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S/MIME Capabilities for Public Key Definitions

Abstract

This document defines a set of Secure/Multipurpose Internet Mail Extensions (S/MIME) Capability types for ASN.1 encoding for the current set of public keys defined by the PKIX working group. This facilitates the ability for a requester to specify information on the public keys and signature algorithms to be used in responses. "Online Certificate Status Protocol Algorithm Agility" (RFC 6277) details an example of where this is used.

Status of This Memo

This document is not an Internet Standards Track specification; it is published for informational purposes.

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Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at http://www.rfc-editor.org/info/rfc6664.

Table of Contents

1. Introduction

In the process of dealing with the Online Certificate Status Protocol (OCSP) agility issues in [RFC6277], it was noted that we really wanted to describe information to be used in selecting a public key, but we did not have any way of doing so. This document fills that hole by defining a set of Secure/Multipurpose Internet Mail Extensions (S/MIME) Capability types for a small set of public key representations.

S/MIME capabilities were originally defined in [SMIMEv3-MSG] as a way for the sender of an S/MIME message to tell the recipient of the message the set of encryption algorithms that were supported by the sender's system. In the beginning, the focus was primarily on communicating the set of encryption algorithms that were supported by the sender. Over time, it was expanded to allow for an S/MIME client to state that it supported new features such as the compression data type and binary encoded contents. The structure was defined so that parameters can be passed in as part of the capability to allow for subsets of algorithms to be used. This was used for the RC2 encryption algorithm, although only two values out of the set of values were ever used. The goal of restricting the set of values is to allow a client to use a simple binary comparison in order to check

for equality. The client should never need to decode the capability and do an element-by-element comparison. Historically, this has not been a problem as the vast majority of S/MIME capabilities consist of just the algorithm identifier for the algorithm.

Many people are under the impression that only a single data structure can be assigned to an object identifier, but this is not the case. As an example, the OID rsaEncryption is used in multiple locations for different data. It represents a public key, a key transport algorithm (in S/MIME), and was originally used in the Public-Key Cryptography Standards (PKCS) #7 specification as a signature value identifier (this has since been changed by the S/MIME specifications). One of the implications is that when mapping an object identifier to a data type structure, the location in the ASN.1 structure needs to be taken into consideration as well.

1.1. ASN.1 Notation

The main body of the text is written using snippets of ASN.1 that are extracted from the ASN.1 2008 module in Appendix A. ASN.1 2008 is used in this document because it directly represents the metadata that is not representable in the 1988 version of ASN.1 but instead is part of the text. In keeping with the current policy of the PKIX working group, the 1988 module along with the text is the normative module. In the event of a conflict between the content of the two modules, the 1988 module is authoritative.

When reading this document, it is assumed that you will have a degree of familiarity with the basic object module that is presented in Section 3 of RFC 5912 [RFC5912]. We use the SMIME-CAPS object in this document; it associates two fields together in a single object.

```
SMIME-CAPS ::= CLASS {
    &id          OBJECT IDENTIFIER UNIQUE,
    &Type        OPTIONAL
}
WITH SYNTAX { [TYPE &Type] IDENTIFIED BY &id }
```

These fields are:

&id contains an object identifier. When placed in an object set, this element is tagged so that no two elements can be placed in the set that have the same value in the &id field. Note that this is not a restriction saying that only a single object can exist with a single object identifier.

&Type optionally contains an ASN.1 type identifier. If the field &Type is not defined, then the optional parameters field of the AlgorithmIdentifier type would be omitted.

The class also has a specialized syntax for how to define an object in this class. The all uppercase words TYPE IDENTIFIER and BY are syntactic sugar to make it easier to read. The square brackets define optional pieces of the syntax.

The ASN.1 syntax permits any field in an object to be referenced in another location. This means that if an object called foo has a field named &value, the value can be directly referenced as foo.&value. This means that any updates to values or types are automatically propagated, and we do not need to replicate the data.

1.2. Requirements Terminology

When capitalized, 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].

