recommendation for Block Cipher Modes of Operation – Methods*
97 *and Techniques*, NIST Special Publication 800-38A, Dec 2001,
98 <http://csrc.nist.gov/publications/nistpubs/800-38a/sp800-38a.pdf>

99 [SP800-38B] M. Dworkin, *Recommendation for Block Cipher Modes of Operation: The CMAC*
100 *Mode for Authentication*, NIST Special Publication 800-38B, May 2005,
101 http://csrc.nist.gov/publications/nistpubs/800-38B/SP_800-38B.pdf

102 [SP800-38C] M. Dworkin, *Recommendation for Block Cipher Modes of Operation: the CCM*
103 *Mode for Authentication and Confidentiality*, NIST Special Publication 800-38C,
104 May 2004, http://csrc.nist.gov/publications/nistpubs/800-38C/SP800-38C_updated-July20_2007.pdf

105 [SP800-38D] M. Dworkin, *Recommendation for Block Cipher Modes of Operation:*
106 *Galois/Counter Mode (GCM) and GMAC*, NIST Special Publication 800-38D, Nov
107 2007, <http://csrc.nist.gov/publications/nistpubs/800-38D/SP-800-38D.pdf>

108 [SP800-38E] M. Dworkin, *Recommendation for Block Cipher Modes of Operation: The XTS-*
109 *AES Mode for Confidentiality on Block-Oriented Storage Devices*, NIST Special
110 Publication 800-38E, Jan 2010, <http://csrc.nist.gov/publications/nistpubs/800-38E/nist-sp-800-38E.pdf>

111 [SP800-56A] E. Barker, D. Johnson, and M. Smid, *Recommendation for Pair-Wise Key*
112 *Establishment Schemes Using Discrete Logarithm Cryptography (Revised)*, NIST
113 Special Publication 800-56A, March 2007,
114 http://csrc.nist.gov/publications/nistpubs/800-56A/SP800-56A_Revision1_Mar08-2007.pdf

115 [SP800-56B] E. Barker, L. Chen, A. Regenscheid, M. Smid, *Recommendation for Pair-Wise*
116 *Key Establishment Schemes Using Integer Factorization Cryptography*, NIST
117 Special Publication 800-56B, August 2009,
118 <http://csrc.nist.gov/publications/nistpubs/800-56B/sp800-56B.pdf>

119 [SP800-57-1] E. Barker, W. Barker, W. Burr, W. Polk, and M. Smid, *Recommendations for Key*
120 *Management - Part 1: General (Revised)*, NIST Special Publication 800-57 part
121 1, March 2007, http://csrc.nist.gov/publications/nistpubs/800-57/sp800-57-Part1-revised2_Mar08-2007.pdf

122 [SP800-67] W. Barker, *Recommendation for the Triple Data Encryption Algorithm (TDEA)*
123 *Block Cipher*, NIST Special Publication 800-67, Version 1.1, Revised 19 May
124 2008, <http://csrc.nist.gov/publications/nistpubs/800-67/SP800-67.pdf>

125 [SP800-108] L. Chen, *Recommendation for Key Derivation Using Pseudorandom Functions*
126 *(Revised)*, NIST Special Publication 800-108, October 2009,
127 <http://csrc.nist.gov/publications/nistpubs/800-108/sp800-108.pdf>

128 [X.509] International Telecommunication Union (ITU)–T, X.509: Information technology
129 – Open systems interconnection – The Directory: Public-key and attribute
130 certificate frameworks, August 2005, <http://www.itu.int/rec/T-REC-X.509-200508-l/en>

131 [X9.24-1] ANSI, *X9.24: Retail Financial Services Symmetric Key Management - Part 1:*
132 *Using Symmetric Techniques*, 2004.

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

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

137 [X9-57] ANSI, *X9-57: Public Key Cryptography for the Financial Services Industry:*
138 *Certificate Management*, 1997.

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

141 [X9-63] ANSI, *X9-63: Public Key Cryptography for the Financial Services Industry, Key*
142 *Agreement and Key Transport Using Elliptic Curve Cryptography*, 2001.

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

150 **[X9 TR-31]** ANSI, *X9 TR-31: Interoperable Secure Key Exchange Key Block Specification for*
151 *Symmetric Algorithms*, 2005.

152 **1.3 Non-normative References**

153 **[KMIP-UC]** OASIS Committee Draft 11, *Key Management Interoperability Protocol Use*
154 *Cases Version 1.0*, May 2010. [http://docs.oasis-](http://docs.oasis-open.org/kmip/usecases/v1.0/cd11/kmip-usecases-1.0-cd-11.doc)
155 [open.org/kmip/usecases/v1.0/cd11/kmip-usecases-1.0-cd-11.doc](http://docs.oasis-open.org/kmip/usecases/v1.0/cd11/kmip-usecases-1.0-cd-11.doc)

156 2 Assumptions

157 The section describes assumptions that underlie the KMIP protocol and the implementation of clients and
158 servers that utilize the protocol.

159 2.1 Island of Trust

160 Clients may be provided key material by the server, but they only use that keying material for the
161 purposes explicitly listed in the delivery payload. Clients that ignore these instructions and use the keys in
162 ways not explicitly allowed by the server are non-compliant. There is no requirement for the key
163 management system, however, to enforce this behavior.

164 2.2 Message Security

165 KMIP relies on the chosen authentication suite as specified in **[KMIP-Prof]** to authenticate the client and
166 on the underlying transport protocol to provide confidentiality, integrity, message authentication and
167 protection against replay attack. KMIP offers a wrapping mechanism for the Key Value that does not rely
168 on the transport mechanism used for the messages; the wrapping mechanism is intended for importing or
169 exporting managed cryptographic objects.

170 2.3 State-less Server

171 The protocol operates on the assumption that the server is state-less, which means that there is no
172 concept of “sessions” inherent in the protocol. State-less server operation is much more reliable and
173 easier to implement than stateful operation, and is consistent with possible implementation scenarios,
174 such as web-services-based servers. This does not mean that the server itself maintains no state, only
175 that the protocol does not require this.

176 2.4 Extensible Protocol

177 The protocol provides for “private” or vendor-specific extensions, which allow for differentiation among
178 vendor implementations. However, any objects, attributes and operations included in an implementation
179 are always implemented as specified in **[KMIP-Spec]**, regardless of whether they are optional or
180 mandatory.

181 2.5 Server Policy

182 A server is required to be conformant to KMIP and support the conformance clauses as specified in
183 **[KMIP-Spec]**. However, a server may refuse a server-supported operation or client-settable attribute if
184 disallowed by the server policy.

185 2.6 Support for Cryptographic Objects

186 The protocol supports all reasonable key management system-related cryptographic objects. This list
187 currently includes:

- 188 • Symmetric Keys
- 189 • Split (multi-part) Keys
- 190 • Asymmetric Key Pairs and their components
- 191 • Digital Certificates
- 192 • Derived Keys
- 193 • Secret Data
- 194 • Opaque (non-interpretable) cryptographic objects

195 **2.7 Client-Server Message-based Model**

196 The protocol operates primarily in a client-server, message-based model. This means that most protocol
197 exchanges are initiated by a client sending a request message to a server, which then sends a response
198 to the client. The protocol also provides optional mechanisms to allow for unsolicited notification of events
199 to clients using the Notify operation, and unsolicited delivery of cryptographic objects to clients using the
200 Put operation; that is, the protocol allows a “push” model, whereby the server initiates the protocol
201 exchange with either a Notify or Put operation. These Notify or Put features are optionally supported by
202 servers and clients. Clients may register in order to receive such events/notifications. Registration is
203 implementation-specific and not described in the specification.

204 **2.8 Synchronous and Asynchronous Messages**

205 The protocol allows two modes of operation. Synchronous (mandatory) operations are those in which a
206 client sends a request and waits for a response from the server. Polled Asynchronous operations
207 (optional) are those in which the client sends a request, the server responds with a “pending” status, and
208 the client polls the server for the completed response and completion status. Server implementations may
209 choose not to support the Polled Asynchronous feature of the protocol.

210 **2.9 Support for “Intelligent Clients” and “Key Using Devices”**

211 The protocol supports intelligent clients, such as end-user workstations, which are capable of requesting
212 all of the functions of KMIP. It also allows subsets of the protocol and possible alternate message
213 representations in order to support less-capable devices, which only need a subset of the features of
214 KMIP.

215 **2.10 Batched Requests and Responses**

216 The protocol contains a mechanism for sending batched requests and receiving the corresponding
217 batched responses, to allow for higher throughput on operations that deal with a large number of entities,
218 e. g., requesting dozens or hundreds of keys from a server at one time, and performing operations in a
219 group. An option is provided to indicate whether to continue processing requests after an earlier request
220 in the batch fails or to stop processing the remaining requests in the batch. Note that there is no option to
221 treat an entire batch as atomic, that is, if a request in the batch fails, then preceding requests in the batch
222 are not undone or rolled back (see Section 3.15). A special ID Placeholder (see Section 3.19) is provided
223 in KMIP to allow related requests in a batch to be pipelined.

224 **2.11 Reliable Message Delivery**

225 The reliable message delivery function is relegated to the transport protocol, and is not part of the key
226 management protocol itself.

227 **2.12 Large Responses**

228 For requests that could result in large responses, a mechanism in the protocol allows a client to specify in
229 a request the maximum allowed size of a response. The server indicates in a response to such a request
230 that the response would have been too large and, therefore, is not returned.

231 **2.13 Key Life-cycle and Key State**

232 **[KMIP-Spec]** describes the key life-cycle model, based on the NIST SP 800-57 key state definitions
233 **[SP800-57-1]**, supported by the KMIP protocol. Particular implications of the key life-cycle model in terms
234 of defining time-related attributes of objects are discussed in Section 3.5 below.

235

236

3 Usage Guidelines

237
238

This section provides guidance on using the functionality described in the Key Management Interoperability Protocol Specification.

239

3.1 Authentication

240
241
242
243
244

As discussed in **[KMIP-Spec]**, a conforming KMIP implementation establishes and maintains channel confidentiality and integrity, and provides assurance of server authenticity for KMIP messaging. Client authentication is performed according to the chosen KMIP authentication suite as specified in **[KMIP-Prof]**. Other mechanisms for client and server authentication are possible and optional for KMIP implementations.

245
246
247
248
249
250
251
252
253
254
255
256
257
258
259

KMIP implementations that support the KMIP-defined Credential Types or use other vendor-specific mechanisms for authentication may use the optional Authentication field specified inside the Request Header to include additional identification information. Depending on the server's configuration, the server may interpret the identity of the requestor from the Credential object, contained in the Authentication structure if it is not provided during the channel-level authentication. For example, in addition to performing mutual authentication during a TLS handshake, the client passes the Credential object (e.g., a username and password) in the request. If the requestor's username is not specified inside the client certificate and is instead specified in the Credential object, the server interprets the identity of the requestor from the Credential object. This supports use cases where channel-level authentication authenticates a machine or service that is used by multiple users of the KMIP server. If the client provides the username of the requestor in both the client certificate and the Credential object, the server verifies that the usernames are the same. If they differ, the authentication fails and the server returns an error. If no Credential object is included in the request, the username of the requestor is expected to be provided inside the certificate. If no username is provided in the client certificate and no Credential object is included in the request message, the server is expected to refuse authentication and return an error.

260
261
262

If authentication is unsuccessful, and it is possible to return an "authentication not successful" error, this error should be returned in preference to any other result status. This prevents status code probing by a client that is not able to authenticate.

263
264
265

Server decisions regarding which operations to reject if there is insufficiently strong authentication of the client are not specified in the protocol. However, see Section 3.2 for operations for which authentication and authorization are particularly important.

