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CMS Symmetric Key Management and Distribution
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Status of this Memo

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Abstract

This document describes a mechanism to manage (i.e., setup, distribute, and rekey) keys used with symmetric cryptographic algorithms. Also defined herein is a mechanism to organize users into groups to support distribution of encrypted content using symmetric cryptographic algorithms. The mechanism uses the Cryptographic Message Syntax (CMS) protocol [CMS] and Certificate Management Message over CMS (CMC) protocol [CMC] to manage the symmetric keys. Any member of the group can then later use this distributed shared key to decrypt other CMS encrypted objects with the symmetric key.

This mechanism has been developed to support S/MIME Mail List Agents (MLAs).

Conventions used in this document

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

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1. Introduction

With the ever-expanding use of secure electronic communications (e.g., S/MIME [MSG]), users require a mechanism to distribute encrypted data to multiple recipients (i.e., a group of users). There are essentially two ways to encrypt the data for recipients: using asymmetric algorithms with public key certificates (PKCs) or symmetric algorithms with symmetric keys.

With asymmetric algorithms, the originator forms an originator-determined content-encryption key (CEK) and encrypts the content,

using a symmetric algorithm. Then, using an asymmetric algorithm and the recipient's PKCs, the originator generates per-recipient information that either (a) encrypts the CEK for a particular recipient (ktri RecipientInfo CHOICE), or (b) transfers sufficient parameters to enable a particular recipient to independently generate the same KEK (kari RecipientInfo CHOICE). If the group is large, processing of the per-recipient information may take quite some time, not to mention the time required to collect and validate the PKCs for each of the recipients. Each recipient identifies its per-recipient information and uses the private key associated with the public key of its PKC to decrypt the CEK and hence gain access to the encrypted content.

With symmetric algorithms, the origination process is slightly different. Instead of using PKCs, the originator uses a previously distributed secret key-encryption key (KEK) to encrypt the CEK (kekri RecipientInfo CHOICE). Only one copy of the encrypted CEK is required because all the recipients already have the shared KEK needed to decrypt the CEK and hence gain access to the encrypted content.

The techniques to protect the shared KEK are beyond the scope of this document. Only the members of the list and the key manager should have the KEK in order to maintain confidentiality. Access control to the information protected by the KEK is determined by the entity that encrypts the information, as all members of the group have access. If the entity that is performing the encryption wants to ensure some subset of the group does not gain access to the information either a different KEK should be used (shared only with this smaller group) or asymmetric algorithms should be used.

1.1. Applicability to E-mail

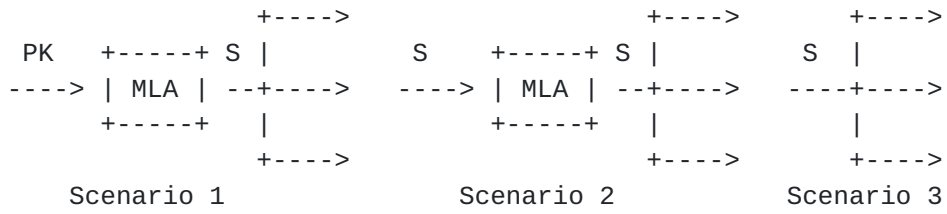
One primary audience for this distribution mechanism is e-mail. Distribution lists, sometimes referred to as mail lists, support the distribution of messages to recipients subscribed to the mail list. There are two models for how the mail list can be used. If the originator is a member of the mail list, the originator sends messages encrypted with the shared KEK to the mail list (e.g., listserv or majordomo) and the message is distributed to the mail list members. If the originator is not a member of the mail list (does not have the shared KEK), the originator sends the message (encrypted for the MLA) to the mail list agent (MLA), and then the MLA uses the shared KEK to encrypt the message for the members. In either case the recipients of the mail list use the previously distributed-shared KEK to decrypt the message.

1.2. Applicability to Repositories

Objects can also be distributed via a repository (e.g., Lightweight Directory Protocol (LDAP) servers, X.500 Directory System Agents (DSAs), Web-based servers). If an object is stored in a repository encrypted with a symmetric key algorithm, anyone with the shared KEK and access to that object can then decrypt that object. The encrypted object and the encrypted, shared KEK can be stored in the repository.

1.3. Using the Group Key

This document was written with three specific scenarios in mind: two supporting mail list agents and one for general message distribution. Scenario 1 depicts the originator sending a public key (PK) protected message to a MLA who then uses the shared KEK(s) to redistribute the message to the members of the list. Scenario 2 depicts the originator sending a shared KEK protected message to a MLA who then redistributes the message to the members of the list (the MLA only adds additional recipients). The key used by the originator could either be a key shared amongst all recipients or just between the member and the MLA. Note that if the originator use a key shared only with the MLA, then the MLA will need to decrypt the message and rencrypt the message for the list recipients. Scenario 3 shows an originator sending a shared KEK protected message to a group of recipients without an intermediate MLA.



2. Architecture

Figure 1 depicts the architecture to support symmetric key distribution. The Group List Agent (GLA) supports two distinct functions with two different agents:

- The Key Management Agent (KMA) which is responsible for generating the shared KEKs.

- The Group Management Agent (GMA) which is responsible for managing the Group List (GL) to which the shared KEKs are distributed.

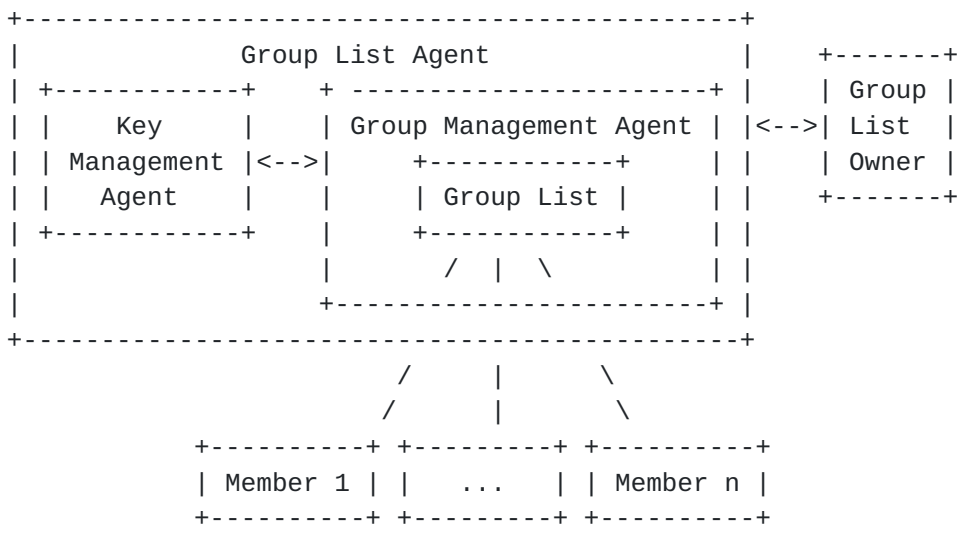


Figure 1 - Key Distribution Architecture

A GLA may support multiple KMAs. A GLA in general supports only one GMA, but the GMA may support multiple GLs. Multiple KMAs may support a GMA in the same fashion as GLAs support multiple KMAs. Assigning a particular KMA to a GL is beyond the scope of this document.

Modeling real world GL implementations shows that there are very restrictive GLs, where a human determines GL membership, and very open GLs, where there are no restrictions on GL membership. To support this spectrum, the mechanism described herein supports both managed (i.e., where access control is applied) and unmanaged (i.e., where no access control is applied) GLs. The access control mechanism for managed lists is beyond the scope of this document.

Note: If the distribution for the list is performed by an entity other than the originator (e.g., an MLA distributing a mail message), this entity can also enforce access control rules.

In either case, the GL must initially be constructed by an entity hereafter called the Group List Owner (GLO). There may be multiple entities who 'own' the GL and who are allowed to make changes to the GL's properties or membership. The GLO determines if the GL will be managed or unmanaged and is the only entity that may delete the GL. GLO(s) may or may not be GL members. GLO(s) may also set up lists that are closed, where the GLO solely determines GL membership.

Though Figure 1 depicts the GLA as encompassing both the KMA and GMA functions, the two functions could be supported by the same entity or they could be supported by two different entities. If two entities are used, they could be located on one or two platforms. There is

however a close relationship between the KMA and GMA functions. If the GMA stores all information pertaining to the GLs and the KMA merely generates keys, a corrupted GMA could cause havoc. To protect against a corrupted GMA, the KMA would be forced to double check the requests it receives to ensure the GMA did not tamper with them. These duplicative checks blur the functionality of the two components together. For this reason, the interactions between the KMA and GMA are beyond the scope of this document.

Proprietary mechanisms may be used to separate the functions by strengthening the trust relationship between the two entities. Henceforth, the distinction between the two agents is not discussed further; the term GLA will be used to address both functions. It should be noted that corrupt GLA can always cause havoc.

3. Protocol Interactions

There are existing mechanisms (e.g., listserv and majordomo) to manage GLs; however, this document does not address securing these mechanisms, as they are not standardized. Instead, it defines protocol interactions, as depicted in Figure 2, used by the GL members, GLA, and GLO(s) to manage GLs and distribute shared KEKs. The interactions have been divided into administration messages and distribution messages. The administrative messages are the request and response messages needed to setup the GL, delete the GL, add members to the GL, delete members of the GL, request a group rekey, add owners to the GL, remove owners of the GL, indicate a group key compromise, refresh a group key, interrogate the GLA, and update member's and owner's public key certificates. The distribution messages are the messages that distribute the shared KEKs. The following sections describe the ASN.1 for both the administration and distribution messages. Section 4 describes how to use the administration messages, and section 5 describes how to use the distribution messages.

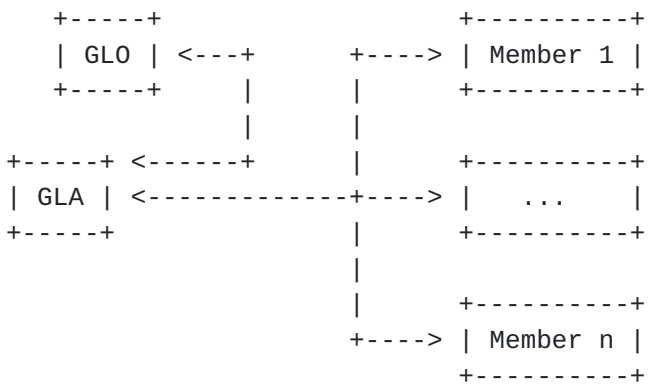


Figure 2 - Protocol Interactions

3.1. Control Attributes

To avoid creating an entirely new protocol, the Certificate Management Messages over CMS (CMC) protocol was chosen as the foundation of this protocol. The main reason for the choice was the layering aspect provided by CMC where one or more control attributes are included in message, protected with CMS, to request or respond to a desired action. The CMC PKIData structure is used for requests, and the CMC PKIResponse structure is used for responses. The content-types PKIData and PKIResponse are then encapsulated in CMS's SignedData or EnvelopedData, or a combination of the two (see section 3.2). The following are the control attributes defined in this document:

Control Attribute	OID	Syntax
glUseKEK	id-skd 1	GLUseKEK
glDelete	id-skd 2	GeneralName
glAddMember	id-skd 3	GLAddMember
glDeleteMember	id-skd 4	GLDeleteMember
glRekey	id-skd 5	GLRekey
glAddOwner	id-skd 6	GLOwnerAdministration
glRemoveOwner	id-skd 7	GLOwnerAdministration
glkCompromise	id-skd 8	GeneralName
glkRefresh	id-skd 9	GLKRefresh
glaQueryRequest	id-skd 11	GLAQueryRequest
glaQueryResponse	id-skd 12	GLAQueryResponse
glProvideCert	id-skd 13	GLManageCert
glUpdateCert	id-skd 14	GLManageCert
glKey	id-skd 15	GLKey

In the following conformance tables, the column headings have the following meanings: O for originate, R for receive, and F for forward. There are three types of implementations: GLOs, GLAs, and GL members. The GLO is an optional component hence all GLO O and GLO R messages are optional, and GLA F messages are optional. The first table includes messages that conformant implementions MUST support. The second table includes messages that MAY be implemented. The second table should be interpreted as follows: if the control attribute is implemented by a component then it must be implemented as indicated. For example, if a GLA is implemented that supports the glAddMember control attribute, then it MUST support receiving the glAddMember message. Note that "-" means not applicable.

Required

Implementation Requirement						Control
GLO		GLA		GL Member		Attribute
O	R	O	R	F	O	R	
MAY	-	MUST	-	MAY	-	MUST	glProvideCert
MAY	MAY	-	MUST	MAY	MUST	-	glUpdateCert
-	-	MUST	-	-	-	MUST	glKey

Optional

Implementation Requirement						Control
GLO		GLA		GL Member		Attribute
O	R	O	R	F	O	R	
MAY	-	-	MAY	-	-	-	glUseKEK
MAY	-	-	MAY	-	-	-	glDelete
MAY	MAY	-	MUST	MAY	MUST	-	glAddMember
MAY	MAY	-	MUST	MAY	MUST	-	glDeleteMember
MAY	-	-	MAY	-	-	-	glRekey
MAY	-	-	MAY	-	-	-	glAddOwner
MAY	-	-	MAY	-	-	-	glRemoveOwner
MAY	MAY	-	MUST	MAY	MUST	-	glkCompromise
MAY	-	-	MUST	-	MUST	-	glkRefresh
MAY	-	-	SHOULD	-	MAY	-	glaQueryRequest
-	MAY	SHOULD	-	-	-	MAY	glaQueryResponse

glaQueryResponse and gloResponse are carried in the CMC PKIResponse content-type, all other control attributes are carried in the CMC PKIData content-type. The exception is glUpdateCert which can be carried in either PKIData or PKIResponse.

Success and failure messages use CMC (see section 3.2.4).

3.1.1. GL USE KEK

The GLO uses glUseKEK to request that a shared KEK be assigned to a GL. glUseKEK messages MUST be signed by the GLO. The glUseKEK control attribute has the syntax GLUseKEK:

```
GLUseKEK ::= SEQUENCE {
  glInfo            GLInfo,
  glOwnerInfo       SEQUENCE SIZE (1..MAX) OF GLOwnerInfo,
  glAdministration  GLAdministration DEFAULT 1,
  glKeyAttributes   GLKeyAttributes OPTIONAL }

GLInfo ::= SEQUENCE {
  glName     GeneralName,
  glAddress  GeneralName }

GLOwnerInfo ::= SEQUENCE {
  glOwnerName     GeneralName,
  glOwnerAddress  GeneralName,
  certificate     Certificates OPTIONAL }

Certificates ::= SEQUENCE {
  pKC       [0] Certificate OPTIONAL,
                -- See [PROFILE]
  aC        [1] SEQUENCE SIZE (1.. MAX) OF
                  AttributeCertificate OPTIONAL,
                -- See [ACPROF]
  certPath  [2] CertificateSet OPTIONAL }
                -- From [CMS]

-- CertificateSet and CertificateChoices are included only
-- for illustrative purposes as they are imported from [CMS].

CertificateSet ::= SET SIZE (1..MAX) OF CertificateChoices

-- CertificateChoices supports X.509 public key certificates in
-- certificates and v2 attribute certificates in v2AttrCert.

GLAdministration ::= INTEGER {
  unmanaged  (0),
  managed    (1),
  closed     (2) }
```

```
GLKeyAttributes ::= SEQUENCE {
  rekeyControlledByGLO        [0] BOOLEAN DEFAULT FALSE,
  recipientsNotMutuallyAware  [1] BOOLEAN DEFAULT TRUE,
  duration                    [2] INTEGER DEFAULT 0,
  generationCounter           [3] INTEGER DEFAULT 2,
  requestedAlgorithm          [4] AlgorithmIdentifier
                                  DEFAULT { id-aes128-wrap } }
```

The fields in GLUseKEK have the following meaning:

- glInfo indicates the name of the GL in glName and the address of the GL in glAddress. The glName and glAddress can be the same, but this is not always the case. Both the name and address MUST be unique for a given GLA.

- glOwnerInfo indicates:

  -- glOwnerName indicates the name of the owner of the GL. One of the names in glOwnerName MUST match one of the names in the certificate (either the subject distinguished name or one of the subject alternative names) used to sign this SignedData.PKIData creating the GL (i.e., the immediate signer).

  -- glOwnerAddress indicates the address of the owner of the GL.

  -- certificates MAY be included. It contains the following three fields:

    --- certificates.pKC includes the encryption certificate for the GLO. It will be used to encrypt responses for the GLO.

    --- certificates.aC MAY be included to convey any attribute certificate (see [ACPROF]) associated with the encryption certificate of the GLO included in certificates.pKC.

    --- certificates.certPath MAY also be included to convey certificates that might aid the recipient in constructing valid certification paths for the certificate provided in certificates.pKC and the attribute certificates provided in certificates.aC. Theses certificates are optional because they might already be included elsewhere in the message (e.g., in the outer CMS layer).

-- glAdministration indicates how the GL ought to be administered. The default is for the list to be managed. Three values are supported for glAdministration:

--- Unmanaged - When the GLO sets glAdministration to unmanaged, it is allowing prospective members to request addition and deletion from the GL without GLO intervention.

--- Managed - When the GLO sets glAdministration to managed, it is allowing prospective members to request addition and deletion from the GL, but the request is redirected by the GLA to GLO for review. The GLO makes the determination as to whether to honor the request.

