                 Use of the IDEA Encryption Algorithm in CMS

Status of this Memo

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Abstract

   This memo specifies how to incorporate International Data Encryption
   Algorithm (IDEA) into CMS or S/MIME as an additional strong algorithm
   for symmetric encryption. For organizations who make use of IDEA for
   data security purposes it is of high interest that IDEA is also
   available in S/MIME. The intention of this memo is to provide the
   OIDs and algorithms required that IDEA can be included in S/MIME for
   symmetric content and key encryption.

1. Introduction

   This memo specifies how to incorporate International Data Encryption
   Algorithm (IDEA) [IDEA] into CMS or S/MIME [SMIME2, SMIME3] as an
   additional strong algorithm for symmetric encryption. For
   organizations who make use of IDEA for data security purposes it is
   of high interest that IDEA is also available in S/MIME. The
   intention of this memo is to provide the OIDs and algorithms required
   that IDEA can be included in S/MIME for symmetric content and key
   encryption.

   The general functional capabilities and preferences of S/MIME are
   specified by the registered list of S/MIME object identifiers (OIDs).
   This list of OIDs is available from the Internet Mail Consortium at
   <http://www.imc.org/ietf-smime/oids.html>. The set of S/MIME
   functions provided by a client is expressed by the S/MIME
   capabilities attribute. This attribute contains a list of OIDs of
   supported cryptographic functions.

In this document, the terms MUST, MUST NOT, SHOULD, and SHOULD NOT
are used in capital letters. This conforms to the definitions in
[MUSTSHOULD].

2. Object Identifier for Content and Key Encryption

The Cryptographic Message Syntax [CMS], derived from PKCS#7 [PKCS7],
is the framework for the implementation of cryptographic functions in
S/MIME. It specifies data formats and encryption processes without
naming the cryptographic algorithms. Each algorithm which is used
for encryption purposes must be specified by a unique algorithm
identifier. For example, in the special case of content encryption
the ContentEncryptionAlgorithmIdentifier specifies the algorithm to
be applied. However, according to [CMS] any symmetric encryption
algorithm that a CMS implementation includes as a content-encryption
algorithm must also be included as a key-encryption algorithm.

IDEA is added to the set of optional symmetric encryption algorithms
in S/MIME by providing two unique object identifiers (OIDs). One OID
defines content encryption and the other one key encryption. Thus an
S/MIME agent can apply IDEA either for content or key encryption by
selecting the corresponding object identifier, supplying the required
parameter, and starting the program code.

For content encryption the use of IDEA in cipher block chaining (CBC)
mode is recommended. The key length is fixed to 128 bits.

The IDEA content-encryption algorithm in CBC mode has the object
identifier

    IDEA-CBC OBJECT IDENTIFIER
      ::= { iso(1) identified-organization(3)
          usdod(6) oid(1) private(4) enterprises(1)
          ascom(188) systec(7) security(1) algorithms(1) 2 }

The identifier's parameters field contains the initialization vector
(IV) as an optional parameter.

    IDEA-CBCPar ::= SEQUENCE {
      iv OCTET STRING OPTIONAL } -- exactly 8 octets

If IV is specified as above, it MUST be used as initial vector. In
this case, the ciphertext MUST NOT include the initial vector. If IV
is not specified, the first 64 bits of the ciphertext MUST be
considered as the initial vector. However, this alternative of not
including IV into "iv OCTET STRING" of IDEA-CBCPar SHOULD NOT be
applied in CMS or S/MIME.

   The key-wrap/unwrap algorithms used to encrypt/decrypt an IDEA
   content-encryption key with an IDEA key-encryption key are specified
   in the following section. Generation and distribution of IDEA key-
   encryption keys are beyond the scope of this document.

   The IDEA key-encryption algorithm has the object identifier

      id-alg-CMSIDEAwrap OBJECT IDENTIFIER
         ::= { iso(1) identified-organization(3)
               usdod(6) oid(1) private(4) enterprises(1)
               ascom(188) systec(7) security(1) algorithms(1) 6 }

   The identifier's parameters field MUST be NULL.

3. Key-Wrapping and Unwrapping

   In the following subsections IDEA key-wrap and key-unwrap algorithms
   are specified in conformance with [CMS], section 12.3.