2. RSA Public Keys

There are currently three different public key object identifiers for RSA public keys. These are RSA, RSA Encryption Scheme - Optimal Asymmetric Encryption Padding (RSAES-OAEP), and RSA Signature Scheme with Appendix - Probabilistic Signature Scheme (RSASSA-PSS).

2.1. Generic RSA Public Keys

Almost all RSA keys that are contained in certificates today use the generic RSA public key format and identifier. This allows for the public key to be used both for key transport and for signature validation (assuming it is compatible with the bits in the key usage extension). The only reason for using one of the more specific public key identifiers is if the user wants to restrict the usage of the RSA public key to a specific algorithm.

For the generic RSA public key, the S/MIME capability that is advertised is a request for a specific key size to be used. This would normally be used for dealing with a request on the key to be used for a signature that the client would then verify. In general, the user would provide a specific key when a key transport algorithm is being considered.

The ASN.1 that is used for the generic RSA public key is defined as below:

```
scap-pk-rsa SMIME-CAPS ::= {
  TYPE RSAKeyCapabilities
  IDENTIFIED BY pk-rsa.&id
}

RSAKeyCapabilities ::= SEQUENCE {
   minKeySize        RSAKeySize,
   maxKeySize        RSAKeySize OPTIONAL
}

RSAKeySize ::= INTEGER (1024 | 2048 | 3072 | 4096 | 7680 |
                        8192 | 15360, ...)
```

In the above ASN.1, we have defined the following:

scap-pk-rsa is a new SMIME-CAPS object. This object associates the existing object identifier (rsaEncryption) used for the public key in certificates (defined in [RFC3279] and [RFC5912]) with a new type defined in this document.

RSAKeyCapabilities carries the set of desired capabilities for an RSA key. The fields of this type are:

minKeySize contains the minimum length of the RSA modulus to be used. This field SHOULD NOT contain a value less than 1024.

maxKeySize contains the maximum length of the RSA modules that should be used. If this field is absent, then no maximum length is requested/expected. This value is normally selected so as not to cause the current code to run unacceptably long when processing signatures.

RSAKeySize provides a set of suggested values to be used. The values 1024, 2048, 3072, 7680, and 15360 are from the NIST guide on signature sizes [NIST-SIZES] while the others are common powers of two that are used. The list is not closed, and other values can be used.

2.2. RSASSA-PSS Signature Public Keys

While one will use the generic RSA public key identifier in a certificate most of the time, the RSASSA-PSS identifier can be used if the owner of the key desires to restrict the usage of the key to just this algorithm. This algorithm does have the ability to place a

set of algorithm parameters in the public key info structure, but they have not been included in this location as the same information should be carried in the signature S/MIME capabilities instead.

The ASN.1 that is used for the RSASSA-PSS public key is defined below:

```
scap-pk-rsaSSA-PSS SMIME-CAPS ::= {
  TYPE RSAKeyCapabilities
  IDENTIFIED BY pk-rsaSSA-PSS.&id
}
```

In the above ASN.1, we have defined the following:

scap-pk-rsaSSA-PSS is a new SMIME-CAPS object. This object associates the existing object identifier (id-RSASSA-PSS) used for the public key certificates (defined in [RFC4055] and [RFC5912]) with type RSAKeyCapabilities.

2.3. RSAES-OAEP Key Transport Public Keys

While one will use the generic RSA public key identifier in a certificate most of the time, the RSAES-OAEP identifier can be used if the owner of the key desires to restrict the usage of the key to just this algorithm. This algorithm does have the ability to place a set of algorithm parameters in the public key info structure, but they have not been included in this location as the same information should be carried in the key transport S/MIME capabilities instead.

The ASN.1 that is used for the RSAES-OAEP public key is defined below:

```
scap-pk-rsaES-OAEP SMIME-CAPS ::= {
  TYPE RSAKeyCapabilities
  IDENTIFIED BY pk-rsaES-OAEP.&id
}
```

In the above ASN.1, we have defined the following:

scap-pk-rsaES-OAEP is a new SMIME-CAPS object. This object associates the existing object identifier (id-RSAES-OAEP) used for the public key certificates (defined in [RFC4055] and [RFC5912]) with type RSAKeyCapabilities.