--- Closed - When the GLO sets glAdministration to closed, it is not allowing prospective members to request addition or deletion from the GL. The GLA will only accept glAddMember and glDeleteMember requests from the GLO.

-- glKeyAttributes indicates the attributes the GLO wants the GLA to assign to the shared KEK. If this field is omitted, GL rekeys will be controlled by the GLA, the recipients are allowed to know about one another, the algorithm will be Triple-DES (see paragrpah 7), the shared KEK will be valid for a calendar month (i.e., first of the month until the last day of the month), and two shared KEKs will be distributed initially. The fields in glKeyAttributes have the following meaning:

--- rekeyControlledByGLO indicates whether the GL rekey messages will be generated by the GLO or by the GLA. The default is for the GLA to control rekeys. If GL rekey is controlled by the GLA, the GL will continue to be rekeyed until the GLO deletes the GL or changes the GL rekey to be GLO controlled.

--- recipientsNotMutuallyAware indicates that the GLO wants the GLA to distribute the shared KEK individually for each of the GL members (i.e., a separate glKey message is sent to each recipient). The default is for separate glKey message not to be required.

NOTE: This supports lists where one member does not know the identities of the other members. For example, a list is configured granting submit permissions to

only one member. All other members are 'listening.' The security policy of the list does not allow the members to know who else is on the list. If a glKey is constructed for all of the GL members, information about each of the members may be derived from the information in RecipientInfos. To make sure the glkey message does not divulge information about the other recipients, a separate glKey message would be sent to each GL member.

--- duration indicates the length of time (in days) during which the shared KEK is considered valid. The value zero (0) indicates that the shared KEK is valid for a calendar month in the UTC Zulu time zone. For example if the duration is zero (0), if the GL shared KEK is requested on July 24, the first key will be valid until the end of July and the next key will be valid for the entire month of August. If the value is not zero (0), the shared KEK will be valid for the number of days indicated by the value. For example, if the value of duration is seven (7) and the shared KEK is requested on Monday but not generated until Tuesday (2359); the shared KEKs will be valid from Tuesday (2359) to Tuesday (2359). The exact time of the day is determined when the key is generated.

--- generationCounter indicates the number of keys the GLO wants the GLA to distribute. To ensure uninterrupted function of the GL two (2) shared KEKs at a minimum MUST be initially distributed. The second shared KEK is distributed with the first shared KEK, so that when the first shared KEK is no longer valid the second key can be used. If the GLA controls rekey then it also indicates the number of shared KEKs the GLO wants outstanding at any one time. See sections 4.5 and 5 for more on rekey.

--- requestedAlgorithm indicates the algorithm and any parameters the GLO wants the GLA to use with the shared KEK. The parameters are conveyed via the SMIMECapabilities attribute (see [MSG]). See section 6 for more on algorithms.

3.1.2. Delete GL

GLOs use glDelete to request that a GL be deleted from the GLA. The glDelete control attribute has the syntax GeneralName. The glDelete

message MUST be signed by the GLO. The name of the GL to be deleted is included in GeneralName:

```
DeleteGL ::= GeneralName
```

3.1.3. Add GL Member

GLOs use the glAddMember to request addition of new members, and prospective GL members use the glAddMember to request their own addition to the GL. The glAddMember message MUST be signed by either the GLO or the prospective GL member. The glAddMember control attribute has the syntax GLAddMember:

```
GLAddMember ::= SEQUENCE {
 glName    GeneralName,
 glMember  GLMember }

GLMember ::= SEQUENCE {
  glMemberName     GeneralName,
  glMemberAddress  GeneralName OPTIONAL,
  certificates     Certificates OPTIONAL }
```

The fields in GLAddMembers have the following meaning:

- glName indicates the name of the GL to which the member should be added.

- glMember indicates the particulars for the GL member. Both of the following fields must be unique for a given GL:

  -- glMemberName indicates the name of the GL member.

  -- glMemberAddress indicates the GL member's address. It MUST be included.

     Note: In some instances the glMemberName and glMemberAddress may be the same, but this is not always the case.

  -- certificates MUST be included. It contains the following three fields:

     --- certificates.pKC includes the member's encryption certificate. It will be used, at least initially, to encrypt the shared KEK for that member. If the message is generated by a prospective GL member, the pKC MUST be included. If the message is generated by a GLO, the pKC SHOULD be included.

--- certificates.aC MAY be included to convey any attribute certificate (see [ACPROF]) associated with the member's encryption certificate.

--- certificates.certPath MAY also be included to convey certificates that might aid the recipient in constructing valid certification paths for the certificate provided in certificates.pKC and the attribute certificates provided in certificates.aC. These certificates are optional because they might already be included elsewhere in the message (e.g., in the outer CMS layer).

3.1.4. Delete GL Member

GLOs use the glDeleteMember to request deletion of GL members, and GL members use the glDeleteMember to request their own removal from the GL. The glDeleteMember message MUST be signed by either the GLO or the GL member. The glDeleteMember control attribute has the syntax GLDeleteMember:

```
GLDeleteMember ::= SEQUENCE {
  glName            GeneralName,
  glMemberToDelete  GeneralName }
```

The fields in GLDeleteMembers have the following meaning:

- glName indicates the name of the GL from which the member should be removed.

- glMemberToDelete indicates the name or address of the member to be deleted.

3.1.5. Rekey GL

GLOs use the glRekey to request a GL rekey. The glRekey message MUST be signed by the GLO. The glRekey control attribute has the syntax GLRekey:

```
GLRekey ::= SEQUENCE {
  glName              GeneralName,
  glAdministration    GLAdministration OPTIONAL,
  glNewKeyAttributes  GLNewKeyAttributes OPTIONAL,
  glRekeyAllGLKeys    BOOLEAN OPTIONAL }
```

```
GLNewKeyAttributes ::= SEQUENCE {
  rekeyControlledByGLO       [0] BOOLEAN OPTIONAL,
  recipientsNotMutuallyAware [1] BOOLEAN OPTIONAL,
  duration                   [2] INTEGER OPTIONAL,
  generationCounter          [3] INTEGER OPTIONAL,
  requestedAlgorithm         [4] AlgorithmIdentifier OPTIONAL }
```

The fields in GLRekey have the following meaning:

- glName indicates the name of the GL to be rekeyed.

- glAdministration indicates if there is any change to how the GL should be administered. See section 3.1.1 for the three options. This field is only included if there is a change from the previously registered administered.

- glNewKeyAttributes indicates whether the rekey of the GLO is controlled by the GLA or GL, what algorithm and parameters the GLO wishes to use, the duration of the key, and how many keys will be issued. The field is only included if there is a change from the previously registered glKeyAttributes.

- glRekeyAllGLKeys indicates whether the GLO wants all of the outstanding GL's shared KEKs rekeyed. If it is set to TRUE then all outstanding KEKs MUST be issued. If it is set to FALSE then all outstanding KEKs need not be resissued.

3.1.6. Add GL Owner

GLOs use the glAddOwner to request that a new GLO be allowed to administer the GL. The glAddOwner message MUST be signed by a registered GLO. The glAddOwner control attribute has the syntax GLOwnerAdministration:

```
GLOwnerAdministration ::= SEQUENCE {
  glName       GeneralName,
  glOwnerInfo  GLOwnerInfo }
```

The fields in GLAddOwners have the following meaning:

- glName indicates the name of the GL to which the new GLO should be associated.

- glOwnerInfo indicates the name, address, and certificates of the new GLO. As this message includes names of new GLOs, the certificates.pKC MUST be included, and it MUST include the encryption certificate of the new GLO.

3.1.7. Remove GL Owner

GLOs use the glRemoveOwner to request that a GLO be disassociated with the GL. The glRemoveOwner message MUST be signed by a registered GLO. The glRemoveOwner control attribute has the syntax GLOwnerAdministration:

```
GLOwnerAdministration ::= SEQUENCE {
  glName       GeneralName,
  glOwnerInfo  GLOwnerInfo }
```

The fields in GLRemoveOwners have the following meaning:

- glName indicates the name of the GL to which the GLO should be disassociated.

- glOwnerInfo indicates the name and address of the GLO to be removed. The certificates field SHOULD be omitted, as it will be ignored.

3.1.8. GL Key Compromise

GL members and GLOs use glkCompromise to indicate that the shared KEK possessed has been compromised. The glKeyCompromise control attribute has the syntax GeneralName. This message is always redirected by the GLA to the GLO for further action. The glkCompromise MAY be included in an EnvelopedData generated with the compromised shared KEK. The name of the GL to which the compromised key is associated with is placed in GeneralName:

```
GLKCompromise ::= GeneralName
```

3.1.9. GL Key Refresh

GL members use the glkRefresh to request that the shared KEK be redistributed to them. The glkRefresh control attribute has the syntax GLKRefresh.

```
GLKRefresh ::= SEQUENCE {
 glName  GeneralName,
 dates   SEQUENCE SIZE (1..MAX) OF Date }

Date ::= SEQUENCE {
  start GeneralizedTime,
  end   GeneralizedTime OPTIONAL }
```

The fields in GLKRefresh have the following meaning:

- glName indicates the name of the GL for which the GL member wants shared KEKs.

- dates indicates a date range for keys the GL member wants. The start field indicates the first date the GL member wants and the end field indicates the last date. The end date MAY be omitted to indicate the GL member wants all keys from the specified start date to the current date. Note that a procedural mechanism is needed to restrict users from accessing messages that they are not allowed to access.

3.1.10. GLA Query Request and Response

There are situations where GLOs and GL members may need to determine some information from the GLA about the GL. GLOs and GL members use the glaQueryRequest, defined in section 3.1.10.1, to request information and GLAs use the glaQueryResponse, defined in section 3.1.10.2, to return the requested information. Section 3.1.10.3 includes one request and response type and value; others may be defined in additional documents.

3.1.10.1. GLA Query Request

GLOs and GL members use the glaQueryRequest to ascertain information about the GLA. The glaQueryRequest control attribute has the syntax GLAQueryRequest:

```
GLAQueryRequest ::= SEQUENCE {
  glaRequestType   OBJECT IDENTIFIER,
  glaRequestValue  ANY DEFINED BY glaRequestType }
```

3.1.10.2. GLA Query Response

GLAs return the glaQueryResponse after receiving a GLAQueryRequest. The glaQueryResponse MUST be signed by a GLA. The glaQueryResponse control attribute has the syntax GLAQueryResponse:

```
GLAQueryResponse ::= SEQUENCE {
  glaResponseType   OBJECT IDENTIFIER,
  glaResponseValue  ANY DEFINED BY glaResponseType }
```

3.1.10.3. Request and Response Types

Request and Responses are registered as a pair under the following object identifier arc:

```
id-cmc-glaRR OBJECT IDENTIFIER ::= { id-cmc 99 }
```

This document defines one request/response pair for GL members and GLOs to query the GLA for the list of algorithm it supports. The following object identifier (OID) is included in the glaQueryType field:

```
id-cmc-gla-skdAlgRequest OBJECT IDENTIFIER ::={ id-cmc-glaRR 1 }

SKDAlgRequest ::= NULL
```

If the GLA supports GLAQueryRequest and GLAQueryResponse messages, the GLA may return the following OID in the glaQueryType field:

```
id-cmc-gla-skdAlgResponse OBJECT IDENTIFIER ::= { id-cmc-glaRR 2 }
```

The glaQueryValue has the form of the smimeCapabilities attributes as defined in [MSG].

3.1.11. Provide Cert

GLAs and GLOs use the glProvideCert to request that a GL member provide an updated or new encryption certificate. The glProvideCert message MUST be signed by either GLA or GLO. If the GL member's PKC has been revoked, the GLO or GLA MUST NOT use it to generate the EnvelopedData that encapsulates the glProvideCert request. The glProvideCert control attribute has the syntax GLManageCert:

```
GLManageCert ::= SEQUENCE {
  glName    GeneralName,
  glMember  GLMember }
```

The fields in GLManageCert have the following meaning:

- glName indicates the name of the GL to which the GL member's new certificate is to be associated.

- glMember indicates particulars for the GL member:

  -- glMemberName indicates the GL member's name.

-- glMemberAddress indicates the GL member's address. It MAY be omitted.

-- certificates SHOULD be omitted.

3.1.12. Update Cert

GL members and GLOs use the glUpdateCert to provide a new certificate for the GL. GL members can generate an unsolicited glUpdateCert or generate a response glUpdateCert as a result of receiveing a glProvideCert message. GL members MUST sign the glUpdateCert. If the GL member's encryption certificate has been revoked, the GL member MUST NOT use it to generate the EnvelopedData that encapsulates the glUpdateCert request or response. The glUpdateCert control attribute has the syntax GLManageCert:

```
GLManageCert ::= SEQUENCE {
  glName    GeneralName,
  glMember  GLMember }
```

The fields in GLManageCert have the following meaning:

- glName indicates the name of the GL to which the GL member's new certificate should be associated.

- glMember indicates the particulars for the GL member:

  -- glMemberName indicates the GL member's name.

  -- glMemberAddress indicates the GL member's address. It MAY be omitted.

  -- certificates MAY be omitted if the GLManageCert message is sent to request the GL member's certificate; otherwise, it MUST be included. It includes the following three fields:

    ---- certificates.pKC includes the member's encryption certificate that will be used to encrypt the shared KEK for that member.

    --- certificates.aC MAY be included to convey one or more attribute certificate associated with the member's encryption certificate.

    --- certificates.certPath MAY also be included to convey certificates that might aid the recipient in constructing valid certification paths for the

certificate provided in certificates.pKC and the attribute certificates provided in certificates.aC. These certificates is optional because they might already be included elsewhere in the message (e.g., in the outer CMS layer).

3.1.13. GL Key

The GLA uses the glKey to distribute the shared KEK. The glKey message MUST be signed by the GLA. The glKey control attribute has the syntax GLKey:

```
  GLKey ::= SEQUENCE {
    glName        GeneralName,
    glIdentifier  KEKIdentifier,      -- See [CMS]
    glkWrapped    RecipientInfos,     -- See [CMS]
    glkAlgorithm  AlgorithmIdentifier,
    glkNotBefore  GeneralizedTime,
    glkNotAfter   GeneralizedTime }

-- KEKIdentifier is included only for illustrative purposes as
-- it is imported from [CMS].

  KEKIdentifier ::= SEQUENCE {
    keyIdentifier OCTET STRING,
    date GeneralizedTime OPTIONAL,
    other OtherKeyAttribute OPTIONAL }
```

The fields in GLKey have the following meaning:

- glName is the name of the GL.

- glIdentifier is the key identifier of the shared KEK. See paragraph 6.2.3 of [CMS] for a description of the subfields.

- glkWrapped is the wrapped shared KEK for the GL for a particular duration. The RecipientInfos MUST be generated as specified in section 6.2 of [CMS]. The ktri RecipientInfo choice MUST be supported. The key in the EncryptedKey field (i.e., the distributed shared KEK) MUST be generated according to the section concerning random number generation in the security considerations of [CMS].

- glkAlgorithm identifies the algorithm the shared KEK is used with. Since no encrypted data content is being conveyed at this point, the parameters encoded with the algorithm should be the

structure defined for smimeCapabilities rather than encrypted content.

- glkNotBefore indicates the date at which the shared KEK is considered valid. GeneralizedTime values MUST be expressed in UTC (Zulu) and MUST include seconds (i.e., times are YYYYMMDDHHMMSSZ), even where the number of seconds is zero. GeneralizedTime values MUST NOT include fractional seconds.

- glkNotAfter indicates the date after which the shared KEK is considered invalid. GeneralizedTime values MUST be expressed in UTC (Zulu) and MUST include seconds (i.e., times are YYYYMMDDHHMMSSZ), even where the number of seconds is zero. GeneralizedTime values MUST NOT include fractional seconds.

If the glKey message is in response to a glUseKEK message:

- The GLA MUST generate separate glKey messages for each recipient if glUseKEK.glKeyAttributes.recipientsNotMutuallyAware is set to TRUE. For each recipient, you want to generate a message that contains that recipient's key (i.e., one message with one attribute).

- The GLA MUST generate the requested number of glKey messages. The value in glUseKEK.glKeyAttributes.generationCounter indicates the number of glKey messages requested.

If the glKey message is in response to a glRekey message:

- The GLA MUST generate separate glKey messages for each recipient if glRekey.glNewKeyAttributes.recipientsNotMutuallyAware is set to TRUE.

- The GLA MUST generate the requested number of glKey messages. The value in glUseKEK.glKeyAttributes.generationCounter indicates the number of glKey messages requested.

- The GLA MUST generate one glKey messagefor each outstanding shared KEKs for the GL when glRekeyAllGLKeys is set to TRUE.

If the glKey message was not in response to a glRekey or glUseKEK (e.g., where the GLA controls rekey):

- The GLA MUST generate separate glKey messages for each recipient when glUseKEK.glNewKeyAttributes.recipientsNotMutuallyAware that set up the GL was set to TRUE.

- The GLA MAY generate glKey messages prior to the duration on the last outstanding shared KEK expiring, where the number of glKey messages generated is generationCounter minus one (1). Other distribution mechanisms can also be supported to support this functionality.

3.2. Use of CMC, CMS, and PKIX

The following sections outline the use of CMC, CMS, and the PKIX certificate and CRL profile.

3.2.1. Protection Layers

The following sections outline the protection required for the control attributes defined in this document.

Note: There are multiple ways to encapsulate SignedData and EnvelopedData. The first is to use a MIME wrapper around each ContentInfo, as specified in [MSG]. The second is to not use a MIME wrapper around each ContentInfo, as specified in Transporting S/MIME Objects in X.400 [X400TRANS].