266

3.1.1 Credential

267
268
269
270
271
272
273

[KMIP-Spec] defines the Username and Password structure for the Credential Type Username and Password. The structure consists of two fields: Username and Password. Password is a recommended, but optional, field, which may be excluded only if the client is authenticated using one of the authentication suites defined in **[KMIP-Prof]**. For example, if the client performs client certificate authentication during the TLS handshake, and the Authentication field is provided in the Message Request, the Password field is an optional field in the Username and Password structure of the Credential object.

274

275
276
277
278
279
280

The Credential object is used to provide additional identification information. As described above, for certain use cases, channel-level authentication may only authenticate a machine or service that is used by multiple clients of the KMIP server. The Credential object may be used in this scenario to identify individual clients by specifying the username in the Username and Password structure. Depending on the client's environment, the username may be the device's serial number, the volume name or some other unique identifier.

281
282
283

Multiple clients should not be authenticated using the same channel-level authentication credential (e.g., the same client certificate). The Credential object may be used to authenticate individual clients by requiring the Username and Password to be provided in the Credential object.

284 3.2 Authorization for Revoke, Recover, Destroy and Archive 285 Operations

286 Neither authentication nor authorization is handled by the KMIP protocol directly. In particular, the
287 Credential attribute is not guaranteed to be an authenticated identity of the requesting client. However,
288 the authentication suite, as specified in [KMIP-Prof], describes how the client identity is established for
289 KMIP-compliant implementations. This authentication is performed for all KMIP operations, with the single
290 exception of the Query operation.

291 Certain operations that may be requested by a client via KMIP, particularly Revoke, Recover, Destroy and
292 Archive, may have a significant impact on the availability of a key, on server performance and on key
293 security. When a server receives a request for one of these operations, it should ensure that the client
294 has authenticated its identity (see the Authentication Suites section in [KMIP-Prof]). The server should
295 also ensure that the client requesting the operation is an object creator, security officer or other identity
296 authorized to issue the request. It may also require additional authentication to ensure that the object
297 owner or a security officer has issued that request. Even with such authentication and authorization,
298 requests for these operations should be considered only a “hint” to the key management system, which
299 may or may not choose to act upon this request.

300 3.3 Using Notify and Put Operations

301 The Notify and Put operations are the only operations in the KMIP protocol that are initiated by the server,
302 rather than the client. As client-initiated requests are able to perform these functions (e.g., by polling to
303 request notification), these operations are optional for conforming KMIP implementations. However, they
304 provide a mechanism for optimized communication between KMIP servers and clients and have,
305 therefore, been included in [KMIP-Spec].

306 In using Notify and Put, the following constraints and guidelines should be observed:

- 307 • The client registers with the server, so that the server knows how to locate the client to which a
308 Notify or Put is being sent and which events for the Notify are supported. However, such
309 registration is outside the scope of the KMIP protocol. Registration also includes a specification of
310 whether a given client supports Put and Notify, and what attributes may be included in a Put for a
311 particular client.
- 312 • Communication between the client and the server is properly authenticated to forestall man-in-
313 the-middle attacks in which the client receives Notify or Put operations from an unauthenticated
314 server. Authentication for a particular client/server implementation is at a minimum accomplished
315 using one of the mandatory authentication mechanisms (see [KMIP-Prof]). Further strengthening
316 of the client/server communications integrity by means of signed message content and/or
317 wrapped keys is recommended. Attribute values other than “Last Change Date” should not be
318 included in a Notify to minimize risk of exposure of attribute information.
- 319 • In order to minimize possible divergence of key or state information between client and server as
320 a result of server-initiated communication, any client receiving Notify or Put messages returns
321 acknowledgements of these messages to the server. This acknowledgement may be at
322 communication layers below the KMIP layer, such as by using transport-level acknowledgement
323 provided in TCP/IP.
- 324 • For client devices that are incapable of responding to messages from the server, communication
325 with the server happens via a proxy entity that communicates with the server, using KMIP, on
326 behalf of the client. It is possible to secure communication between a proxy entity and the client
327 using other, potentially proprietary mechanisms.

328 3.4 Usage Allocation

329 Usage should be allocated and handled carefully at the client, since power outages or other types of
330 client failures (crashes) may render allocated usage lost. For example, in the case of a key being used for
331 the encryption of tapes, such a loss of the usage allocation information following a client failure during
332 encryption may result in the necessity for the entire tape backup session to be re-encrypted using a

333 different key, if the server is not able to allocate more usage. It is possible to address this through such
334 approaches as caching usage allocation information on stable storage at the client, and/or having
335 conservative allocation policies at the server (e.g., by keeping the maximum possible usage allocation per
336 client request moderate). In general, usage allocations should be as small as possible; it is preferable to
337 use multiple smaller allocation requests rather than a single larger request to minimize the likelihood of
338 unused allocation.

339 3.5 Key State and Times

340 **[KMIP-Spec]** provides a number of time-related attributes, including the following:

- 341 • Initial Date: The date and time when the managed cryptographic object was first created by or
342 registered at the server
- 343 • Activation Date: The date and time when the managed cryptographic object may begin to be used
344 for applying cryptographic protection to data
- 345 • Process Start Date: The date and time when a managed symmetric key object may begin to be
346 used for processing cryptographically protected data
- 347 • Protect Stop Date: The date and time when a managed symmetric key object may no longer be
348 used for applying cryptographic protection to data
- 349 • Deactivation Date: The date and time when the managed cryptographic object may no longer be
350 used for any purpose, except for decryption, signature verification, or unwrapping, but only under
351 extraordinary circumstances and when special permission is granted
- 352 • Destroy Date: The date and time when the managed cryptographic object was destroyed
- 353 • Compromise Occurrence Date: The date and time when the managed cryptographic object was
354 first believed to be compromised
- 355 • Compromise Date: The date and time when the managed cryptographic object is entered into the
356 compromised state
- 357 • Archive Date: The date and time when the managed object was placed in Off-Line storage

358 These attributes apply to all cryptographic objects (symmetric keys, asymmetric keys, etc) with exceptions
359 as noted in **[KMIP-Spec]**. However, certain of these attributes (such as the Initial Date) are not specified
360 by the client and are implicitly set by the server.

361 In using these attributes, the following guidelines should be observed:

- 362 • As discussed for each of these attributes in Section 3 of **[KMIP-Spec]**, a number of these times
363 are set once and it is not possible for the client or server to modify them. However, several of the
364 time attributes (particularly the Activation Date, Protect Start Date, Process Stop Date and
365 Deactivation Date) may be set by the server and/or requested by the client. Coordination of time-
366 related attributes between client and server, therefore, is primarily the responsibility of the server,
367 as it manages the cryptographic object and its state. However, special conditions related to time-
368 related attributes, governing when the server accepts client modifications to time-related
369 attributes, may be negotiated by policy exchange between the client and server, outside the Key
370 Management Interoperability Protocol.

371
372 In general, state transitions occur as a result of operational requests, such as Create, Create Key
373 Pair, Register, Activate, Revoke, and Destroy. However, clients may need to specify times in the
374 future for such things as Activation Date, Deactivation Date, Process Start Date, and Protect Stop
375 Date.

376
377 KMIP allows clients to specify times in the past for such attributes as Activation Date and
378 Deactivation Date. This is intended primarily for clients that were disconnected from the server at
379 the time that the client performed that operation on a given key.

- 380 • It is valid to have a projected Deactivation Date when there is no Activation Date. This means,
381 however, that the key is not yet active, even though its projected Deactivation Date has been
382 specified. A valid Deactivation Date is greater than or equal to the Activation Date.

- 383 • The Protect Stop Date may be equal to, but may not be later than the Deactivation Date.
384 Similarly, the Process Start Date may be equal to, but may not precede, the Activation Date.
385 KMIP implementations should consider specifying both these attributes, particularly for symmetric
386 keys, as a key may be needed for processing protected data (e.g., decryption) long after it is no
387 longer appropriate to use it for applying cryptographic protection to data (e.g., encryption).
- 388 • KMIP does not allow an Active object to be destroyed with the Destroy operation. The server is
389 required to return an error, if the client invokes the Destroy operation on an Active object. To
390 destroy an Active object, clients are required to first call the Revoke operation or explicitly set the
391 Deactivation Date of the object. Once the object is in Deactivated state, clients may destroy the
392 object by calling the Destroy operation. These operations may be performed in a batch. If other
393 time-related attributes (e.g., Protect Stop Date) are set to a future date, the server should set
394 these to the Deactivation Date.
- 395 • After a cryptographic object is destroyed, a key management server may retain certain
396 information about the object, such as the Unique Identifier.
- 397 KMIP allows the specification of attributes on a per-client basis, such that a server could maintain or
398 present different sets of attributes for different clients. This flexibility may be necessary in some cases,
399 such as when a server maintains the availability of a given key for some clients, even after that same key
400 is moved to an inactive state (e.g., Deactivated state) for other clients. However, such an approach might
401 result in significant inconsistencies regarding the object state from the point of view of all participating
402 clients and should, therefore, be avoided. A server should maintain a consistent state for each object,
403 across all clients that have or are able to request that object.

404 3.6 Template

405 The usage of templates is an alternative approach for setting attributes in an operation request. Instead of
406 individually specifying each attribute, a template may be used to set any of the following attributes for a
407 managed object:

- 408 • Cryptographic Algorithm
- 409 • Cryptographic Length
- 410 • Cryptographic Domain Parameters
- 411 • Cryptographic Parameters
- 412 • Operation Policy Name
- 413 • Cryptographic Usage Mask
- 414 • Usage Limits
- 415 • Activation Date
- 416 • Process Start Date
- 417 • Protect Stop Date
- 418 • Deactivation Date
- 419 • Object Group
- 420 • Application Specific Information
- 421 • Contact Information
- 422 • Custom Attribute

423 In addition to these attributes, the template has attributes that are applicable to the template itself. These
424 include the attributes (Unique Identifier, Initial Date, Last Change Date, and Archive Date) set implicitly
425 after successfully completing a certain operation and attributes set by the client (Object Type and Name)
426 in the Register request. When registering a template, the Name attribute for the template should be set. It
427 is used to specify and identify the template in the Template-Attribute structure when attributes for a
428 managed object are set.

429

430 The Template-Attribute structure allows for multiple template names and individual attributes to be
431 specified in an operation request. The structure is used in the Create, Create Key Pair, Register, Re-key,
432 Derive Key, Certify, and Re-certify operations. All of these operations with the exception of the Create
433 Key Pair operation use the Template-Attribute tag. The Create Key Pair operation uses the Common
434 Template-Attribute, Private Key Template Attribute, and Public Key Template-Attribute tags.

435

436 Templates may be the subject of the Register, Locate, Get, Get Attributes, Get Attribute List, Add
437 Attribute, Modify Attribute, Delete Attribute, Delete Attribute, and Destroy operations. Clients are not able
438 to create a template with the Create operation; instead templates are created using the Register
439 operation. When the template is the subject of the operation, the Unique ID is used to identify the
440 template. The template name is only used to identify the template inside a Template-Attribute structure.

441 **3.6.1 Template Usage Examples**

442 The purpose of these examples is to illustrate how templates are used. The first example shows how a
443 template is registered. The second example shows how the newly registered template is used to create a
444 symmetric key.

445 **3.6.1.1 Example of Registering a Template**

446 In this example, a client registers a template by encapsulating attributes for creating a 256-bit AES key
447 with the Cryptographic Usage Mask set to Encrypt and Decrypt.

448

449 The following is specified inside the Register Request Payload:

- 450 • Object Type: Template
- 451 • Template-Attribute:
 - 452 – Name: Template1
 - 453 – Cryptographic Algorithm: AES
 - 454 – Cryptographic Length: 256
 - 455 – Cryptographic Usage Mask: Encrypt and Decrypt
 - 456 – Operation Policy Name: OperationPolicy1

457 The Operation Policy OperationPolicy1 applies to the AES key being created using the template. It is not
458 used to control operations on the template itself. KMIP does not allow operation policies to be specified
459 for controlling operations on the template itself. The default policy for template objects is used for this
460 purpose and is specified in the KMIP Specification.