3. Diffie-Hellman Keys

There are currently two Diffie-Hellman (DH) public key object identifiers. These are DH key agreement and Digital Signature Standard (DSA).

3.1. DSA Signature Public Key

This public key type is used for the validation of DSA signatures.

The ASN.1 that is used for DSA keys is defined below:

```
scap-pk-dsa SMIME-CAPS ::= {
  TYPE DSAKeyCapabilities
  IDENTIFIED BY pk-dsa.&id
}

DSAKeyCapabilities ::= CHOICE {
    keySizes         [0] SEQUENCE {
       minKeySize            DSAKeySize,
       maxKeySize            DSAKeySize OPTIONAL,
       maxSizeP              [1] INTEGER OPTIONAL,
       maxSizeQ              [2] INTEGER OPTIONAL,
       maxSizeG              [3] INTEGER OPTIONAL
    },
    keyParams        [1] pk-dsa.&Params
}

DSAKeySize ::= INTEGER (1024 | 2048 | 3072 | 7680 | 15360 )
```

In the above ASN.1, we have defined the following:

scap-pk-dsa is a new SMIME-CAPS object. This object associates the existing object identifier (id-dsa) used for the public key in certificates (defined in [RFC3279] and [RFC5912]) with a new type defined here, DSAKeyCapabilities.

DSAKeyCapabilities carries the desired set of capabilities for the DSA key. The fields of this type are:

keySizes is used when only a key size is needed to be specified and not a specific group. It is expected that this would be the most commonly used of the two options. In key sizes, the fields are used as follows:

minKeySize contains the minimum length of the DSA modulus to be used.

maxKeySize contains the maximum length of the DSA modules that should be used. If this field is absent, then no maximum length is requested/expected.

maxSizeP contains the maximum length of the value p that should be used. If this field is absent, then no maximum length is imposed.

maxSizeQ contains the maximum length of the value q that should be used. If this field is absent, then no maximum length is imposed.

maxSizeG contains the maximum length of the value g that should be used. If this field is absent, then no maximum length is imposed.

keyParams contains the exact set of DSA for the key used to sign the message. This field is provided for completeness and to match the fields for Elliptic Curve; however, it is expected that usage of this field will be extremely rare.

3.2. DH Key Agreement Keys

This public key type is used with the DH key agreement algorithm.

The ASN.1 that is used for DH keys is defined below:

```
scap-pk-dh SMIME-CAPS ::= {
  TYPE DSAKeyCapabilities
  IDENTIFIED BY pk-dh.&id
}
```

In the above ASN.1, we have defined the following:

scap-pk-dh is a new SMIME-CAPS object. This object associates the existing object identifier (dhpublicnumber) used for the public key algorithm in the certificates (defined in [RFC3279] and [RFC5912]) with a new type defined above, DSAKeyCapabilities.

4. Elliptic Curve Keys

There are currently three Elliptic Curve Cryptography (ECC) public key object identifiers. These are EC, EC-DH, and Elliptic Curve Menezes-Qu-Vanstone (EC-MQV).

4.1. Generic Elliptic Curve Keys

Almost all ECC keys that are contained in certificates today use the generic ECC public key format and identifier. This allows for the public key to be used both for key agreement and for signature validation (assuming the appropriate bits are in the certificate). The only reason for using one of the more specific public key identifier is if the user wants to restrict the usage of the ECC public key to a specific algorithm.

For the generic ECC public key, the S/MIME capability that is advertised is a request for a specific group to be used.

The ASN.1 that is used for the generic ECC public key is defined below:

```
scap-pk-ec SMIME-CAPS ::= {
   TYPE EC-SMimeCaps
   IDENTIFIED BY pk-ec.&id
}

EC-SMimeCaps ::= SEQUENCE (SIZE (1..MAX)) OF ECParameters
```

In the above ASN.1, we have defined the following:

scap-pk-ec is a new SMIME-CAPS object. This object associates the existing object identifier (id-ecPublicKey) used for the public key algorithm in the certificates (defined in [RFC5480] and [RFC5912]) with the new type EC-SMimeCaps.