3.2.1.1. Minimum Protection

At a minimum, a SignedData MUST protect each request and response encapsulated in PKIData and PKIResponse. The following is a depiction of the minimum wrappings:

```
Minimum Protection
------------------
SignedData
 PKIData or PKIResponse
  controlSequence
```

Prior to taking any action on any request or response SignedData(s) MUST be processed according to [CMS].

3.2.1.2. Additional Protection

An additional EnvelopedData MAY also be used to provide confidentiality of the request and response. An additional SignedData MAY also be added to provide authentication and integrity of the encapsulated EnvelopedData. The following is a depiction of the optional additional wrappings:

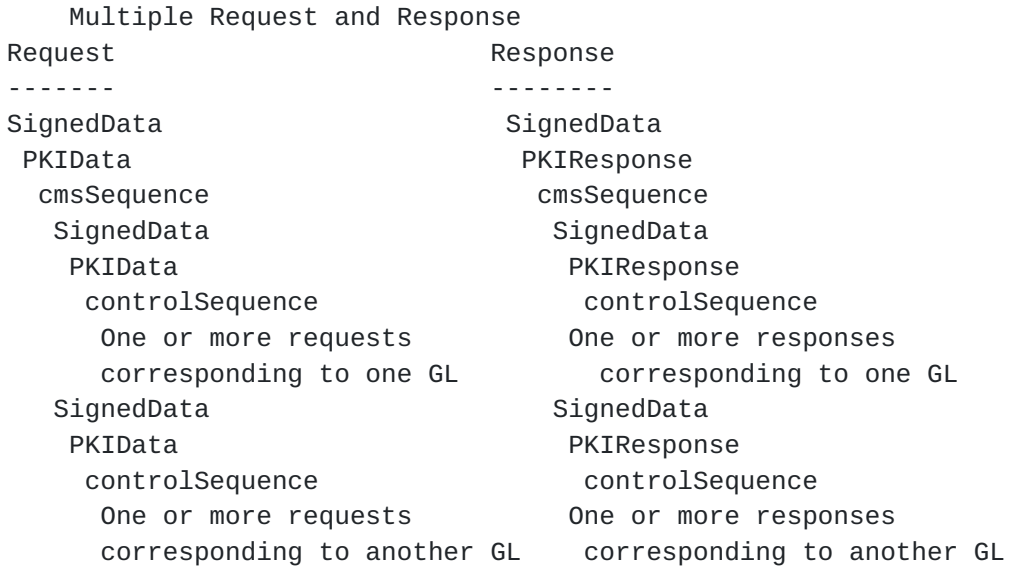
Confidentiality Protection	Authentication and Integrity of Confidentiality Protection
EnvelopedData	SignedData
SignedData	EnvelopedData
PKIData or PKIResponse	SignedData
controlSequence	PKIData or PKIResponse
	controlSequence

If an incoming message is encrypted, the confidentiality of the message MUST be preserved. All EnvelopedData objects MUST be processed as specified in [CMS]. If a SignedData is added over an EnvelopedData, a ContentHints attribute SHOULD be added. See paragraph 2.9 of Extended Security Services for S/MIME [ESS].

If the GLO or GL member applies confidentiality to a request, the EnvelopedData MUST include the GLA as a recipient. If the GLA forwards the GL member request to the GLO, then the GLA MUST decrypt the EnvelopedData content, strip the confidentiality layer, and apply its own confidentiality layer as an EnvelopedData with the GLO as a recipient.

3.2.2. Combining Requests and Responses

Multiple requests and response corresponding to a GL MAY be included in one PKIData.controlSequence or PKIResponse.controlSequence. Requests and responses for multiple GLs MAY be combined in one PKIData or PKIResponse by using PKIData.cmsSequence and PKIResponse.cmsSequence. A separate cmsSequence MUST be used for different GLs. That is, requests corresponding to two different GLs are included in different cmsSequences. The following is a diagram depicting multiple requests and responses combined in one PKIData and PKIResponse:



When applying confidentiality to multiple requests and responses, all of the requests/response MAY be included in one EnvelopedData.

The following is a depiction:

```
Confidentiality of Multiple Requests and Responses
Wrapped Together
----------------
EnvelopedData
 SignedData
  PKIData
   cmsSequence
    SignedData
     PKIResponse
      controlSequence
       One or more requests
       corresponding to one GL
    SignedData
     PKIData
      controlSequence
       One or more requests
       corresponding to one GL
```

Certain combinations of requests in one PKIData.controlSequence and one PKIResponse.controlSequence are not allowed. The invalid combinations listed here MUST NOT be generated:

Invalid Combinations	
glUseKEK	& glDeleteMember
glUseKEK	& glRekey
glUseKEK	& glDelete
glDelete	& glAddMember
glDelete	& glDeleteMember
glDelete	& glRekey
glDelete	& glAddOwner
glDelete	& glRemoveOwner

To avoid unnecessary errors, certain requests and responses SHOULD be processed prior to others. The following is the priority of message processing, if not listed it is an implementation decision as to which to process first: glUseKEK before glAddMember, glRekey before glAddMember, and glDeleteMember before glRekey. Note that there is a processing priority but it does not imply an ordering within the content.

3.2.3. GLA Generated Messages

When the GLA generates a success or fail message, it generates one for each request. SKDFailInfo values of unsupportedDuration,

unsupportedDeliveryMethod, unsupportedAlgorithm, noGLONameMatch, nameAlreadyInUse, alreadyAnOwner, notAnOwner are not returned to GL members.

If GLKeyAttributes.recipientsNotMutuallyAware is set to TRUE, a separate PKIResponse.cMCStatusInfoExt and PKIData.glKey MUST be generated for each recipient. However, it is valid to send one message with multiple attributes to the same recipient.

If the GL has multiple GLOs, the GLA MUST send cMCStatusInfoExt messages to the requesting GLO. The mechanism to determine which GLO made the request is beyond the scope of this document.

If a GL is managed and the GLA receives a glAddMember, glDeleteMember, or glkCompromise message, the GLA redirects the request to the GLO for review. An additional, SignedData MUST be applied to the redirected request as follows:

```
GLA Forwarded Requests
----------------------
SignedData
 PKIData
   cmsSequence
     SignedData
      PKIData
       controlSequence
```

3.2.4. CMC Control Attributes and CMS Signed Attributes

CMC carries control attributes as CMS signed attributes. These attributes are defined in [CMC] and [CMS]. Some of these attributes are REQUIRED; others are OPTIONAL. The required attributes are as follows: cMCStatusInfoExt transactionId, senderNonce, recipientNonce, queryPending, and signingTime. Other attributes can also be used; however, their use is beyond the scope of this document. The following sections specify requirements in addition to those already specified in [CMC] and [CMS].

3.2.4.1. Using cMCStatusInfoExt

cMCStatusInfoExt is used by GLAs to indicate to GLOs and GL members that a request was unsuccessful. Two classes of failure codes are used within this document. Errors from the CMCFailInfo list, found in section 5.1.4 of CMC, are encoded as defined in CMC. Error codes defined in this document are encoded using the ExtendedFailInfo field of the cmcStatusInfoExt structure. If the same failure code applies to multiple commands, a single cmcStatusInfoExt structure can be used

with multiple items in cMCStatusInfoExt.bodyList. The GLA MAY also return other pertinent information in statusString. The SKDFailInfo object identifier and value are:

```
id-cet-skdFailInfo OBJECT IDENTIFIER ::= { iso(1)
  identified-organization(3) dod(6) internet(1) security(5)
  mechanisms(5) pkix(7) cet(15) skdFailInfo(1) }

SKDFailInfo ::= INTEGER {
  unspecified           (0),
  closedGL              (1),
  unsupportedDuration   (2),
  noGLACertificate      (3),
  invalidCert           (4),
  unsupportedAlgorithm  (5),
  noGLONameMatch        (6),
  invalidGLName         (7),
  nameAlreadyInUse      (8),
  noSpam                (9),
  deniedAccess          (10),
  alreadyAMember        (11),
  notAMember            (12),
  alreadyAnOwner        (13),
  notAnOwner            (14) }
```

The values have the following meaning:

- unspecified indicates that the GLA is unable or unwilling to perform the requested action and does not want to indicate the reason.

- closedGL indicates that members can only be added or deleted by the GLO.

- unsupportedDuration indicates the GLA does not support generating keys that are valid for the requested duration.

- noGLACertificate indicates that the GLA does not have a valid certificate.

- invalidCert indicates the member's encryption certificate was not verifiable (i.e., signature did not validate, certificate's serial number present on a CRL, expired, etc.).

- unsupportedAlgorithm indicates the GLA does not support the requested algorithm.

- noGLONameMatch indicates that one of the names in the certificate used to sign a request does not match the name of a registered GLO.

- invalidGLName indicates the GLA does not support the glName present in the request.

- nameAlreadyInUse indicates the glName is already assigned on the GLA.

- noSpam indicates the prospective GL member did not sign the request (i.e., if the name in glMember.glMemberName does not match one of the names (either the subject distinguished name or one of the subject alternative names) in the certificate used to sign the request).

- alreadyAMember indicates the prospective GL member is already a GL member.

- notAMember indicates the prospective GL member to be deleted is not presently a GL member.

- alreadyAnOwner indicates the prospective GLO is already a GLO.

- notAnOwner indicates the prospective GLO to be deleted is not presently a GLO.

cMCStatusInfoExt is used by GLAs to indicate to GLOs and GL members that a request was successfully completed. If the request was successful, the GLA returns a cMCStatusInfoExt response with cMCStatus.success and optionally other pertinent information in statusString.

When the GL is managed and the GLO has reviewed GL member initiated glAddMember, glDeleteMember, and glkComrpomise requests, the GLO uses cMCStatusInfoExt to indicate the success or failure of the request. If the request is allowed, cMCStatus.success is returned and statusString is optionally returned to convey additional information. If the request is denied, cMCStatus.failed is returned and statusString is optionally returned to convey additional information. Additionally, the appropriate SKDFailInfo can be included in cMCStatusInfoExt.extendedFailInfo.

cMCStatusInfoExt is used by GLOs, GLAs, and GL members to indicate that signature verification failed. If the signature failed to verify over any control attibute except a cMCStatusInfoExt, a cMCStatusInfoExt control attribute MUST be returned indicating

cMCStatus.failed and otherInfo.failInfo.badMessageCheck. If the signature over the outermost PKIData failed, the bodyList value is zero (0). If the signature over any other PKIData failed the bodyList value is the bodyPartId value from the request or response. GLOs and GL members who receive cMCStatusInfoExt messages whose signatures are invalid SHOULD generate a new request to avoid badMessageCheck message loops.

cMCStatusInfoExt is also used by GLOs and GLAs to indicate that a request could not be performed immediately. If the request could not be processed immediately by the GLA or GLO, the cMCStatusInfoExt control attribute MUST be returned indicating cMCStatus.pending and otherInfo.pendInfo. When requests are redirected to the GLO for approval (for managed lists), the GLA MUST NOT return a cMCStatusInfoExt indicating query pending.

cMCStatusInfoExt is also used by GLAs to indicate that a glaQueryRequest is not supported. If the glaQueryRequest is not supported, the cMCStatusInfoExt control attribute MUST be returned indicating cMCStatus.noSupport and statusString is optionally returned to convey additional information.

cMCStatusInfoExt is also used by GL members, GLOs, and GLAs to indicate that the signingTime (see section 3.2.4.3) is not close enough to the locally specified time. If the local time is not close enough to the time specified in signingTime, a cMCStatus.failed and otherInfo.failInfo.badTime MAY be returned.

3.2.4.2. Using transactionId

transactionId MAY be included by GLOs, GLAs, or GL members to identify a given transaction. All subsequent requests and responses related to the original request MUST include the same transactionId control attribute. If GL members include a transactionId and the request is redirected to the GLO, the GLA MAY include an additional transactionId in the outer PKIData. If the GLA included an additional transactionId in the outer PKIData, when the GLO generates a cMCStatusInfoExt response it generates one for the GLA with the GLA's transactionId and one for the GL member with the GL member's transactionId.

3.2.4.3. Using nonces and signingTime

The use of nonces (see section 5.6 of [CMC]) and an indication of when the message was signed (see section 11.3 of [CMS]) can be used to provide application-level replay prevention.

To protect the GL, all messages MUST include the signingTime attribute. Message originators and recipients can then use the time provided in this attribute to determine whether they have previously received the message.

If the originating message includes a senderNonce, the response to the message MUST include the received senderNonce value as the recipientNonce and a new value as the senderNonce value in the response.

If a GLA aggragates multiple messages together or forwards a message to a GLO, the GLA MAY optionally generate a new nonce value and include that in the wrapping message. When the response comes back from the GLO, the GLA builds a response to the originator(s) of the message(s) and deals with each of the nonce values from the originating messages.

For these attributes it is necessary to maintain state information on exchanges to compare one result to another. The time period for which this information is maintained in a local policy.

3.2.4.4. CMC and CMS Attribute Support Requirements

The following are the implementation requirements for CMC control attributes and CMS signed attributes for an implementation be considered conformant to this specification:

Implementation Requirement						
GLO		GLA			GL Member		Attribute
O	R	O	R	F	O	R	
MUST	MUST	MUST	MUST	-	MUST	MUST	cMCStatusInfoExt
MAY	MAY	MUST	MUST	-	MAY	MAY	transactionId
MAY	MAY	MUST	MUST	-	MAY	MAY	senderNonce
MAY	MAY	MUST	MUST	-	MAY	MAY	recepientNonce
MUST	MUST	MUST	MUST	-	MUST	MUST	SKDFailInfo
MUST	MUST	MUST	MUST	-	MUST	MUST	signingTime

3.2.5. Resubmitted GL Member Messages

When the GL is managed, the GLA forwards the GL member requests to the GLO for GLO approval by creating a new request message containing the GL member request(s) as a cmsSequence item. If the GLO approves the request it can either add a new layer of wrapping and send it back to the GLA or create a new message and send it to the GLA. (Note in this case there are now 3 layers of PKIData messages with appropriate signing layers.)

3.2.6. PKIX Certificate and CRL Profile

Signatures, certificates, and CRLs are verified according to the PKIX profile [PROFILE].

Name matching is performed according to the PKIX profile [PROFILE].

All distinguished name forms must follow the UTF8String convention noted in the PKIX profile [PROFILE].

A certificate per-GL would be issued to the GLA.

GL policy may mandate that the GL member's address be included in the GL member's certificate.

4. Administrative Messages

There are a number of administrative messages that must be performed to manage a GL. The following sections describe each request and response message combination in detail. The procedures defined in this section are not prescriptive.

4.1. Assign KEK To GL

Prior to generating a group key, a GL needs to be setup and a shared KEK assigned to the GL. Figure 3 depicts the protocol interactions to setup and assign a shared KEK. Note that error messages are not depicted in Figure 3. Additionally, behavior for the optional transactionId, senderNonce, and recipientNonce CMC control attributes is not addressed in these procedures.

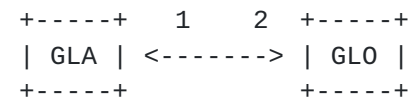


Figure 3 - Create Group List

The process is as follows:

1 - The GLO is the entity responsible for requesting the creation of the GL. The GLO sends a SignedData.PKIData.controlSequence.glUseKEK request to the GLA (1 in Figure 3). The GLO MUST include: glName, glAddress, glOwnerName, glOwnerAddress, and glAdministration. The GLO MAY also include their preferences for the shared KEK in glKeyAttributes by indicating whether the GLO controls the rekey in rekeyControlledByGLO, whether separate glKey messages

should be sent to each recipient in recipientsNotMutuallyAware, the requested algorithm to be used with the shared KEK in requestedAlgorithm, the duration of the shared KEK, and how many shared KEKs should be initially distributed in generationCounter. The GLO MUST also include the signingTime attribute with this request.

1.a - If the GLO knows of members to be added to the GL, the glAddMember request(s) MAY be included in the same controlSequence as the glUseKEK request (see section 3.2.2). The GLO indicates the same glName in the glAddMember request as in glUseKEK.glInfo.glName. Further glAddMember procedures are covered in section 4.3.

1.b - The GLO can apply confidentiality to the request by encapsulating the SignedData.PKIData in an EnvelopedData (see section 3.2.1.2).

1.c - The GLO can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

2 - Upon receipt of the request, the GLA checks the signingTime and verifies the signature on the inner most SignedData.PKIData. If an additional SignedData and/or EnvelopedData encapsulates the request (see sections 3.2.1.2 and 3.2.2), the GLA verifies the outer signature(s) and/or decrypt the outer layer(s) prior to verifying the signature on the inner most SignedData.

2.a - If the signingTime attribute value is not within the locally accepted time window, the GLA MAY return a response indicating cMCStatus.failed and otherInfo.failInfo.badTime and a signingTime attribute.

2.b - Else if signature processing continues and if the signatures do not verify, the GLA returns a cMCStatusInfoExt response indicating cMCStatus.failed and otherInfo.failInfo.badMessageCheck. Additionally, a signingTime attribute is included with the response.

2.c - Else if the signatures do verify but the GLA does not have a valid certificate, the GLA returns a cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of noValidGLACertificate. Additionally, a signingTime attribute is included with the response. Instead of immediately returning the error code, the GLA attempts to get a certificate, possibly using [CMC].

