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Certificate Management Protocol (CMP) Updates

Abstract

This document contains a set of updates to the syntax and transport of Certificate Management Protocol (CMP) version 2. This document updates RFC 4210 and RFC 6712.

The aspects of CMP updated in this document are using EnvelopedData instead of EncryptedValue, adding new general message types, defining extended key usages to identify certificates of CMP endpoints on certification and registration authorities, and adding an HTTP URI discovery mechanism and extending the URI structure.

To properly differentiate the support of EnvelopedData instead of EncryptedValue, the CMP version 3 is introduced in case a transaction is supposed to use EnvelopedData.

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1. Introduction

[RFC Editor: please delete]: !!! The change history was moved to Appendix B !!!

While using [CMP](#) [[RFC4210](#)] in industrial and IoT environments and developing the [Lightweight CMP Profile](#) [[I-D.ietf-lamps-lightweight-cmp-profile](#)] some limitations were identified in the original CMP specification. This document updates [RFC 4210](#) [[RFC4210](#)] and [RFC 6712](#) [[RFC6712](#)] to overcome these limitations.

Among others, this document improves the crypto agility of CMP, which means to be flexible to react on future advances in cryptography.

This document also introduces new extended key usages to identify CMP endpoints on registration and certification authorities.

1.1. Convention and Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [[RFC2119](#)] [[RFC8174](#)] when, and only when, they appear in all capitals, as shown here.

Technical terminology is used in conformance with [RFC 4210](#) [[RFC4210](#)], [RFC 4211](#) [[RFC4211](#)], and [RFC 5280](#) [[RFC5280](#)]. The following key words are used:

CA:

Certification authority, which issues certificates.

RA: Registration authority, an optional system component to which a CA delegates certificate management functions such as authorization checks.

KGA: Key generation authority, which generates key pairs on behalf of an EE. The KGA could be co-located with an RA or a CA.

EE: End entity, a user, device, or service that holds a PKI certificate. An identifier for the EE is given as its subject of the certificate.

2. Updates to RFC 4210 - Certificate Management Protocol (CMP)

2.1. New Section 1.1. - Changes since RFC 4210

The following subsection describes feature updates to [RFC 4210](#) [[RFC4210](#)]. They are always related to the base specification. Hence references to the original sections in [RFC 4210](#) [[RFC4210](#)] are used whenever possible.

Insert this section at the end of the current Section 1:

1.1. Changes since RFC 4210

The following updates are made in [thisRFC]:

- *Add new extended key usages for various CMP server types, e.g., registration authority and certification authority, to express the authorization of the entity identified in the certificate containing the respective extended key usage extension to act as the indicated PKI management entity.
- *Extend the description of multiple protection to cover additional use cases, e.g., batch processing of messages.
- *Offering EnvelopedData as the preferred choice next to EncryptedValue to better support crypto agility in CMP. Note that according to [RFC 4211](#) [[RFC4211](#)] section 2.1. point 9 the use of the EncryptedValue structure has been deprecated in favor of the EnvelopedData structure. [RFC 4211](#) [[RFC4211](#)] offers the EncryptedKey structure, a choice of EncryptedValue and EnvelopedData for migration to EnvelopedData. For reasons of completeness and consistency the type EncryptedValue has been exchanged in all occurrences in [RFC 4210](#) [[RFC4210](#)]. This includes the protection of centrally generated private keys, encryption of certificates, and protection of revocation passphrases. To properly differentiate the support of EnvelopedData instead of

EncryptedValue, the CMP version 3 is introduced in case a transaction is supposed to use EnvelopedData.

*Adding new general message types to request CA certificates, a root CA update, or a certificate request template.

*Extend the usage of polling to p10cr messages.

*Delete the mandatory algorithm profile in [RFC 4210 Appendix D.2 \[RFC4210\]](#) and refer to [CMP Algorithms Section 7 \[I-D.ietf-lamps-cmp-algorithms\]](#).

2.2. New Section 4.5 - Extended Key Usage

The following subsection describes new extended key usages for various CMP server types specified in [RFC 4210 \[RFC4210\]](#).

Insert this section at the end of the current Section 4:

4.5. Extended Key Usage

The Extended Key Usage (EKU) extension indicates the purposes for which the certified key pair may be used. It therefore restricts the use of a certificate to specific applications.

A CA may want to delegate parts of its duties to other PKI management entities. The mechanism to prove this delegation explained in this section offers automatic way of checking the authorization of such delegation. Such delegation could also be expressed by other means, e.g., explicit configuration.

To offer automatic validation for the delegation of a role by a CA, the certificates used for CMP message protection or signed data for central key generation MUST be issued by the delegating CA and MUST contain the respective EKUs. This proves the authorization of this entity by the delegating CA to act in the given role as described below.

The OIDs to be used for these EKUs are:

```
id-kp-cmcCA OBJECT IDENTIFIER ::= {
    iso(1) identified-organization(3) dod(6) internet(1)
    security(5) mechanisms(5) pkix(7) kp(3) 27 }
id-kp-cmcRA OBJECT IDENTIFIER ::= {
    iso(1) identified-organization(3) dod(6) internet(1)
    security(5) mechanisms(5) pkix(7) kp(3) 28 }
id-kp-cmKGA OBJECT IDENTIFIER ::= {
    iso(1) identified-organization(3) dod(6) internet(1)
    security(5) mechanisms(5) pkix(7) kp(3) 32 }
```

Note: [RFC 6402 section 2.10](#) [RFC6402] specifies OIDs for a CMC CA and a CMC RA. As the functionality of a CA and RA is not specific to using CMC or CMP as certificate management protocol, these OIDs SHALL be re-used also for CMP CAs and for CMP RAs.

The description of the PKI management entity for each of the EKUs is as follows:

CMP CA: CMP Certification Authorities are CMP endpoints on CA equipment as described in section 3.1.1.2. The private key used in the context of CMP management operations, especially CMP message protection, does not need to be the same as for signing certificates. It is necessary, however, to ensure that the entity acting as CMP CA is authorized to do so. Therefore, the CMP CA MUST do one of the following,

- *use the CA private key also for the CMP endpoint, or
- *explicitly designate this role to another entity.

For automatic validation of such a delegation this MUST be indicated by the id-kp-cmcCA extended key usage. This extended key usage MUST be placed into the certificate used on the CA equipment and the CA that delegates this role MUST issue the CMP CA certificate.

Note: Using a separate key pair for protecting CMP management operations at the CA decreases the number of operations of the private key used to sign certificates.

CMP RA: CMP Registration Authorities are CMP endpoints on RA equipment as described in Section 3.1.1.3. A CMP RA is identified by the id-kp-cmcRA extended key usage. This extended key usage MUST be placed in RA certificates. The CA that delegated this role is identified by the CA that issued the CMP RA certificate.

CMP KGA: CMP Key Generation Authorities are identified by the id-kp-cmKGA extended key usage. The CMP KGA knows the private key it generated on behalf of the end entity. This is a very sensitive service and therefore needs specific authorization. This authorization is either with the CA certificate itself, or it MUST be indicated by placing the id-kp-cmKGA extended key usage in the certificate used to authenticate the origin of the generated private key, and to express the authorization to offer this service.

< TBD: Tomas addressed the question if the CMP CA role and ECU are really needed. The discussion is ongoing. >

Note: In device PKIs, especially those issuing IDevID certificates [IEEE 802.1AR Section 8.5](#) [[IEEE.802.1AR 2018](#)], CA certificates may have very long validity (including the GeneralizedTime value 99991231235959Z to indicate a not well-defined expiration date as specified in [IEEE 802.1AR Section 8.5](#) [[IEEE.802.1AR 2018](#)] and [RFC 5280 Section 4.1.2.5](#) [[RFC5280](#)]). Such validity periods SHOULD NOT be used for protection of CMP messages. Certificates for delegated CMP message protection (CMP CA, CMP RA, CMP KGA) MUST NOT use indefinite expiration date.

2.3. Update Section 5.1.1. - PKI Message Header

Section 5.1.1 of [RFC 4210](#) [[RFC4210](#)] describes the PKI message header. This document introduces the new version 3 indicating support of EnvelopedData as specified in [Section 2.6](#).

Replace the ASN.1 Syntax of PKIHeader and the subsequent description of pvno with the following text:

```
PKIHeader ::= SEQUENCE {
    pvno                INTEGER      { cmp1999(1), cmp2000(2),
                                     cmp2021(3) },
    sender              GeneralName,
    recipient           GeneralName,
    messageTime        [0] GeneralizedTime      OPTIONAL,
    protectionAlg       [1] AlgorithmIdentifier  OPTIONAL,
    senderKID           [2] KeyIdentifier         OPTIONAL,
    recipKID            [3] KeyIdentifier         OPTIONAL,
    transactionID       [4] OCTET STRING         OPTIONAL,
    senderNonce         [5] OCTET STRING         OPTIONAL,
    recipNonce          [6] OCTET STRING         OPTIONAL,
    freeText            [7] PKIFreeText          OPTIONAL,
    generalInfo         [8] SEQUENCE SIZE (1..MAX) OF
                        InfoTypeAndValue        OPTIONAL
}
```

```
PKIFreeText ::= SEQUENCE SIZE (1..MAX) OF UTF8String
```

The usage of different pvno values is described in Section 7.

2.4. Update Section 5.1.3.1. - Shared Secret Information

Section 5.1.3.1 of [RFC 4210](#) [[RFC4210](#)] describes the MAC based protection of a PKIMessage using the algorithm id-PasswordBasedMac.

Replace the first paragraph with the following text:

In this case, the sender and recipient share secret information with sufficient entropy (established via out-of-band means or from a

previous PKI management operation). PKIProtection will contain a MAC value and the protectionAlg will be the following (see also [[RFC4211](#)] and [[I-D.ietf-lamps-crmf-update-algs](#)]):

2.5. Replace Section 5.1.3.4 - Multiple Protection

Section 5.1.3.4 of [RFC 4210](#) [[RFC4210](#)] describes the nested message. This document enables using opens the usage of nested messages also for batch transport of PKI messages between PKI management entities and also with mixed body types.

Replace the text of the section with the following text:

5.1.3.4. Multiple Protection

When receiving a protected PKI message, a PKI management entity such as an RA MAY forward that message adding its own protection (which MAY be a MAC or a signature, depending on the information and certificates shared between the RA and the CA). Moreover, multiple PKI messages MAY be aggregated. There are several use cases for such messages.

- *The RA confirms having validated and authorized a message and forwards the original message unchanged.
- *The RA collects several messages that are to be forwarded in the same direction and forwards them in a batch. In communication to the CA request messages and in communication from the CA response or announcement messages will be collected. This can for instance be used when bridging an off-line connection between two PKI management entities.
- *The RA modifies the message(s) in some way (e.g., add or modify particular field values or add new extensions) before forwarding them, then it MAY create its own desired PKIBody. In case the changes made by the RA to PKIMessage breaks the POP of a certificate request, the RA MUST set the POP RAVerified. It MAY include the original PKIMessage from the EE in the generalInfo field of PKIHeader of the nested message (to accommodate, for example, cases in which the CA wishes to check POP or other information on the original EE message). The infoType to be used in this situation is {id-it 15} (see Section 5.3.19 for the value of id-it) and the infoValue is PKIMessages (contents MUST be in the same order as the message in PKIBody).

These use cases are accomplished by nesting the messages sent by the PKI entity within a new PKI message. The structure used is as follows:

NestedMessageContent ::= PKIMessages

2.6. Replace Section 5.2.2. - Encrypted Values

Section 5.2.2 of [RFC 4210](#) [[RFC4210](#)] describes the use of EncryptedValue to transport encrypted data. This document extends the encryption of data to preferably use EnvelopedData.