EC-SMimeCaps carries a sequence of at least one ECParameters structure. This allows for multiple curves to be requested in a single capability request. A maximum/minimum style of specifying sizes is not provided as much greater care is required in selecting a specific curve than is needed to create the parameters for a DSA/DH key. As specified in [RFC5480], for PKIX-compliant certificates, only the namedCurve choice of ECParameters is expected to be used.

4.2. Elliptic Curve DH Keys

This public key type is used with the Elliptic Curve Diffie-Hellman key agreement algorithm.

The ASN.1 that is used for EC-DH keys is defined below:

```
scap-pk-ecDH SMIME-CAPS ::= {
  TYPE EC-SMimeCaps
  IDENTIFIED BY pk-ecDH.&id
}
```

In the above ASN.1, we have defined the following:

scap-pk-ecDH is a new SMIME-CAPS object. This object associates the existing object identifier (id-ecDH) used for the public key algorithm in the certificate (defined in [RFC5480] and [RFC5912]) with the same type structure used for public keys.

4.3. Elliptic Curve MQV Keys

This public key type is used with the Elliptic Curve MQV key agreement algorithm.

The ASN.1 that is used for EC-MQV keys is defined below:

```
scap-pk-ecMQV SMIME-CAPS ::= {
  TYPE EC-SMimeCaps
  IDENTIFIED BY pk-ecMQV.&id
}
```

In the above ASN.1, we have defined the following:

scap-pk-ecMQV is a new SMIME-CAPS object. This object associates the existing object identifier (id-ecMQV) used for the public key algorithm in the certificate (defined in [RFC5480] and [RFC5912]) with the same type structure used for public keys.

5. RSASSA-PSS Signature Algorithm Capability

This document defines a new SMIMECapability for the RSASSA-PSS signature algorithm. One already exists in [RFC4055] where the parameters field is not used.

When the S/MIME group defined an S/MIME capability for the RSASSA-PSS signature algorithm, it was done in the context of how S/MIME defines and uses S/MIME capabilities. When placed in an S/MIME message [SMIME-MSG] or in a certificate [RFC4262], it is always placed in a

sequence of capabilities. This means that one could place the identifier for RSASSA-PSS in the sequence along with the identifier for MD5, SHA-1, and SHA-256. The assumption was then made that one could compute the matrix of all answers, and the publisher would support all elements in the matrix. This has the possibility that the publisher could accidentally publish a point in the matrix that is not supported.

In this situation, there is only a single item that is published. This means that we need to publish all of the associated information along with the identifier for the signature algorithm in a single entity. For this reason, we now define a new parameter type to be used as the SMIMECapability type, which contains a hash identifier and a mask identifier. The ASN.1 used for this is as follows:

```
scap-sa-rsaSSA-PSS SMIME-CAPS ::= {
   TYPE RsaSsa-Pss-sig-caps
   IDENTIFIED BY sa-rsaSSA-PSS.&id
}

RsaSsa-Pss-sig-caps ::= SEQUENCE {
   hashAlg  SMIMECapability{{ MaskAlgorithmSet }},
   maskAlg  SMIMECapability{{ ... }} OPTIONAL,
   trailerField INTEGER DEFAULT 1
}

scap-mf-mgf1 SMIME-CAPS ::= {
   TYPE SMIMECapability{{ ... }}
   IDENTIFIED BY id-mgf1
}

MaskAlgorithmSet SMIME-CAPS ::= {scap-mf-mgf1, ...}
```

In the above ASN.1, we have defined the following:

scap-sa-rsaSSA-PSS is a new SMIME-CAPS object. This object associates the existing object identifier (id-RSASSA-PSS) used for the signature algorithm (defined in [RFC4055] and [RFC5912]) with the new type RsaSsa-Pss-sig-caps.

RsaSsa-Pss-sig-caps carries the desired set of capabilities for the RSASSA-PSS signature algorithm. The fields of this type are:

hashAlg contains the S/MIME capability for the hash algorithm we are declaring we support with the RSASSA-PSS signature algorithm.

maskAlg contains the S/MIME capability for the mask algorithm we are declaring we support with the RSASSA-PSS signature algorithm.

trailerField specifies which trailer field algorithm is being supported. This MUST be the value 1.