461 **3.6.1.2 Example of Creating a Symmetric Key using a Template**

462 In this example, the client uses the template created in example 3.6.1 to create a 256-bit AES key.

463

464 The following is specified in the Create Request Payload:

465

- 466 • Object Type: Symmetric Key
- 467 • Template-Attribute:
 - 468 – Name: Template1
 - 469 – Attribute:
 - 470 Name: AESkey
 - 471 Custom Attribute: x-ID74592

472

473 The Template-Attribute specifies both a template name and additional attributes. The Name attribute is
474 not an attribute that may be set by a template. The Name attribute set for the template applies to the
475 template itself (e.g., Template1 is the Name attribute of the Template object). The Name attribute for the
476 symmetric key is therefore specified separately under Attribute. It is possible to specify the Custom
477 Attribute inside the template; however, this particular example sets this attribute separately.

478 **3.7 Archive Operations**

479 When the Archive operation is performed, it is recommended that an object identifier and a minimal set of
480 attributes be retained within the server for operational efficiency. In such a case, the retained attributes
481 may include Unique Identifier and State.

482 **3.8 Message Extensions**

483 Any number of vendor-specific extensions may be included in the Message Extension optional structure.
484 This allows KMIP implementations to create multiple extensions to the protocol.

485 **3.9 Unique Identifiers**

486 For clients that require unique identifiers in a special form, out-of-band registration/configuration may be
487 used to communicate this requirement to the server.

488 **3.10 Result Message Text**

489 KMIP specifies the Result Status, the Result Reason and the Result Message as normative message
490 contents. For the Result Status and Result Reason, the enumerations provided in **[KMIP-Spec]** are the
491 normative values. The values for the Result Message text, on the other hand, are implementation-
492 specific. In consideration of internationalization, it is recommended that any vendor implementation of
493 KMIP provide appropriate language support for the Return Message. How a client specifies the language
494 for Result Messages is outside the scope of the KMIP.

495 **3.11 Query**

496 Query does not explicitly support client requests to determine what operations require authentication. To
497 determine whether an operation requires authentication, a client should request that operation.

498 **3.12 Canceling Asynchronous Operations**

499 If an asynchronous operation is cancelled by the client, no information is returned by the server in the
500 result code regarding any operations that may have been partially completed. Identification and
501 remediation of partially completed operations is the responsibility of the server.

502 It is the responsibility of the server to determine when to discard the status of asynchronous operations.
503 The determination of how long a server should retain the status of an asynchronous operation is
504 implementation-dependent and not defined by KMIP.

505 Once a client has received the status on an asynchronous operation other than "pending", any
506 subsequent request for status of that operation may return either the same status as in a previous polling
507 request or an "unavailable" response.

508 **3.13 Multi-instance Hash**

509 The Digest attribute contains the output of hashing a managed object, such as a key or a certificate. The
510 server always generates the SHA-256 hash value when the object is created or generated. KMIP allows
511 multiple instances of the digest attribute to be associated with the same managed object. For example, it
512 is common practice for publicly trusted CAs to publish two digests (often referred to as the fingerprint or
513 the thumbprint) of their certificate: one calculated using the SHA-1 algorithm and another using the MD5
514 algorithm. In this case, each digest would be calculated by the server using a different hash algorithm.

515 **3.14 Returning Related Objects**

516 The key block is intended to return a single object, with associated attributes and other data. For those
517 cases in which multiple related objects are needed by a client, such as the private key and the related
518 certificate specified by RACF and JKS, the client should issue multiple Get requests to obtain these
519 related objects.

520 **3.15 Reducing Multiple Requests through the Use of Batch**

521 KMIP supports batch operations in order to reduce the number of calls between the client and server for
522 related operations. For example, Locate and Get are likely to be commonly accomplished within a single
523 batch request.

524 KMIP does not ensure that batch operations are atomic on the server side. If servers implement such
525 atomicity, the client is able to use the optional “undo” mode to request roll-back for batch operations
526 implemented as atomic transactions. However, support for “undo” mode is optional in the protocol, and
527 there is no guarantee that a server that supports “undo” mode has effectively implemented atomic
528 batches. The use of “undo”, therefore, should be restricted to those cases in which it is possible to assure
529 the client, through mechanisms outside of KMIP, of the server effectively supporting atomicity for batch
530 operations.

531 **3.16 Maximum Message Size**

532 When a server is processing requests in a batch, it should compare the cumulative response size of the
533 message to be returned after each request with the specified Maximum Response Size. If the message is
534 too large, it should prepare a maximum message size error response message at that point, rather than
535 continuing with operations in the batch. This increases the client’s ability to understand what operations
536 have and have not been completed.

537 When processing individual requests within the batch, the server that has encountered a Maximum
538 Response Size error should not return attribute values or other information as part of the error response.

539 **3.17 Using Offset in Re-key and Re-certify Operations**

540 Both the Re-key and the Re-certify operations allow the specification of an offset interval.

541 The Re-key operation allows the client to specify an offset interval for activation of the key. This offset
542 specifies the duration of time between the time the request is made and the time when the activation of
543 the key occurs. If an offset is specified, all other times for the new key are determined from the new
544 Activation Date, based on the intervals used by the previous key, i.e., from the Activation Date to the
545 Process Start Date, Protect Stop Date, etc.

546 The Re-certify operation allows the client to specify an offset interval that indicates the difference between
547 the Initial Date of the new certificate and the Activation Date of the new certificate. As with the Re-key
548 operation, all other times for the certificate are determined using the intervals used for the previous
549 certificate.

550 **3.18 Locate Queries**

551 It is possible to formulate Locate queries to address any of the following conditions:

- 552 • Exact match of a transition to a given state. Locate the key(s) with a transition to a certain state at
553 a specified time (t).
- 554 • Range match of a transition to a given state. Locate the key(s) with a transition to a certain state
555 at any time at or between two specified times (t and t’).
- 556 • Exact match of a state at a specified time. Locate the key(s) that are in a certain state at a
557 specified time (t).

558 • Match of a state during an entire time range. Locate the key(s) that are in a certain state during
559 an entire time specified with times (t and t'). Note that the Activation Date could occur at or before
560 t and that the Deactivation Date could occur at or after t'+1.

561 • Match of a state at some point during a time range. Locate the key(s) that are in a certain state at
562 some time at or between two specified times (t and t'). In this case, the transition to that state
563 could be before the start of the specified time range.

564 This is accomplished by allowing any date/time attribute to be present either once (for an exact match) or
565 at most twice (for a range match).

566 For instance, if the state we are interested in is Active, the Locate queries would be the following
567 (corresponding to the bulleted list above):

568 • Exact match of a transition to a given state: Locate (ActivationDate(t)). Locate keys with an
569 Activation Date of t.

570 • Range match of a transition to a given state: Locate (ActivationDate(t), ActivationDate(t')). Locate
571 keys with an Activation Date at or between t and t'.

572 • Exact match of a state at a specified time: Locate (ActivationDate(0), ActivationDate(t),
573 DeactivationDate(t+1), DeactivationDate(MAX_INT), CompromiseDate(t+1),
574 CompromiseDate(MAX_INT)). Locate keys in the Active state at time t, by looking for keys with a
575 transition to Active before or until t, and a transition to Deactivated or Compromised after t
576 (because we don't want the keys that have a transition to Deactivated or Compromised before t).
577 The server assumes that keys without a DeactivationDate or CompromiseDate is equivalent to
578 MAX_INT (i.e., infinite).

579 • Match of a state during an entire time range: Locate (ActivationDate(0), ActivationDate(t),
580 DeactivationDate(t'+1), DeactivationDate(MAX_INT), CompromiseDate(t'+1),
581 CompromiseDate(MAX_INT)). Locate keys in the Active state during the entire time from t to t'.

582 • Match of a state at some point during a time range: Locate (ActivationDate(0), ActivationDate(t'-
583 1), DeactivationDate(t+1), DeactivationDate(MAX_INT), CompromiseDate(t+1),
584 CompromiseDate(MAX_INT)). Locate keys in the Active state at some time from t to t', by looking
585 for keys with a transition to Active between 0 and t'-1 and exit out of Active on or after t+1.

586 The queries would be similar for Initial Date, Deactivation Date, Compromise Date and Destroy Date.

587 In the case of the Destroyed-Compromise state, there are two dates recorded: the Destroy Date and the
588 Compromise Date. For this state, the Locate operation would be expressed as follows:

589 • Exact match of a transition to a given state: Locate (CompromiseDate(t), State(Destroyed-
590 Compromised)) and Locate (DestroyDate(t), State(Destroyed-Compromised)). KMIP does not
591 support the OR in the Locate request, so two requests should be issued. Locate keys that were
592 Destroyed and transitioned to the Destroyed-Compromised state at time t, and locate keys that
593 were Compromised and transitioned to the Destroyed-Compromised state at time t.

594 • Range match of a transition to a given state: Locate (CompromiseDate(t), CompromiseDate(t'),
595 State(Destroyed-Compromised)) and Locate (DestroyDate(t), DestroyDate(t'), State(Destroyed-
596 Compromised)). Locate keys that are Destroyed-Compromised and were Compromised or
597 Destroyed at or between t and t'.

598 • Exact match of a state at a specified time: Locate (CompromiseDate(0), CompromiseDate(t),
599 DestroyDate(0), DestroyDate(t)); nothing else is needed, since there is no exit transition. Locate
600 keys with a Compromise Date at or before t, and with a Destroy Date at or before t. These keys
601 are, therefore, in the Destroyed-Compromised state at time t.

602 • Match of a state during an entire time range: Locate (CompromiseDate(0), CompromiseDate(t),
603 DestroyDate(0), DestroyDate(t)). Same as above. As there is no exit transition from the
604 Destroyed-Compromised state, the end of the range (t') is irrelevant.

605 • Match of a state at some point during a time range: Locate (CompromiseDate(0),
606 CompromiseDate(t'-1), DestroyDate(0), DestroyDate(t'-1)). Locate keys with a Compromise Date
607 at or before t'-1, and with a Destroy Date at or before t'-1. As there is no exit transition from the
608 Destroyed-Compromised state, the start of the range (t) is irrelevant.

609 **3.19 ID Placeholder**

610 A number of operations are affected by a mechanism referred to as the ID Placeholder. This is a
 611 temporary variable consisting of a single Unique Identifier that is stored inside the server for the duration
 612 of executing a batch of operations. The ID Placeholder is obtained from the Unique Identifier returned by
 613 certain operations; the applicable operations are identified in Table 1, along with a list of operations that
 614 accept the ID Placeholder as input.

Operation	ID Placeholder at the beginning of the operation	ID Placeholder upon completion of the operation (in case of operation failure, a batch using the ID Placeholder stops)
Create	-	ID of new Object
Create Key Pair	-	ID of new Private Key (ID of new Public Key may be obtained via a Locate)
Register	-	ID of newly registered Object
Derive Key	- (multiple Unique Identifiers may be specified in the request)	ID of new Symmetric Key
Locate	-	ID of located Object
Get	ID of Object	no change
Validate	-	-
Get Attributes List/Modify/Add/Delete	ID of Object	no change
Activate	ID of Object	no change
Revoke	ID of Object	no change
Destroy	ID of Object	no change
Archive/Recover	ID of Object	no change
Certify	ID of Public Key	ID of new Certificate
Re-certify	ID of Certificate	ID of new Certificate
Re-key	ID of Symmetric Key to be rekeyed	ID of new Symmetric Key
Obtain Lease	ID of Object	no change
Get Usage Allocation	ID of Key	no change
Check	ID of Object	no change

615 **Table 1: ID Placeholder Prior to and Resulting from a KMIP Operation**

616 **3.20 Key Block**

617 The protocol uses the Key Block structure to transport a key to the client or server. This Key Block
 618 consists of the Key Value Type, the Key Value, and the Key Wrapping Data. The Key Value Type
 619 identifies the format of the Key Material, e.g., Raw format or Transparent Key structure. The Key Value

620 consists of the Key Material and optional attributes. The Key Wrapping Data provides information about
621 the wrapping key and the wrapping mechanism, and is returned only if the client requests the Key Value
622 to be wrapped by specifying the Key Wrapping Specification inside the Get Request Payload. The Key
623 Wrapping Data may also be included inside the Key Block if the client registers a wrapped key.