Replace the text of the section with the following text:

5.2.2. Encrypted Values

Where encrypted data (in this specification, private keys, certificates, or revocation passphrase) are sent in PKI messages, the EncryptedKey data structure is used.

```
EncryptedKey ::= CHOICE {  
    encryptedValue      EncryptedValue, -- deprecated  
    envelopedData      [0] EnvelopedData }
```

See [CRMF](#) [[RFC4211](#)] for EncryptedKey and EncryptedValue syntax and [CMS](#) [[RFC5652](#)] for EnvelopedData syntax. Using the EncryptedKey data structure, offers the choice to either use EncryptedValue (for backward compatibility only) or EnvelopedData. The use of the EncryptedValue structure has been deprecated in favor of the EnvelopedData structure. Therefore, it is recommended to use EnvelopedData.

Note: The EncryptedKey structure defined in [CRMF](#) [[RFC4211](#)] is reused here, which makes the update is backward compatible. Using the new syntax with the untagged default choice EncryptedValue is bits-on-the-wire compatible with the old syntax.

To indicate support for EnvelopedData the pvno cmp2021 is introduced by this document. Details on the usage of different pvno values is described in Section 7.

The EncryptedKey data structure is used in CMP to transport a private key, certificate, or revocation passphrase in encrypted form.

EnvelopedData is used as follows:

- *It contains only one RecipientInfo structure because the content is encrypted only for one recipient.

- *It may contain a private key in the AsymmetricKeyPackage structure as defined in [RFC 5958](#) [[RFC5958](#)] wrapped in a

SignedData structure as specified in [CMS section 5 \[RFC5652\]](#) signed by the Key Generation Authority.

*It may contain a certificate or revocation passphrase directly in the encryptedContent field.

The content of the EnvelopedData structure, as specified in [CMS section 6 \[RFC5652\]](#), MUST be encrypted using a newly generated symmetric content-encryption key. This content-encryption key MUST be securely provided to the recipient using one of three key management techniques.

The choice of the key management technique to be used by the sender depends on the credential available at the recipient:

*Recipient's certificate that contains a key usage extension asserting keyAgreement: The content-encryption key will be protected using the key agreement key management technique, as specified in [CMS section 6.2.2 \[RFC5652\]](#). This is the preferred technique.

*Recipient's certificate that contains a key usage extension asserting keyEncipherment: The content-encryption key will be protected using the key transport key management technique, as specified in [CMS section 6.2.1 \[RFC5652\]](#).

*A password or shared secret: The content-encryption key will be protected using the password-based key management technique, as specified in [CMS section 6.2.4 \[RFC5652\]](#).

2.7. Update Section 5.3.4. - Certification Response

Section 5.3.4 of [RFC 4210 \[RFC4210\]](#) describes the Certification Response. This document updates the syntax by using the parent structure EncryptedKey instead of EncryptedValue as described in [Section 2.6](#) above.

Replace the ASN.1 syntax of CertifiedKeyPair and CertOrEncCert with the following text:

```

CertifiedKeyPair ::= SEQUENCE {
    certOrEncCert      CertOrEncCert,
    privateKey         [0] EncryptedKey      OPTIONAL,
    -- see [CRMF] for comment on encoding
    publicationInfo    [1] PKIPublicationInfo OPTIONAL
}

CertOrEncCert ::= CHOICE {
    certificate         [0] Certificate,
    encryptedCert       [1] EncryptedKey
}

```

Add the following as a new paragraph right after the ASN.1 syntax:

A p10cr message contains exactly one CertificationRequestInfo data structure as specified in [PKCS#10 \[RFC2986\]](#) but no certReqId. Therefore, the certReqId in the corresponding certification response (cp) message MUST be set to 0.

Add the following as new paragraphs to the end of the section:

The use of EncryptedKey is described in Section 5.2.2.

Note: To indicate support for EnvelopedData the pvno cmp2021 is introduced by this document. Details on the usage of different pvno values is described in Section 7.

2.8. Update Section 5.3.19.2. - Signing Key Pair Types

The following section clarifies the usage of the Signing Key Pair Types PKI general message on referencing EC curves.

Insert this note at the end of Section 5.3.19.2:

Note: In case several EC curves are supported, several id-ecPublicKey elements need to be given, one each per named curve.

2.9. Update Section 5.3.19.3. - Encryption/Key Agreement Key Pair Types

The following section clarifies the use of the Encryption/Key Agreement Key Pair Types PKI general message on referencing EC curves.

Insert this note at the end of Section 5.3.19.3:

Note: In case several EC curves are supported, several id-ecPublicKey elements need to be given, one each per named curve.

2.10. Replace Section 5.3.19.9. - Revocation Passphrase

Section 5.3.19.9 of [RFC 4210](#) [[RFC4210](#)] describes the provisioning of a revocation passphrase for authenticating a later revocation request. This document updates the handling by using the parent structure EncryptedKey instead of EncryptedValue to transport this information as described in [Section 2.6](#) above.

Replace the text of the section with the following text:

5.3.19.9. Revocation Passphrase

This MAY be used by the EE to send a passphrase to a CA/RA for the purpose of authenticating a later revocation request (in the case that the appropriate signing private key is no longer available to authenticate the request). See Appendix B for further details on the use of this mechanism.

GenMsg: {id-it 12}, EncryptedKey
GenRep: {id-it 12}, < absent >

The use of EncryptedKey is described in section 5.2.2.

2.11. New Section 5.3.19.14 - CA Certificates

The following subsection describes the PKI general message using id-it-caCerts. The use is specified in Lightweight CMP Profile [I-D.ietf-lamps-lightweight-cmp-profile] Section 4.4.

Insert this section after Section 5.3.19.13:

2.3.19.14 CA Certificates

This MAY be used by the client to get the current CA intermediate and issuing CA certificates.

GenMsg: {id-it 17}, < absent >
GenRep: {id-it 17}, SEQUENCE OF CMPCertificate | < absent >

2.12. New Section 5.3.19.15 - Root CA Certificate Update

The following subsection describes the PKI general message using id-it-rootCaKeyUpdate. The use is specified in Lightweight CMP Profile [I-D.ietf-lamps-lightweight-cmp-profile] Section 4.4.

Insert this section after new Section 5.3.19.14:

5.3.19.15. Root CA Certificate Update

This MAY be used by the client to get an update of an existing root CA Certificate. In contrast to the ckuann message it follows the request/response model.

GenMsg: {id-it 18}, < absent >

GenRep: {id-it 18}, RootCaKeyUpdateContent | < absent >

```
RootCaKeyUpdateContent ::= SEQUENCE {  
    newWithNew      CMPCertificate  
    newWithOld      [0] CMPCertificate OPTIONAL,  
    oldWithNew      [1] CMPCertificate OPTIONAL  
}
```

< TBD: In case the PKI offers updates of various root CA certificates, it needs to be defined how the EE requests an update of a specific root CA certificate. >

Note: In contrast to CAKeyUpdAnnContent, this type offers omitting newWithOld and oldWithNew in the GenRep message, depending on the needs of the EE.

2.13. New Section 5.3.19.16 - Certificate Request Template

The following subsection describes the PKI general message using id-it-certReqTemplate. The use is specified in Lightweight CMP Profile [I-D.ietf-lamps-lightweight-cmp-profile] Section 4.4.

Insert this section after new Section 5.3.19.15:

5.3.19.16. Certificate Request Template

This MAY be used by the client to get a template containing requirements for certificate request attributes and extensions and optionally a specification for the key pair to generate for a future certificate request operation.

```

GenMsg:      {id-it 19}, < absent >
GenRep:      {id-it 19}, CertReqTemplateContent | < absent >

CertReqTemplateContent ::= SEQUENCE {
    certTemplate      CertTemplate,
    keySpec           Controls OPTIONAL
}

Controls ::= SEQUENCE SIZE(1..MAX) OF AttributeTypeAndValue

id-regCtrl-algId OBJECT IDENTIFIER ::= { iso(1)
    identified-organization(3) dod(6) internet(1) security(5)
    mechanisms(5) pkix(7) pkix(5) regCtrl(1) TBD3 }
AlgIdCtrl ::= AlgorithmIdentifier

id-regCtrl-rsaKeyLen OBJECT IDENTIFIER ::= { iso(1)
    identified-organization(3) dod(6) internet(1) security(5)
    mechanisms(5) pkix(7) pkix(5) regCtrl(1) TBD4 }
RsaKeyLenCtrl ::= Integer

```

< TBD: The OIDs TBD3 and TBD4 have to be registered at IANA. >

< TBD: In case the PKI offers certificate request templates for various certificates, it needs to be defined how the EE requests a specific certificate request template. >

CertReqTemplateValue contains a prefilled certTemplate to be used for the future certificate request. The SubjectPublicKeyInfo field in the certTemplate MUST NOT be used. In case the PKI management entity wishes to specify supported algorithms, the keySpec field MUST be used. One AttributeTypeAndValue per supported algorithm or RSA key length MUST be used.

Note: The Controls ASN.1 type is defined in [CRMF Section 6](#) [[RFC4211](#)]

2.14. Update Section 5.3.22 - Polling Request and Response

Section 5.3.22 of [RFC 4210](#) [[RFC4210](#)] describes when and how polling messages are used. This document adds the polling mechanism also for outstanding responses to a p10cr.

Replace in the first paragraph the word 'cr' by 'cr, p10cr' and add just before the state machine diagram the following text:

A p10cr message contains exactly one CertificationRequestInfo data structure as specified in [PKCS#10](#) [[RFC2986](#)] but no certificate request identifier. Therefore, the certReqId MUST be set to 0 in all subsequent messages of this transaction.

2.15. Update Section 7 - Version Negotiation

Section 7 of [RFC 4210](#) [[RFC4210](#)] describes the use of different CMP protocol versions. This document describes the handling of the additional CMP version cmp2021 introduced to indicate support of EnvelopedData.

Replace the text of the first two paragraphs with the following text:

This section defines the version negotiation between client and servers used to choose among cmp1999 (specified in [RFC 2510](#) [[RFC2510](#)]), of cmp2000 (specified in [RFC 4210](#) [[RFC4210](#)]), and cmp2021 (specified in this document). The only difference between protocol versions cmp2021 and cmp2000 is that EnvelopedData replaces EncryptedValue.

If a client does not support cmp2021 it chooses the versions for a request as follows:

- *If the client knows the protocol version(s) supported by the server (e.g., from a previous PKIMessage exchange or via some out-of-band means), then it MUST send a PKIMessage with the highest version supported by both it and the server.
- *If the client does not know what version(s) the server supports, then it MUST send a PKIMessage using the highest version it supports.

If a client supports cmp2021 and encrypted values are supposed to be transferred in the PKI management operation the client MUST choose the version for a request as follows:

- *If the client supports EnvelopedData, but not EncryptedValue, then it MUST send a PKIMessage using cmp2021.
- *If the client does not support EnvelopedData, but EncryptedValue, then it MUST send a PKIMessage using cmp2000.
- *If the client supports both EnvelopedData and EncryptedValues:
 - If the client knows the protocol version(s) supported by the server (e.g., from a previous PKIMessage exchange or via some out-of-band means), then it MUST send a PKIMessage with the highest version supported the server.
 - If the client does not know what version(s) the server supports, then it MUST send a PKIMessage using cmp2021.

2.16. Update Section 7.1.1. - Clients Talking to RFC 2510 Servers

Section 7.1.1 of [RFC 4210](#) [[RFC4210](#)] describes the behaviour of a client talking to a cmp1999 server. This document extends the section to all clients with a higher version than cmp1999.