NOTE: In at least one iteration of the design, we used a sequence of hash identifiers and a sequence of masking functions and again made the assumption that the entire matrix would be supported. This has been removed at this point since the original intent of S/MIME capabilities is that one should be able to do a binary comparison of the DER encoding of the field and determine a specific capability was published. We could return to using the sequence if we wanted to lose the ability to do a binary compare but needed to shorten the encodings. This does not currently appear to be an issue at this point.

6. Security Considerations

This document provides new fields that can be placed in an S/MIME capabilities sequence. There are number of considerations that need to be taken into account when doing this.

As mentioned above, we have defined data structures to be associated with object identifiers in cases where an association already exists. When either encoding or decoding structures, care needs to be taken that the association used is one appropriate for the location in the surrounding ASN.1 structure. This means that one needs to make sure that only public keys are placed in public key locations, signatures are placed in signature locations, and S/MIME capabilities are placed in SMIMECapability locations. Failure to do so will create decode errors at best and can cause incorrect behavior at worst.

The more specific the information that is provided in an S/MIME Capabilities field, the better the end results are going to be. Specifying a signature algorithm means that there are no questions for the receiver that the signature algorithm is supported. Signature algorithms can be implied by specifying both public key algorithms and hash algorithms together. If the list includes RSA v1.5, EC-DSA, SHA-1, and SHA-256, the implication is that all four values in the cross section are supported by the sender. If the sender does not support EC-DSA with SHA-1, this would lead to a situation where the recipient uses a signature algorithm that the sender does not support. Omitting SHA-1 from the list may lead to the problem where both entities support RSA v1.5 with SHA-1 as their only common algorithm, but this is no longer discoverable by the recipient.

As a general rule, providing more information about the algorithms that are supported is preferable. The more choices that are provided the recipient, the greater the likelihood that a common algorithm with good security can be used by both parties. However, one should avoid being exhaustive in providing the list of algorithms to the recipient. The greater the number of algorithms that are passed, the more difficult it is for a recipient to make intelligent decisions about which algorithm to use. This is a more significant problem when there are more than two entities involved in the "negotiation" of a common algorithm to be used (such as sending an encrypted S/MIME message where a common content encryption algorithm is needed). The larger the set of algorithms and the more recipients involved, the more memory and processing time will be needed in order to complete the decision-making process.

The S/MIME capabilities are defined so that the order of algorithms in the sequence is meant to encode a preference order by the sender of the sequence. Many entities will ignore the order preference when making a decision either by using their own preferred order or using a random decision from a matrix.

7. References

7.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[RFC3279] Bassham, L., Polk, W., and R. Housley, "Algorithms and Identifiers for the Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile", RFC 3279, April 2002.

[RFC4055] Schaad, J., Kaliski, B., and R. Housley, "Additional Algorithms and Identifiers for RSA Cryptography for use in the Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile", RFC 4055, June 2005.

[RFC5480] Turner, S., Brown, D., Yiu, K., Housley, R., and T. Polk, "Elliptic Curve Cryptography Subject Public Key Information", RFC 5480, March 2009.

7.2. Informative References

[NIST-SIZES] Barker, E., Barker, W., Burr, W., Polk, W., and M. Smid, "Recommendation for Key Management -- Part 1: General", NIST Special Publication 800-57, March 2007.

[RFC4262] Santesson, S., "X.509 Certificate Extension for Secure/Multipurpose Internet Mail Extensions (S/MIME) Capabilities", RFC 4262, December 2005.

[RFC5912] Hoffman, P. and J. Schaad, "New ASN.1 Modules for the Public Key Infrastructure Using X.509 (PKIX)", RFC 5912, June 2010.

[RFC6277] Santesson, S. and P. Hallam-Baker, "Online Certificate Status Protocol Algorithm Agility", RFC 6277, June 2011.

[SMIME-MSG] Ramsdell, B. and S. Turner, "Secure/Multipurpose Internet Mail Extensions (S/MIME) Version 3.2 Message Specification", RFC 5751, January 2010.