2.d - Else the signatures are valid and the GLA does have a valid certificate, the GLA checks that one of the names in the certificate used to sign the request matches one of the names in glUseKEK.glOwnerInfo.glOwnerName.

2.d.1 - If the names do not match, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of noGLONameMatch. Additionally, a signingTime attribute is included with the response.

2.d.2 - Else if the names all match, the GLA checks that the glName and glAddress is not already in use. The GLA also checks any glAddMember included within the controlSequence with this glUseKEK. Further processing of the glAddMember is covered in section 4.3.

2.d.2.a - If the glName is already in use the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of nameAlreadyInUse. Additionally, a signingTime attribute is included with the response.

2.d.2.b - Else if the requestedAlgorithm is not supported, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of unsupportedAlgorithm. Additionally, a signingTime attribute is included with the response.

2.d.2.c - Else if the duration cannot be supported, determining this is beyond the scope of this document, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of unsupportedDuration. Additionally, a signingTime attribute is included with the response.

2.d.2.d - Else if the GL cannot be supported for other reasons, which the GLA does not wish to disclose, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of unspecified. Additionally, a signingTime attribute is included with the response.

2.d.2.e - Else if the glName is not already in use, the duration can be supported, and the requestedAlgorithm is supported, the GLA MUST return a cMCStatusInfoExt indicating cMCStatus.success and a signingTime attribute. (2 in Figure 3). The GLA also takes administrative actions, which are beyond the scope of this document, to store the glName, glAddress, glKeyAttributes, glOwnerName, and glOwnerAddress. The GLA also sends a glKey message as described in section 5.

2.d.2.e.1 - The GLA can apply confidentiality to the response by encapsulating the SignedData.PKIResponse in an EnvelopedData if the request was encapsulated in an EnvelopedData (see section 3.2.1.2).

2.d.2.e.2 - The GLA can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

3 - Upon receipt of the cMCStatusInfoExt responses, the GLO checks the signingTime and verifies the GLA signature(s). If an additional SignedData and/or EnvelopedData encapsulates the response (see section 3.2.1.2 or 3.2.2), the GLO verifies the outer signature and/or decrypt the outer layer prior to verifying the signature on the inner most SignedData.

3.a - If the signingTime attribute value is not within the locally accepted time window, the GLO MAY return a response indicating cMCStatus.failed and otherInfo.failInfo.badTime and a signingTime attribute.

3.b - Else if signature processing continues and if the signatures do verify, the GLO MUST check that one of the names in the certificate used to sign the response matches the name of the GL.

3.b.1 - If the name of the GL does not match the name present in the certificate used to sign the message, the GLO should not believe the response.

3.b.2 - Else if the name of the GL does match the name present in the certificate and:

3.b.2.a - If the signatures do verify and the response was cMCStatusInfoExt indicating cMCStatus.success, the GLO has successfully created the GL.

3.b.2.b - Else if the signatures are valid and the response is cMCStatusInfoExt.cMCStatus.failed with any reason, the GLO can reattempt to create the GL using the information provided in the response. The GLO can also use the glaQueryRequest to determine the algorithms and other characteristics supported by the GLA (see section 4.9).

4.2. Delete GL From GLA

From time to time, there are instances when a GL is no longer needed. In this case, the GLO deletes the GL. Figure 4 depicts that protocol interactions to delete a GL. Note that behavior for the optional transactionId, senderNonce, and recipientNonce CMC control attributes is not addressed in these procedures.

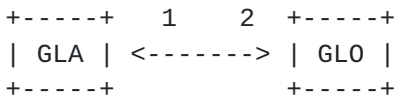


Figure 4 - Delete Group List

The process is as follows:

1 - The GLO is responsible for requesting the deletion of the GL. The GLO sends a SignedData.PKIData.controlSequence.glDelete request to the GLA (1 in Figure 4). The name of the GL to be deleted is included in GeneralName. The GLO MUST also include the signingTime attribute and can also include a transactionId and senderNonce attributes.

1.a - The GLO can optionally apply confidentiality to the request by encapsulating the SignedData.PKIData in an EnvelopedData (see section 3.2.1.2).

1.b - The GLO MAY optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

2 - Upon receipt of the request the GLA checks the signingTime and verifies the signature on the inner most SignedData.PKIData. If an additional SignedData and/or EnvelopedData encapsulates the request (see section 3.2.1.2 or 3.2.2), the GLA verifies the outer signature and/or decrypt the outer layer prior to verifying the signature on the inner most SignedData.

2.a - If the signingTime attribute value is not within the locally accepted time window, the GLA MAY return a response

indicating cMCStatus.failed and otherInfo.failInfo.badTime and a signingTime attribute.

2.b - Else if signature processing continues and if the signatures cannot be verified, the GLA returns a cMCStatusInfoExt response indicating cMCStatus.failed and otherInfo.failInfo.badMessageCheck. Additionally, a signingTime attribute is included with the response.

2.c - Else if the signatures verify, the GLA makes sure the GL is supported by checking the name of the GL matches a glName stored on the GLA.

2.c.1 - If the glName is not supported by the GLA, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of invalidGLName. Additionally, a signingTime attribute is included with the response.

2.c.2 - Else if the glName is supported by the GLA, the GLA ensures a registered GLO signed the glDelete request by checking if one of the names present in the digital signature certificate used to sign the glDelete request matches a registered GLO.

2.c.2.a - If the names do not match, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of noGLONameMatch. Additionally, a signingTime attribute is included with the response.

2.c.2.b - Else if the names do match, but the GL cannot be deleted for other reasons, which the GLA does not wish to disclose, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of unspecified. Additionally, a signingTime attribute is included with the response. Actions beyond the scope of this document must then be taken to delete the GL from the GLA.

2.c.2.c - Else if the names do match, the GLA returns a cMCStatusInfoExt indicating cMCStatus.success and a signingTime attribute (2 in Figure 4). The GLA ought not accept further requests for member additions, member deletions, or group rekeys for this GL.

2.c.2.c.1 - The GLA can apply confidentiality to the response by encapsulating the SignedData.PKIResponse in an EnvelopedData if the request was encapsulated in an EnvelopedData (see section 3.2.1.2).

2.c.2.c.2 - The GLA MAY optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

3 - Upon receipt of the cMCStatusInfoExt response, the GLO checks the signingTime and verifies the GLA signature(s). If an additional SignedData and/or EnvelopedData encapsulates the response (see section 3.2.1.2 or 3.2.2), the GLO verifies the outer signature and/or decrypt the outer layer prior to verifying the signature on the inner most SignedData.

3.a - If the signingTime attribute value is not within the locally accepted time window, the GLO MAY return a response indicating cMCStatus.failed and otherInfo.failInfo.badTime and a signingTime attribute.

3.b - Else if signature processing continues and if the signatures verify, the GLO checks that one of the names in the certificate used to sign the response matches the name of the GL.

3.b.1 - If the name of the GL does not match the name present in the certificate used to sign the message, the GLO should not believe the response.

3.b.2 - Else if the name of the GL does match the name present in the certificate and:

3.b.2.a - If the signatures verify and the response was cMCStatusInfoExt indicating cMCStatus.success, the GLO has successfully deleted the GL.

3.b.2.b - Else if the signatures do verify and the response was cMCStatusInfoExt.cMCStatus.failed with any reason, the GLO can reattempt to delete the GL using the information provided in the response.

4.3. Add Members To GL

To add members to GLs, either the GLO or prospective members use the glAddMember request. The GLA processes GLO and prospective GL member requests differently though. GLOs can submit the request at any time to add members to the GL, and the GLA, once it has verified the

request came from a registered GLO, should process it. If a prospective member sends the request, the GLA needs to determine how the GL is administered. When the GLO initially configured the GL, they set the GL to be unmanaged, managed, or closed (see section 3.1.1). In the unmanaged case, the GLA merely processes the member's request. For the managed case, the GLA forwards the requests from the prospective members to the GLO for review. Where there are multiple GLOs for a GL, which GLO the request is forwarded to is beyond the scope of this document. The GLO reviews the request and either rejects it or submits a reformed request to the GLA. In the closed case, the GLA will not accept requests from prospective members. The following sections describe the processing for the GLO(s), GLA, and prospective GL members depending on where the glAddMeber request originated, either from a GLO or from prospective members. Figure 5 depicts the protocol interactions for the three options. Note that the error messages are not depicted. Additionally, note that behavior for the optional transactionId, senderNonce, and recipientNonce CMC control attributes is not addressed in these procedures.

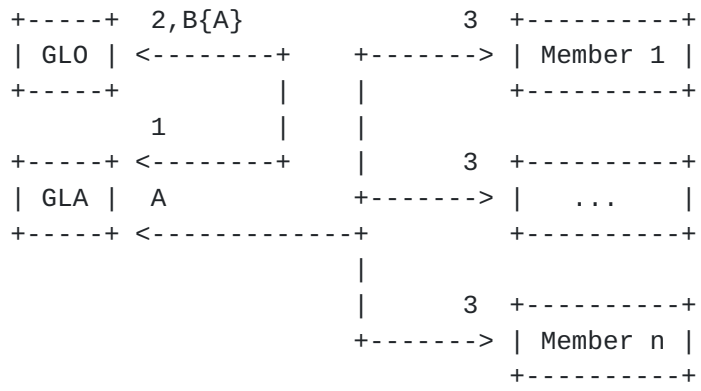


Figure 5 - Member Addition

An important decision that needs to be made on a group by group basis is whether to rekey the group every time a new member is added. Typically, unmanaged GLs should not be rekeyed when a new member is added, as the overhead associated with rekeying the group becomes prohibitive, as the group becomes large. However, managed and closed GLs can be rekeyed to maintain the confidentiality of the traffic sent by group members. An option to rekeying managed or closed GLs when a member is added is to generate a new GL with a different group key. Group rekeying is discussed in sections 4.5 and 5.

4.3.1. GLO Initiated Additions

The process for GLO initiated glAddMember requests is as follows:

1 - The GLO collects the pertinent information for the member(s) to be added (this may be done through an out of bands means). The GLO then sends a SignedData.PKIData.controlSequence with a separate glAddMember request for each member to the GLA (1 in Figure 5). The GLO includes: the GL name in glName, the member's name in glMember.glMemberName, the member's address in glMember.glMemberAddress, and the member's encryption certificate in glMember.certificates.pKC. The GLO can also include any attribute certificates associated with the member's encryption certificate in glMember.certificates.aC, and the certification path associated with the member's encryption and attribute certificates in glMember.certificates.certPath. The GLO MUST also include the signingTime attribute with this request.

1.a - The GLO can optionally apply confidentiality to the request by encapsulating the SignedData.PKIData in an EnvelopedData (see section 3.2.1.2).

1.b - The GLO can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

2 - Upon receipt of the request, the GLA checks the signingTime and verifies the signature on the inner most SignedData.PKIData. If an additional SignedData and/or EnvelopedData encapsulates the request (see section 3.2.1.2 or 3.2.2), the GLA verifies the outer signature and/or decrypt the outer layer prior to verifying the signature on the inner most SignedData.

2.a - If the signingTime attribute value is not within the locally accepted time window, the GLA MAY return a response indicating cMCStatus.failed and otherInfo.failInfo.badTime and a signingTime attribute.

2.b - Else if signature processing continues and if the signatures cannot be verified, the GLA returns a cMCStatusInfoExt response indicating cMCStatus.failed and otherInfo.failInfo.badMessageCheck. Additionally, a signingTime attribute is included with the response.

2.c - Else if the signatures verify, the glAddMember request is included in a controlSequence with the glUseKEK request, and the processing in section 4.1 item 2.e is successfully

completed the GLA returns a cMCStatusInfoExt indicating cMCStatus.success and a signingTime attribute (2 in Figure 5).

2.c.1 - The GLA can apply confidentiality to the response by encapsulating the SignedData.PKIData in an EnvelopedData if the request was encapsulated in an EnvelopedData (see section 3.2.1.2).

2.c.2 - The GLA can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

2.d - Else if the signatures verify and the GLAddMember request is not included in a controlSequence with the GLCreate request, the GLA makes sure the GL is supported by checking that the glName matches a glName stored on the GLA.

2.d.1 - If the glName is not supported by the GLA, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of invalidGLName. Additionally, a signingTime attribute is included with the response.

2.d.2 - Else if the glName is supported by the GLA, the GLA checks to see if the glMemberName is present on the GL.

2.d.2.a - If the glMemberName is present on the GL, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of alreadyAMember. Additionally, a signingTime attribute is included with the response.

2.d.2.b - Else if the glMemberName is not present on the GL, the GLA checks how the GL is administered.

2.d.2.b.1 - If the GL is closed, the GLA checks that a registered GLO signed the request by checking that one of the names in the digital signature certificate used to sign the request matches a registered GLO.

2.d.2.b.1.a - If the names do not match, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of noGLONameMatch. Additionally, a signingTime attribute is included with the response.

2.d.2.b.1.b - Else if the names match, the GLA verifies the member's encryption certificate.

2.d.2.b.1.b.1 - If the member's encryption certificate cannot be verified, the GLA can return a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of invalidCert to the GLO. Additionally, a signingTime attribute is included with the response. If the GLA does not return a cMCStatusInfoExt.cMCStatus.failed response, the GLA issues a glProvideCert request (see section 4.10).

2.d.2.b.1.b.2 - Else if the member's certificate verifies, the GLA returns a cMCStatusInfoExt indicating cMCStatus.success and a signingTime attribute (2 in Figure 5). The GLA also takes administrative actions, which are beyond the scope of this document, to add the member to the GL stored on the GLA. The GLA also distributes the shared KEK to the member via the mechanism described in section 5.

2.d.2.b.1.b.2.a - The GLA applies confidentiality to the response by encapsulating the SignedData.PKIData in an EnvelopedData if the request was encapsulated in an EnvelopedData (see section 3.2.1.2).

2.d.2.b.1.b.2.b - The GLA can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

2.d.2.b.2 - Else if the GL is managed, the GLA checks that either a registered GLO or the prospective member signed the request. For GLOs, one of the names in the certificate used to sign the request needs to match a registered GLO. For the prospective member, the name in glMember.glMemberName needs to match one of the names in the certificate used to sign the request.

2.d.2.b.2.a - If the signer is neither a registered GLO nor the prospective GL member, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of noSpam. Additionally, a signingTime attribute is included with the response.

2.d.2.b.2.b - Else if the signer is a registered GLO, the GLA verifies the member's encryption certificate.

2.d.2.b.2.b.1 - If the member's certificate cannot be verified, the GLA can return a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of invalidCert. Additionally, a signingTime attribute is included with the response. If the GLA does not return a cMCStatus.failed response, the GLA MUST issue a glProvideCert request (see section 4.10).

2.d.2.b.2.b.2 - Else if the member's certificate verifies, the GLA MUST return a cMCStatusInfoExt indicating cMCStatus.success and a signingTime attribute to the GLO (2 in Figure 5). The GLA also takes administrative actions, which are beyond the scope of this document, to add the member to the GL stored on the GLA. The GLA also distributes the shared KEK to the member via the mechanism described in section 5. The GL policy may mandate that the GL member's address be included in the GL member's certificate.

2.d.2.b.2.b.2.a - The GLA applies confidentiality to the response by encapsulating the SignedData.PKIData in an EnvelopedData if the request was encapsulated in an EnvelopedData (see section 3.2.1.2).

2.d.2.b.2.b.2.b - The GLA can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

2.d.2.b.2.c - Else if the signer is the prospective member, the GLA forwards the glAddMember request (see section 3.2.3) to a registered GLO (B{A} in Figure 5). If there is more than one registered GLO, the GLO to which the request is forwarded to is beyond the scope of this document. Further processing of the forwarded request by GLOs is addressed in 3 of section 4.3.2.

2.d.2.b.2.c.1 - The GLA applies confidentiality to the forwarded request by encapsulating the SignedData.PKIData in an EnvelopedData if the original request was encapsulated in an EnvelopedData (see section 3.2.1.2).

2.d.2.b.2.c.2 - The GLA can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

2.d.2.b.3 - Else if the GL is unmanaged, the GLA checks that either a registered GLO or the prospective member signed the request. For GLOs, one of the names in the certificate used to sign the request needs tp match the name of a registered GLO. For the prospective member, the name in glMember.glMemberName needs to match one of the names in the certificate used to sign the request.

2.d.2.b.3.a - If the signer is neither a registered GLO nor the prospective member, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of noSpam. Additionally, a signingTime attribute is included with the response.

2.d.2.b.3.b - Else if the signer is either a registered GLO or the prospective member, the GLA verifies the member's encryption certificate.

2.d.2.b.3.b.1 - If the member's certificate cannot be verified, the GLA can return a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of invalidCert and a signingTime attribute to either the GLO or the prospective member depending on where the request originated. If the GLA does not return a cMCStatus.failed response, the GLA issues a glProvideCert request (see section 4.10) to either the GLO or prospective member depending on where the request originated.

2.d.2.b.3.b.2 - Else if the member's certificate verifies, the GLA returns a cMCStatusInfoExt indicating cMCStatus.success and a signingTime attribute to the GLO (2 in Figure 5) if the GLO signed the request and to the GL member (3 in Figure 5) if the GL member signed the request. The GLA also takes administrative actions, which are beyond the scope of this document, to add the member to the GL stored on the GLA. The GLA also distributes the shared KEK to the member via the mechanism described in section 5.

2.d.2.b.3.b.2.a - The GLA applies confidentiality to the response by encapsulating the SignedData.PKIData in an EnvelopedData if the request was encapsulated in an EnvelopedData (see section 3.2.1.2).