Replace the first sentence of section 7.1.1 with the following text:

If, after sending a message with a higher protocol version number than cmp1999, a client receives an ErrorMessageContent with a version of cmp1999, then it MUST abort the current transaction.

2.17. Update Section 9 - IANA Considerations

Section 9 of [RFC 4210](#) [[RFC4210](#)] contains the IANA Considerations of that document. As this document defines one new and updates two existing Extended Key Usages, the IANA Considerations need to be updated accordingly.

Add the following paragraphs after the third paragraph of the section:

In the SMI-numbers registry "SMI Security for PKIX Extended Key Purpose Identifiers (1.3.6.1.5.5.7.3)" (see <https://www.iana.org/assignments/smi-numbers/smi-numbers.xhtml#smi-numbers-1.3.6.1.5.5.7.3>) as defined in [RFC 7299](#) [[RFC7299](#)] three changes have been performed.

Two existing entries have been updated to also point to this document:

Decimal	Description	References
27	id-kp-cmcCA	[RFC6402][thisRFC]
28	id-kp-cmcRA	[RFC6402][thisRFC]

Table 1: Changes to the PKIX Extended Key Purpose Identifiers registry

One new entry has been added:

Decimal	Description	References
32	id-kp-cmKGA	[thisRFC]

Table 2: Addition to the PKIX Extended Key Purpose Identifiers registry

In the SMI-numbers registry "SMI Security for PKIX CMP Information Types (1.3.6.1.5.5.7.4)" (see <https://www.iana.org/assignments/smi->

numbers/smi-numbers.xhtml#smi-numbers-1.3.6.1.5.5.7.4) as defined in [RFC 7299](#) [[RFC7299](#)] three additions have been performed.

Three new entries have been added:

Decimal	Description	References
17	id-it-caCerts	[thisRFC]
18	id-it-rootCaKeyUpdate	[thisRFC]
19	id-it-certReqTemplate	[thisRFC]

Table 3: Addition to the PKIX CMP
Information Types registry

In the SMI-numbers registry " SMI Security for PKIX CRMF Registration Controls (1.3.6.1.5.5.7.5.1)" (see <https://www.iana.org/assignments/smi-numbers/smi-numbers.xhtml#smi-numbers-1.3.6.1.5.5.7.5.1>) as defined in [RFC 7299](#) [[RFC7299](#)] two additions have been performed.

Two new entries have been added:

Decimal	Description	References
TBD3	id-regCtrl-algId	[thisRFC]
TBD4	id-regCtrl-rsaKeyLen	[thisRFC]

Table 4: Addition to the PKIX CRMF
Registration Controls registry

2.18. Update Appendix B - The Use of Revocation Passphrase

Appendix B of [RFC 4210](#) [[RFC4210](#)] describes the use of the revocation passphrase. As this document updates [RFC 4210](#) [[RFC4210](#)] to utilize the parent structure EncryptedKey instead of EncryptedValue as described in [Section 2.6](#) above, the description is updated accordingly.

Replace the first bullet point of this section with the following text:

*The OID and value specified in Section 5.3.19.9 MAY be sent in a GenMsg message at any time, or MAY be sent in the generalInfo field of the PKIHeader of any PKIMessage at any time. (In particular, the EncryptedKey structure as described in section 5.2.2 may be sent in the header of the certConf message that confirms acceptance of certificates requested in an initialization request or certificate request message.) This conveys a revocation passphrase chosen by the entity to the relevant CA/RA. For use of EnvelopedData this is in the decrypted bytes of encryptedContent field and for use of EncryptedValue

this is in the decrypted bytes of the encValue field.
Furthermore, the transfer is accomplished with appropriate confidentiality characteristics.

Replace the third bullet point of this section with the following text:

*When using EnvelopedData the localKeyId attribute as specified in [RFC 2985](#) [[RFC2985](#)] and when using EncryptedValue the valueHint field MAY contain a key identifier (chosen by the entity, along with the passphrase itself) to assist in later retrieval of the correct passphrase (e.g., when the revocation request is constructed by the entity and received by the CA/RA).

2.19. Update Appendix C - Request Message Behavioral Clarifications

Appendix C of [RFC 4210](#) [[RFC4210](#)] provides clarifications to the request message behavior. As this document updates [RFC 4210](#) [[RFC4210](#)] to utilize the parent structure EncryptedKey instead of EncryptedValue as described in [Section 2.6](#) above, the description is updated accordingly.

Replace the comment within the ASN.1 syntax coming after the definition of POPOPrivKey with the following text:

```
-- *****
-- *   the type of "thisMessage" is given as BIT STRING in RFC 4211
-- *   [RFC4211]; it should be "EncryptedKey" (in accordance with
-- *   Section 5.2.2 of this specification). Therefore, this
-- *   document makes the behavioral clarification of specifying
-- *   that the contents of "thisMessage" MUST be encoded either as
-- *   "EnvelopedData" or "EncryptedValue" (only for backward
-- *   compatibility) and then wrapped in a BIT STRING. This
-- *   allows the necessary conveyance and protection of the
-- *   private key while maintaining bits-on-the-wire compatibility
-- *   with RFC 4211 [RFC4211].
-- *****
```

2.20. Update Appendix D.1. - General Rules for Interpretation of These Profiles

Appendix D.1 of [RFC 4210](#) [[RFC4210](#)] provides general rules for interpretation of the PKI management messages profiles specified in Appendix D and Appendix E of [RFC 4210](#) [[RFC4210](#)]. This document updates a sentence regarding the new protocol version cmp2021.

Replace the last sentence of the first paragraph of the section with the following text:

Mandatory fields are not mentioned if they have an obvious value (e.g., in this version of these profiles, pvno is always cmp2000).

2.21. Update Appendix D.2. - Algorithm Use Profile

[Appendix D.2 of RFC 4210](#) [RFC4210] provides a list of algorithms that implementations must support when claiming conformance with PKI Management Message Profiles as specified in [CMP Appendix D.2](#) [RFC4210]. This document redirects to the new algorithm profile as specified in Appendix A.1 of [CMP Algorithms](#) [I-D.ietf-lamps-cmp-algorithms].

Replace the text of the section with the following text:

D.2. Algorithm Use Profile

For specifications of algorithm identifiers and respective conventions for conforming implementations, please refer to [CMP Algorithms Appendix A.1](#) [I-D.ietf-lamps-cmp-algorithms].

2.22. Update Appendix D.4. - Initial Registration/Certification (Basic Authenticated Scheme)

Appendix D.4 of [RFC 4210](#) [RFC4210] provides the initial registration/certification scheme. This scheme shall continue using EncryptedValue for backward compatibility reasons.

Replace the comment after the privateKey field of crc[1].certifiedKeyPair in the syntax of the Initialization Response message with the following text:

```
-- see Appendix C, Request Message Behavioral Clarifications
-- for backward compatibility reasons, use EncryptedValue
```

3. Updates to RFC 6712 - HTTP Transfer for the Certificate Management Protocol (CMP)

3.1. New Section 1.1. - Changes since RFC 6712

The following subsection describes feature updates to [RFC 6712](#) [RFC6712]. They are related to the base specification. Hence references to the original sections in [RFC 6712](#) [RFC6712] are used whenever possible.

Insert this section at the end of the current Section 1:

1.1 Changes since RFC 6712

The following updates are made in [thisRFC]:

- *Introduce the HTTP path '/.well-known/cmp'.

- *Extend the URI structure.

3.2. Replace Section 3.6. - HTTP Request-URI

Section 3.6 of [RFC 6712](#) [RFC6712] specifies the used HTTP URIs. This document introduces the HTTP path '/.well-known/cmp' and extends the URIs.

Replace the text of the section with the following text:

3.6. HTTP Request-URI

Each CMP server on a PKI management entity supporting HTTP or HTTPS transport MUST support the use of the path prefix '/.well-known/' as defined in [RFC 8615](#) [RFC8615] and the registered name 'cmp' to ease interworking in a multi-vendor environment.

The CMP client needs to be configured with sufficient information to form the CMP server URI. This is at least the authority portion of the URI, e.g., 'www.example.com:80', or the full operation path segment of the PKI management entity. Additionally, OPTIONAL path segments MAY be added after the registered application name as part of the full operation path to provide further distinction. A path segment could for example support the differentiation of specific CAs, certificate profiles, or PKI management operations. A valid full operation path segment can look like this:

```
http://www.example.com/.well-known/cmp
http://www.example.com/.well-known/cmp/operationLabel
http://www.example.com/.well-known/cmp/profileLabel
http://www.example.com/.well-known/cmp/profileLabel/
operationLabel
```

3.3. Update Section 6. - IANA Considerations

Section 6 of [RFC 6712](#) [RFC6712] contains the IANA Considerations of that document. As this document defines a new well-known URI, the IANA Considerations need to be updated accordingly.

Add the following text between the first and second paragraph of the section:

In the well-known URI registry (see <https://www.iana.org/assignments/well-known-uris/well-known-uris.xhtml#well-known-uris-1>) as defined in [RFC 8615](#) [RFC8615] the following change has been performed.

One new name entry has been added:

URI suffix	Change controller
cmp	IETF

Table 5

4. IANA Considerations

This document contains an update to the IANA Consideration sections to be added to [[RFC4210](#)] and [[RFC6712](#)].

< TBD: This document updates the ASN.1 modules of [RFC 4210 Appendix F](#) [[RFC4210](#)] and [RFC 5912 Section 9](#) [[RFC5912](#)]. New OIDs TBD1 and TBD2 need to be registered to identify the updates ASN.1 modules. >

< TBD: New OIDs TBD3 (id-regCtrl-algId) and TBD4 (id-regCtrl-rsaKeyLen) need to be registered. >

< TBD: The existing description and information of id-kp-cmcRA and id-kp-cmcCA need to be updated to reflect their extended usage. >

5. Security Considerations

No changes are made to the existing security considerations of [RFC 4210](#) [[RFC4210](#)] and [RFC 6712](#) [[RFC6712](#)].

6. Acknowledgements

Special thank goes to Jim Schaad for his guidance and the inspiration on structuring and writing this document we got from [[RFC6402](#)] which updates CMC. Special thank also goes also to Russ Housley and Tomas Gustavsson for reviewing and providing valuable suggestions on improving this document.

We also thank all reviewers of this document for their valuable feedback.

7. References

7.1. Normative References

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- [RFC8615] Nottingham, M., "Well-Known Uniform Resource Identifiers (URIs)", RFC 8615, DOI 10.17487/RFC8615, May 2019, <<https://www.rfc-editor.org/info/rfc8615>>.