624 The protocol allows any attribute to be included inside the Key Value and allows these attributes to be
625 cryptographically bound to the Key Material (i.e., by signing, MACing, encrypting, or both encrypting and
626 signing/MACing the Key Value). Some of the attributes that may be included include the following:

- 627 • Unique Identifier – uniquely identifies the key
- 628 • Cryptographic Algorithm (e.g., AES, 3DES, RSA) – this attribute is either specified inside the Key
629 Block structure or the Key Value structure
- 630 • Cryptographic Length (e.g., 128, 256, 2048) – this attribute is either specified inside the Key
631 Block structure or the Key Value structure
- 632 • Cryptographic Usage Mask– identifies the cryptographic usage of the key (e.g., Encrypt, Wrap
633 Key, Export)
- 634 • Cryptographic Parameters – provides additional parameters for determining how the key may be
635 used
 - 636 – Block Cipher Mode (e.g., CBC, NISTKeyWrap, GCM) – this parameter identifies the mode of
637 operation, including block cipher-based MACs or wrapping mechanisms
 - 638 – Padding Method (e.g., OAEP, X9.31, PSS) – identifies the padding method and if applicable
639 the signature or encryption scheme
 - 640 – Hashing Algorithm (e.g., SHA-256) – identifies the hash algorithm to be used with the
641 signature/encryption mechanism or Mask Generation Function; note that the different HMACs
642 are defined individually as algorithms and do not require the Hashing Algorithm parameter to
643 be set
 - 644 – Key Role Type – Identifies the financial key role (e.g., DEK, KEK)
- 645 • State (e.g., Active)
- 646 • Dates (e.g., Activation Date, Process Start Date, Protect Stop Date)
- 647 • Custom Attribute – allows vendors and clients to define vendor-specific attributes; may also be
648 used to prevent replay attacks by setting a nonce

649 **3.21 Using Wrapped Keys with KMIP**

650 KMIP provides the option to register and get keys in wrapped format. Clients request the server to return
651 a wrapped key by including the Key Wrapping Specification in the Get Request Payload. Similarly, clients
652 register a wrapped key by including the Key Wrapping Data in the Register Request Payload. The
653 Wrapping Method identifies the type of mechanism used to wrap the key, but does not identify the
654 algorithm or block cipher mode. It is possible to determine these from the attributes set for the specified
655 Encryption Key or MAC/Signing Key. If a key has multiple Cryptographic Parameters set, clients may
656 include the applicable parameters in Key Wrapping Specification. If omitted, the server chooses the
657 Cryptographic Parameter attribute with the lowest index.

658 The Key Value includes both the Key Material and, optionally, attributes of the key; these may be
659 provided by the client in the Register Request Payload; the server only includes attributes when
660 requested in the Key Wrapping Specification of the Get Request Payload. The Key Value may be
661 encrypted, signed/MACed, or both encrypted and signed/MACed (and vice versa). In addition, clients
662 have the option to request or import a wrapped Key Block according to standards, such as ANSI TR-31,
663 or vendor-specific key wrapping methods.

664 It is important to note that if the Key Wrapping Specification is included in the Get Request Payload, the
665 Key Value may not necessarily be encrypted. If the Wrapping Method is MAC/sign, the returned Key
666 Value is in plaintext, and the Key Wrapping Data includes the MAC or Signature of the Key Value.

667 Prior to wrapping or unwrapping a key, the server should verify that the wrapping key is allowed to be
668 used for the specified purpose. For example, if the Unique ID of a symmetric key is specified in the Key

669 Wrapping Specification inside the Get request, the symmetric key should have the “Wrap Key” bit set in
670 its Cryptographic Usage Mask. Similarly, if the client registers a signed key, the server should verify that
671 the Signature Key, as specified by the client inside the Key Wrapper Data, has the “Verify” bit set in the
672 Cryptographic Usage Mask. If the wrapping key is not permitted to be used for the requested purpose
673 (e.g., when the Cryptographic Usage Mask is not set), the server should return the Operation Failed error.

674 **3.21.1 Encrypt-only Example with a Symmetric Key as an Encryption Key** 675 **for a Get Request and Response**

676 The client sends a Get request to obtain a key that is stored on the server. When the client sends a Get
677 request to the server, a Key Wrapping Specification may be included. If a Key Wrapping Specification is
678 included in the Get request, and a client wants the requested key and its Cryptographic Usage Mask
679 attribute to be wrapped with AES key wrap, the client includes the following information in the Key
680 Wrapping Specification:

- 681 • Wrapping Method: Encrypt
- 682 • Encryption Key Information
 - 683 – Unique Key ID: Key ID of the AES wrapping key
 - 684 – Cryptographic Parameters: The Block Cipher Mode is NISTKeyWrap (not necessary if default
 - 685 block cipher mode for wrapping key is NISTKeyWrap)
- 686 • Attribute Name: Cryptographic Usage Mask

687 The server uses the Unique Key ID specified by the client to determine the attributes set for the proposed
688 wrapping key. For example, the algorithm of the wrapping key is not explicitly specified inside the Key
689 Wrapping Specification. The server determines the algorithm to be used for wrapping the key by
690 identifying the Algorithm attribute set for the specified Encryption Key.

691 The Cryptographic Parameters attribute should be specified by the client if multiple instances of the
692 Cryptographic Parameters exist, and the lowest index does not correspond to the NIST key wrap mode of
693 operation. The server should verify that the AES wrapping key has NISTKeyWrap set as an allowable
694 Block Cipher Mode, and that the “Wrap Key” bit is set in the Cryptographic Usage Mask.

695 If the correct data was provided to the server, and no conflicts exist, the server AES key wraps the Key
696 Value (both the Key Material and the Cryptographic Usage Mask attribute) for the requested key with the
697 wrapping key specified in the Encryption Key Information. The wrapped key (byte string) is returned in the
698 server’s response inside the Key Value of the Key Block.

699 The Key Wrapping Data of the Key Block in the Get Response Payload includes the same data as
700 specified in the Key Wrapping Specification of the Get Request Payload except for the Attribute Name.

701 **3.21.2 Encrypt-only Example with a Symmetric Key as an Encryption Key** 702 **for a Register Request and Response**

703 The client sends a Register request to the server and includes the wrapped key and the Unique ID of the
704 wrapping key inside the Request Payload. The wrapped key is provided to the server inside the Key
705 Block. The Key Block includes the Key Value Type, the Key Value, and the Key Wrapping Data. The Key
706 Value Type identifies the format of the Key Material, the Key Value consists of the Key Material and
707 optional attributes that may be included to cryptographically bind the attributes to the Key Material, and
708 the Key Wrapping Data identifies the wrapping mechanism and the encryption key used to wrap the
709 object and the wrapping mechanism.

710 Similar to the example in 3.21.1 the key is wrapped using the AES key wrap. The Key Value includes four
711 attributes: Cryptographic Algorithm, Cryptographic Length, Cryptographic Parameters, and Cryptographic
712 Usage Mask.

713 The Key Wrapping Data includes the following information:

- 714 • Wrapping Method: Encrypt
- 715 • Encryption Key Information
 - 716 – Unique Key ID: Key ID of the AES wrapping key

717 – Cryptographic Parameters: The Block Cipher Mode is NISTKeyWrap (not necessary if default
718 block cipher mode for wrapping key is NISTKeyWrap)

719 Attributes do not need to be specified in the Key Wrapping Data. When registering a wrapped Key Value
720 with attributes, clients may include these attributes inside the Key Value without specifying them inside
721 the Template-Attribute.

722 Prior to unwrapping the key, the server determines the wrapping algorithm from the Algorithm attribute set
723 for the specified Unique ID in the Encryption Key Information. The server verifies that the wrapping key
724 may be used for the specified purpose. In particular, if the client includes the Cryptographic Parameters in
725 the Encryption Key Information, the server verifies that the specified Block Cipher Mode is set for the
726 wrapping key. The server also verifies that the wrapping key has the “Unwrap Key” bit set in the
727 Cryptographic Usage Mask.

728 The Register Response Payload includes the Unique ID of the newly registered key and an optional list of
729 attributes that were implicitly set by the server.

730 **3.21.3 Encrypt-only Example with an Asymmetric Key as an Encryption** 731 **Key for a Get Request and Response**

732 The client sends a Get request to obtain a key (either symmetric or asymmetric) that is stored on the
733 server. When the client sends a Get request to the server, a Key Wrapping Specification may be
734 included. If a Key Wrapping Specification is included, and the key is to be wrapped with an RSA public
735 key using the OAEP encryption scheme, the client includes the following information in the Key Wrapping
736 Specification. Note that for this example, attributes for the requested key are not requested.

- 737 • Wrapping Method: Encrypt
- 738 • Encryption Key Information
 - 739 – Unique Key ID: Key ID of the RSA public key
 - 740 – Cryptographic Parameters:
 - 741 Padding Method: OAEP
 - 742 Hashing Algorithm: SHA-256

743 The Cryptographic Parameters attribute is specified by the client if multiple instances of Cryptographic
744 Parameters exist for the wrapping key, and the lowest index does not correspond to the associated
745 padding method. The server should verify that the specified Cryptographic Parameters in the Key
746 Wrapping Specification and the “Wrap Key” bit in the Cryptographic Usage Mask are set for the
747 corresponding wrapping key.

748 The Key Wrapping Data returned by the server in the Key Block of the Get Response Payload includes
749 the same data as specified in the Key Wrapping Specification of the Get Request Payload.

750 For both OAEP and PSS, KMIP currently assumes that the Hashing Algorithm specified in the
751 Cryptographic Parameters of the Get request is used for both the Mask Generation Function (MGF) and
752 hashing data. The example above requires the server to use SHA-256 for both purposes.

753 **3.21.4 MAC-only Example with an HMAC Key as an Authentication Key for** 754 **a Get Request and Response**

755 The client sends a Get request to obtain a key that is stored on the server. When the client sends a Get
756 request to the server, a Key Wrapping Specification may be included. If a key and Custom Attribute (i.e.,
757 x-Nonce) is to be MACed with HMAC SHA-256, the following Key Wrapping Specification is specified:

- 758 • Wrapping Method: MAC/sign
- 759 • MAC/Signature Key Information
 - 760 – Unique Key ID: Key ID of the MACing key (note that the algorithm associated with this key
761 would be HMAC-256)
- 762 • Attribute Name: x-Nonce

763 For HMAC, no Cryptographic Parameters need to be specified, since the algorithm, including the hash
764 function, may be determined from the Algorithm attribute set for the specified MAC Key. The server
765 should verify that the HMAC key has the “MAC Generate” bit set in the Cryptographic Usage Mask. Note
766 that an HMAC key does not require the “Wrap Key” bit to be set in the Cryptographic Usage Mask.

767 The server creates an HMAC value over the Key Value if the specified MACing key may be used for the
768 specified purpose and no conflicts exist. The Key Value is returned in plaintext, and the Key Block
769 includes the following Key Wrapping Data:

- 770 • Wrapping Method: MAC/sign
- 771 • MAC/Signature Key Information
- 772 • Unique Key ID: Key ID of the MACing key
- 773 • MAC/Signature: HMAC result of the Key Value

774 In the example, the custom attribute x-Nonce was included to help clients, who are relying on the proxy
775 model, to detect replay attacks. End-clients, who communicate with the key management server, may not
776 support TLS and may not be able to rely on the message protection mechanisms provided by a security
777 protocol. An alternative approach for these clients would be to use the custom attribute to hold a random
778 number, counter, nonce, date, or time. The custom attribute needs to be created before requesting the
779 server to return a wrapped key and is recommended to be set if clients frequently wrap/sign the same key
780 with the same wrapping/signing key.