2.d.2.b.3.b.2.b - The GLA can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

3 - Upon receipt of the cMCStatusInfoExt response, the GLO checks the signingTime and verifies the GLA signature(s). If an additional SignedData and/or EnvelopedData encapsulates the response (see section 3.2.1.2 or 3.2.2), the GLO verifies the outer signature and/or decrypt the outer layer prior to verifying the signature on the inner most SignedData.

3.a - If the signingTime attribute value is not within the locally accepted time window, the GLO MAY return a response indicating cMCStatus.failed and otherInfo.failInfo.badTime and a signingTime attribute.

3.b - Else if signature processing continues and if the signatures verify, the GLO checks that one of the names in the certificate used to sign the response matches the name of the GL.

3.b.1 - If the name of the GL does not match the name present in the certificate used to sign the message, the GLO should not believe the response.

3.b.2 - Else if the name of the GL matches the name present in the certificate and:

3.b.2.a - If the signatures verify and the response is cMCStatusInfoExt indicating cMCStatus.success, the GLA has added the member to the GL. If member was added to a managed list and the original request was signed by the member, the GLO sends a cMCStatusInfoExt.cMCStatus.success and a signingTime attribute to the GL member.

3.b.2.b - Else if the GLO received a cMCStatusInfoExt.cMCStatus.failed with any reason, the GLO can reattempt to add the member to the GL using the information provided in the response.

4 - Upon receipt of the cMCStatusInfoExt response, the prospective member checks the signingTime and verifies the GLA signatures or GLO signatures. If an additional SignedData and/or EnvelopedData encapsulates the response (see section 3.2.1.2 or 3.2.2), the GLO verifies the outer signature and/or decrypt the outer layer prior to verifying the signature on the inner most SignedData.

4.a - If the signingTime attribute value is not within the locally accepted time window, the prospective member MAY return a response indicating cMCStatus.failed and otherInfo.failInfo.badTime and a signingTime attribute.

4.b - Else if signature processing continues and if the signatures verify, the GL member checks that one of the names in the certificate used to sign the response matches the name of the GL.

4.b.1 - If the name of the GL does not match the name present in the certificate used to sign the message, the GL member should not believe the response.

4.b.2 - Else if the name of the GL matches the name present in the certificate and:

4.b.2.a - If the signatures verify, the prospective member has been added to the GL.

4.b.2.b - Else if the prospective member received a cMCStatusInfoExt.cMCStatus.failed, for any reason, the prospective member MAY reattempt to add themselves to the GL using the information provided in the response.

4.3.2. Prospective Member Initiated Additions

The process for prospective member initiated glAddMember requests is as follows:

1 - The prospective GL member sends a SignedData.PKIData.controlSequence.glAddMember request to the GLA (A in Figure 5). The prospective GL member includes: the GL name in glName, their name in glMember.glMemberName, their address in glMember.glMemberAddress, and their encryption certificate in glMember.certificates.pKC. The prospective GL member can also include any attribute certificates associated with their encryption certificate in glMember.certificates.aC, and the certification path associated with their encryption and

attribute certificates in glMember.certificates.certPath. The prosepective member MUST also include the signingTime attribute with this request.

1.a - The prospective GL member can optionally apply confidentiality to the request by encapsulating the SignedData.PKIData in an EnvelopedData (see section 3.2.1.2).

1.b - The prospective GL member MAY optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

2 - Upon receipt of the request, the GLA verifies the request as per 2 in section 4.3.1.

3 - Upon receipt of the forwarded request, the GLO checks the signingTime and verifies the prospective GL member signature on the inner most SignedData.PKIData and the GLA signature on the outer layer. If an EnvelopedData encapsulates the inner most layer (see section 3.2.1.2 or 3.2.2), the GLO decrypts the outer layer prior to verifying the signature on the inner most SignedData.

Note: For cases where the GL is closed and either a) a prospective member sends directly to the GLO or b) the GLA has mistakenly forwarded the request to the GLO, the GLO should first determine whether to honor the request.

3.a - If the signingTime attribute value is not within the locally accepted time window, the GLO MAY return a response indicating cMCStatus.failed and otherInfo.failInfo.badTime.

3.b - Else if signature processing continues and if the signatures verify, the GLO checks to make sure one of the names in the certificate used to sign the request matches the name in glMember.glMemberName.

3.b.1 - If the names do not match, the GLO sends a SignedData.PKIResponse.controlSequence message back to the prospective member with cMCStatusInfoExt.cMCStatus.failed indicating why the prospective member was denied in cMCStausInfo.statusString. This stops people from adding people to GLs without their permission. Additionally, a signingTime attribute is included with the response.

3.b.2 - Else if the names match, the GLO determines whether the prospective member is allowed to be added. The mechanism is

beyond the scope of this document; however, the GLO should check to see that the glMember.glMemberName is not already on the GL.

3.b.2.a - If the GLO determines the prospective member is not allowed to join the GL, the GLO can return a SignedData.PKIResponse.controlSequence message back to the prospective member with cMCStatusInfoExt.cMCtatus.failed indicating why the prospective member was denied in cMCStatus.statusString. Additionally, a signingTime attribute is included with the response.

3.b.2.b - Else if GLO determines the prospective member is allowed to join the GL, the GLO verifies the member's encryption certificate.

3.b.2.b.1 - If the member's certificate cannot be verified, the GLO returns a SignedData.PKIResponse.controlSequence back to the prospective member with cMCStatusInfoExt.cMCtatus.failed indicating that the member's encryption certificate did not verify in cMCStatus.statusString. Additionally, a signingTime attribute is included with the response. If the GLO does not return a cMCStatusInfoExt response, the GLO sends a SignedData.PKIData.controlSequence.glProvideCert message to the prospective member requesting a new encryption certificate (see section 4.10).

3.b.2.b.2 - Else if the member's certificate verifies, the GLO resubmits the glAddMember request (see section 3.2.5) to the GLA (1 in Figure 5).

3.b.2.b.2.a - The GLO applies confidentiality to the new GLAddMember request by encapsulating the SignedData.PKIData in an EnvelopedData if the initial request was encapsulated in an EnvelopedData (see section 3.2.1.2).

3.b.2.b.2.b - The GLO can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

4 - Processing continues as in 2 of section 4.3.1.

4.4. Delete Members From GL

To delete members from GLs, either the GLO or members to be removed use the glDeleteMember request. The GLA processes GLO and members requesting their own removal make requests differently. The GLO can submit the request at any time to delete members from the GL, and the GLA, once it has verified the request came from a registered GLO, should delete the member. If a member sends the request, the GLA needs to determine how the GL is administered. When the GLO initially configured the GL, they set the GL to be unmanaged, managed, or closed (see section 3.1.1). In the unmanaged case, the GLA merely processes the member's request. For the managed case, the GLA forwards the requests from the member to the GLO for review. Where there are multiple GLOs for a GL, which GLO the request is forwarded to is beyond the scope of this document. The GLO reviews the request and either rejects it or submits a reformed request to the GLA. In the closed case, the GLA will not accept requests from members. The following sections describe the processing for the GLO(s), GLA, and GL members depending on where the request originated, either from a GLO or from members wanting to be removed. Figure 6 depicts the protocol interactions for the three options. Note that the error messages are not depicted. Additionally, behavior for the optional transactionId, senderNonce, and recipientNonce CMC control attributes is not addressed in these procedures.

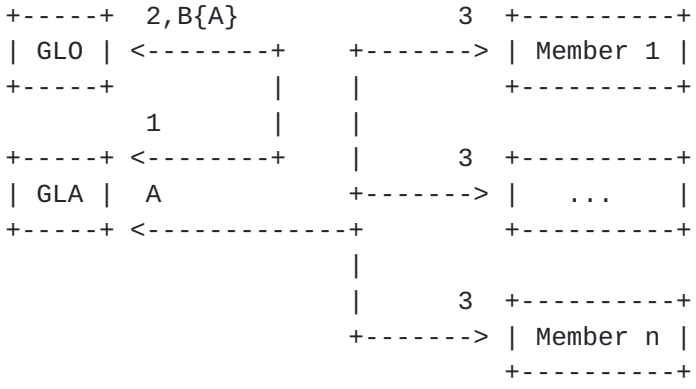


Figure 6 - Member Deletion

If the member is not removed from the GL, they will continue to receive and be able to decrypt data protected with the shared KEK and will continue to receive rekeys. For unmanaged lists, there is no point to a group rekey because there is no guarantee that the member requesting to be removed has not already added themselves back on the GL under a different name. For managed and closed GLs, the GLO needs to take steps to ensure the member being deleted is not on the GL twice. After ensuring this, managed and closed GLs can be rekeyed to

maintain the confidentiality of the traffic sent by group members. If the GLO is sure the member has been deleted the group rekey mechanism can be used to distribute the new key (see sections 4.5 and 5).

4.4.1. GLO Initiated Deletions

The process for GLO initiated glDeleteMember requests is as follows:

1 - The GLO collects the pertinent information for the member(s) to be deleted (this can be done through an out of bands means). The GLO then sends a SignedData.PKIData.controlSequence with a separate glDeleteMember request for each member to the GLA (1 in Figure 6). The GLO MUST include: the GL name in glName and the member's name in glMemberToDelete. If the GL from which the member is being deleted in a closed or managed GL, the GLO MUST also generate a glRekey request and include it with the glDeletemember request (see section 4.5). The GLO MUST also include the signingTime attribute with this request.

1.a - The GLO can optionally apply confidentiality to the request by encapsulating the SignedData.PKIData in an EnvelopedData (see section 3.2.1.2).

1.b - The GLO can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

2 - Upon receipt of the request, the GLA checks the signingTime attribute and verifies the signature on the inner most SignedData.PKIData. If an additional SignedData and/or EnvelopedData encapsulates the request (see section 3.2.1.2 or 3.2.2), the GLA verifies the outer signature and/or decrypt the outer layer prior to verifying the signature on the inner most SignedData.

2.a - If the signingTime attribute value is not within the locally accepted time window, the GLA MAY return a response indicating cMCStatus.failed and otherInfo.failInfo.badTime and a signingTime attribute.

2.b - Else if signature processing continues and if the signatures cannot be verified, the GLA returns a cMCStatusInfoExt response indicating cMCStatus.failed and otherInfo.failInfo.badMessageCheck. Additionally, a signingTime attribute is included with the response.

2.c - Else if the signatures verify, the GLA makes sure the GL is supported by the GLA by checking that the glName matches a glName stored on the GLA.

2.c.1 - If the glName is not supported by the GLA, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of invalidGLName. Additionally, a signingTime attribute is included with the response.

2.c.2 - Else if the glName is supported by the GLA, the GLA checks to see if the glMemberName is present on the GL.

2.c.2.a - If the glMemberName is not present on the GL, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of notAMember. Additionally, a signingTime attribute is included with the response.

2.c.2.b - Else if the glMemberName is already on the GL, the GLA checks how the GL is administered.

2.c.2.b.1 - If the GL is closed, the GLA checks that the registered GLO signed the request by checking that one of the names in the digital signature certificate used to sign the request matches the registered GLO.

2.c.2.b.1.a - If the names do not match, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of closedGL. Additionally, a signingTime attribute is included with the response.

2.c.2.b.1.b - Else if the names do match, the GLA returns a cMCStatusInfoExt.cMCStatus.success and a signingTime attribute (2 in Figure 5). The GLA also takes administrative actions, which are beyond the scope of this document, to delete the member with the GL stored on the GLA. Note that he GL also needs to be rekeyed as described in section 5.

2.c.2.b.1.b.1 - The GLA applies confidentiality to the response by encapsulating the SignedData.PKIData in an EnvelopedData if the request was encapsulated in an EnvelopedData (see section 3.2.1.2).

2.c.2.b.1.b.2 - The GLA can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

2.c.2.b.2 - Else if the GL is managed, the GLA checks that either a registered GLO or the prospective member signed the request. For GLOs, one of the names in the certificate used to sign the request needs to match a registered GLO. For the prospective member, the name in glMember.glMemberName needs to match one of the names in the certificate used to sign the request.

2.c.2.b.2.a - If the signer is neither a registered GLO nor the prospective GL member, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of noSpam. Additionally, a signingTime attribute is included with the response.

2.c.2.b.2.b - Else if the signer is a registered GLO, the GLA returns a cMCStatusInfoExt.cMCStatus.success and a signingTime attribute(2 in Figure 6). The GLA also takes administrative actions, which are beyond the scope of this document, to delete the member with the GL stored on the GLA. Note that the GL will also be rekeyed as described in section 5.

2.c.2.b.2.b.1 - The GLA applies confidentiality to the response by encapsulating the SignedData.PKIData in an EnvelopedData if the request was encapsulated in an EnvelopedData (see section 3.2.1.2).

2.c.2.b.2.b.2 - The GLA can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

2.c.2.b.2.c - Else if the signer is the prospective member, the GLA forwards the glDeleteMember request (see section 3.2.3) to the GLO (B{A} in Figure 6). If there is more than one registered GLO, the GLO to which the request is forwarded to is beyond the scope of this document. Further processing of the forwarded request by GLOs is addressed in 3 of section 4.4.2.

2.c.2.b.2.c.1 - The GLA applies confidentiality to the forwarded request by encapsulating the SignedData.PKIData in an

EnvelopedData if the request was encapsulated in an EnvelopedData (see section 3.2.1.2).

2.c.2.b.2.c.2 - The GLA can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

2.c.2.b.3 - Else if the GL is unmanaged, the GLA checks that either a registered GLO or the prospective member signed the request. For GLOs, one of the names in the certificate used to sign the request needs to match the name of a registered GLO. For the prospective member, the name in glMember.glMemberName needs to match one of the names in the certificate used to sign the request.

2.c.2.b.3.a - If the signer is neither the GLO nor the prospective member, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of noSpam. Additionally, a signingTime attribute is included with the response.

2.c.2.b.3.b - Else if the signer is either a registered GLO or the member, the GLA returns a cMCStatusInfoExt.cMCStatus.success and a signingTime attribute to the GLO (2 in Figure 6) if the GLO signed the request and to the GL member (3 in Figure 6) if the GL member signed the request. The GLA also takes administrative actions, which are beyond the scope of this document, to delete the member with the GL stored on the GLA.

2.c.2.b.3.b.1 - The GLA applies confidentiality to the response by encapsulating the SignedData.PKIData in an EnvelopedData if the request was encapsulated in an EnvelopedData (see section 3.2.1.2).

2.c.2.b.3.b.2 - The GLA can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

3 - Upon receipt of the cMCStatusInfoExt response, the GLO checks the signingTime and verifies the GLA signatures. If an additional SignedData and/or EnvelopedData encapsulates the response (see section 3.2.1.2 or 3.2.2), the GLO verifies the outer signature and/or decrypt the outer layer prior to verifying the signature on the inner most SignedData.

3.a - If the signingTime attribute value is not within the locally accepted time window, the GLO MAY return a response indicating cMCStatus.failed and otherInfo.failInfo.badTime and a signingTime attribute.

3.b - Else if signature processing continues and if the signatures do verify, the GLO checks that one of the names in the certificate used to sign the response matches the name of the GL.

3.b.1 - If the name of the GL does not match the name present in the certificate used to sign the message, the GLO should not believe the response.

3.b.2 - Else if the name of the GL matches the name present in the certificate and:

3.b.2.a - If the signatures verify and the response is cMCStatusInfoExt.cMCStatus.success, the GLO has deleted the member from the GL. If member was deleted from a managed list and the original request was signed by the member, the GLO sends a cMCStatusInfoExt.cMCStatus.success and a signingTime attribute to the GL member.

3.b.2.b - Else if the GLO received a cMCStatusInfoExt.cMCStatus.failed with any reason, the GLO may reattempt to delete the member from the GL using the information provided in the response.

4 - Upon receipt of the cMCStatusInfoExt response, the member checks the signingTime and verifies the GLA signature(s) or GLO signature(s). If an additional SignedData and/or EnvelopedData encapsulates the response (see section 3.2.1.2 or 3.2.2), the GLO verifies the outer signature and/or decrypt the outer layer prior to verifying the signature on the inner most SignedData.

4.a - If the signingTime attribute value is not within the locally accepted time window, the prospective member MAY return a response indicating cMCStatus.failed and otherInfo.failInfo.badTime and a signingTime attribute.

4.b - Else if signature processing continues and if the signatures verify, the GL member checks that one of the names in the certificate used to sign the response matches the name of the GL.

4.b.1 - If the name of the GL does not match the name present in the certificate used to sign the message, the GL member should not believe the response.

4.b.2 - Else if the name of the GL matches the name present in the certificate and:

4.b.2.a - If the signature(s) verify, the member has been deleted from the GL.

4.b.2.b - Else if the member received a cMCStatusInfoExt.cMCStatus.failed with any reason, the member can reattempt to delete themselves from the GL using the information provided in the response.

4.4.2. Member Initiated Deletions

The process for member initiated deletion of their own membership using the glDeleteMember requests is as follows:

1 - The member sends a SignedData.PKIData.controlSequence.glDeleteMember request to the GLA (A in Figure 6). The member includes: the name of the GL in glName and their own name in glMemberToDelete. The GL member MUST also include the signingTime attribute with this request.

1.a - The member can optionally apply confidentiality to the request by encapsulating the SignedData.PKIData in an EnvelopedData (see section 3.2.1.2).

1.b - The member can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

2 - Upon receipt of the request, the GLA verifies the request as per 2 in section 4.4.1.