7.2. Informative References

- [I-D.ietf-lamps-lightweight-cmp-profile] Brockhaus, H., Fries, S., and D. V. Oheimb, "Lightweight CMP Profile", Work in Progress, Internet-Draft, draft-ietf-lamps-lightweight-cmp-profile-04, 2 November 2020, <<https://tools.ietf.org/html/draft-ietf-lamps-lightweight-cmp-profile-04>>.
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Appendix A. ASN.1 Modules

A.1. 1988 ASN.1 Module

This section contains the updated ASN.1 module for [[RFC4210](#)]. This module replaces the module in Appendix F of that document. Although a 2002 ASN.1 module is provided, this 1988 ASN.1 module remains the normative module as per the policy of the PKIX working group.


```

PKIXCMP {iso(1) identified-organization(3)
    dod(6) internet(1) security(5) mechanisms(5) pkix(7)
    id-mod(0) id-mod-cmp2021-88(TBD1)}

DEFINITIONS EXPLICIT TAGS ::=

BEGIN

-- EXPORTS ALL --

IMPORTS

    Certificate, CertificateList, Extensions, AlgorithmIdentifier,
    UTF8String, id-kp -- if required; otherwise, comment out
        FROM PKIX1Explicit88 {iso(1) identified-organization(3)
            dod(6) internet(1) security(5) mechanisms(5) pkix(7)
            id-mod(0) id-pkix1-explicit-88(1)}

    GeneralName, KeyIdentifier
        FROM PKIX1Implicit88 {iso(1) identified-organization(3)
            dod(6) internet(1) security(5) mechanisms(5) pkix(7)
            id-mod(0) id-pkix1-implicit-88(2)}

    CertTemplate, PKIPublicationInfo, EncryptedKey, CertId,
    CertReqMessages, Controls, id-regCtrl
        FROM PKIXCRMF-2005 {iso(1) identified-organization(3)
            dod(6) internet(1) security(5) mechanisms(5) pkix(7)
            id-mod(0) id-mod-crmf2005(36)}
-- The import of EncryptedKey is added due to the updates made
-- in CMP Updates [thisRFC]]. EncryptedValue does not need to
-- be imported anymore and is therefore removed here.

-- see also the behavioral clarifications to CRMF codified in
-- Appendix C of this specification
CertificationRequest
    FROM PKCS-10 {iso(1) member-body(2)
        us(840) rsadsi(113549)
        pkcs(1) pkcs-10(10) modules(1) pkcs-10(1)}
-- (specified in RFC 2986 with 1993 ASN.1 syntax and IMPLICIT
-- tags). Alternatively, implementers may directly include
-- the [PKCS10] syntax in this module

localKeyId
    FROM PKCS-9 {iso(1) member-body(2) us(840) rsadsi(113549)
        pkcs(1) pkcs-9(9) modules(0) pkcs-9(1)}
-- The import of localKeyId is added due to the updates made in
-- CMP Updates [thisRFC]

EnvelopedData, SignedData

```

```

        FROM CryptographicMessageSyntax2004 { iso(1)
        member-body(2) us(840) rsadsi(113549) pkcs(1) pkcs-9(9)
        smime(16) modules(0) cms-2004(24) }
-- The import of EnvelopedData and SignedData is added due to
-- the updates made in CMP Updates [thisRFC]

;

-- the rest of the module contains locally-defined OIDs and
-- constructs

CMPCertificate ::= CHOICE {
    x509v3PKCert      Certificate
}
-- This syntax, while bits-on-the-wire compatible with the
-- standard X.509 definition of "Certificate", allows the
-- possibility of future certificate types (such as X.509
-- attribute certificates, WAP WTLS certificates, or other kinds
-- of certificates) within this certificate management protocol,
-- should a need ever arise to support such generality. Those
-- implementations that do not foresee a need to ever support
-- other certificate types MAY, if they wish, comment out the
-- above structure and "un-comment" the following one prior to
-- compiling this ASN.1 module. (Note that interoperability
-- with implementations that don't do this will be unaffected by
-- this change.)

-- CMPCertificate ::= Certificate

PKIMessage ::= SEQUENCE {
    header          PKIHeader,
    body            PKIBody,
    protection      [0] PKIProtection OPTIONAL,
    extraCerts      [1] SEQUENCE SIZE (1..MAX) OF CMPCertificate
                    OPTIONAL
}

PKIMessages ::= SEQUENCE SIZE (1..MAX) OF PKIMessage

PKIHeader ::= SEQUENCE {
    pvno            INTEGER      { cmp1999(1), cmp2000(2),
                                cmp2021(3) },
    sender           GeneralName,
    -- identifies the sender
    recipient        GeneralName,
    -- identifies the intended recipient
    messageTime      [0] GeneralizedTime      OPTIONAL,
    -- time of production of this message (used when sender
    -- believes that the transport will be "suitable"; i.e.,

```

```

-- that the time will still be meaningful upon receipt)
protectionAlg  [1] AlgorithmIdentifier    OPTIONAL,
-- algorithm used for calculation of protection bits
senderKID      [2] KeyIdentifier          OPTIONAL,
recipKID       [3] KeyIdentifier          OPTIONAL,
-- to identify specific keys used for protection
transactionID  [4] OCTET STRING           OPTIONAL,
-- identifies the transaction; i.e., this will be the same in
-- corresponding request, response, certConf, and PKIConf
-- messages
senderNonce    [5] OCTET STRING           OPTIONAL,
recipNonce     [6] OCTET STRING           OPTIONAL,
-- nonces used to provide replay protection, senderNonce
-- is inserted by the creator of this message; recipNonce
-- is a nonce previously inserted in a related message by
-- the intended recipient of this message
freeText       [7] PKIFreeText            OPTIONAL,
-- this may be used to indicate context-specific instructions
-- (this field is intended for human consumption)
generalInfo    [8] SEQUENCE SIZE (1..MAX) OF
--                                     InfoTypeAndValue    OPTIONAL
-- this may be used to convey context-specific information
-- (this field not primarily intended for human consumption)
}

```

```

PKIFreeText ::= SEQUENCE SIZE (1..MAX) OF UTF8String
-- text encoded as UTF-8 String [RFC3629] (note: each
-- UTF8String MAY include an [RFC3066] language tag
-- to indicate the language of the contained text
-- see [RFC2482] for details)

```

```

PKIBody ::= CHOICE {
-- message-specific body elements
  ir      [0] CertReqMessages,    --Initialization Request
  ip      [1] CertRepMessage,     --Initialization Response
  cr      [2] CertReqMessages,    --Certification Request
  cp      [3] CertRepMessage,     --Certification Response
  p10cr   [4] CertificationRequest, --imported from [PKCS10]
  popdecc [5] POP0DeckKeyChallContent, --pop Challenge
  popdecr [6] POP0DeckKeyRespContent, --pop Response
  kur     [7] CertReqMessages,    --Key Update Request
  kup     [8] CertRepMessage,     --Key Update Response
  krr     [9] CertReqMessages,    --Key Recovery Request
  krp     [10] KeyRecRepContent,   --Key Recovery Response
  rr      [11] RevReqContent,     --Revocation Request
  rp      [12] RevRepContent,     --Revocation Response
  ccr     [13] CertReqMessages,   --Cross-Cert. Request
  ccp     [14] CertRepMessage,    --Cross-Cert. Response
  ckuann  [15] CAKeyUpdAnnContent, --CA Key Update Ann.
  cann    [16] CertAnnContent,    --Certificate Ann.

```

```

    rann      [17] RevAnnContent,          --Revocation Ann.
    crlann    [18] CRLAnnContent,          --CRL Announcement
    pkiconf   [19] PKIConfirmContent,      --Confirmation
    nested    [20] NestedMessageContent,  --Nested Message
    genm      [21] GenMsgContent,          --General Message
    genp      [22] GenRepContent,          --General Response
    error     [23] ErrorMsgContent,        --Error Message
    certConf  [24] CertConfirmContent,     --Certificate confirm
    pollReq   [25] PollReqContent,         --Polling request
    pollRep   [26] PollRepContent          --Polling response
}

PKIProtection ::= BIT STRING

ProtectedPart ::= SEQUENCE {
    header     PKIHeader,
    body       PKIBody
}

id-PasswordBasedMac OBJECT IDENTIFIER ::= {1 2 840 113533 7 66 13}
PBMPParameter ::= SEQUENCE {
    salt                OCTET STRING,
    -- note:  implementations MAY wish to limit acceptable sizes
    -- of this string to values appropriate for their environment
    -- in order to reduce the risk of denial-of-service attacks
    owf                 AlgorithmIdentifier,
    -- AlgId for a One-Way Function (SHA-1 recommended)
    iterationCount      INTEGER,
    -- number of times the OWF is applied
    -- note:  implementations MAY wish to limit acceptable sizes
    -- of this integer to values appropriate for their environment
    -- in order to reduce the risk of denial-of-service attacks
    mac                 AlgorithmIdentifier
    -- the MAC AlgId (e.g., DES-MAC, Triple-DES-MAC [PKCS11],
} -- or HMAC [RFC2104, RFC2202])

id-DHBasedMac OBJECT IDENTIFIER ::= {1 2 840 113533 7 66 30}
DHBMPParameter ::= SEQUENCE {
    owf                 AlgorithmIdentifier,
    -- AlgId for a One-Way Function (SHA-1 recommended)
    mac                 AlgorithmIdentifier
    -- the MAC AlgId (e.g., DES-MAC, Triple-DES-MAC [PKCS11],
} -- or HMAC [RFC2104, RFC2202])

NestedMessageContent ::= PKIMessages

PKIStatus ::= INTEGER {
    accepted              (0),

```

```

-- you got exactly what you asked for
grantedWithMods      (1),
-- you got something like what you asked for; the
-- requester is responsible for ascertaining the differences
rejection            (2),
-- you don't get it, more information elsewhere in the message
waiting              (3),
-- the request body part has not yet been processed; expect to
-- hear more later (note: proper handling of this status
-- response MAY use the polling req/rep PKIMessages specified
-- in Section 5.3.22; alternatively, polling in the underlying
-- transport layer MAY have some utility in this regard)
revocationWarning    (4),
-- this message contains a warning that a revocation is
-- imminent
revocationNotification (5),
-- notification that a revocation has occurred
keyUpdateWarning     (6)
-- update already done for the oldCertId specified in
-- CertReqMsg
}

```

```

PKIFailureInfo ::= BIT STRING {
-- since we can fail in more than one way!
-- More codes may be added in the future if/when required.
badAlg                (0),
-- unrecognized or unsupported Algorithm Identifier
badMessageCheck       (1),
-- integrity check failed (e.g., signature did not verify)
badRequest            (2),
-- transaction not permitted or supported
badTime               (3),
-- messageTime was not sufficiently close to the system time,
-- as defined by local policy
badCertId             (4),
-- no certificate could be found matching the provided criteria
badDataFormat         (5),
-- the data submitted has the wrong format
wrongAuthority        (6),
-- the authority indicated in the request is different from the
-- one creating the response token
incorrectData         (7),
-- the requester's data is incorrect (for notary services)
missingTimeStamp      (8),
-- when the timestamp is missing but should be there
-- (by policy)
badPOP                (9),
-- the proof-of-possession failed
certRevoked           (10),

```

```

    -- the certificate has already been revoked
certConfirmed      (11),
    -- the certificate has already been confirmed
wrongIntegrity     (12),
    -- invalid integrity, password based instead of signature or
    -- vice versa
badRecipientNonce  (13),
    -- invalid recipient nonce, either missing or wrong value
timeNotAvailable   (14),
    -- the TSA's time source is not available
unacceptedPolicy   (15),
    -- the requested TSA policy is not supported by the TSA.
unacceptedExtension (16),
    -- the requested extension is not supported by the TSA.
addInfoNotAvailable (17),
    -- the additional information requested could not be
    -- understood or is not available
badSenderNonce     (18),
    -- invalid sender nonce, either missing or wrong size
badCertTemplate     (19),
    -- invalid cert. template or missing mandatory information
signerNotTrusted   (20),
    -- signer of the message unknown or not trusted
transactionIdInUse (21),
    -- the transaction identifier is already in use
unsupportedVersion  (22),
    -- the version of the message is not supported
notAuthorized      (23),
    -- the sender was not authorized to make the preceding
    -- request or perform the preceding action
systemUnavail      (24),
    -- the request cannot be handled due to system unavailability
systemFailure       (25),
    -- the request cannot be handled due to system failure
duplicateCertReq    (26)
    -- certificate cannot be issued because a duplicate
    -- certificate already exists
}

```

```

PKIStatusInfo ::= SEQUENCE {
    status          PKIStatus,
    statusString    PKIFreeText    OPTIONAL,
    failInfo        PKIFailureInfo OPTIONAL
}