781 3.21.5 Registering a Wrapped Key as an Opaque Cryptographic Object

782 Clients may want to register and store a wrapped key on the server without the server being able to
783 unwrap the key (i.e., the wrapping key is not known to the server). Instead of storing the wrapped key as
784 an opaque object, clients have the option to store the wrapped key inside the Key Block as an opaque
785 cryptographic object, i.e., the wrapped key is registered as a managed cryptographic object, but the
786 encoding of the key is unknown to the server. Registering an opaque cryptographic object allows clients
787 to set all the applicable attributes that apply to cryptographic objects (e.g., Cryptographic Algorithm and
788 Cryptographic Length),

789 Opaque cryptographic objects are set by specifying the following inside the Key Block structure:

- 790 • Key Format Type: Opaque
- 791 • Key Material: Wrapped key as a Byte String

792 The Key Wrapping Data does not need to be specified.

793 3.22 Object Group

794 The key management system may specify rules for valid group names which may be created by the
795 client. Clients are informed of such rules by a mechanism that is not specified by **[KMIP-Spec]**. In the
796 protocol, the group names themselves are character strings of no specified format. Specific key
797 management system implementations may choose to support hierarchical naming schemes or other
798 syntax restrictions on the names. Groups may be used to associate objects for a variety of purposes. A
799 set of keys used for a common purpose, but for different time intervals, may be linked by a common
800 Object Group. Servers may create predefined groups and add objects to them independently of client
801 requests.

802 3.23 Certify and Re-certify

803 The key management system may contain multiple embedded CAs or may have access to multiple
804 external CAs. How the server routes a certificate request to a CA is vendor-specific and outside the scope
805 of KMIP. If the server requires and supports the capability for clients to specify the CA to be used for
806 signing a Certificate Request, then this information may be provided by including the Certificate Issuer
807 attribute in the Certify or Re-certify request.

808 **[KMIP-Spec]** supports multiple options for submitting a certificate request to the key management server
809 within a Certify or Re-Certify operation. It is a vendor decision as to whether the key management server

810 offers certification authority (CA) functionality or proxies the certificate request onto a separate CA for
811 processing. The type of certificate request formats supported is also a vendor decision, and this may, in
812 part, be based upon the request formats supported by any CA to which the server proxies the certificate
813 requests.

814 All certificate request formats for requesting X.509 certificates specified in **[KMIP-Spec]** (i.e., PKCS#10,
815 PEM and CRMF) provide a means for allowing the CA to verify that the client that created the certificate
816 request possesses the private key corresponding to the public key in the certificate request. This is
817 referred to as Proof-of-Possession (POP). However, it should be noted that in the case of the CRMF
818 format, some CAs may not support the CRMF POP option, but instead rely upon the underlying certificate
819 management protocols (i.e., CMP and CMC) to provide POP. In the case where the CA does not support
820 POP via the CRMF format (including CA functionality within the key management server), an alternative
821 certificate request format (i.e., PKCS#10, PEM) would need to be used if POP needs to be verified.

822 **3.24 Specifying Attributes during a Create Key Pair Operation**

823 The Create Key Pair operation allows clients to specify attributes using the Common Template-Attribute,
824 Private Key Template-Attribute, and Public Key Template-Attribute. The Common Template-Attribute
825 object includes a list of attributes that apply to both the public and private key. Attributes that are not
826 common to both keys may be specified using the Private Key Template-Attribute or Public Key Template-
827 Attribute. If a single-instance attribute is specified in multiple Template-Attribute objects, the server obeys
828 the following order of precedence:

- 829 1. Attributes specified explicitly in the Private and Public Key Template-Attribute, then
- 830 2. Attributes specified via templates in the Private and Public Key Template-Attribute, then
- 831 3. Attributes specified explicitly in the Common Template-Attribute, then
- 832 4. Attributes specified via templates in the Common Template-Attribute

833 **3.24.1 Example of Specifying Attributes during the Create Key Pair** 834 **Operation**

835 A client specifies several attributes in the Create Key Pair Request Payload. The Common Template-
836 Attribute includes the template name RSACom and other explicitly specified common attributes:

837 Common Template-Attribute

- 838 • RSACom Template
 - 839 – Cryptographic Algorithm: RSA
 - 840 – Cryptographic Length: 2048
 - 841 – Cryptographic Parameters: Padding Method OAEP
 - 842 – Custom Attribute: x-Serial 1234
 - 843 – Object Group: Key encryption group 1
- 844 • Attribute
 - 845 – Cryptographic Length: 4096
 - 846 – Cryptographic Parameters: Padding Method PKCS1 v1.5
 - 847 – Custom Attribute: x-ID 56789

848 The Private Key Template-Attribute includes the template name RSAPriv and other explicitly-specified
849 private key attributes:

850 Private Key Template-Attribute

- 851 • RSAPriv Template
 - 852 – Object Group: Key encryption group 2
- 853 • Attribute

- 854 – Cryptographic Usage Mask: Unwrap Key
- 855 – Name: PrivateKey1

856 The Public Key Template Attribute includes explicitly-specified public key attributes:

857 Public Key Template-Attribute

- 858 • Attribute
 - 859 – Cryptographic Usage Mask: Wrap Key
 - 860 – Name: PublicKey1

861
862 Following the attribute precedence rule, the server creates a 4096-bit RSA key. The following client-
863 specified attributes are set:

864 Private Key

- 865 • Cryptographic Algorithm: RSA
- 866 • Cryptographic Length: 4096
- 867 • Cryptographic Parameters: OAEP
- 868 • Cryptographic Parameters: PKCS1 v1.5
- 869 • Cryptographic Usage Mask: Unwrap Key
- 870 • Custom Attribute: x-Serial 1234
- 871 • Custom Attribute: x-ID 56789
- 872 • Object Group: Key encryption group 1
- 873 • Object Group: Key encryption group 2
- 874 • Name: PrivateKey1

875 Public Key

- 876 • Cryptographic Algorithm: RSA
- 877 • Cryptographic Length: 4096
- 878 • Cryptographic Parameters: OAEP
- 879 • Cryptographic Parameters: PKCS1 v1.5
- 880 • Cryptographic Usage Mask: Wrap Key
- 881 • Custom Attribute: x-Serial 1234
- 882 • Custom Attribute: x-ID 56789
- 883 • Object Group: Key encryption group 1
- 884 • Name: PublicKey1

885 **3.25 Registering a Key Pair**

886 During a Create Key Pair operation, a Link Attribute is automatically created by the server for each object
887 (i.e., a link is created from the private key to the public key and vice versa). Certain attributes are the
888 same for both objects and are set by the server while creating the key pair. The KMIP protocol does not
889 support an equivalent operation for registering a key pair. Clients are able to register the objects
890 independently and manually set the Link attributes to make the server aware that these keys are
891 associated with each other. When the Link attribute is set for both objects, the server should verify that
892 the registered objects indeed correspond to each other and apply similar restrictions as if the key pair was
893 created on the server.

894 Clients should perform the following steps when registering a key pair:

- 895 1. Register the public key and set all associated attributes:
 - 896 a. Cryptographic Algorithm

- 897 b. Cryptographic Length
- 898 c. Cryptographic Usage Mask
- 899 2. Register the private key and set all associated attributes
- 900 a. Cryptographic Algorithm is the same for both public and private key
- 901 b. Cryptographic Length is the same for both public and private key
- 902 c. Cryptographic Parameters may be set; if set, the value is the same for both the public and
903 private key
- 904 d. Cryptographic Usage Mask is set, but does not contain the same value for both the public
905 and private key
- 906 e. Link is set with Link Type *Public Key Link* and the Linked Object Identifier of the
907 corresponding Public Key
- 908 f. Link is set for the Public Key with Link Type *Private Key Link* and the Linked Object Identifier
909 of the corresponding Private Key

910 **3.26 Non-Cryptographic Objects**

911 The KMIP protocol allows clients to register Secret Data objects. Secret Data objects may include
912 passwords or data that are used to derive keys.

913 KMIP defines Secret Data as cryptographic objects. Even if the object is not used for cryptographic
914 purposes, clients still set certain attributes, such as the Cryptographic Usage Mask, for this object unless
915 otherwise stated. Similarly, servers set certain attributes for this object, including the Digest, State, and
916 certain Date attributes, even if the attributes seem relevant only for cryptographic objects.

917 When registering a Secret Data object, the following attributes are set by the server:

- 918 • Unique Identifier
- 919 • Object Type
- 920 • Digest
- 921 • State
- 922 • Initial Date
- 923 • Last Change Date

924 When registering a Secret Data object for non-cryptographic purposes, the following attributes are set by
925 either the client or the server:

- 926 • Cryptographic Usage Mask

927 **3.27 Asymmetric Concepts with Symmetric Keys**

928 The Cryptographic Usage Mask attribute is intended to adequately support asymmetric concepts using
929 symmetric keys. This is fairly common practice in established crypto systems: the MAC is an example of
930 an operation where a single symmetric key is used at both ends, but policy dictates that one end may
931 only generate cryptographic tokens using this key (the MAC) and the other end may only verify tokens.
932 The security of the system fails if the verifying end is able to use the key to perform generate operations.

933 In these cases it is not sufficient to describe the usage policy on the keys in terms of cryptographic
934 primitives like “encrypt” vs. “decrypt” or “sign” vs. “verify”. There are two reasons why this is the case.

- 935 • In some of these operations, such as MAC generate and verify, the same cryptographic primitive
936 is used in both of the complementary operations. MAC generation involves computing and
937 returning the MAC, while MAC verification involves computing that same MAC and comparing it
938 to a supplied value to determine if they are the same. Thus, both generation and verification use
939 the “encrypt” operation, and the two usages are not able to be distinguished by considering only
940 “encrypt” vs. “decrypt”.

- Some operations which require separate key types use the same fundamental cryptographic primitives. For example, encryption of data, encryption of a key, and computation of a MAC all use the fundamental operation “encrypt”, but in many applications, securely differentiated keys are used for these three operations. Simply looking for an attribute that permits “encrypt” is not sufficient.

Allowing the use of these keys outside of their specialized purposes may compromise security. Instead, specialized application-level permissions are necessary to control the use of these keys. KMIP provides several pairs of such permissions in the Cryptographic Usage Mask (3.14), such as:

MAC GENERATE MAC VERIFY	For cryptographic MAC operations. Although it is possible to compose certain MACs using a series of encrypt calls, the security of the MAC relies on the operation being atomic and specific.
GENERATE CRYPTOGRAM VALIDATE CRYPTOGRAM	For composite cryptogram operations such as financial CVC or ARQC. To specify exactly which cryptogram the key is used for it is also necessary to specify a <i>role</i> for the key (see Section 3.6 “Cryptographic Parameters” in [KMIP-Spec]).
TRANSLATE ENCRYPT TRANSLATE DECRYPT TRANSLATE WRAP TRANSLATE UNWRAP	To accommodate secure routing of traffic and data. In many areas that rely on symmetric techniques (notably, but not exclusively financial networks), information is sent from place to place encrypted using shared symmetric keys. When encryption keys are changed, it is desirable for the change to be an atomic operation, otherwise distinct unwrap-wrap or decrypt-encrypt steps risk leaking the plaintext data during the translation process. <i>TRANSLATE ENCRYPT/DECRYPT</i> is used for data encipherment. <i>TRANSLATE WRAP/UNWRAP</i> is used for key wrapping.

Table 2: Cryptographic Usage Masks Pairs

In order to support asymmetric concepts using symmetric keys in a KMIP system, the server implementation needs to be able to differentiate between clients for generate operations and clients for verify operations. As indicated by Section 3 (“Attributes”) of [KMIP-Spec] there is a single key object in the system to which all relevant clients refer, but when a client requests that key, the server is able to choose which attributes (permissions) to send with it, based on the identity and configured access rights of that specific client. There is, thus, no need to maintain and synchronize distinct copies of the symmetric key – just a need to define access policy for each client or group of clients.