[SMIMEv3-MSG] Ramsdell, B., "S/MIME Version 3 Message Specification", RFC 2633, June 1999.

Appendix A. 2008 ASN.1 Module

This appendix contains a module compatible with the work done to update the PKIX ASN.1 modules to recent versions of the ASN.1 specifications [RFC5912]. This appendix is to be considered informational per the current direction of the PKIX working group.

```
PUBLIC-KEY-SMIME-CAPABILITIES
   { iso(1) identified-organization(3) dod(6) internet(1)
     security(5) mechanisms(5) pkix(7) id-mod(0)
     id-mod-pubKeySMIMECaps-08(78) }
DEFINITIONS ::=
BEGIN
   IMPORTS
   SMIME-CAPS, PUBLIC-KEY, SMIMECapability
   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)}

   pk-rsa, pk-dsa, pk-dh, pk-ec, pk-ecDH, pk-ecMQV, ECParameters
   FROM PKIXAlgs-2009
      { iso(1) identified-organization(3) dod(6) internet(1)
        security(5) mechanisms(5) pkix(7) id-mod(0)
        id-mod-pkix1-algorithms2008-02(56) }

   pk-rsaSSA-PSS, pk-rsaES-OAEP, sa-rsaSSA-PSS,
   HashAlgorithms, id-mgf1
   FROM PKIX1-PSS-OAEP-Algorithms-2009
      { iso(1) identified-organization(3) dod(6) internet(1)
        security(5) mechanisms(5) pkix(7) id-mod(0)
        id-mod-pkix1-rsa-pkalgs-02(54)}
   ;

   --
   --  Define a set containing all of the S/MIME capabilities defined
   --  by this document.
   --

   SMimeCaps SMIME-CAPS ::= {
      PubKeys-SMimeCaps |
      scap-sa-rsaSSA-PSS
   }

   PubKeys-SMimeCaps SMIME-CAPS ::= {
      scap-pk-rsa | scap-pk-rsaSSA-PSS |
      scap-pk-dsa |
      scap-pk-ec | scap-pk-ecDH | scap-pk-ecMQV
```

```
}

--
--  We defined RSA keys from the modules in RFC 3279 and RFC 4055.
--

scap-pk-rsa SMIME-CAPS ::= {
  TYPE RSAKeyCapabilities
  IDENTIFIED BY pk-rsa.&id
}

RSAKeyCapabilities ::= SEQUENCE {
   minKeySize        RSAKeySize,
   maxKeySize        RSAKeySize OPTIONAL
}

RSAKeySize ::= INTEGER (1024 | 2048 | 3072 | 4096 | 7680 |
                        8192 | 15360, ...)


scap-pk-rsaES-OAEP SMIME-CAPS ::= {
  TYPE RSAKeyCapabilities
  IDENTIFIED BY pk-rsaES-OAEP.&id
}

scap-pk-rsaSSA-PSS SMIME-CAPS ::= {
  TYPE RSAKeyCapabilities
  IDENTIFIED BY pk-rsaSSA-PSS.&id
}

scap-sa-rsaSSA-PSS SMIME-CAPS ::= {
   TYPE RsaSsa-Pss-sig-caps
   IDENTIFIED BY sa-rsaSSA-PSS.&id
}

RsaSsa-Pss-sig-caps ::= SEQUENCE {
   hashAlg  SMIMECapability{{ MaskAlgorithmSet }},
   maskAlg  SMIMECapability{{ ... }} OPTIONAL,
   trailerField INTEGER DEFAULT 1
}

scap-mf-mgf1 SMIME-CAPS ::= {
   TYPE SMIMECapability{{ ... }}
   IDENTIFIED BY id-mgf1
}

MaskAlgorithmSet SMIME-CAPS ::= {scap-mf-mgf1, ...}
```

```
--
--  We define DH/DSA keys from the module in RFC 3279.
--

scap-pk-dsa SMIME-CAPS ::= {
  TYPE DSAKeyCapabilities
  IDENTIFIED BY pk-dsa.&id
}

DSAKeyCapabilities ::= CHOICE {
    keySizes         [0] SEQUENCE {
       minKeySize            DSAKeySize,
       maxKeySize            DSAKeySize OPTIONAL,
       maxSizeP              [1] INTEGER OPTIONAL,
       maxSizeQ              [2] INTEGER OPTIONAL,
       maxSizeG              [3] INTEGER OPTIONAL
    },
    keyParams        [1] pk-dsa.&Params
}

DSAKeySize ::= INTEGER (1024 | 2048 | 3072 | 7680 | 15360 )

scap-pk-dh SMIME-CAPS ::= {
  TYPE DSAKeyCapabilities
  IDENTIFIED BY pk-dh.&id
}

--
--  We define Elliptic Curve keys from the module in RFC 3279.
--

scap-pk-ec SMIME-CAPS ::= {
   TYPE EC-SMimeCaps
   IDENTIFIED BY pk-ec.&id
}

EC-SMimeCaps ::= SEQUENCE (SIZE (1..MAX)) OF ECParameters

scap-pk-ecDH SMIME-CAPS ::= {
  TYPE EC-SMimeCaps
  IDENTIFIED BY pk-ecDH.&id
}

scap-pk-ecMQV SMIME-CAPS ::= {
  TYPE EC-SMimeCaps
  IDENTIFIED BY pk-ecMQV.&id
}
```

```
   END
```