```

```

OOBCert ::= CMPCertificate

```

```

OOBCertHash ::= SEQUENCE {
    hashAlg      [0] AlgorithmIdentifier    OPTIONAL,

```

```

    certId      [1] CertId                      OPTIONAL,
    hashVal     BIT STRING
    -- hashVal is calculated over the DER encoding of the
    -- self-signed certificate with the identifier certID.
}

POPODecKeyChallContent ::= SEQUENCE OF Challenge
-- One Challenge per encryption key certification request (in the
-- same order as these requests appear in CertReqMessages).

Challenge ::= SEQUENCE {
    owf          AlgorithmIdentifier OPTIONAL,
    -- MUST be present in the first Challenge; MAY be omitted in
    -- any subsequent Challenge in POPODecKeyChallContent (if
    -- omitted, then the owf used in the immediately preceding
    -- Challenge is to be used).
    witness      OCTET STRING,
    -- the result of applying the one-way function (owf) to a
    -- randomly-generated INTEGER, A. [Note that a different
    -- INTEGER MUST be used for each Challenge.]
    challenge    OCTET STRING
    -- the encryption (under the public key for which the cert.
    -- request is being made) of Rand.
}

-- Added in CMP Updates [thisRFC]

Rand ::= SEQUENCE {
    -- Rand is encrypted under the public key to form the challenge
    -- in POPODecKeyChallContent
    int          INTEGER,
    -- the randomly-generated INTEGER A (above)
    sender       GeneralName
    -- the sender's name (as included in PKIHeader)
}

POPODecKeyRespContent ::= SEQUENCE OF INTEGER
-- One INTEGER per encryption key certification request (in the
-- same order as these requests appear in CertReqMessages). The
-- retrieved INTEGER A (above) is returned to the sender of the
-- corresponding Challenge.

CertRepMessage ::= SEQUENCE {
    caPubs       [1] SEQUENCE SIZE (1..MAX) OF CMPCertificate
                  OPTIONAL,
    response     SEQUENCE OF CertResponse
}

CertResponse ::= SEQUENCE {

```

```

certReqId          INTEGER,
-- to match this response with corresponding request (a value
-- of 0 is to be used if certReqId is not specified in the
-- corresponding request, which can only be a p10cr)
status             PKIStatusInfo,
certifiedKeyPair    CertifiedKeyPair    OPTIONAL,
rspInfo            OCTET STRING          OPTIONAL
-- analogous to the id-regInfo-utf8Pairs string defined
-- for regInfo in CertReqMsg [CRMF]
}

CertifiedKeyPair ::= SEQUENCE {
    certOrEncCert     CertOrEncCert,
    privateKey        [0] EncryptedKey    OPTIONAL,
-- see [CRMF] for comment on encoding
-- Changed from Encrypted Value to EncryptedKey as a CHOICE of
-- EncryptedValue and EnvelopedData due to the changes made in
-- CMP Updates [thisRFC]
-- Using the choice EncryptedValue is bit-compatible to the
-- syntax without this change
    publicationInfo   [1] PKIPublicationInfo  OPTIONAL
}

CertOrEncCert ::= CHOICE {
    certificate        [0] CMPCertificate,
    encryptedCert      [1] EncryptedKey
-- Changed from Encrypted Value to EncryptedKey as a CHOICE of
-- EncryptedValue and EnvelopedData due to the changes made in
-- CMP Updates [thisRFC]
-- Using the choice EncryptedValue is bit-compatible to the
-- syntax without this change
}

KeyRecRepContent ::= SEQUENCE {
    status             PKIStatusInfo,
    newSigCert         [0] CMPCertificate OPTIONAL,
    caCerts            [1] SEQUENCE SIZE (1..MAX) OF
                                CMPCertificate OPTIONAL,
    keyPairHist        [2] SEQUENCE SIZE (1..MAX) OF
                                CertifiedKeyPair OPTIONAL
}

RevReqContent ::= SEQUENCE OF RevDetails

RevDetails ::= SEQUENCE {
    certDetails        CertTemplate,
-- allows requester to specify as much as they can about
-- the cert. for which revocation is requested
-- (e.g., for cases in which serialNumber is not available)

```



```

    crlEntryDetails    Extensions    OPTIONAL
    -- requested crlEntryExtensions
}

RevRepContent ::= SEQUENCE {
    status             SEQUENCE SIZE (1..MAX) OF PKIStatusInfo,
    -- in same order as was sent in RevReqContent
    revCerts [0] SEQUENCE SIZE (1..MAX) OF CertId
                                OPTIONAL,
    -- IDs for which revocation was requested
    -- (same order as status)
    crls      [1] SEQUENCE SIZE (1..MAX) OF CertificateList
                                OPTIONAL
    -- the resulting CRLs (there may be more than one)
}

CAKeyUpdAnnContent ::= SEQUENCE {
    oldWithNew    CMPCertificate, -- old pub signed with new priv
    newWithOld    CMPCertificate, -- new pub signed with old priv
    newWithNew    CMPCertificate  -- new pub signed with new priv
}

CertAnnContent ::= CMPCertificate

RevAnnContent ::= SEQUENCE {
    status             PKIStatus,
    certId             CertId,
    willBeRevokedAt    GeneralizedTime,
    badSinceDate       GeneralizedTime,
    crlDetails         Extensions OPTIONAL
    -- extra CRL details (e.g., crl number, reason, location, etc.)
}

CRLAnnContent ::= SEQUENCE OF CertificateList

CertConfirmContent ::= SEQUENCE OF CertStatus

CertStatus ::= SEQUENCE {
    certHash    OCTET STRING,
    -- the hash of the certificate, using the same hash algorithm
    -- as is used to create and verify the certificate signature
    certReqId   INTEGER,
    -- to match this confirmation with the corresponding req/rep
    statusInfo  PKIStatusInfo OPTIONAL
}

PKIConfirmContent ::= NULL

-- Added in CMP Updates [thisRFC]

```

```

RootCaKeyUpdateContent ::= SEQUENCE {
    newWithNew          CMPCertificate
    -- new root CA certificate
    newWithOld    [0] CMPCertificate OPTIONAL,
    -- X.509 certificate containing the new public root CA key
    -- signed with the old private root CA key
    oldWithNew    [1] CMPCertificate OPTIONAL
    -- X.509 certificate containing the old public root CA key
    -- signed with the new private root CA key
}

-- Added in CMP Updates [thisRFC]

CertReqTemplateContent ::= SEQUENCE {
    certTemplate          CertTemplate,
    -- prefilled certTemplate structure elements
    -- The SubjectPublicKeyInfo field in the certTemplate MUST NOT
    -- be used.
    keySpec              Controls OPTIONAL
    -- MAY be used to specify supported algorithms.
    -- Controls ::= SEQUENCE SIZE(1..MAX) OF AttributeTypeAndValue
    -- as specified in CRMF (RFC4211)
}

id-regCtrl-algId OBJECT IDENTIFIER ::= { id-regCtrl TBD3 }
AlgIdCtrl ::= AlgorithmIdentifier
-- SHALL be used to specify supported algorithms other than RSA

id-regCtrl-rsaKeyLen OBJECT IDENTIFIER ::= { id-regCtrl TBD4 }
RsaKeyLenCtrl ::= Integer
-- SHALL be used to specify supported RSA key lengths

InfoTypeAndValue ::= SEQUENCE {
    infoType              OBJECT IDENTIFIER,
    infoValue             ANY DEFINED BY infoType OPTIONAL
}

-- Example InfoTypeAndValue contents include, but are not limited
-- to, the following (un-comment in this ASN.1 module and use as
-- appropriate for a given environment):
--
-- id-it-caProtEncCert    OBJECT IDENTIFIER ::= {id-it 1}
--   CAProtEncCertValue   ::= CMPCertificate
-- id-it-signKeyPairTypes OBJECT IDENTIFIER ::= {id-it 2}
--   SignKeyPairTypesValue ::= SEQUENCE OF AlgorithmIdentifier
-- id-it-encKeyPairTypes  OBJECT IDENTIFIER ::= {id-it 3}
--   EncKeyPairTypesValue  ::= SEQUENCE OF AlgorithmIdentifier
-- id-it-preferredSymmAlg OBJECT IDENTIFIER ::= {id-it 4}
--   PreferredSymmAlgValue  ::= AlgorithmIdentifier
-- id-it-caKeyUpdateInfo  OBJECT IDENTIFIER ::= {id-it 5}

```

```

--      CAKeyUpdateInfoValue      ::= CAKeyUpdAnnContent
--      id-it-currentCRL          OBJECT IDENTIFIER ::= {id-it 6}
--      CurrentCRLValue           ::= CertificateList
--      id-it-unsupportedOIDs     OBJECT IDENTIFIER ::= {id-it 7}
--      UnsupportedOIDsValue      ::= SEQUENCE OF OBJECT IDENTIFIER
--      id-it-keyPairParamReq     OBJECT IDENTIFIER ::= {id-it 10}
--      KeyPairParamReqValue      ::= OBJECT IDENTIFIER
--      id-it-keyPairParamRep     OBJECT IDENTIFIER ::= {id-it 11}
--      KeyPairParamRepValue      ::= AlgorithmIdentifier
--      id-it-revPassphrase       OBJECT IDENTIFIER ::= {id-it 12}
--      RevPassphraseValue        ::= EncryptedKey
--      -- Changed from Encrypted Value to EncryptedKey as a CHOICE
--      -- of EncryptedValue and EnvelopedData due to the changes
--      -- made in CMP Updates [thisRFC]
--      -- Using the choice EncryptedValue is bit-compatible to the
--      -- syntax without this change
--      id-it-implicitConfirm     OBJECT IDENTIFIER ::= {id-it 13}
--      ImplicitConfirmValue      ::= NULL
--      id-it-confirmWaitTime     OBJECT IDENTIFIER ::= {id-it 14}
--      ConfirmWaitTimeValue      ::= GeneralizedTime
--      id-it-origPKIMessage      OBJECT IDENTIFIER ::= {id-it 15}
--      OrigPKIMessageValue       ::= PKIMessages
--      id-it-supplLangTags       OBJECT IDENTIFIER ::= {id-it 16}
--      SupplLangTagsValue        ::= SEQUENCE OF UTF8String
--      id-it-caCerts             OBJECT IDENTIFIER ::= { id-it 17}
--      CaCertsValue              ::= SEQUENCE OF CMPCertificate
--      -- id-it-caCerts added in CMP Updates [thisRFC]
--      id-it-rootCaKeyUpdate     OBJECT IDENTIFIER ::= { id-it 18}
--      RootCaKeyUpdateValue      ::= RootCaKeyUpdateContent
--      -- id-it-rootCaKeyUpdate added in CMP Updates [thisRFC]
--      id-it-certReqTemplate     OBJECT IDENTIFIER ::= { id-it 19}
--      CertReqTemplateValue      ::= CertReqTemplateContent
--      -- id-it-certReqTemplate added in CMP Updates [thisRFC]
--
-- where
--
--      id-pkix OBJECT IDENTIFIER ::= {
--          iso(1) identified-organization(3)
--          dod(6) internet(1) security(5) mechanisms(5) pkix(7)}
--      and
--      id-it   OBJECT IDENTIFIER ::= {id-pkix 4}
--
--
-- This construct MAY also be used to define new PKIX Certificate
-- Management Protocol request and response messages, or general-
-- purpose (e.g., announcement) messages for future needs or for
-- specific environments.