The internal implementation of this feature at the server end is a matter of choice for the vendor: storing multiple key blocks with all necessary combinations of attributes or generating key blocks dynamically are both acceptable approaches.

3.28 Application Specific Information

The Application Specific Information attribute is used to store data which is specific to the application(s) using the object. Some examples of Application Name Space and Application Data pairs are given below.

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

967 • Client Generated Key ID, '450994003'
968 The following Application Name Spaces are recommended:

- 969 • SMIME
- 970 • TLS
- 971 • IPSEC
- 972 • HTTPS
- 973 • PGP
- 974 • Volume Identification
- 975 • File Name
- 976 • LTO4
- 977 • LIBRARY-LTO4

978 KMIP provides optional support for server-generated Application Data. Clients may request the server to
979 generate the Application Data for the client by omitting Application Data while setting or modifying the
980 Application Specific Information attribute. A server only generates the Application Data if the Application
981 Data is completely omitted from the request, and the client-specified Application Name Space is
982 recognized and supported by the server. An example for requesting the server to generate the Application
983 Data is shown below:

```
984       AddAttribute(UID, AppSpecInfo{AppNameSpace='LIBRARY-LTO4'});
```

985 If the server does not recognize the name space, the “Application Name Space Not Supported” error is
986 returned to the client.

987 If the Application Data is set to null, as shown in the example below, and the Application Name Space is
988 recognized by the server, the server does not generate the Application Data for the client. The server
989 stores the Application Specific Information attribute with the Application Data value set to null.

```
990       AddAttribute(UID, AppSpecInfo{AppNameSpace='LIBRARY-LTO4', AppData=null});
```

991 **3.29 Mutating Attributes**

992 KMIP does not support server mutation of client-supplied attributes. If a server does not accept an
993 attribute value that is being specified inside the request by the client, the server returns an error and
994 specifies “Invalid Field” as Result Reason.

995 Attributes that are not set by the client, but are implicitly set by the server as a result of the operation, may
996 optionally be returned by the server in the operation response inside the Template–Attribute.

997 If a client sets a time-related attribute to the current date and time (as perceived by the client), but as a
998 result of a clock skew, the specified date of the attribute is earlier than the time perceived by the server,
999 the server’s policy will be used to determine whether to accept the “backdated attribute”. KMIP does not
1000 require the server to fail a request if a backdated attribute is set by the client.

1001 If a server does not support backdated attributes, and cryptographic objects are expected to change state
1002 at the specified current date and time (as perceived by the client), clients are recommended to issue the
1003 operation that would implicitly set the date for the client. For example, instead of explicitly setting the
1004 Activation Date, clients could issue the Activate operation. This would require the server to set the
1005 Activation Date to the current date and time as perceived by the server.

1006 If it is not possible to set a date attribute via an operation, and the server does not support backdated
1007 attributes, clients need to take into account that potential clock skew issues may cause the server to
1008 return an error even if a date attribute is set to the client’s current date and time.

1009 For additional information, refer to the sections describing the State attribute and the Time Stamp field in
1010 **[KMIP-Spec]**.

1011 **3.30 Interoperable Key Naming for Tape**

1012 This section describes methods for creating and storing key identifiers that are interoperable across multi-
1013 vendor KMIP clients.

1014 **3.30.1 Native Tape Encryption by a KMIP Client**

1015 This method is primarily intended to promote interoperable key naming between tape library products
1016 which already support non-KMIP key managers, where KMIP support is being added.

1017 When those existing library products become KMIP clients, a common method for naming and storing
1018 keys may be used to support moving tape cartridges between the libraries, and successfully retrieving
1019 keys, assuming that the clients have appropriate access privileges. The library clients may be from
1020 multiple vendors, and may be served by a KMIP key manager from a different vendor.

1021 **3.30.1.1 Method Overview**

- 1022 • The method uses the KMIP Application Specific Information (ASI) attribute's Application Data field
1023 to store the key name. The ASI Application Name Space is used to identify the namespace (such
1024 as LIBRARY-LTO4).
- 1025 • The method also uses the tape format's Key Associated Data (KAD) fields to store the key name.
1026 Tape formats may provide both authenticated and unauthenticated storage for the KAD data. This
1027 method ensures optimum utilization of the authenticated KAD data when the tape format supports
1028 authentication.
- 1029 • The method supports both client-generated and server-generated key names.
- 1030 • The method, in many cases, is backward-compatible if tapes are returned to a non-KMIP key
1031 manager environment.
- 1032 • Key names stored in the KMIP server's ASI attribute are always text format. Key names stored on
1033 the KMIP client's KAD fields are always numeric format, due to space limitations of the tape
1034 format. The method basically consists of implementing a specific algorithm for converting
1035 between text and numeric formats.
- 1036 • The algorithm used by this conversion is reversible.

1037 **3.30.1.2 Definitions**

- 1038 • Key Associated Data (KAD). Part of the tape format. May be segmented into authenticated and
1039 unauthenticated fields. KAD usage is detailed in the SCSI SSC-3 standard from the T10
1040 organization.
- 1041 • Application Specific Information (ASI). A KMIP attribute.
- 1042 • Hexadecimal numeric characters. Case-sensitive, printable, single byte ASCII characters
1043 representing the numbers 0 through 9 and uppercase alpha A through F. (US-ASCII characters
1044 30h-39h and 41h-46h).
1045
1046 Hexadecimal numeric characters are always paired, each pair representing a single 8-bit numeric
1047 value. A leading zero character is provided, if necessary, so that every byte in the tape's KAD is
1048 represented by exactly 2 hexadecimal numeric characters.
- 1049 • N(k). The number of bytes in the tape format's combined KAD fields (both authenticated and
1050 unauthenticated).
- 1051 • N(a), N(u). The number of bytes in the tape format's authenticated, and unauthenticated KAD
1052 fields, respectively.

1053 **3.30.1.3 Algorithm 1. Numeric to text direction (tape format's KAD to KMIP ASI)**

1054 Description: All information contained in the tape format's KAD fields is converted to a null-terminated
1055 ASCII string consisting of hexadecimal numeric character pairs. First, the unauthenticated KAD data is

1056 converted to text. Then, the authenticated KAD data is converted and appended to the end of the string.
1057 The string is then null-terminated.

1058

1059 Implementation Example:

- 1060 1. Define an input buffer sized for $N(k)$. For LTO4, $N(k)$ is 44 bytes (12 bytes authenticated, 32
1061 unauthenticated).
- 1062 2. Define an output buffer sufficient to contain a null-terminated string with a maximum length of
1063 $2*N(k)+1$ bytes.
- 1064 3. Define the standard POSIX (also known as C) locale. Each character in the string is a single-byte US-
1065 ASCII character.
- 1066 4. Copy the tape format's KAD data, from the unauthenticated KAD field first, to the input buffer.
1067 Effectively, the first byte (byte 0) of the input buffer is the first byte of unauthenticated KAD. Bytes
1068 from the authenticated KAD are concatenated, after the unauthenticated bytes.
- 1069 5. For each byte in the input buffer, convert to US-ASCII as follows:
 - 1070 a. Convert the byte's value to exactly 2 hexadecimal numeric characters, including a leading 0
1071 where necessary. Append these 2 numeric characters to the output buffer, with the high-nibble
1072 represented by the left-most hexadecimal numeric character.
 - 1073 b. After all byte values have been converted, null terminate the output buffer.
- 1074 6. When storing the string to the KMIP server, use the object's ASI attribute's Application Data field.
1075 Store the namespace (such as LIBRARY-LTO4) in the ASI attribute's Application Name Space field.

1076 **3.30.1.4 Algorithm 2. Text to numeric direction (KMIP ASI to tape format's KAD)**

1077 Description: Hexadecimal numeric character pairs in the null-terminated ASCII string are converted to
1078 single byte numeric values, and stored in the tape format's KAD fields. The authenticated KAD field is
1079 populated first, from a sub-string consisting of the last $2*N(a)$ characters in the full string. Any remaining
1080 characters in the string are converted and stored to the unauthenticated KAD field. The null termination
1081 byte is not converted.

1082

1083 Implementation Example:

- 1084 1. Obtain the key's name from the KMIP server's ASI attribute for that object. Copy the null terminated
1085 string to an input buffer of size $2*N(k) + 1$ bytes. For LTO4, an 89 character string, including null
1086 termination, is sufficient for all possible key descriptors when names are directly referenced.
- 1087 2. Define output buffers for unauthenticated KAD, and authenticated KAD, of size $N(u)$ and $N(a)$
1088 respectively. For LTO4, this would be 32 bytes of unauthenticated data, and 12 bytes of authenticated
1089 data.
- 1090 3. Define the standard POSIX (also known as C) locale. Each character in the string is a single-byte US-
1091 ASCII character.
- 1092 4. First, populate the authenticated KAD buffer, converting a sub-string consisting of the last $2*N(a)$
1093 characters of the full string, not including the null termination byte.
- 1094 5. When the authenticated KAD is filled, next populate the unauthenticated KAD buffer, by converting
1095 the remaining hexadecimal character pairs in the string.

1096 **3.30.1.5 Example Output**

1097 The following are examples illustrating some results of this method. In the following examples, the sizes
1098 of the KAD for LTO4 are used. Different tape formats may utilize different KAD sizes.

1099

1100 Example 1. Full combined KAD

1101
1102 This LTO4 tape's combined KAD contains the following data (represented in hexadecimal). For LTO4, the
1103 unauthenticated KAD contains 32 bytes, and the authenticated KAD contains 12 bytes.
1104

1105 Example 1a. Hexadecimal numeric data from a tape's KAD.
1106 Shaded data is authenticated by the tape drive.

1107
1108 02 04 17 11 39 43 42 36 30 41 33 34 39 31 44 33
1109 41 41 43 36 32 42 07 F6 54 54 32 36 30 38 4C 34
1110 30 30 30 39 30 35 32 38 30 34 31 32

1111
1112 The algorithm converts the numeric KAD data to the following 89 character null-terminated string for
1113 storage in the Application Data field of a KMIP object's Application Specific Information attribute. The ASI
1114 Application Name Space contains "LIBRARY-LTO4".

1115
1116 Example 1b. Text string from KMIP ASI Application Data.

1117 Shaded characters are derived from authenticated data. The null character is represented as
1118 <null>

1119
1120 0204171139434236304133343931443341414336324207F65454323630384C343030303930353
1121 23830343132<null>
1122

1123 Example 1c. The hexadecimal values of the 89 US-ASCII characters in string 1b, from the KMIP
1124 ASI Application Data. Note: these values are always in the range 30h-39h, or in the range 41h-
1125 46h, or the 0h null.

1126 30 32 30 34 31 37 31 31 33 39 34 33 34 32 33 36 33 30 34 31 33 33 33 34 33 39 33 31 34 34 33
1127 33 34 31 34 31 34 33 33 36 33 32 34 32 30 37 46 36 35 34 35 34 33 32 33 36 33 30 33 38 34 43
1128 33 34 33 30 33 30 33 30 33 39 33 30 33 35 33 32 33 38 33 30 33 34 33 31 33 32 00

1129
1130 For the reverse transformation, a client would retrieve the string in 1b from the server, derive the numeric
1131 values shown in 1a, and store them to the tape format's KAD data. First, the sub-string containing the
1132 right-most 24 characters of the full 1b string are used to derive the 12-byte authenticated KAD. The
1133 remaining characters are used to derive the 32-byte unauthenticated KAD.

1134
1135 Example 2. Authenticated KAD only

1136 This LTO4 tape's KAD contains the following data (represented in hexadecimal), all 12 bytes obtained
1137 from the authenticated KAD field. There is no unauthenticated KAD data.

1138
1139 Example 2a. Hexadecimal numeric data from a tape's KAD.
1140 Shaded data is authenticated.