Appendix B. 1988 ASN.1 Module

This appendix contains the normative ASN.1 module for this document.

```
   PUBLIC-KEY-SMIME-CAPABILITIES-88
      { iso(1) identified-organization(3) dod(6) internet(1)
        security(5) mechanisms(5) pkix(7) id-mod(0)
        id-mod-pubKeySMIMECaps-88(77) }
   DEFINITIONS ::=
   BEGIN
      IMPORTS

      ECParameters
      FROM  PKIX1Algorithms2008
           { iso(1) identified-organization(3) dod(6)
             internet(1) security(5) mechanisms(5) pkix(7) id-mod(0)
             45 }

      id-mgf1
      FROM   PKIX1-PSS-OAEP-Algorithms
           { iso(1) identified-organization(3) dod(6)
             internet(1) security(5) mechanisms(5) pkix(7) id-mod(0)
             id-mod-pkix1-rsa-pkalgs(33) }

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

      ;

      --
      --  We define RSA keys from the modules in RFC 3279 and RFC 4055.
      --

      RSAKeyCapabilities ::= SEQUENCE {
         minKeySize        RSAKeySize,
         maxKeySize        RSAKeySize OPTIONAL
      }

      RSAKeySize ::= INTEGER (1024 | 2048 | 3072 | 4096 | 7680 |
                              8192 | 15360, ...)


      RsaSsa-Pss-sig-caps ::= SEQUENCE {
```

```
         hashAlg  AlgorithmIdentifier,
         maskAlg  AlgorithmIdentifier OPTIONAL,
         trailerField INTEGER DEFAULT 1
      }

      --
      --  We define DH/DSA keys from the module in RFC 3279.
      --

      DSAKeyCapabilities ::= CHOICE {
          keySizes         [0] SEQUENCE {
             minKeySize             DSAKeySize,
             maxKeySize             DSAKeySize OPTIONAL,
             maxSizeP               [1] INTEGER OPTIONAL,
             maxSizeQ               [2] INTEGER OPTIONAL,
             maxSizeG               [3] INTEGER OPTIONAL
          },
          keyParams        [1] pk-dsa.&Params
      }

      DSAKeySize ::= INTEGER (1024 | 2048 | 3072 | 7680 | 15360 )

      --
      --  We define Elliptic Curve keys from the module in RFC 3279.
      --

      EC-SMimeCaps ::= SEQUENCE (SIZE (1..MAX)) OF ECParameters

   END
```

Appendix C. Future Work

A future revision of [RFC5912] should be done at some point to expand the definition of the PUBLIC-KEY class and allow for an SMIMECapability to be included in the class definition. This would encourage people to think about this as an issue when defining new public key structures in the future.

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