```

GenMsgContent ::= SEQUENCE OF InfoTypeAndValue

```
-- May be sent by EE, RA, or CA (depending on message content).
-- The OPTIONAL infoValue parameter of InfoTypeAndValue will
-- typically be omitted for some of the examples given above.
-- The receiver is free to ignore any contained OBJ. IDs that it
-- does not recognize. If sent from EE to CA, the empty set
-- indicates that the CA may send
-- any/all information that it wishes.
```

```
GenRepContent ::= SEQUENCE OF InfoTypeAndValue
-- Receiver MAY ignore any contained OIDs that it does not
-- recognize.
```

```
ErrorMsgContent ::= SEQUENCE {
    pKISStatusInfo      PKISStatusInfo,
    errorCode            INTEGER          OPTIONAL,
    -- implementation-specific error codes
    errorDetails        PKIFreeText      OPTIONAL
    -- implementation-specific error details
}
```

```
PollReqContent ::= SEQUENCE OF SEQUENCE {
    certReqId           INTEGER
}
```

```
PollRepContent ::= SEQUENCE OF SEQUENCE {
    certReqId           INTEGER,
    checkAfter          INTEGER, -- time in seconds
    reason              PKIFreeText OPTIONAL
}
```

```
--
-- Extended Key Usage extension for PKI entities used in CMP
-- operations, added due to the changes made in
-- CMP Updates [thisRFC]
-- The EKUs for the CA and RA are reused from CMC as defined in
-- [RFC6402]
--
```

```
-- id-kp-cmcCA OBJECT IDENTIFIER ::= { id-kp 27 }
-- id-kp-cmcRA OBJECT IDENTIFIER ::= { id-kp 28 }
id-kp-cmKGA OBJECT IDENTIFIER ::= { id-kp 32 }
```

```
END -- of CMP module
```

A.2. 2002 ASN.1 Module

This section contains the updated 2002 ASN.1 module for [[RFC5912](#)]. This module replaces the module in Section 9 of that document. The module contains those changes to the normative ASN.1 module from [RFC4210 Appendix F](#) [[RFC4210](#)] that were to update to 2002 ASN.1 standard done in [[RFC5912](#)] as well as changes made in this document.

```

PKIXCMP-2009
    { iso(1) identified-organization(3) dod(6) internet(1)
      security(5) mechanisms(5) pkix(7) id-mod(0)
      id-mod-cmp2021-02(TBD2) }
DEFINITIONS EXPLICIT TAGS ::=
BEGIN
IMPORTS

AttributeSet{}, Extensions{}, EXTENSION, ATTRIBUTE
FROM PKIX-CommonTypes-2009
    {iso(1) identified-organization(3) dod(6) internet(1) security(5)
     mechanisms(5) pkix(7) id-mod(0) id-mod-pkixCommon-02(57)}

AlgorithmIdentifier{}, SIGNATURE-ALGORITHM, ALGORITHM,
    DIGEST-ALGORITHM, MAC-ALGORITHM
FROM AlgorithmInformation-2009
    {iso(1) identified-organization(3) dod(6) internet(1) security(5)
     mechanisms(5) pkix(7) id-mod(0)
     id-mod-algorithmInformation-02(58)}

Certificate, CertificateList, id-kp
FROM PKIX1Explicit-2009
    {iso(1) identified-organization(3) dod(6) internet(1) security(5)
     mechanisms(5) pkix(7) id-mod(0) id-mod-pkix1-explicit-02(51)}

GeneralName, KeyIdentifier
FROM PKIX1Implicit-2009
    {iso(1) identified-organization(3) dod(6) internet(1) security(5)
     mechanisms(5) pkix(7) id-mod(0) id-mod-pkix1-implicit-02(59)}

CertTemplate, PKIPublicationInfo, EncryptedKey, CertId,
    CertReqMessages, Controls, id-regCtrl
FROM PKIXCRMF-2009
    { iso(1) identified-organization(3) dod(6) internet(1)
      security(5) mechanisms(5) pkix(7) id-mod(0)
      id-mod-crmf2005-02(55) }
    -- The import of EncryptedKey is added due to the updates made
    -- in CMP Updates [thisRFC]. EncryptedValue does not need to
    -- be imported anymore and is therefore removed here.

-- see also the behavioral clarifications to CRMF codified in
-- Appendix C of this specification

CertificationRequest
FROM PKCS-10
    {iso(1) identified-organization(3) dod(6) internet(1) security(5)
     mechanisms(5) pkix(7) id-mod(0) id-mod-pkcs10-2009(69)}
    -- (specified in RFC 2986 with 1993 ASN.1 syntax and IMPLICIT
    -- tags). Alternatively, implementers may directly include

```

```

-- the [PKCS10] syntax in this module

localKeyId
FROM PKCS-9
    {iso(1) member-body(2) us(840) rsadsi(113549) pkcs(1) pkcs-9(9)
    modules(0) pkcs-9(1)}
    -- The import of localKeyId is added due to the updates made in
    -- CMP Updates [thisRFC]

EnvelopedData, SignedData
FROM CryptographicMessageSyntax-2009
    {iso(1) member-body(2) us(840) rsadsi(113549) pkcs(1) pkcs-9(9)
    smime(16) modules(0) id-mod-cms-2004-02(41)}
    -- The import of EnvelopedData and SignedData is added due to
    -- the updates made in CMP Updates [thisRFC]
;

-- the rest of the module contains locally defined OIDs and
-- constructs

CMPCertificate ::= CHOICE { x509v3PKCert Certificate, ... }
-- This syntax, while bits-on-the-wire compatible with the
-- standard X.509 definition of "Certificate", allows the
-- possibility of future certificate types (such as X.509
-- attribute certificates, WAP WTLS certificates, or other kinds
-- of certificates) within this certificate management protocol,
-- should a need ever arise to support such generality. Those
-- implementations that do not foresee a need to ever support
-- other certificate types MAY, if they wish, comment out the
-- above structure and "uncomment" the following one prior to
-- compiling this ASN.1 module. (Note that interoperability
-- with implementations that don't do this will be unaffected by
-- this change.)

-- CMPCertificate ::= Certificate

PKIMessage ::= SEQUENCE {
    header          PKIHeader,
    body            PKIBody,
    protection      [0] PKIProtection OPTIONAL,
    extraCerts      [1] SEQUENCE SIZE (1..MAX) OF CMPCertificate
                    OPTIONAL }

PKIMessages ::= SEQUENCE SIZE (1..MAX) OF PKIMessage

PKIHeader ::= SEQUENCE {
    pvno            INTEGER      { cmp1999(1), cmp2000(2),
                                cmp2012(3) },
    sender          GeneralName,
    -- identifies the sender

```

```

recipient      GeneralName,
-- identifies the intended recipient
messageTime    [0] GeneralizedTime      OPTIONAL,
-- time of production of this message (used when sender
-- believes that the transport will be "suitable"; i.e.,
-- that the time will still be meaningful upon receipt)
protectionAlg  [1] AlgorithmIdentifier{ALGORITHM, {...}}
                OPTIONAL,
-- algorithm used for calculation of protection bits
senderKID      [2] KeyIdentifier          OPTIONAL,
recipKID       [3] KeyIdentifier          OPTIONAL,
-- to identify specific keys used for protection
transactionID  [4] OCTET STRING           OPTIONAL,
-- identifies the transaction; i.e., this will be the same in
-- corresponding request, response, certConf, and PKIConf
-- messages
senderNonce    [5] OCTET STRING           OPTIONAL,
recipNonce     [6] OCTET STRING           OPTIONAL,
-- nonces used to provide replay protection, senderNonce
-- is inserted by the creator of this message; recipNonce
-- is a nonce previously inserted in a related message by
-- the intended recipient of this message
freeText       [7] PKIFreeText            OPTIONAL,
-- this may be used to indicate context-specific instructions
-- (this field is intended for human consumption)
generalInfo    [8] SEQUENCE SIZE (1..MAX) OF
                InfoTypeAndValue          OPTIONAL
-- this may be used to convey context-specific information
-- (this field not primarily intended for human consumption)
}

```

```

PKIFreeText ::= SEQUENCE SIZE (1..MAX) OF UTF8String
-- text encoded as UTF-8 String [RFC3629] (note: each
-- UTF8String MAY include an [RFC3066] language tag
-- to indicate the language of the contained text;
-- see [RFC2482] for details)

```

```

PKIBody ::= CHOICE {
-- message-specific body elements
ir      [0] CertReqMessages,      --Initialization Request
ip      [1] CertRepMessage,       --Initialization Response
cr      [2] CertReqMessages,      --Certification Request
cp      [3] CertRepMessage,       --Certification Response
p10cr   [4] CertificationRequest, --imported from [PKCS10]
popdecc [5] POP0DecKeyChallContent, --pop Challenge
popdecr [6] POP0DecKeyRespContent, --pop Response
kur     [7] CertReqMessages,      --Key Update Request
kup     [8] CertRepMessage,       --Key Update Response
krr     [9] CertReqMessages,      --Key Recovery Request
krp     [10] KeyRecRepContent,     --Key Recovery Response

```



```

rr      [11] RevReqContent,      --Revocation Request
rp      [12] RevRepContent,      --Revocation Response
ccr     [13] CertReqMessages,    --Cross-Cert. Request
ccp     [14] CertRepMessage,     --Cross-Cert. Response
ckuann  [15] CAKeyUpdAnnContent,  --CA Key Update Ann.
cann    [16] CertAnnContent,     --Certificate Ann.
rann    [17] RevAnnContent,      --Revocation Ann.
crlann  [18] CRLAnnContent,      --CRL Announcement
pkiconf [19] PKIConfirmContent,   --Confirmation
nested  [20] NestedMessageContent, --Nested Message
genm    [21] GenMsgContent,      --General Message
genp    [22] GenRepContent,      --General Response
error   [23] ErrorMessageContent, --Error Message
certConf [24] CertConfirmContent, --Certificate confirm
pollReq [25] PollReqContent,     --Polling request
pollRep [26] PollRepContent      --Polling response
}

```

```

PKIProtection ::= BIT STRING

```

```

ProtectedPart ::= SEQUENCE {
    header    PKIHeader,
    body      PKIBody }

```

```

id-PasswordBasedMac OBJECT IDENTIFIER ::= { iso(1) member-body(2)
    usa(840) nt(113533) nsn(7) algorithms(66) 13 }

```

```

PBMPParameter ::= SEQUENCE {
    salt                OCTET STRING,
    -- note: implementations MAY wish to limit acceptable sizes
    -- of this string to values appropriate for their environment
    -- in order to reduce the risk of denial-of-service attacks
    owf                AlgorithmIdentifier{DIGEST-ALGORITHM, {...}},
    -- AlgId for a One-Way Function (SHA-1 recommended)
    iterationCount      INTEGER,
    -- number of times the OWF is applied
    -- note: implementations MAY wish to limit acceptable sizes
    -- of this integer to values appropriate for their environment
    -- in order to reduce the risk of denial-of-service attacks
    mac                AlgorithmIdentifier{MAC-ALGORITHM, {...}}
    -- the MAC AlgId (e.g., DES-MAC, Triple-DES-MAC [PKCS11],
    -- or HMAC [RFC2104, RFC2202])
}

```

```

id-DHBasedMac OBJECT IDENTIFIER ::= { iso(1) member-body(2)
    usa(840) nt(113533) nsn(7) algorithms(66) 30 }

```

```

DHBMParameter ::= SEQUENCE {
    owf                AlgorithmIdentifier{DIGEST-ALGORITHM, {...}},
    -- AlgId for a One-Way Function (SHA-1 recommended)
    mac                AlgorithmIdentifier{MAC-ALGORITHM, {...}}
}