3 - Upon receipt of the forwarded request, the GLO checks the signingTime and verifies the member signature on the inner most SignedData.PKIData and the GLA signature on the outer layer. If an EnvelopedData encapsulates the inner most layer (see section 3.2.1.2 or 3.2.2), the GLO decrypts the outer layer prior to verifying the signature on the inner most SignedData. Note: For cases where the GL is closed and either (a) a prospective member sends directly to the GLO or (b) the GLA has mistakenly forwarded the request to the GLO, the GLO should first determine whether to honor the request.

3.a - If the signingTime attribute value is not within the locally accepted time window, the GLO MAY return a response indicating cMCStatus.failed and otherInfo.failInfo.badTime and a signingTime attribute.

3.b - Else if signature processing continues if the signatures cannot be verified, the GLO returns a cMCStatusInfoExt response indicating cMCStatus.failed and otherInfo.failInfo.badMessageCheck and a signingTime attribute.

3.c - Else if the signatures verify, the GLO checks to make sure one of the names in the certificates used to sign the request matches the name in glMemberToDelete.

3.c.1 - If the names match, the GLO sends a SignedData.PKIResponse.controlSequence message back to the prospective member with cMCStatusInfoExt.cMCtatus.failed indicating why the prospective member was denied in cMCStatusInfoExt.statusString. This stops people from adding people to GLs without their permission. Additionally, a signingTime attribute is included with the response.

3.c.2 - Else if the names match, the GLO resubmits the glDeleteMember request (see section 3.2.5) to the GLA (1 in Figure 6). The GLO makes sure the glMemberName is already on the GL. The GLO also generates a glRekey request and include it with the GLDeleteMember request (see section 4.5).

3.c.2.a - The GLO applies confidentiality to the new GLDeleteMember request by encapsulating the SignedData.PKIData in an EnvelopedData if the initial request was encapsulated in an EnvelopedData (see section 3.2.1.2).

3.c.2.b - The GLO can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

4 - Further processing is as in 2 of section 4.4.1.

4.5. Request Rekey Of GL

From time to time, the GL will need to be rekeyed. Some situations follow:

- When a member is removed from a closed or managed GL. In this case, the PKIData.controlSequence containing the glDeleteMember ought to contain a glRekey request.

- Depending on policy, when a member is removed from an unmanaged GL. If the policy is to rekey the GL, the PKIData.controlSequence containing the glDeleteMember could also contain a glRekey request or an out of bands means could be used to tell the GLA to rekey the GL. Rekeying of unmanaged GLs when members are deleted is not advised.

- When the current shared KEK has been compromised.

- When the current shared KEK is about to expire. Consider two cases:

  - If the GLO controls the GL rekey, the GLA should not assume that a new shared KEK should be distributed, but instead wait for the glRekey message.

  - If the GLA controls the GL rekey, the GLA should initiate a glKey message as specified in section 5.

If the generationCounter (see section 3.1.1) is set to a value greater than one (1) and the GLO controls the GL rekey, the GLO may generate a glRekey any time before the last shared KEK has expired. To be on the safe side, the GLO ought to request a rekey one (1) duration before the last shared KEK expires.

The GLA and GLO are the only entities allowed to initiate a GL rekey. The GLO indicated whether they are going to control rekeys or whether the GLA is going to control rekeys when they assigned the shared KEK to GL (see section 3.1.1). The GLO initiates a GL rekey at any time. The GLA can be configured to automatically rekey the GL prior to the expiration of the shared KEK (the length of time before the expiration is an implementation decision). The GLA can also automatically rekey GLs that have been compromised, but this is covered in section 5. Figure 7 depicts the protocol interactions to request a GL rekey. Note that error messages are not depicted. Additionally, behavior for the optional transactionId, senderNonce, and recipientNonce CMC control attributes is not addressed in these procedures.

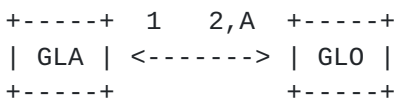


Figure 7 - GL Rekey Request

4.5.1. GLO Initiated Rekey Requests

The process for GLO initiated glRekey requests is as follows:

1 - The GLO sends a SignedData.PKIData.controlSequence.glRekey request to the GLA (1 in Figure 7). The GLO includes the glName. If glAdministration and glKeyNewAttributes are omitted then there is no change from the previously registered GL values for these fields. If the GLO wants to force a rekey for all outstanding shared KEKs it includes the glRekeyAllGLKeys set to TRUE. The GLO MUST also include a signingTime attribute is included with this request.

1.a - The GLO can optionally apply confidentiality to the request by encapsulating the SignedData.PKIData in an EnvelopedData (see section 3.2.1.2).

1.b - The GLO can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

2 - Upon receipt of the request, the GLA checks the signingTime and verifies the signature on the inner most SignedData.PKIData. If an additional SignedData and/or EnvelopedData encapsulates the request (see section 3.2.1.2 or 3.2.2), the GLA verifies the outer signature and/or decrypt the outer layer prior to verifying the signature on the inner most SignedData.

2.a - If the signingTime attribute value is not within the locally accepted time window, the GLA MAY return a response indicating cMCStatus.failed and otherInfo.failInfo.badTime and a signingTime attribute.

2.b - Else if signature processing continues and if the signatures do not verify, the GLA returns a cMCStatusInfoExt response indicating cMCStatus.failed and otherInfo.failInfo.badMessageCheck. Additionally, a signingTime attribute is included with the response.

2.c - Else if the signatures do verify, the GLA makes sure the GL is supported by the GLA by checking that the glName matches a glName stored on the GLA.

2.c.1 - If the glName present does not match a GL stored on the GLA, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of invalidGLName. Additionally, a signingTime attribute is included with the response.

2.c.2 - Else if the glName present matches a GL stored on the GLA, the GLA checks that a registered GLO signed the request by checking that one of the names in the certificate used to sign the request is a registered GLO.

2.c.2.a - If the names do not match, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of noGLONameMatch. Additionally, a signingTime attribute is included with the response.

2.c.2.b - Else if the names match, the GLA checks the glNewKeyAttribute values.

2.c.2.b.1 - If the new value for requestedAlgorithm is not supported, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of unsupportedAlgorithm. Additionally, a signingTime attribute is included with the response.

2.c.2.b.2 - Else if the new value duration is not supportable, determining this is beyond the scope this document, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of unsupportedDuration. Additionally, a signingTime attribute is included with the response.

2.c.2.b.3 - Else if the GL is not supportable for other reasons, which the GLA does not wish to disclose, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of unspecified. Additionally, a signingTime attribute is included with the response.

2.c.2.b.4 - Else if the new requestedAlgorithm and duration are supportable or the glNewKeyAttributes was omitted, the GLA returns a cMCStatusInfoExt.cMCStatus.success and a

sigingTime attribute (2 in Figure 7). The GLA also uses the glKey message to distribute the rekey shared KEK (see section 5).

2.c.2.b.4.a - The GLA applies confidentiality to response by encapsulating the SignedData.PKIData in an EnvelopedData if the request was encapsulated in an EnvelopedData (see section 3.2.1.2).

2.c.2.b.4.b - The GLA can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

3 - Upon receipt of the cMCStatusInfoExt response, the GLO checks the signingTime and verifies the GLA signature(s). If an additional SignedData and/or EnvelopedData encapsulates the forwarded response (see section 3.2.1.2 or 3.2.2), the GLO verifies the outer signature and/or decrypt the forwarded response prior to verifying the signature on the inner most SignedData.

3.a - If the signingTime attribute value is not within the locally accepted time window, the GLA MAY return a response indicating cMCStatus.failed and otherInfo.failInfo.badTime and a signingTime attribute.

3.b - Else if signature processing continues and if the signatures verify, the GLO checks that one of the names in the certificate used to sign the response matches the name of the GL.

3.b.1 - If the name of the GL does not match the name present in the certificate used to sign the message, the GLO should not believe the response.

3.b.2 - Else if the name of the GL matches the name present in the certificate and:

3.b.2.a - If the signatures verify and the response is cMCStatusInfoExt.cMCStatus.success, the GLO has successfully rekeyed the GL.

3.b.2.b - Else if the GLO received a cMCStatusInfoExt.cMCStatus.failed with any reason, the GLO can reattempt to rekey the GL using the information provided in the response.

4.5.2. GLA Initiated Rekey Requests

If the GLA is in charge of rekeying the GL the GLA will automatically issue a glKey message (see section 5). In addition the GLA will generate a cMCStatusInfoExt to indicate to the GL that a successful rekey has occurred. The process for GLA initiated rekey is as follows:

1 - The GLA generates for all GLOs a SignedData.PKIData.controlSequence.cMCStatusInfoExt.cMCStatus. success and includes a signingTime attribute (A in Figure 7).

1.a - The GLA can optionally apply confidentiality to the request by encapsulating the SignedData.PKIData in an EnvelopedData (see section 3.2.1.2).

1.b - The GLA can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

2 - Upon receipt of the cMCStatusInfoExt.cMCStatus.success response, the GLO checks the signingTime and verifies the GLA signature(s). If an additional SignedData and/or EnvelopedData encapsulates the forwarded response (see section 3.2.1.2 or 3.2.2), the GLO MUST verify the outer signature and/or decrypt the outer layer prior to verifying the signature on the inner most SignedData.

2.a - If the signingTime attribute value is not within the locally accepted time window, the GLO MAY return a response indicating cMCStatus.failed and otherInfo.failInfo.badTime and a signingTime attribute.

2.b - Else if signature processing continues and if the signatures verify, the GLO checks that one of the names in the certificate used to sign the response matches the name of the GL.

2.b.1 - If the name of the GL does not match the name present in the certificate used to sign the message, the GLO ought not believe the response.

2.b.2 - Else if the name of the GL does match the name present in the certificate and and the response is cMCStatusInfoExt.cMCStatus.success, the GLO knows the GLA has successfully rekeyed the GL.

4.6. Change GLO

Management of managed and closed GLs can become difficult for one GLO if the GL membership grows large. To support distributing the workload, GLAs support having GLs be managed by multiple GLOs. The glAddOwner and glRemoveOwner messages are designed to support adding and removing registered GLOs. Figure 8 depicts the protocol interactions to send glAddOwner and glRemoveOwner messages and the resulting response messages. Note that error messages are not shown. Additionally, behavior for the optional transactionId, senderNonce, and recipientNonce CMC control attributes is not addressed in these procedures.

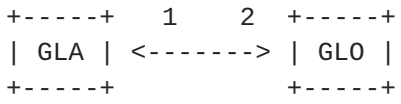


Figure 8 - GLO Add & Delete Owners

The process for glAddOwner and glDeleteOwner is as follows:

1 - The GLO sends a SignedData.PKIData.controlSequence.glAddOwner or glRemoveOwner request to the GLA (1 in Figure 8). The GLO includes: the GL name in glName, the name and address of the GLO in glOwnerName and glOwnerAddress, respectively. The GLO MUST also include the signingTime attribute with this request.

1.a - The GLO can optionally apply confidentiality to the request by encapsulating the SignedData.PKIData in an EnvelopedData (see section 3.2.1.2).

1.b - The GLO can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

2 - Upon receipt of the glAddOwner or glRemoveOwner request, the GLA checks the signingTime and verifies the GLO signature(s). If an additional SignedData and/or EnvelopedData encapsulates the request (see section 3.2.1.2 or 3.2.2), the GLA verifies the outer signature and/or decrypt the outer layer prior to verifying the signature on the inner most SignedData.

2.a - If the signingTime attribute value is not within the locally accepted time window, the GLA MAY return a response indicating cMCStatus.failed and otherInfo.failInfo.badTime and a signingTime attribute.

2.b - Else if signature processing continues and if the signatures cannot verified, the GLA returns a cMCStatusInfoExt response indicating cMCStatus.failed and otherInfo.failInfo.badMessageCheck. Additionally, a signingTime attribute is included with the response.

2.c - Else if the signatures verify, the GLA makes sure the GL is supported by checking that the glName matches a glName stored on the GLA.

2.c.1 - If the glName is not supported by the GLA, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of invalidGLName. Additionally, a signingTime attribute is included with the response.

2.c.2 - Else if the glName is supported by the GLA, the GLA ensures a registered GLO signed the glAddOwner or glRemoveOwner request by checking that one of the names present in the digital signature certificate used to sign the glAddOwner or glDeleteOwner request matches the name of a registered GLO.

2.c.2.a - If the names do not match, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of noGLONameMatch. Additionally, a signingTime attribute is included with the response.

2.c.2.b - Else if the names match, the GLA returns a cMCStatusInfoExt.cMCStatus.success and a signingTime attribute (2 in Figure 4). The GLA also takes administrative actions to associate the new glOwnerName with the GL in the case of glAddOwner or to disassociate the old glOwnerName with the GL in the cased of glRemoveOwner.

2.c.2.b.1 - The GLA applies confidentiality to the response by encapsulating the SignedData.PKIResponse in an EnvelopedData if the request was encapsulated in an EnvelopedData (see section 3.2.1.2).

2.c.2.b.2 - The GLA can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

3 - Upon receipt of the cMCStatusInfoExt response, the GLO checks the signingTime and verifies the GLA's signature(s). If an

additional SignedData and/or EnvelopedData encapsulates the response (see section 3.2.1.2 or 3.2.2), the GLO verifies the outer signature and/or decrypt the outer layer prior to verifying the signature on the inner most SignedData.

3.a - If the signingTime attribute value is not within the locally accepted time window, the GLO MAY return a response indicating cMCStatus.failed and otherInfo.failInfo.badTime and a signingTime attribute.

3.b - Else if signature processing continues and if the signatures verify, the GLO checks that one of the names in the certificate used to sign the response matches the name of the GL.

3.b.1 - If the name of GL does not match the name present in the certificate used to sign the message, the GLO should not believe the response.

3.b.2 - Else if the name of the GL does match the name present in the certificate and:

3.b.2.a - If the signatures verify and the response was cMCStatusInfoExt.cMCStatus.success, the GLO has successfully added or removed the GLO.

3.b.2.b - Else if the signatures verify and the response was cMCStatusInfoExt.cMCStatus.failed with any reason, the GLO can reattempt to add or delete the GLO using the information provided in the response.

4.7. Indicate KEK Compromise

There will be times when the shared KEK is compromised. GL members and GLOs use glkCompromise to tell the GLA that the shared KEK has been compromised. Figure 9 depicts the protocol interactions for GL Key Compromise. Note that error messages are not shown. Additionally, behavior for the optional transactionId, senderNonce, and recipientNonce CMC control attributes is not addressed in these procedures.

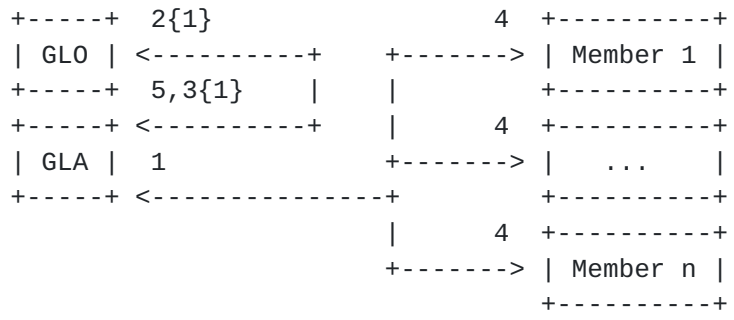


Figure 9 - GL Key Compromise

4.7.1. GL Member Initiated KEK Compromise Message

The process for GL member initiated glkCompromise messages is as follows:

1 - The GL member sends a SignedData.PKIData.controlSequence.glkCompromise request to the GLA (1 in Figure 9). The GL member includes the name of the GL in GeneralName. The GL member MUST also include the signingTime attribute with this request.

1.a - The GL member can optionally apply confidentiality to the request by encapsulating the SignedData.PKIData in an EnvelopedData (see section 3.2.1.2). The glkCompromise can be included in an EnvelopedData generated with the compromised shared KEK.

1.b - The GL member can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

2 - Upon receipt of the glkCompromise request, the GLA checks the signingTime and verifies the GL member signature(s). If an additional SignedData and/or EnvelopedData encapsulates the request (see section 3.2.1.2 or 3.2.2), the GLA verifies the outer signature and/or decrypt the outer layer prior to verifying the signature on the inner most SignedData.

2.a - If the signingTime attribute value is not within the locally accepted time window, the GLA MAY return a response indicating cMCStatus.failed and otherInfo.failInfo.badTime and a signingTime attribute.

2.b - Else if signature processing continues and if the signatures cannotbe verified, the GLA returns a cMCStatusInfoExt response indicating cMCStatus.failed and

otherInfo.failInfo.badMessageCheck. Additionally, a signingTime attribute is included with the response.

2.c - Else if the signatures verify, the GLA makes sure the GL is supported by checking that the indicated GL name matches a glName stored on the GLA.

2.c.1 - If the glName is not supported by the GLA, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of invalidGLName. Additionally, a signingTime attribute is included with the response.

2.c.2 - Else if the glName is supported by the GLA, the GLA checks who signed the request. For GLOs, one of the names in the certificate used to sign the request needs to match a registered GLO. For the member, the name in glMember.glMemberName needs to match one of the names in the certificate used to sign the request.

2.c.2.a - If the GLO signed the request, the GLA generates a glKey message as described in section 5 to rekey the GL (4 in Figure 9).