1141
1142 17 48 33 C6 20 42 10 A7 E8 05 F8 C7

1143 The algorithm converts the numeric KAD data to the following 24 character null-terminated string, for
1144 storage in the Application Data field of a KMIP object's Application Specific Information attribute.

1145
1146 Example 2b. Text string from KMIP ASI Application Data.

1147 Shaded characters are derived from authenticated data. The null character is represented as
1148 <null>
1149

1150 174833C6204210A7E805F8C7<null>

1151
1152 For the reverse transformation, a client would derive the numeric values in 2a, and store them to the tape
1153 format's KAD data. The right-most 24 characters of the string in 2b are used to derive the 12 byte
1154 authenticated KAD. In this example, there is no unauthenticated KAD data.

1155
1156 Example 3. Partially filled authenticated KAD originating from a non-KMIP method

1157 This LTO4 tape's KAD contains the following data (represented in hexadecimal). The unauthenticated
1158 KAD contains 10 bytes, and the authenticated KAD contains 8 bytes.

1159
1160 Since the authenticated KAD was not filled, but the unauthenticated data was populated, the method
1161 creating this key name is potentially not backward-compatible with the KMIP key naming method. See
1162 backward-compatibility assessment, below.

1163
1164 Example 3a. Hexadecimal numeric data from a non-KMIP tape's KAD.

1165 Shaded data is authenticated.

1166
1167 02 04 17 11 39 43 42 36 30 41 30 30 30 39 30 35

1168 32 38

1169
1170 The algorithm converts the numeric KAD data to the following 36 character null-terminated string, for
1171 storage in the Application Data field of a KMIP object's Application Specific Information attribute.

1172
1173 Example 3b. Text string from KMIP ASI Application Data.

1174 Shaded characters are derived from authenticated data. The null character is represented as
1175 <null>

1176
1177 020417113943423630413030303930353238<null>

1178
1179 For the reverse transformation, a client would derive the same numeric values shown in 3a, and store
1180 them to the tape's KAD. But their storage locations within the KAD now differs (see 3c). The right-most 24
1181 characters from the text string in 3b are used to derive the 12-byte authenticated KAD. The remaining
1182 characters are used to fill the 32-byte unauthenticated KAD.

1183
1184 Example 3c. Hexadecimal numeric data from a tape's KAD.

1185 Shaded data is authenticated.

1186
1187 02 04 17 11 39 43 42 36 30 41 30 30 30 39 30 35

1188 32 38

1189 3.30.1.6 Backward-compatibility assessment

1190 Where all the following conditions exist, a non-KMIP solution may encounter compatibility issues during
1191 the Read and Appended Write use cases.

- 1192 1. The tape format supports authenticated KAD, but the non-KMIP solution does not use, or only
1193 partially uses, the authenticated KAD field.
- 1194 2. The non-KMIP solution is sensitive to data position within the combined KAD.
- 1195 3. The media was written in a KMIP environment, using this method, then moved to the non-KMIP
1196 environment.

1197 3.31 Revocation Reason Codes

1198 The enumerations for the Revocation Reason attribute specified in KMIP (see table 9.1.3.2.17 in **[KMIP-
1199 Spec]**) are aligned with the Reason Code specified in X.509 and referenced in RFC 5280 with the
1200 following exceptions. The *certificateHold* and *removeFromCRL* reason codes have been excluded from
1201 **[KMIP-Spec]**, since this version of KMIP does not support certificate suspension (putting a certificate
1202 hold) or unsuspension (removing a certificate from hold). The *aaCompromise* reason code has been
1203 excluded from **[KMIP-Spec]** since it only applies to attribute certificates, and, at this point of time, attribute
1204 certificates are considered out-of-scope for **[KMIP-Spec]**. The *privilegeWithdrawn* reason code is
1205 included in **[KMIP-Spec]** since it may be used for either attribute or public key certificates. In the context
1206 of its use within KMIP it is assumed to only apply to public key certificates.

1207 3.32 Certificate Renewal, Update, and Re-key

1208 The process of generating a new certificate to replace an existing certificate may be referred to by
1209 multiple terms, based upon what data within the certificate is changed when the new certificate is created.
1210 In all situations, the new certificate includes a new serial number and new validity dates. **[KMIP-Spec]**
1211 uses the following terminology which is aligned with the definitions found in IETF RFCs **[RFC3647]** and
1212 **[RFC4949]**:

- 1213 • *Certificate Renewal*: The issuance of a new certificate to the subject without changing the subject
1214 public key or other information (except the serial number and certificate validity dates) in the
1215 certificate.
- 1216 • *Certificate Update*: The issuance of a new certificate, due to changes in the information in the
1217 certificate other than the subject public key.
- 1218 • *Certificate Rekey*: The generation of a new key pair for the subject and the issuance of a new
1219 certificate that certifies the new public key.

1220 The current KMIP Specification supports certificate renewals using the Re-Certify operation and certificate
1221 updates using the Certify operation. Support for certificate rekey is not currently supported by KMIP, since
1222 certificate rekey requires the ability to rekey an asymmetric key pair a capability not currently supported
1223 by KMIP. Support for rekey of asymmetric key pairs, along with certificate rekey, may be considered for a
1224 future KMIP release.

1225 3.33 Key Encoding

1226 Two parties receiving the same key as a Key BYTE STRING make use of the key in exactly the same
1227 way in order to interoperate. To ensure that, it is necessary to define a correspondence between the
1228 abstract syntax of Key and the notation in the standard algorithm description that defines how the key is
1229 used. The next sections establish that correspondence for the algorithms AES **[FIPS197]** and Triple-DES
1230 **[SP800-67]**.

1231 3.33.1 AES Key Encoding

1232 **[FIPS197]** section 5.2, titled Key Expansion, uses the input key as an array of bytes indexed starting at 0.
1233 The first byte of the Key becomes the key byte in AES that is labeled index 0 in **[FIPS197]** and the other
1234 key bytes follow in index order.

1235 Proper parsing and key load of the contents of the Key for AES is determined by using the following Key
1236 byte string to generate and match the key expansion test vectors in **[FIPS197]** Appendix A for the 128-bit
1237 (16 byte) AES Cipher Key: 2B 7E 15 16 28 AE D2 A6 AB F7 15 88 09 CF 4F 3C.

1238 **3.33.2 Triple-DES Key Encoding**

1239 A Triple-DES key consists of three keys for the cryptographic engine (Key1, Key2, and Key3) that are
1240 each 64 bits (even though only 56 are used); the three keys are also referred to as a key bundle (KEY)
1241 **[SP800-67]**. A key bundle may employ either two or three mutually independent keys. When only two are
1242 employed (called two-key Triple-DES), then Key1 = Key3.

1243 Each key in a Triple-DES key bundle is expanded into a key schedule according to a procedure defined in
1244 **[SP800-67]** Appendix A. That procedure numbers the bits in the key from 1 to 64, with number 1 being
1245 the left-most, or most significant bit. The first byte of the Key is bits 1 through 8 of Key1, with bit 1 being
1246 the most significant bit. The second byte of the Key is bits 9 through 16 of Key1, and so forth, so that the
1247 last byte of the KEY is bits 57 through 64 of Key3 (or Key2 for two-key Triple-DES).

1248 Proper parsing and key load of the contents of Key for Triple-DES is determined by using the following
1249 Key byte string to generate and match the key expansion test vectors in **[SP800-67]** Appendix B for the
1250 key bundle:

1251 Key1 = 0123456789ABCDEF

1252 Key2 = 23456789ABCDEF01

1253 Key3 = 456789ABCDEF0123

1254 **3.34 Using the Same Asymmetric Key Pair in Multiple Algorithms**

1255 There are mathematical relationships between certain asymmetric cryptographic algorithms such as the
1256 Digital Signature Algorithm (DSA) and Diffie-Hellman (DH) and their elliptic curve equivalents ECDSA and
1257 ECDH that allow the same asymmetric key pair to be used in both algorithms. In addition, one will notice
1258 overlaps in the key format used to represent the asymmetric key pair for each algorithm type.

1259 Even though a single key pair may be used in multiple algorithms, the KMIP Specification has chosen to
1260 specify separate key formats for representing the asymmetric key pair for use in each algorithm. This
1261 approach keeps KMIP in line with the reference standards (e.g., NIST FIPS 186-3 **[FIPS186-3]**, ANSI
1262 X9.42 **[X9.42]**, etc) from which the key formats for DSA, DH, ECDSA, etc. are obtained and the best
1263 practice documents (e.g., NIST SP800-57 part 1 **[SP800-57-1]**, NIST SP800-56A **[SP800-56A]**, etc)
1264 which recommend that a key pair only be used for one purpose.

1265
1266
1267
1268
1269
1270
1271
1272
1273
1274
1275
1276
1277
1278
1279
1280
1281
1282
1283
1284
1285
1286
1287
1288
1289
1290
1291
1292
1293
1294
1295
1296
1297
1298
1299
1300
1301
1302
1303
1304
1305
1306
1307
1308
1309
1310

4 Deferred KMIP Functionality

The KMIP Specification is currently missing items that have been judged candidates for future inclusion in the specification. These items currently include:

- Registration of Clients. This would allow in-band registration and management of clients, which currently may only be registered and/or managed using off-line mechanisms.
- Client-requested specification of additional clients that are allowed to use a key. This requires coordinated identities between the client and server, and as such, is deferred until registration of clients is addressed.
- Registration of Notifications. This would allow clients to specify, using an in-band mechanism, information and events that they wish to be notified of, and what mechanisms should be used for such notifications, possibly including the configuration of pushed cryptographic material. This functionality would assume the Registration of Clients as a prerequisite.
- Key Migration. This would standardize the migration of keys from one HSM to another, using mechanisms already in the protocol or ones added for this purpose.
- Server to Server key management. This would extend the protocol to support communication between key management servers in different key management domains, for purposes of exporting and importing cryptographic material and potentially policy information.
- Multiple derived keys. This would allow the creation of multiple derived keys from one or more input keys. Note, however, that the current version of KMIP provides the capability to derive multiple keys and initialization vectors by creating a Secret Data object and specifying a cryptographic length equal to the total length of the derived objects.
- XML encoding. Expression of KMIP in XML rather than in tag/type/length/value may be considered for the future.
- Specification of Mask Generation Function. KMIP does not currently allow clients to specify the Mask Generation Function and assumes that encryption or signature schemes, such as OAEP or PSS, use MGF1 with the hash function as specified in the Cryptographic Parameters attribute. Client specification of MGFs may be considered for the future.
- Certificate creation without client-provided Certificate Request. This would allow clients to request the server to perform the Certify or Re-certify operation from the specified key pair IDs without providing a Certificate Request.
- Server monitoring of client status. This would enable the transfer of information about the client and its cryptographic module to the server. This information would enable the server to generate alarms and/or disallow requests from a client running component versions with known vulnerabilities.
- Symmetric key pairs. Only a subset of the cryptographic usage bits of the Cryptographic Usage Mask attribute may be permitted for keys distributed to a particular client. KMIP does not currently address how to securely assign and determine the applicable cryptographic usage for a client.
- Hardware-protected attribute. This attribute would allow clients and servers to determine if a key may only be processed inside a secure cryptographic device, such as an HSM. If this attribute is set, the key may only exist in cleartext within a secure hardware device, and all security-relevant attributes are bound to it in such a way that they may not be modified outside of such a secure device.
- Alternative profiles for key establishment. Less capable end-clients may not be able to support TLS and should use a proxy to communicate with the key management system. The KMIP protocol does not currently support alternative profiles, nor does it allow end-clients relying on the proxy model to securely establish a key with the server.