```

```

-- the MAC AlgId (e.g., DES-MAC, Triple-DES-MAC [PKCS11],
-- or HMAC [RFC2104, RFC2202])
}

PKIStatus ::= INTEGER {
    accepted                (0),
    -- you got exactly what you asked for
    grantedWithMods         (1),
    -- you got something like what you asked for; the
    -- requester is responsible for ascertaining the differences
    rejection               (2),
    -- you don't get it, more information elsewhere in the message
    waiting                 (3),
    -- the request body part has not yet been processed; expect to
    -- hear more later (note: proper handling of this status
    -- response MAY use the polling req/rep PKIMessages specified
    -- in Section 5.3.22; alternatively, polling in the underlying
    -- transport layer MAY have some utility in this regard)
    revocationWarning       (4),
    -- this message contains a warning that a revocation is
    -- imminent
    revocationNotification (5),
    -- notification that a revocation has occurred
    keyUpdateWarning        (6)
    -- update already done for the oldCertId specified in
    -- CertReqMsg
}

```

```

PKIFailureInfo ::= BIT STRING {
    -- since we can fail in more than one way!
    -- More codes may be added in the future if/when required.
    badAlg                (0),
    -- unrecognized or unsupported Algorithm Identifier
    badMessageCheck       (1),
    -- integrity check failed (e.g., signature did not verify)
    badRequest            (2),
    -- transaction not permitted or supported
    badTime               (3),
    -- messageTime was not sufficiently close to the system time,
    -- as defined by local policy
    badCertId             (4),
    -- no certificate could be found matching the provided criteria
    badDataFormat         (5),
    -- the data submitted has the wrong format
    wrongAuthority        (6),
    -- the authority indicated in the request is different from the
    -- one creating the response token
    incorrectData         (7),
    -- the requester's data is incorrect (for notary services)
}

```

```

missingTimeStamp      (8),
-- when the timestamp is missing but should be there
-- (by policy)
badPOP                (9),
-- the proof-of-possession failed
certRevoked           (10),
-- the certificate has already been revoked
certConfirmed         (11),
-- the certificate has already been confirmed
wrongIntegrity        (12),
-- invalid integrity, password based instead of signature or
-- vice versa
badRecipientNonce     (13),
-- invalid recipient nonce, either missing or wrong value
timeNotAvailable      (14),
-- the TSA's time source is not available
unacceptedPolicy      (15),
-- the requested TSA policy is not supported by the TSA
unacceptedExtension   (16),
-- the requested extension is not supported by the TSA
addInfoNotAvailable   (17),
-- the additional information requested could not be
-- understood or is not available
badSenderNonce        (18),
-- invalid sender nonce, either missing or wrong size
badCertTemplate       (19),
-- invalid cert. template or missing mandatory information
signerNotTrusted      (20),
-- signer of the message unknown or not trusted
transactionIdInUse    (21),
-- the transaction identifier is already in use
unsupportedVersion     (22),
-- the version of the message is not supported
notAuthorized         (23),
-- the sender was not authorized to make the preceding
-- request or perform the preceding action
systemUnavail         (24),
-- the request cannot be handled due to system unavailability
systemFailure         (25),
-- the request cannot be handled due to system failure
duplicateCertReq      (26)
-- certificate cannot be issued because a duplicate
-- certificate already exists
}

```

```

PKIStatusInfo ::= SEQUENCE {
    status          PKIStatus,
    statusString    PKIFreeText    OPTIONAL,
    failInfo        PKIFailureInfo OPTIONAL }

```

OOBCert ::= CMPCertificate

```
OOBCertHash ::= SEQUENCE {
    hashAlg      [0] AlgorithmIdentifier{DIGEST-ALGORITHM, {...}}
                  OPTIONAL,
    certId       [1] CertId                      OPTIONAL,
    hashVal      BIT STRING
    -- hashVal is calculated over the DER encoding of the
    -- self-signed certificate with the identifier certID.
}
```

POPODecKeyChallContent ::= SEQUENCE OF Challenge
-- One Challenge per encryption key certification request (in the
-- same order as these requests appear in CertReqMessages).

```
Challenge ::= SEQUENCE {
    owf          AlgorithmIdentifier{DIGEST-ALGORITHM, {...}}
                  OPTIONAL,
    -- MUST be present in the first Challenge; MAY be omitted in
    -- any subsequent Challenge in POPODecKeyChallContent (if
    -- omitted, then the owf used in the immediately preceding
    -- Challenge is to be used).
    witness      OCTET STRING,
    -- the result of applying the one-way function (owf) to a
    -- randomly-generated INTEGER, A. [Note that a different
    -- INTEGER MUST be used for each Challenge.]
    challenge    OCTET STRING
    -- the encryption (under the public key for which the cert.
    -- request is being made) of Rand.
}
```

-- Added in CMP Updates [thisRFC]

```
Rand ::= SEQUENCE {
    -- Rand is encrypted under the public key to form the challenge
    -- in POPODecKeyChallContent
    int          INTEGER,
    -- the randomly-generated INTEGER A (above)
    sender       GeneralName
    -- the sender's name (as included in PKIHeader)
}
```

POPODecKeyRespContent ::= SEQUENCE OF INTEGER
-- One INTEGER per encryption key certification request (in the
-- same order as these requests appear in CertReqMessages). The
-- retrieved INTEGER A (above) is returned to the sender of the
-- corresponding Challenge.

CertRepMessage ::= SEQUENCE {

```

caPubs      [1] SEQUENCE SIZE (1..MAX) OF CMPCertificate
            OPTIONAL,
response    SEQUENCE OF CertResponse }

CertResponse ::= SEQUENCE {
    certReqId      INTEGER,
    -- to match this response with the corresponding request (a value
    -- of 0 is to be used if certReqId is not specified in the
    -- corresponding request, which can only be a p10cr)
    status         PKIStatusInfo,
    certifiedKeyPair CertifiedKeyPair OPTIONAL,
    rspInfo        OCTET STRING OPTIONAL
    -- analogous to the id-regInfo-utf8Pairs string defined
    -- for regInfo in CertReqMsg [RFC4211]
}

CertifiedKeyPair ::= SEQUENCE {
    certOrEncCert  CertOrEncCert,
    privateKey     [0] EncryptedKey OPTIONAL,
    -- see [RFC4211] for comment on encoding
    -- Changed from Encrypted Value to EncryptedKey as a CHOICE of
    -- EncryptedValue and EnvelopedData due to the changes made in
    -- CMP Updates [thisRFC]
    -- Using the choice EncryptedValue is bit-compatible to the
    -- syntax without this change
    publicationInfo [1] PKIPublicationInfo OPTIONAL }

CertOrEncCert ::= CHOICE {
    certificate     [0] CMPCertificate,
    encryptedCert   [1] EncryptedKey
    -- Changed from Encrypted Value to EncryptedKey as a CHOICE of
    -- EncryptedValue and EnvelopedData due to the changes made in
    -- CMP Updates [thisRFC]
    -- Using the choice EncryptedValue is bit-compatible to the
    -- syntax without this change
}

KeyRecRepContent ::= SEQUENCE {
    status         PKIStatusInfo,
    newSigCert     [0] CMPCertificate OPTIONAL,
    caCerts        [1] SEQUENCE SIZE (1..MAX) OF
                    CMPCertificate OPTIONAL,
    keyPairHist    [2] SEQUENCE SIZE (1..MAX) OF
                    CertifiedKeyPair OPTIONAL }

RevReqContent ::= SEQUENCE OF RevDetails

RevDetails ::= SEQUENCE {
    certDetails    CertTemplate,

```

```

-- allows requester to specify as much as they can about
-- the cert. for which revocation is requested
-- (e.g., for cases in which serialNumber is not available)
crlEntryDetails    Extensions{{...}}    OPTIONAL
-- requested crlEntryExtensions
}

RevRepContent ::= SEQUENCE {
    status          SEQUENCE SIZE (1..MAX) OF PKIStatusInfo,
    -- in same order as was sent in RevReqContent
    revCerts [0] SEQUENCE SIZE (1..MAX) OF CertId OPTIONAL,
    -- IDs for which revocation was requested
    -- (same order as status)
    crls [1] SEQUENCE SIZE (1..MAX) OF CertificateList OPTIONAL
    -- the resulting CRLs (there may be more than one)
}

CAKeyUpdAnnContent ::= SEQUENCE {
    oldWithNew      CMPCertificate, -- old pub signed with new priv
    newWithOld      CMPCertificate, -- new pub signed with old priv
    newWithNew      CMPCertificate  -- new pub signed with new priv
}

CertAnnContent ::= CMPCertificate

RevAnnContent ::= SEQUENCE {
    status          PKIStatus,
    certId          CertId,
    willBeRevokedAt GeneralizedTime,
    badSinceDate    GeneralizedTime,
    crlDetails      Extensions{{...}} OPTIONAL
    -- extra CRL details (e.g., crl number, reason, location, etc.)
}

CRLAnnContent ::= SEQUENCE OF CertificateList
PKIConfirmContent ::= NULL

NestedMessageContent ::= PKIMessages

-- Added in CMP Updates [thisRFC]

RootCaKeyUpdateContent ::= SEQUENCE {
    newWithNew      CMPCertificate
    -- new root CA certificate
    newWithOld [0] CMPCertificate OPTIONAL,
    -- X.509 certificate containing the new public root CA key
    -- signed with the old private root CA key
    oldWithNew [1] CMPCertificate OPTIONAL
    -- X.509 certificate containing the old public root CA key
    -- signed with the new private root CA key
}

```

```

    }

-- Added in CMP Updates [thisRFC]

CertReqTemplateContent ::= SEQUENCE {
    certTemplate          CertTemplate,
    -- prefilled certTemplate structure elements
    -- The SubjectPublicKeyInfo field in the certTemplate MUST NOT
    -- be used.
    keySpec               Controls OPTIONAL
    -- MAY be used to specify supported algorithms.
    -- Controls ::= SEQUENCE SIZE(1..MAX) OF AttributeTypeAndValue
    -- as specified in CRMF (RFC4211)
}

id-regCtrl-algId OBJECT IDENTIFIER ::= { id-regCtrl TBD3 }
AlgIdCtrl ::= AlgorithmIdentifier
-- SHALL be used to specify supported algorithms other than RSA

id-regCtrl-rsaKeyLen OBJECT IDENTIFIER ::= { id-regCtrl TBD4 }
RsaKeyLenCtrl ::= Integer
-- SHALL be used to specify supported RSA key lengths

INFO-TYPE-AND-VALUE ::= TYPE-IDENTIFIER

InfoTypeAndValue ::= SEQUENCE {
    infoType      INFO-TYPE-AND-VALUE,
                  &id({SupportedInfoSet}),
    infoValue     INFO-TYPE-AND-VALUE,
                  &Type({SupportedInfoSet}{@infoType}) }

SupportedInfoSet INFO-TYPE-AND-VALUE ::= { ... }

-- Example InfoTypeAndValue contents include, but are not limited
-- to, the following (uncomment in this ASN.1 module and use as
-- appropriate for a given environment):
--
--   id-it-caProtEncCert      OBJECT IDENTIFIER ::= {id-it 1}
--   CAProtEncCertValue       ::= CMPCertificate
--   id-it-signKeyPairTypes OBJECT IDENTIFIER ::= {id-it 2}
--   SignKeyPairTypesValue   ::= SEQUENCE OF
--                               AlgorithmIdentifier{...}
--   id-it-encKeyPairTypes OBJECT IDENTIFIER ::= {id-it 3}
--   EncKeyPairTypesValue    ::= SEQUENCE OF
--                               AlgorithmIdentifier{...}
--   id-it-preferredSymmAlg OBJECT IDENTIFIER ::= {id-it 4}
--   PreferredSymmAlgValue   ::= AlgorithmIdentifier{...}
--   id-it-caKeyUpdateInfo OBJECT IDENTIFIER ::= {id-it 5}
--   CAKeyUpdateInfoValue    ::= CAKeyUpdAnnContent
--   id-it-currentCRL        OBJECT IDENTIFIER ::= {id-it 6}