2.c.2.b - Else if someone other than the GLO signed the request, the GLA forwards the glkCompromise message (see section 3.2.3) to the GLO (2{1} in Figure 9). If there is more than one GLO, to which GLO the request is forwarded is beyond the scope of this document. Further processing by the GLO is discussed in section 4.7.2.

4.7.2. GLO Initiated KEK Compromise Message

The process for GLO initiated glkCompromise messages is as follows:

1 - The GLO either:

1.a - Generates the glkCompromise message itself by sending a SignedData.PKIData.controlSequence.glkCompromise request to the GLA (5 in Figure 9). The GLO includes the name of the GL in GeneralName. The GLO MUST also include a signingTime attribute with this request.

1.a.1 - The GLO can optionally apply confidentiality to the request by encapsulating the SignedData.PKIData in an EnvelopedData (see section 3.2.1.2). The glkCompromise can be included in an EnvelopedData generated with the compromised shared KEK.

1.a.2 - The GLO can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

1.b - Otherwise, checks the signingTime and verifies the GLA and GL member signatures on the forwarded glkCompromise message. If an additional SignedData and/or EnvelopedData encapsulates the request (see section 3.2.1.2 or 3.2.2), the GLO verifies the outer signature and/or decrypt the outer layer prior to verifying the signature on the inner most SignedData.

1.b.1 - If the signingTime attribute value is not within the locally accepted time window, the GLO MAY return a response indicating cMCStatus.failed and otherInfo.failInfo.badTime and a signingTime attribute.

1.b.2 - Else if signature processing continues and if the signatures cannot be verified, the GLO returns a cMCStatusInfoExt response indicating cMCStatus.failed and otherInfo.failInfo.badMessageCheck. Additionally, a signingTime attribute is included with the response.

1.b.2.a - If the signatures verify, the GLO checks the names in the certificate match the name of the signer (i.e., the name in the certificate used to sign the GL member's request is the GL member).

1.b.2.a.1 - If either name does not match, the GLO ought not trust the signer and it ought not forward the message to the GLA.

1.b.2.a.2 - Else if the names match and the signatures verify, the GLO determines whether to forward the glkCompromise message back to the GLA (3{1} in Figure 9). Further processing by the GLA is in 2 of section 4.7.1. The GLO can also return a response to the prospective member with cMCStatusInfoExt.cMCtatus.success indicating that the glkCompromise message was successfully received.

4.8. Request KEK Refresh

There will be times when GL members have unrecoverably lost their shared KEK. The shared KEK is not compromised and a rekey of the entire GL is not necessary. GL members use the glkRefresh message to request that the shared KEK(s) be redistributed to them. Figure 10 depicts the protocol interactions for GL Key Refresh. Note that error messages are not shown. Additionally, behavior for the optional

transactionId, senderNonce, and recipientNonce CMC control attributes is not addressed in these procedures.

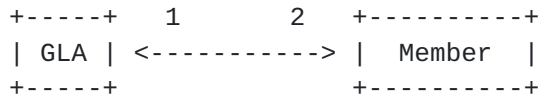


Figure 10 - GL KEK Refresh

The process for glkRefresh is as follows:

1 - The GL member sends a SignedData.PKIData.controlSequence.glkRefresh request to the GLA (1 in Figure 10). The GL member includes name of the GL in GeneralName. The GL member MUST also include a signingTime attribute with this request.

1.a - The GL member can optionally apply confidentiality to the request by encapsulating the SignedData.PKIData in an EnvelopedData (see section 3.2.1.2).

1.b - The GL member can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

2 - Upon receipt of the glkRefresh request, the GLA checks the signingTime and verifies the GL member signature(s). If an additional SignedData and/or EnvelopedData encapsulates the request (see section 3.2.1.2 or 3.2.2), the GLA verifies the outer signature and/or decrypt the outer layer prior to verifying the signature on the inner most SignedData.

2.a - If the signingTime attribute value is not within the locally accepted time window, the GLA MAY return a response indicating cMCStatus.failed and otherInfo.failInfo.badTime and a signingTime attribute.

2.b - Else if signature processing continues and if the signatures cannot be verified, the GLA returns a cMCStatusInfoExt response indicating cMCStatus.failed and otherInfo.failInfo.badMessageCheck. Additionally, a signingTime attribute is included with the response.

2.c - Else if the signatures verify, the GLA makes sure the GL is supported by checking that the GLGeneralName matches a glName stored on the GLA.

2.c.1 - If the name of the GL is not supported by the GLA, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of invalidGLName. Additionally, a signingTime attribute is included with the response.

2.c.2 - Else if the glName is supported by the GLA, the GLA ensures the GL member is on the GL.

2.c.2.a - If the glMemberName is not present on the GL, the GLA returns a response indicating cMCStatusInfoExt with cMCStatus.failed and otherInfo.extendedFailInfo.SKDFailInfo value of noSpam. Additionally, a signingTime attribute is included with the response.

2.c.2.b - Else if the glMemberName is present on the GL, the GLA returns a cMCStatusInfoExt.cMCStatus.success, a signingTime attribute, and a glKey message (2 in Figure 10) as described in section 5.

4.9. GLA Query Request and Response

There will be certain times when a GLO is having trouble setting up a GL because they do not know the algorithm(s) or some other characteristic that the GLA supports. There can also be times when prospective GL members or GL members need to know something about the GLA (these requests are not defined in the document). The glaQueryRequest and glaQueryResponse message have been defined to support determining this information. Figure 11 depicts the protocol interactions for glaQueryRequest and glaQueryResponse. Note error messages are not shown. Additionally, behavior for the optional transactionId, senderNonce, and recipientNonce CMC control attributes is not addressed in these procedures.

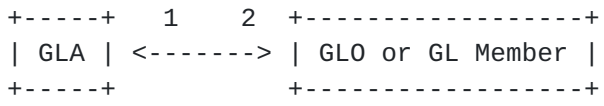


Figure 11 - GLA Query Request & Response

The process for glaQueryRequest and glaQueryResponse is as follows:

1 - The GLO, GL member, or prospective GL member sends a SignedData.PKIData.controlSequence.glaQueryRequest request to the GLA (1 in Figure 11). The GLO, GL member, or prospective GL member indicates the information they are interested in

receiving from the GLA. Additionally, a signingTime attribute is included with this request.

1.a - The GLO, GL member, or prospective GL member can optionally apply confidentiality to the request by encapsulating the SignedData.PKIData in an EnvelopedData (see section 3.2.1.2).

1.b - The GLO, GL member, or prospective GL member can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

2 - Upon receipt of the glaQueryRequest, the GLA determines if it accepts glaQueryRequest messages.

2.a - If the GLA does not accept glaQueryRequest messages, the GLA returns a cMCStatusInfoExt response indicating cMCStatus.noSupport and any other information in statusString.

2.b - Else if the GLA does accept GLAQueryRequests, the GLA checks the signingTime and verifies the GLO, GL member, or prospective GL member signature(s). If an additional SignedData and/or EnvelopedData encapsulates the request (see section 3.2.1.2 or 3.2.2), the GLA verifies the outer signature and/or decrypt the outer layer prior to verifying the signature on the inner most SignedData.

2.b.1 - If the signingTime attribute value is not within the locally accepted time window, the GLA MAY return a response indicating cMCStatus.failed and otherInfo.failInfo.badTime and a signingTime attribute.

2.b.2 - Else if the signature processing continues and if the signatures cannot be verified, the GLA returns a cMCStatusInfoExt response indicating cMCStatus.failed and otherInfo.failInfo.badMessageCheck. Additionally, a signingTime attribute is included with the response.

2.b.3 - Else if the signatures verify, the GLA returns a glaQueryResponse (2 in Figure 11) with the correct response if the glaRequestType is supported or return a cMCStatusInfoExt response indicating cMCStatus.noSupport if the glaRequestType is not supported. Additionally, a signingTime attribute is included with the response.

2.b.3.a - The GLA applies confidentiality to the response by encapsulating the SignedData.PKIResponse in an EnvelopedData if the request was encapsulated in an EnvelopedData (see section 3.2.1.2).

2.b.3.b - The GLA can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

3 - Upon receipt of the glaQueryResponse, the GLO, GL member, or prospective GL member checks the signingTime and verifies the GLA signature(s). If an additional SignedData and/or EnvelopedData encapsulates the response (see section 3.2.1.2 or 3.2.2), the GLO, GL member, or prospective GL member verifies the outer signature and/or decrypt the outer layer prior to verifying the signature on the inner most SignedData.

3.a - If the signingTime attribute value is not within the locally accepted time window, the GLO, GL member, or prospective GL member MAY return a response indicating cMCStatus.failed and otherInfo.failInfo.badTime and a signingTime attribute.

3.b - Else if signature processing continues and if the signatures do not verify, the GLO, GL member, or prospective GL member returns a cMCStatusInfoExt response indicating cMCStatus.failed and otherInfo.failInfo.badMessageCheck. Additionally, a signingTime attribute is included with the response.

3.c - Else if the signatures verify, then the GLO, GL member, or prospective GL member checks that one of the names in the certificate used to sign the response matches the name of the GL.

3.c.1 - If the name of the GL does not match the name present in the certificate used to sign the message, the GLO ought not believe the response.

3.c.2 - Else if the name of the GL matches the name present in the certificate and the response was glaQueryResponse, then the GLO, GL member, or prospective GL member may use the information contained therein.

4.10. Update Member Certificate

When the GLO generates a glAddMember request, when the GLA generates a glKey message, or when the GLA processes a glAddMember there can be instances when GL member's certificate has expired or is invalid. In

these instances the GLO or GLA may request that the GL member provide a new certificate to avoid the GLA from being unable to generate a glKey message for the GL member. There might also be times when the GL member knows their certificate is about to expire or has been revoked and they will not be able to receive GL rekeys. Behavior for the optional transactionId, senderNonce, and recipientNonce CMC control attributes is not addressed in these procedures.

4.10.1. GLO and GLA Initiated Update Member Certificate

The process for GLO initiated glUpdateCert is as follows:

1 - The GLO or GLA sends a SignedData.PKIData.controlSequence.glProvideCert request to the GL member. The GLO or GLA indicates the GL name in glName and the GL member name in glMemberName. Additionally, a signingTime attribute is included with this request.

1.a - The GLO or GLA can optionally apply confidentiality to the request by encapsulating the SignedData.PKIData in an EnvelopedData (see section 3.2.1.2). If the GL member's PKC has been revoked, the GLO or GLA ought not use it to generate the EnvelopedData that encapsulates the glProvideCert request.

1.b - The GLO or GLA can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

2 - Upon receipt of the glProvideCert message, the GL member checks the signingTime and verifies the GLO or GLA signature(s). If an additional SignedData and/or EnvelopedData encapsulates the response (see section 3.2.1.2 or 3.2.2), the GL member verifies the outer signature and/or decrypt the outer layer prior to verifying the signature on the inner most SignedData.

2.a - If the signingTime attribute value is not within the locally accepted time window, the GL member MAY return a response indicating cMCStatus.failed and otherInfo.failInfo.badTime and a signingTime attribute.

2.b - Else if signature processing continues and if the signatures cannot be verified, the GL member returns a cMCStatusInfoExt response indicating cMCStatus.failed and otherInfo.failInfo.badMessageCheck. Additionally, a signingTime attribute is included with the response.

2.c - Else if the signatures verify, the GL member generates a Signed.PKIResponse.controlSequence.glUpdateCert that includes the GL name in glName, the member name in glMember.glMemberName, their encryption certificate in glMember.certificates.pKC. The GL member can also include any attribute certificates associated with their encryption certificate in glMember.certificates.aC, and the certification path associated with their encryption and attribute certificates in glMember.certificates.certPath. Additionally, a signingTime attribute is included with the response.

2.c.1 - The GL member can optionally apply confidentiality to the request by encapsulating the SignedData.PKIResponse in an EnvelopedData (see section 3.2.1.2). If the GL member's PKC has been revoked, the GL member ought not use it to generate the EnvelopedData that encapsulates the glProvideCert request.

2.c.2 - The GL member can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

3 - Upon receipt of the glUpdateCert message, the GLO or GLA checks the signingTime and verifies the GL member signature(s). If an additional SignedData and/or EnvelopedData encapsulates the response (see section 3.2.1.2 or 3.2.2), the GL member verifies the outer signature and/or decrypt the outer layer prior to verifying the signature on the inner most SignedData.

3.a - If the signingTime attribute value is not within the locally accepted time window, the GLO or GLA MAY return a response indicating cMCStatus.failed and otherInfo.failInfo.badTime and a signingTime attribute.

3.b - Else if signature processing continues and if the signatures cannot be verified, the GLO or GLA returns a cMCStatusInfoExt response indicating cMCStatus.failed and otherInfo.failInfo.badMessageCheck. Additionally, a signingTime attribute is included with the response.

3.c - Else if the signatures verify, the GLO or GLA verifies the member's encryption certificate.

3.c.1 - If the member's encryption certificate cannot be verified, the GLO returns either another glProvideCert request or a cMCStatusInfoExt with cMCStatus.failed and the reason why in cMCStatus.statusString. glProvideCert should be returned

only a certain number of times because if the GL member does not have a valid certificate they will never be able to return one. Additionally, a signingTime attribute is included with either response.

3.c.2 - Else if the member's encryption certificate cannot be verified, the GLA returns another glProvideCert request to the GL member or a cMCStatusInfoExt with cMCStatus.failed and the reason why in cMCStatus.statusString to the GLO. glProvideCert should be returned only a certain number of times because if the GL member does not have a valid certificate they will never be able to return one. Additionally, a signingTime attribute is included with the response.

3.c.3 - Else if the member's encryption certificate verifies, the GLO or GLA will use it in subsequent glAddMember requests and glKey messages associated with the GL member.

4.10.2. GL Member Initiated Update Member Certificate

The process for an unsolicited GL member glUpdateCert is as follows:

1 - The GL member sends a Signed.PKIData.controlSequence.glUpdateCert that includes the GL name in glName, the member name in glMember.glMemberName, their encryption certificate in glMember.certificates.pKC. The GL member can also include any attribute certificates associated with their encryption certificate in glMember.certificates.aC, and the certification path associated with their encryption and attribute certificates in glMember.certificates.certPath. The GL member MUST also include a signingTime attribute with this request.

1.a - The GL member can optionally apply confidentiality to the request by encapsulating the SignedData.PKIData in an EnvelopedData (see section 3.2.1.2). If the GL member's PKC has been revoked, the GLO or GLA ought not use it to generate the EnvelopedData that encapsulates the glProvideCert request.

1.b - The GL member can also optionally apply another SignedData over the EnvelopedData (see section 3.2.1.2).

2 - Upon receipt of the glUpdateCert message, the GLA checks the signingTime and verifies the GL member signature(s). If an additional SignedData and/or EnvelopedData encapsulates the

response (see section 3.2.1.2 or 3.2.2), the GLA verifies the outer signature and/or decrypt the outer layer prior to verifying the signature on the inner most SignedData.

2.a - If the signingTime attribute value is not within the locally accepted time window, the GLA MAY return a response indicating cMCStatus.failed and otherInfo.failInfo.badTime and a signingTime attribute.

2.b - Else if signature processing continues and if the signatures cannot be verified, the GLA returns a cMCStatusInfoExt response indicating cMCStatus.failed and otherInfo.failInfo.badMessageCheck.

2.c - Else if the signatures verify, the GLA verifies the member's encryption certificate.

2.c.1 - If the member's encryption certificate cannot be verified, the GLA returns another glProvideCert request to the GL member or a cMCStatusInfoExt with cMCStatus.failed and the reason why in cMCStatus.statusString to the GLO. glProvideCert ought not be returned indefinitely; if the GL member does not have a valid certificate they will never be able to return one. Additionally, a signingTime attribute is included with the response.

2.c.2 - Else if the member's encryption certificate verifies, the GLA will use it in subsequent glAddMember requests and glKey messages associated with the GL member. The GLA also forwards the glUpdateCert message to the GLO.

5. Distribution Message

The GLA uses the glKey message to distribute new, shared KEK(s) after receiving glAddMember, glDeleteMember (for closed and managed GLs), glRekey, glkCompromise, or glkRefresh requests and returning a cMCStatusInfoExt response for the respective request. Figure 12 depicts the protocol interactions to send out glKey messages. Unlike the procedures defined for the administrative messages, the procedures defined in this section MUST be implemented by GLAs for origination and by GL members on reception. Note that error messages are not shown. Additionally, behavior for the optional transactionId, senderNonce, and recipientNonce CMC control attributes is not addressed in these procedures.

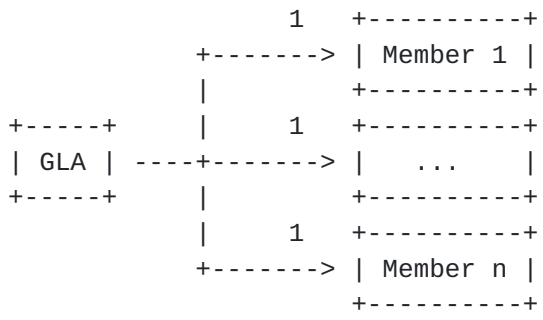


Figure 12 - GL Key Distribution

If the GL was setup with GLKeyAttributes.recipientsNotMutuallyAware set to TRUE, a separate glKey message MUST be sent to each GL member so as to not divulge information about the other GL members.

When the glKey message is generated as a result of a:

- glAddMember request,

- glkComrpomise indication,

- glkRefresh request,

- glDeleteMember request with the GL's glAdministration set to managed or closed, and

- glRekey request with generationCounter set to zero (0).