- 1311 • Attribute mutation. The possibility for the server to use attribute values different than requested by
1312 the client if these values are not suitable for the server, and return these values in the response,
1313 instead of failing the request.
- 1314 • Cryptographic Domain Parameters. KMIP allows a limited number of parameters to be specified
1315 during a Create Key Pair operation. Additional parameters may be considered for the future.
- 1316 • Re-key support for other cryptographic objects. The Re-key operation is currently restricted to
1317 symmetric keys. Applying Re-key to other cryptographic objects, such as asymmetric keys and
1318 certificates, may be considered for the future.
- 1319 • Certificate Suspension/Unsuspend. KMIP does not currently support certificate suspension
1320 (putting a certificate on hold) or unsuspension (removing a certificate from hold). Adding support
1321 for certificate suspension/unsuspension into KMIP may be considered for the future.
- 1322 • Namespace registration. Establishing a registry for namespaces may be considered for the
1323 future.
- 1324 • Registering extensions to KMIP enumerations. Establishing a registry for extensions to defined
1325 KMIP enumerations, such as in support of profiles specific to IEEE P1619.3 or other
1326 organizations, may be considered for the future.

1327 In addition to the functionality listed above, the KMIP TC is interested in establishing a C&A (certification
1328 and accreditation) process for independent validation of claims of KMIP conformance. Defining and
1329 establishing this process is a candidate for work by the KMIP TC after V1.0.

1330 **5 Implementation Conformance**

1331 This document is intended to be informational only and as such has no conformance clauses. The
1332 conformance requirements for the KMIP Specification can be found in the "KMIP Specification" document
1333 itself, at the URL noted on the cover page of this document.

1334

A. Acronyms

1335 The following abbreviations and acronyms are used in this document:

- 1336 3DES - Triple Data Encryption Standard specified in ANSI X9.52
- 1337 AES - Advanced Encryption Standard specified in FIPS 197
- 1338 ANSI - American National Standards Institute
- 1339 ARQC - Authorization Request Cryptogram
- 1340 ASCII - American Standard Code for Information Interchange
- 1341 CA - Certification Authority
- 1342 CBC - Cipher Block Chaining specified in NIST SP 800-38A
- 1343 CMC - Certificate Management Messages over CMS specified in RFC 5275
- 1344 CMP - Certificate Management Protocol specified in RFC 4210
- 1345 CRL - Certificate Revocation List specified in RFC 5280
- 1346 CRMF - Certificate Request Message Format specified in RFC 4211
- 1347 CVC - Card Verification Code
- 1348 DES - Data Encryption Standard specified in FIPS 46-3
- 1349 DEK - Data Encryption Key
- 1350 DH - Diffie-Hellman specified in ANSI X9.42
- 1351 FIPS - Federal Information Processing Standard
- 1352 GCM - Galois/Counter Mode specified in NIST SP 800-38D
- 1353 HMAC - Keyed-Hash Message Authentication Code specified in FIPS 198-1
- 1354 HSM - Hardware Security Module
- 1355 HTTP - Hyper Text Transfer Protocol
- 1356 HTTP(S) - Hyper Text Transfer Protocol (Secure socket)
- 1357 ID - Identification
- 1358 IP - Internet Protocol
- 1359 IPSec - Internet Protocol Security
- 1360 JKS - Java Key Store
- 1361 KEK - Key Encryption Key
- 1362 KMIP - Key Management Interoperability Protocol
- 1363 LTO4 - Linear Tape-Open 4
- 1364 MAC - Message Authentication Code
- 1365 MD5 - Message Digest 5 Algorithm specified in RFC 1321
- 1366 MGF - Mask Generation Function
- 1367 NIST - National Institute of Standards and Technology
- 1368 OAEP - Optimal Asymmetric Encryption Padding specified in PKCS#1
- 1369 PEM - Privacy Enhanced Mail specified in RFC 1421

- 1370 PGP - OpenPGP specified in RFC 4880
- 1371 PKCS - Public-Key Cryptography Standards
- 1372 POP - Proof of Possession
- 1373 POSIX - Portable Operating System Interface
- 1374 PSS - Probabilistic Signature Scheme specified in PKCS#1
- 1375 RACF - Remote Access Control Facility
- 1376 RSA - Rivest, Shamir, Adelman (an algorithm)
- 1377 SHA - Secure Hash Algorithm specified in FIPS 180-2
- 1378 SP - Special Publication
- 1379 S/MIME - Secure/Multipurpose Internet Mail Extensions
- 1380 TCP - Transport Control Protocol
- 1381 TLS - Transport Layer Security
- 1382 TTLV - Tag, Type, Length, Value
- 1383 URI - Uniform Resource Identifier
- 1384 UTF-8 - Universal Transformation Format 8-bit specified in RFC 3629
- 1385 X.509 - Public Key Certificate specified in RFC 5280
- 1386 XML - Extensible Markup Language

1387

B. Acknowledgements

1388 The following individuals have participated in the creation of this specification and are gratefully
1389 acknowledged:

1390 **Original Authors of the initial contribution:**

1391 David Babcock, HP
1392 Steven Bade, IBM
1393 Paolo Bezoari, NetApp
1394 Mathias Björkqvist, IBM
1395 Bruce Brinson, EMC
1396 Christian Cachin, IBM
1397 Tony Crossman, Thales/nCipher
1398 Stan Feather, HP
1399 Indra Fitzgerald, HP
1400 Judy Furlong, EMC
1401 Jon Geater, Thales/nCipher
1402 Bob Griffin, EMC
1403 Robert Haas, IBM
1404 Timothy Hahn, IBM
1405 Jack Harwood, EMC
1406 Walt Hubis, LSI
1407 Glen Jaquette, IBM
1408 Jeff Kravitz, IBM
1409 Michael McIntosh, IBM
1410 Brian Metzger, HP
1411 Anthony Nadalin, IBM
1412 Elaine Palmer, IBM
1413 Joe Pato, HP
1414 René Pawlitzek, IBM
1415 Subhash Sankuratipati, NetApp
1416 Mark Schiller, HP
1417 Martin Skagen, Brocade
1418 Marcus Streets, Thales/nCipher
1419 John Tattan, EMC
1420 Karla Thomas, Brocade
1421 Marko Vukolić , IBM
1422 Steve Wierenga, HP

1423 **Participants:**

1424 Mike Allen, PGP Corporation
1425 Gordon Arnold, IBM
1426 Todd Arnold, IBM
1427 Matthew Ball, Oracle Corporation
1428 Elaine Barker, NIST
1429 Peter Bartok, Venafi, Inc.
1430 Mathias Björkqvist, IBM
1431 Kevin Bocek, Thales e-Security
1432 Kelley Burgin, National Security Agency
1433 Jon Callas, PGP Corporation
1434 Tom Clifford, Symantec Corp.
1435 Graydon Dodson, Lexmark International Inc.
1436 Chris Dunn, SafeNet, Inc.
1437 Paul Earsy, SafeNet, Inc.
1438 Stan Feather, Hewlett-Packard
1439 Indra Fitzgerald, Hewlett-Packard

1440 Alan Frindell, SafeNet, Inc.
1441 Judith Furlong, EMC Corporation
1442 Jonathan Geater, Thales e-Security
1443 Robert Griffin, EMC Corporation
1444 Robert Haas, IBM
1445 Thomas Hardjono, M.I.T.
1446 Kurt Heberlein, 3PAR, Inc.
1447 Marc Hocking, BeCrypt Ltd.
1448 Larry Hofer, Emulex Corporation
1449 Brandon Hoff, Emulex Corporation
1450 Walt Hubis, LSI Corporation
1451 Tim Hudson, Cryptsoft Pty Ltd.
1452 Wyllys Ingersoll, Oracle Corporation
1453 Jay Jacobs, Target Corporation
1454 Glen Jaquette, IBM
1455 Scott Kipp, Brocade Communications Systems, Inc.
1456 David Lawson, Emulex Corporation
1457 Hal Lockhart, Oracle Corporation
1458 Robert Lockhart, Thales e-Security
1459 Shyam Mankala, EMC Corporation
1460 Upendra Mardikar, PayPal Inc.
1461 Marc Massar, Individual
1462 Don McAlister, Associate
1463 Hyrum Mills, Mitre Corporation
1464 Bob Nixon, Emulex Corporation
1465 Landon Curt Noll, Cisco Systems, Inc.
1466 René Pawlitzek, IBM
1467 John Peck, IBM
1468 Rob Philpott, EMC Corporation
1469 Scott Rea, Individual
1470 Bruce Rich, IBM
1471 Scott Rotondo, Oracle Corporation
1472 Saikat Saha, Vormetric, Inc.
1473 Anil Saldhana, Red Hat
1474 Subhash Sankuratripati, NetApp
1475 Mark Schiller, Hewlett-Packard
1476 Jitendra Singh, Brocade Communications Systems, Inc.
1477 Servesh Singh, EMC Corporation
1478 Terence Spies, Voltage Security
1479 Sandy Stewart, Oracle Corporation
1480 Marcus Streets, Thales e-Security
1481 Brett Thompson, SafeNet, Inc.
1482 Benjamin Tomhave, Individual
1483 Sean Turner, IECA, Inc.
1484 Paul Turner, Venafi, Inc.
1485 Marko Vukolić, IBM
1486 Rod Wideman, Quantum Corporation
1487 Steven Wierenga, Hewlett-Packard
1488 Peter Yee, EMC Corporation
1489 Krishna Yellepeddy, IBM
1490 Peter Zelechowski, Election Systems & Software
1491 Grace Zhang, Skyworth TTG Holdings Limited

C. Revision History

Revision	Date	Editor	Changes Made
ed-0.98	2009-04-29	Indra Fitzgerald	Initial conversion of input document to OASIS format.
ed-0.98	2009-07-28	Indra Fitzgerald	Added clarifications, examples, and deferred items.
ed-0.98	2009-09-08	Indra Fitzgerald	Added approved proposals and incorporated Elaine Barker's comments.
ed-0.98	2009-09-23	Indra Fitzgerald	Removed KMIP Profiles section and incorporated the Interoperable Key Naming for Tape proposal.
ed-0.98	2009-09-24	Indra Fitzgerald	Removed the Conformance section; added additional Certificate Request and POP text to Certify and Re-certify; added the Revocation Reason Codes section.
draft-01	2009-10-07	Indra Fitzgerald	Incorporated the Certificate Renewal, Update, Re-key proposal, the Key Encoding proposal; removed normative words "must", "shall", "required", "will", and "can"; added Create Key Pair example; updated the references and acronyms list; incorporated comments from RobertH and SubhashS; updated the Authentication section; added minor edits and clarifications.
draft-02	2009-10-09	Indra Fitzgerald	Incorporated Rod Wideman's comments on the language. Changed the heading indentation, paragraph style, and list styles according to the OASIS template guidelines. Added additional references. Replaced the TBDs. Added a use-case for registering a wrapped key as an opaque cryptographic object.
draft-03	2009-10-21	Indra Fitzgerald	Added the list of participants to Appendix B. Clarified the Authentication section (section 3.1) and added examples. Modified the title page. Performed minor editorial changes.
draft-04	2009-11-06	Indra Fitzgerald	Incorporated Elaine's comments. This is the tentative revision for public review.
draft-05	2009-11-09	Indra Fitzgerald	Minor edits to the reference sections.
draft-06	2010-02-24	Indra Fitzgerald	Addressed public review comments. Clarified how templates work (section 3.6). Added Judy Furlong's proposal on using the same asymmetric key pair in multiple algorithms (section 3.34).
draft-07	2010-03-04	Indra Fitzgerald	Clarified that the Destroy operation cannot destroy Active objects (section 3.5).
draft-08	2010-03-17	Indra Fitzgerald	Added the Server Policy section (2.5). Added the Credential section (3.1.1) to the Authentication section. Replaced SSL/TLS with TLS. Updated the participant list. Other minor edits.
draft-09	2010-03-18	Indra Fitzgerald	Renamed Role Type to Key Role Type. Updated the participant list.

draft-10	2010-05-26	Indra Fitzgerald	Minor edits to the reference and acronym sections. Updated the participant list.
----------	------------	------------------	---

1493