```

```

--      CurrentCRLValue          ::= CertificateList
--      id-it-unsupportedOIDs    OBJECT IDENTIFIER ::= {id-it 7}
--      UnsupportedOIDsValue     ::= SEQUENCE OF OBJECT IDENTIFIER
--      id-it-keyPairParamReq    OBJECT IDENTIFIER ::= {id-it 10}
--      KeyPairParamReqValue     ::= OBJECT IDENTIFIER
--      id-it-keyPairParamRep    OBJECT IDENTIFIER ::= {id-it 11}
--      KeyPairParamRepValue     ::= AlgorithmIdentifier
--      id-it-revPassphrase      OBJECT IDENTIFIER ::= {id-it 12}
--      RevPassphraseValue       ::= EncryptedKey
--      -- Changed from Encrypted Value to EncryptedKey as a CHOICE
--      -- of EncryptedValue and EnvelopedData due to the changes
--      -- made in CMP Updates [thisRFC]
--      -- Using the choice EncryptedValue is bit-compatible to
--      -- the syntax without this change
--      id-it-implicitConfirm    OBJECT IDENTIFIER ::= {id-it 13}
--      ImplicitConfirmValue     ::= NULL
--      id-it-confirmWaitTime    OBJECT IDENTIFIER ::= {id-it 14}
--      ConfirmWaitTimeValue     ::= GeneralizedTime
--      id-it-origPKIMessage     OBJECT IDENTIFIER ::= {id-it 15}
--      OrigPKIMessageValue      ::= PKIMessages
--      id-it-supplLangTags      OBJECT IDENTIFIER ::= {id-it 16}
--      SupplLangTagsValue       ::= SEQUENCE OF UTF8String
--      id-it-caCerts            OBJECT IDENTIFIER ::= { id-it 17}
--      CaCertsValue             ::= SEQUENCE OF CMPCertificate
--      -- id-it-caCerts added in CMP Updates [thisRFC]
--      id-it-rootCaKeyUpdate    OBJECT IDENTIFIER ::= { id-it 18}
--      RootCaKeyUpdateValue     ::= RootCaKeyUpdateContent
--      -- id-it-rootCaKeyUpdate added in CMP Updates [thisRFC]
--      id-it-certReqTemplate    OBJECT IDENTIFIER ::= { id-it 19}
--      CertReqTemplateValue     ::= CertReqTemplateContent
--      -- id-it-certReqTemplate added in CMP Updates [thisRFC]
--
-- where
--
--      id-pkix OBJECT IDENTIFIER ::= {
--          iso(1) identified-organization(3)
--          dod(6) internet(1) security(5) mechanisms(5) pkix(7)}
--      and
--      id-it   OBJECT IDENTIFIER ::= {id-pkix 4}
--
--
-- This construct MAY also be used to define new PKIX Certificate
-- Management Protocol request and response messages, or general-
-- purpose (e.g., announcement) messages for future needs or for
-- specific environments.

```

GenMsgContent ::= SEQUENCE OF InfoTypeAndValue

-- May be sent by EE, RA, or CA (depending on message content).


```
-- The OPTIONAL infoValue parameter of InfoTypeAndValue will
-- typically be omitted for some of the examples given above.
-- The receiver is free to ignore any contained OBJECT IDs that it
-- does not recognize. If sent from EE to CA, the empty set
-- indicates that the CA may send
-- any/all information that it wishes.
```

```
GenRepContent ::= SEQUENCE OF InfoTypeAndValue
-- Receiver MAY ignore any contained OIDs that it does not
-- recognize.
```

```
ErrorMsgContent ::= SEQUENCE {
    pKISStatusInfo      PKISStatusInfo,
    errorCode            INTEGER          OPTIONAL,
    -- implementation-specific error codes
    errorDetails         PKIFreeText      OPTIONAL
    -- implementation-specific error details
}
```

```
CertConfirmContent ::= SEQUENCE OF CertStatus
```

```
CertStatus ::= SEQUENCE {
    certHash      OCTET STRING,
    -- the hash of the certificate, using the same hash algorithm
    -- as is used to create and verify the certificate signature
    certReqId     INTEGER,
    -- to match this confirmation with the corresponding req/rep
    statusInfo    PKISStatusInfo OPTIONAL }
```

```
PollReqContent ::= SEQUENCE OF SEQUENCE {
    certReqId      INTEGER }
```

```
PollRepContent ::= SEQUENCE OF SEQUENCE {
    certReqId      INTEGER,
    checkAfter     INTEGER, -- time in seconds
    reason         PKIFreeText OPTIONAL }
```

```
--
-- Extended Key Usage extension for PKI entities used in CMP
-- operations, added due to the changes made in
-- CMP Updates [thisRFC]
-- The EKUs for the CA and RA are reused from CMC as defined in
-- [RFC6402]
--
```

```
-- id-kp-cmcCA OBJECT IDENTIFIER ::= { id-kp 27 }
-- id-kp-cmcRA OBJECT IDENTIFIER ::= { id-kp 28 }
id-kp-cmKGA OBJECT IDENTIFIER ::= { id-kp 32 }
```

```
END
```

Appendix B. History of changes

Note: This appendix will be deleted in the final version of the document.

From version 07 -> 08:

- *Added a ToDo to Section 2.2 to reflect a current discussion on the need of an additional CMP-CA role and ECU and differentiation from CMP-RA
- *Added Todos to Section 2.12 and 2.13

From version 06 -> 07:

- *Added David von Oheimb as co-author
- *Changed to XML V3
- *Added Section 2.3 to enable a CMP protocol version number 3 in the PKIHeader for cases where EnvelopedData is to be used (see thread "Mail regarding draft-ietf-lamps-cmp-updates").
- *Added Section 2.4 to refer to [I-D.ietf-lamps-crmf-update-algs] for the update of id-PasswordBasedMac for PKI message protection using passwords or shared secrets.
- *Updated Section 2.6 to introduce the protocol version number 3 to properly indicate support of EnvelopedData instead of EncryptedValue in case a transaction requires use of EnvelopedData (see thread "Mail regarding draft-ietf-lamps-cmp-updates").
- *Update Section 2.14 to make the minimal changes to the respective section in CMP more explicit.
- *Added Sections 2.15 and 2.16 to address the new cmp2021 protocol version in Section 7 Version Negotiation.
- *Updated Section 2.17 to add new OIDs for id-regCtrl-algId and id-regCtrl-rsaKeyLen for registration at IANA.
- *Added Section 2.20 to update the general rules of interpretation in Appendix D.1 regarding the new cmp2021 version.
- *Added Section 2.21 to update the Algorithm Use Profile in Appendix D.2 with the reference to the new CMP Algorithms document as decided at IETF 108.
- *Updates Section 3.1 to delete the description of a discovery mechanism as decided at IETF 108.
- *Various changes and corrections in wording.

From version 05 -> 06:

- *Added the update of Appendix D.2 with the reference to the new CMP Algorithms document as decided in IETF 108
- *Updated the IANA considerations to register new OIDs for id-regCtrl-algId and d-regCtrl-rsaKeyLen.

*Minor changes and corrections

From version 04 -> 05:

- *Added [Section 2.8](#) and [Section 2.9](#) to clarify the usage of these general messages types with EC curves (see thread "AlgorithmIdentifier parameters NULL value - Re: InfoTypeAndValue in CMP headers")
- *Split former section 2.7 on adding 'CA Certificates', 'Root CA Certificates Update', and 'Certificate Request Template' in three separate sections for easier readability
- *Changed in [Section 2.12](#) the ASN.1 syntax of CertReqTemplateValue from using `reaKeyLen` to usage of controls as specified in [CRMF Section 6 \[RFC4211\]](#) (see thread "dtaft-ietf-lamps-cmp-updates and rsaKeyLen")
- *Updated the IANA considerations in [Section 2.17](#) to introduce new OID for `id-regCtrl-algId` and `id-regCtrl-rsaKeyLen` (see thread "dtaft-ietf-lamps-cmp-updates and rsaKeyLen")
- *Updated the IANA Considerations in and the Appendixes to introduce new OID for the updates ASN.1 modules (see thread "I-D Action: draft-ietf-lamps-cmp-updates-04.txt")
- *Removed `EncryptedValue` from and added Controls to the list of types imported from [CRMF \[RFC4211\]](#) in ASN.1 modules (see thread "draft-ietf-lamps-cmp-updates and the ASN.1 modules")
- *Moved declaration of `Rand` out of the comment in ASN.1 modules (see thread "draft-ietf-lamps-cmp-updates and the ASN.1 modules")
- *Minor changes and corrections

From version 03 -> 04:

- *Added Section 2.7 to introduce three new id-it IDs for uses in general messages as discussed (see thread "draft-ietf-lamps-cmp-updates add section to introduce id-it-caCerts, id-it-rootCaKeyUpdate, and id-it-certReqTemplate")
- *Added the new id-it IDs and the `/.well-known/cmp` to the IANA Considerations of [\[RFC4210\]](#) in Section 2.9
- *Updated the IANA Considerations of [\[RFC4210\]](#) in [Section 2.18](#)
- *Some changes in wording on [Section 3](#) due to review comments from Martin Peylo

From version 02 -> 03:

- *Added a ToDo on aligning with the CMP Algorithms draft that will be set up as decided in IETF 108
- *Updated section on Encrypted Values in [Section 2.6](#) to add the AsymmetricKey Package structure to transport a newly generated private key as decided in IETF 108
- *Updated the IANA Considerations of [\[RFC4210\]](#) in [Section 2.18](#)
- *Added the pre-registered OID in [Section 2.18](#) and the ASN.1 module

- *Added [Section 3](#) to document the changes to [RFC 6712](#) [[RFC6712](#)] regarding URI discovery and using the path-prefix of '/.well-known/' as discussed in IETF 108
- *Updated the IANA Considerations section
- *Added a complete updated ASN.1 module in 1988 syntax to update Appendix F of [[RFC4210](#)] and a complete updated ASN.1 module in 2002 syntax to update Section 9 of [[RFC5912](#)]
- *Minor changes in wording

From version 01 -> 02:

- *Updated section on ECU OIDs in [Section 2.2](#) as decided in IETF 107
- *Changed from symmetric key-encryption to password-based key management technique in [Section 2.6](#) as discussed with Russ and Jim on the mailing list
- *Defined the attribute containing the key identifier for the revocation passphrase in [Section 2.18](#)
- *Moved the change history to the Appendix

From version 00 -> 01:

- *Minor changes in wording

From draft-brockhaus-lamps-cmp-updates-03 -> draft-ietf-lamps-cmp-updates-00:

- *Changes required to reflect WG adoption

From version 02 -> 03:

- *Added some clarification in [Section 2.1](#)

From version 01 -> 02:

- *Added clarification to section on multiple protection
- *Added clarification on new EKUs after some exchange with Tomas Gustavsson
- *Reused OIDs from [RFC 6402](#) [[RFC6402](#)] as suggested by Sean Turner at IETF 106
- *Added clarification on the field containing the key identifier for a revocation passphrase
- *Minor changes in wording

From version 00 -> 01:

- *Added a section describing the new extended key usages
- *Completed the section on changes to the specification of encrypted values
- *Added a section on clarification to Appendix D.4

*Minor generalization in [RFC 4210](#) [[RFC4210](#)] Sections 5.1.3.4 and 5.3.22

*Minor changes in wording

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