The GLA MUST use either the kari (see section 12.3.2 of [CMS]) or ktri (see section 12.3.1 of [CMS]) choice in glKey.glkWrapped.RecipientInfo to ensure only the intended recipients receive the shared KEK. The GLA MUST support the ktri choice.

When the glKey message is generated as a result of a glRekey request with generationCounter greater than zero (0) or when the GLA controls rekeys, the GLA MAY use the kari, ktri, or kekri (see section 12.3.3 of [CMS]) in glKey.glkWrapped.RecipientInfo to ensure only the intended recipients receive the shared KEK. The GLA MUST support the RecipientInfo.ktri choice.

5.1. Distribution Process

When a glKey message is generated the process is as follows:

1 - The GLA MUST send a SignedData.PKIData.controlSequence.glKey to each member by including: glName, glIdentifier, glkWrapped,

glkAlgorithm, glkNotBefore, and glkNotAfter. If the GLA can not generate a glKey message for the GL member because the GL member's PKC has expired or is otherwise invalid, the GLA MAY send a glUpdateCert to the GL member requesting a new certificate be provided (see section 4.10). The number of glKey messages generated for the GL is described in section 3.1.16. Additionally, a signingTime attribute is included with the distribution message(s).

1.a - The GLA MAY optionally apply another confidentiality layer to the message by encapsulating the SignedData.PKIData in another EnvelopedData (see section 3.2.1.2).

1.b - The GLA MAY also optionally apply another SignedData over the EnvelopedData.SignedData.PKIData (see section 3.2.1.2).

2 - Upon receipt of the glKey message, the GL members MUST check the signingTime and verify the signature over the inner most SignedData.PKIData. If an additional SignedData and/or EnvelopedData encapsulates the message (see section 3.2.1.2 or 3.2.2), the GL Member MUST verify the outer signature and/or decrypt the outer layer prior to verifying the signature on the SignedData.PKIData.controlSequence.glKey.

2.a - If the signingTime attribute value is not within the locally accepted time window, the GLA MAY return a response indicating cMCStatus.failed and otherInfo.failInfo.badTime and a signingTime attribute.

2.b - Else if signature processing continues and if the signatures cannot be verified, the GL member MUST return a cMCStatusInfoExt response indicating cMCStatus.failed and otherInfo.failInfo.badMessageCheck. Additionally, a signingTime attribute is included with the response.

2.c - Else if the signatures verify, the GL member process the RecipientInfos according to [CMS]. Once unwrapped the GL member should store the shared KEK in a safe place. When stored, the glName, glIdentifier, and shared KEK should be associated. Additionally, the GL member MUST return a cMCStatusInfoExt indicating cMCStatus.success to tell the GLA the KEK was received.

6. Algorithms

This section lists the algorithms that MUST be implemented. Additional algorithms that SHOULD be implemented are also included. Further algorithms MAY also be implemented.

6.1. KEK Generation Algorithm

Implementations MUST randomly generate content-encryption keys, message-authentication keys, initialization vectors (IVs), and padding. Also, the generation of public/private key pairs relies on a random numbers. The use of inadequate pseudo-random number generators (PRNGs) to generate cryptographic keys can result in little or no security. An attacker may find it much easier to reproduce the PRNG environment that produced the keys, searching the resulting small set of possibilities, rather than brute force searching the whole key space. The generation of quality random numbers is difficult. RFC 1750 [RANDOM] offers important guidance in this area, and Appendix 3 of FIPS Pub 186 [FIPS] provides one quality PRNG technique.

6.2. Shared KEK Wrap Algorithm

In the mechanisms described in sections 5, the shared KEK being distributed in glkWrapped MUST be protected by a key of equal or greater length (i.e., if an AES 128-bit key is being distributed a key of 128-bits or greater must be used to protect the key). The algorithm object identifiers included in glkWrapped are as specified in [CMSALG] and [CMSAES].

6.3. Shared KEK Algorithm

The shared KEK distributed and indicated in glkAlgorithm MUST support the symmetric key-encryption algorithms as specified in section [CMSALG] and [CMSAES].

7. Message Transport

SMTP [SMTP] MUST be supported. Other transport mechanisms MAY also be supported.

8. Security Considerations

As GLOs control setting up and tearing down the GL, rekeying the GL, and can control member additions and deletions, GLOs play an important role in the management of the GL, and only "trusted" GLOs should be used.

If a member is deleted or removed from a closed or a managed GL, the GL needs to be rekeyed. If the GL is not rekeyed after a member is removed or deleted, the member still posses the group key and will be able to continue to decrypt any messages that can be obtained.

Members who store KEKs MUST associate the name of the GLA that distributed the key so that the members can make sure subsequent rekeys are originated from the same entity.

When generating keys, care should be taken to ensure that the key size is not too small and duration too long because attackers will have more time to attack the key. Key size should be selected to adequately protect sensitive business communications.

GLOs and GLAs need to make sure that the generationCounter and duration are not too large. For example, if the GLO indicates that the generationCounter is 14 and the duration is one year, then 14 keys are generated each with a validity period of a year. An attacker will have at least 13 years to attack the final key.

Assume that two or more parties have a shared KEK, and the shared KEK is used to encrypt a second KEK for confidential distribution to those parties. The second KEK might be used to encrypt a third KEK; the third KEK might be used to encrypt a fourth KEK; and so on. If any of the KEKs in such a chain is compromised, all of the subsequent KEKs in the chain MUST also be considered compromised.

An attacker can attack the group's shared KEK by attacking one member's copy of the shared KEK or attacking multiple member's copies of the shared KEK. For the attacker it may be easier to either attack the group member with the weakest security protecting their copy of the shared KEK or by attacking multiple group members.

An aggregation of the information gathered during the attack(s) may lead to the compromise of the group's shared KEK. Mechanisms to protect the shared KEK should be commensurate with value of the data being protected.

The nonce and signingTime attributes are used to protect against replay attacks. However, these provisions are only helpful if entities maintain state information about the messages they have sent or received for comparison. If sufficient information is not maintained on each exchange, nonces and signingTime are not helpful.

Local policy determines the amount and duration of state information that is maintained. Additionally, without a unified time source, there is the possibility of clocks drifting. Local policy determines

the acceptable difference between the local time and signingTime, which must compensate for unsynchronized clock. Implementations MUST handle messages with sigiiningTime attributes that indicate they were created in the future.

9. IANA Considerations

None: All identifiers are already registered. Please remove this section prior to publication as an RFC.

10. Acknowledgements

Thanks to Russ Housley and Jim Schaad for providing much of the background and review required to write this document.

11. References

11.1. Normative References

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[PROFILE] Housley, R., Ford, W., Polk, W. and D. Solo, "Internet X.509 Public Key Infrastructure: Certificate and CRL Profile", RFC 3280, April 2002.

[ACPROF] Farrell, S., Housley, R., "An Internet Attribute Certificate Profile for Authorization", RFC 3281, April 2002.

[MSG] Ramsdale, B., "S/MIME Version 3.1 Message Specification," RFC 3851, July 2004.

[ESS] Hoffman, P., "Extended Security Services for S/MIME", RFC 2634, June 1999.

Schaad, J., "Extended Security Services (ESS) Update: Adding CertID Algorithm Agility", RFC 5035, August 2007.

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[SMTP] Klensin, J., "Simple Mail Transport Protocol," RFC 2821, April 2001.

11.2. Informative References

[X400TRANS] Hoffman, P., and C. Bonatti, "Transporting S/MIME Objects in X.400", RFC 3855, July 2004.

[RANDOM] Eastlake, D., Crocker, S. and J. Schiller, "Randomness Recommendations for Security", RFC 4086, June 2005.

[FIPS] National Institute of Standards and Technology. FIPS Pub 186-2: Digital Signature Standard. 27 January 2000.

12. ASN.1 Module

```
SMIMESymmetricKeyDistribution

{ iso(1) member-body(2) us(840) rsadsi(113549) pkcs(1) pkcs-9(9)
  smime(16) modules(0) symkeydist(12) }

DEFINITIONS IMPLICIT TAGS ::=

BEGIN

-- EXPORTS All --
-- The types and values defined in this module are exported for use
-- in the other ASN.1 modules.  Other applications may use them for
-- their own purposes.

IMPORTS

-- PKIX Part 1 - Implicit

GeneralName

  FROM PKIX1Implicit88 { iso(1) identified-organization(3) dod(6)
    internet(1) security(5) mechanisms(5) pkix(7) id-mod(0)
    id-pkix1-implicit(19) }
```

```
   -- PKIX Part 1 - Explicit

   AlgorithmIdentifier, Certificate

     FROM PKIX1Explicit88 { iso(1) identified-organization(3) dod(6)
       internet(1) security(5) mechanisms(5) pkix(7) id-mod(0)
       id-pkix1-explicit(18) }

   -- Cryptographic Message Syntax

   RecipientInfos, KEKIdentifier, CertificateSet

     FROM CryptographicMessageSyntax2004 {iso(1) member-body(2) us(840)
       rsadsi(113549) pkcs(1) pkcs-9(9) smime(16) modules(0)
       cms-2004(24) }

   -- Advanced Encryption Standard (AES) with CMS

   id-aes128-wrap

     FROM CMSAesRsaesOaep { iso(1) member-body(2) us(840) rsadsi(113549)
       pkcs(1) pkcs-9(9) smime(16) modules(0) id-mod-cms-aes(19) }

   -- Attribute Certificate Profile

   AttributeCertificate

     FROM PKIXAttributeCertificate { iso(1) identified-organization(3)
       dod(6) internet(1) security(5) mechanisms(5) pkix(7) id-mod(0)
       id-mod-attribute-cert(12) };

   -- This defines the GL symmetric key distribution object identifier
   -- arc.

   id-skd OBJECT IDENTIFIER ::= { iso(1) member-body(2) us(840)
     rsadsi(113549) pkcs(1) pkcs-9(9) smime(16) skd(8) }

   -- This defines the GL Use KEK control attribute

   id-skd-glUseKEK OBJECT IDENTIFIER ::= { id-skd 1}

   GLUseKEK ::= SEQUENCE {
     glInfo            GLInfo,
     glOwnerInfo       SEQUENCE SIZE (1..MAX) OF GLOwnerInfo,
     glAdministration  GLAdministration DEFAULT 1,
     glKeyAttributes   GLKeyAttributes OPTIONAL }
```

```
   GLInfo ::= SEQUENCE {
     glName     GeneralName,
     glAddress  GeneralName }


   GLOwnerInfo ::= SEQUENCE {
     glOwnerName     GeneralName,
     glOwnerAddress  GeneralName,
     certificates    Certificates OPTIONAL }

   GLAdministration ::= INTEGER {
     unmanaged  (0),
     managed    (1),
     closed     (2) }

   GLKeyAttributes ::= SEQUENCE {
     rekeyControlledByGLO       [0] BOOLEAN DEFAULT FALSE,
     recipientsNotMutuallyAware [1] BOOLEAN DEFAULT TRUE,
     duration                   [2] INTEGER DEFAULT 0,
     generationCounter          [3] INTEGER DEFAULT 2,
     requestedAlgorithm         [4] AlgorithmIdentifier
                                      DEFAULT { id-aes128-wrap } }

   -- This defines the Delete GL control attribute.
   -- It has the simple type GeneralName.

   id-skd-glDelete OBJECT IDENTIFIER ::= { id-skd 2}

   DeleteGL ::= GeneralName

   -- This defines the Add GL Member control attribute

   id-skd-glAddMember OBJECT IDENTIFIER ::= { id-skd 3}

   GLAddMember ::= SEQUENCE {
     glName    GeneralName,
     glMember  GLMember }

     GLMember ::= SEQUENCE {
     glMemberName     GeneralName,
     glMemberAddress  GeneralName OPTIONAL,
     certificates     Certificates OPTIONAL }
```

```
   Certificates ::= SEQUENCE {
     pKC       [0] Certificate OPTIONAL,
                   -- See [PROFILE]
     aC        [1] SEQUENCE SIZE (1.. MAX) OF
                     AttributeCertificate OPTIONAL,
                   -- See [ACPROF]
     certPath  [2] CertificateSet OPTIONAL }
                   -- From [CMS]

   -- This defines the Delete GL Member control attribute

   id-skd-glDeleteMember OBJECT IDENTIFIER ::= { id-skd 4}

   GLDeleteMember ::= SEQUENCE {
     glName            GeneralName,
     glMemberToDelete  GeneralName }

   -- This defines the Delete GL Member control attribute

   id-skd-glRekey OBJECT IDENTIFIER ::= { id-skd 5}

   GLRekey ::= SEQUENCE {
     glName              GeneralName,
     glAdministration    GLAdministration OPTIONAL,
     glNewKeyAttributes  GLNewKeyAttributes OPTIONAL,
     glRekeyAllGLKeys    BOOLEAN OPTIONAL }

   GLNewKeyAttributes ::= SEQUENCE {
     rekeyControlledByGLO       [0] BOOLEAN OPTIONAL,
     recipientsNotMutuallyAware [1] BOOLEAN OPTIONAL,
     duration                   [2] INTEGER OPTIONAL,
     generationCounter          [3] INTEGER OPTIONAL,
     requestedAlgorithm         [4] AlgorithmIdentifier OPTIONAL }

   -- This defines the Add and Delete GL Owner control attributes

   id-skd-glAddOwner OBJECT IDENTIFIER ::= { id-skd 6}

   id-skd-glRemoveOwner OBJECT IDENTIFIER ::= { id-skd 7}

   GLOwnerAdministration ::= SEQUENCE {
     glName       GeneralName,
     glOwnerInfo  GLOwnerInfo }

   -- This defines the GL Key Compromise control attribute.
   -- It has the simple type GeneralName.
```

```
   id-skd-glKeyCompromise OBJECT IDENTIFIER ::= { id-skd 8}

   GLKCompromise ::= GeneralName

   -- This defines the GL Key Refresh control attribute.

   id-skd-glkRefresh OBJECT IDENTIFIER ::= { id-skd 9}

   GLKRefresh ::= SEQUENCE {
     glName  GeneralName,
     dates   SEQUENCE SIZE (1..MAX) OF Date }

   Date ::= SEQUENCE {
     start GeneralizedTime,
     end   GeneralizedTime OPTIONAL }

   -- This defines the GLA Query Request control attribute.

   id-skd-glaQueryRequest OBJECT IDENTIFIER ::= { id-skd 11}

   GLAQueryRequest ::= SEQUENCE {
     glaRequestType   OBJECT IDENTIFIER,
     glaRequestValue  ANY DEFINED BY glaRequestType }

   -- This defines the GLA Query Response control attribute.

   id-skd-glaQueryResponse OBJECT IDENTIFIER ::= { id-skd 12}

   GLAQueryResponse ::= SEQUENCE {
     glaResponseType   OBJECT IDENTIFIER,
     glaResponseValue  ANY DEFINED BY glaResponseType }

   -- This defines the GLA Request/Response (glaRR) arc for
   -- glaRequestType/glaResponseType.

   id-cmc-glaRR OBJECT IDENTIFIER ::= {
     iso(1) identified-organization(3) dod(6) internet(1) security(5)
     mechanisms(5) pkix(7) cmc(7) glaRR(99) }

   -- This defines the Algorithm Request

   id-cmc-gla-skdAlgRequest OBJECT IDENTIFIER ::= { id-cmc-glaRR 1 }

   SKDAlgRequest ::= NULL

   -- This defines the Algorithm Response
```

```
   id-cmc-gla-skdAlgResponse OBJECT IDENTIFIER ::= { id-cmc-glaRR 2 }

   -- Note that the response for algorithmSupported request is the
   -- smimeCapabilities attribute as defined in MsgSpec [MSG].
   -- This defines the control attribute to request an updated
   -- certificate to the GLA.

   id-skd-glProvideCert OBJECT IDENTIFIER ::= { id-skd 13}

   GLManageCert ::= SEQUENCE {
     glName    GeneralName,
     glMember  GLMember }

   -- This defines the control attribute to return an updated
   -- certificate to the GLA. It has the type GLManageCert.

   id-skd-glManageCert OBJECT IDENTIFIER ::= { id-skd 14}

   -- This defines the control attribute to distribute the GL shared
   -- KEK.

   id-skd-glKey OBJECT IDENTIFIER ::= { id-skd 15}

   GLKey ::= SEQUENCE {
     glName        GeneralName,
     glIdentifier  KEKIdentifier,   -- See [CMS]
     glkWrapped    RecipientInfos,  -- See [CMS]
     glkAlgorithm  AlgorithmIdentifier,
     glkNotBefore  GeneralizedTime,
     glkNotAfter   GeneralizedTime }

   -- This defines the CMC error types

   id-cet-skdFailInfo  OBJECT IDENTIFIER ::= {
     iso(1) identified-organization(3) dod(6) internet(1) security(5)
     mechanisms(5) pkix(7) cet(15) skdFailInfo(1) }
```

```
   SKDFailInfo ::= INTEGER {
     unspecified           (0),
     closedGL              (1),
     unsupportedDuration   (2),
     noGLACertificate      (3),
     invalidCert           (4),
     unsupportedAlgorithm  (5),
     noGLONameMatch        (6),
     invalidGLName         (7),
     nameAlreadyInUse      (8),
     noSpam                (9),
     deniedAccess          (10),
     alreadyAMember        (11),
     notAMember            (12),
     alreadyAnOwner        (13),
      notAnOwner            (14) }

   END -- SMIMESymmetricKeyDistribution
```

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