3.1 IDEA Key Wrap

   The IDEA key-wrap algorithm encrypts an IDEA content-encryption key
   with an IDEA key-encryption key. The IDEA key-wrap algorithm is
   defined by:

   1. Let the content-encryption key (16 octets) be called CEK
   2. Compute an 8 octet key checksum value on CEK as described in
       [CMS], section 12.6.1, call the result ICV.
   3. Let CEKICV := CEK || ICV.
   4. Generate 8 octets at random, call the result IV.
   5. Encrypt CEKICV using IDEA in CBC mode and the key-encryption key.
       Use the random value generated in the previous step as the
       initialization vector (IV). Call the ciphertext TEMP1.
   6. Let TEMP2 = IV || TEMP1.
   7. Reverse the order of the octets in TEMP2. That is, the most
       significant (first) octet is swapped with the least significant
       (last) octet, and so on. Call the result TEMP3.
   8. Encrypt TEMP3 using IDEA in CBC mode and the key-encryption key.
       Use an initialization vector (IV) of 0x4adda22c79e82105. The
       ciphertext is 32 octets long.

3.2 IDEA Key Unwrap

   The IDEA key-unwrap algorithm decrypts an IDEA content-encryption key
   using an IDEA key-encryption key. The IDEA key-unwrap algorithm is
   defined by:

   1. If the wrapped content-encryption key is not 32 octets, then
       error.
   2. Decrypt the wrapped content-encryption key using IDEA in CBC mode
       with the key-encryption key. Use an initialization vector (IV)
       of 0x4adda22c79e82105. Call the output TEMP3.
   3. Reverse the order of the octets in TEMP3. That is, the most
       significant (first) octet is swapped with the least significant
       (last) octet, and so on. Call the result TEMP2.
   4. Decompose the TEMP2 into IV and TEMP1. IV is the most
       significant (first) 8 octets, and TEMP1 is the remaining (last)
       24 octets.
   5. Decrypt TEMP1 using IDEA in CBC mode with the key-encryption key.
       Use the IV value from the previous step as the initialization
       vector. Call the plaintext CEKICV.
   6. Decompose the CEKICV into CEK and ICV. CEK is the most
       significant (first) 16 octets, and ICV is the least significant
       (last) 8 octets.
   7. Compute an 8 octet key checksum value on CEK as described in
       [CMS], section 12.6.1. If the computed key checksum value does
       not match the decrypted key checksum value, ICV, then error.
   8. Use CEK as the content-encryption key.

4. SMIMECapabilities Attribute

   An S/MIME client can announce the set of cryptographic functions it
   supports by using the S/MIME capabilities attribute as specified in
   [SMIME3]. This attribute provides a partial list of OIDs of
   cryptographic functions and must be signed by the client. These OIDs
   should be logically separated in functional categories and MUST be
   ordered with respect to their preference. If an S/MIME client is
   required to support symmetric encryption and key wrapping based on
   IDEA, the capabilities attribute MUST contain the above specified
   OIDs in the category of symmetric algorithms and key encipherment
   algorithms. IDEA does not require additional OID parameters since it
   has a fixed key length of 128 bits.

   The SMIMECapability SEQUENCE representing the IDEA symmetric
   encryption algorithm MUST include the IDEA-CBC OID in the
   capabilityID field and the parameters field MUST be absent. The
   SMIMECapability SEQUENCE for IDEA encryption SHOULD be included in
   the symmetric encryption algorithms portion of the SMIMECapabilities
   list. The SMIMECapability SEQUENCE representing IDEA MUST be DER-
   encoded as follows: 300D 060B 2B06 0104 0181 3C07 0101 02.

   The SMIMECapability SEQUENCE representing the IDEA key wrapping
   algorithm MUST include the id-alg-CMSIDEAwrap OID in the capabilityID
   field and the parameters field of KeyWrapAlgorithm MUST be absent.
   The SMIMECapability SEQUENCE for IDEA key wrapping SHOULD be included

in the key encipherment algorithms portion of the SMIMECapabilities
list. The SMIMECapability SEQUENCE representing IDEA key wrapping
MUST be DER-encoded as follows: 300D 060B 2B06 0104 0181 3C07 0101
06.

The ASN.1 notation of the SMIMECapability SEQUENCE representing IDEA
is

```
SMIMECapability ::= SEQUENCE {
    capabilityID OBJECT IDENTIFIER,
    parameters ANY DEFINED BY capabilityID OPTIONAL }
```

where capabilityID is IDEA-CBC (no parameters) for IDEA content
encryption in CBC mode or capabilityID is id-alg-CMSIDEAwrap (no
parameters) for IDEA key wrapping.

5. Activation of IDEA in S/MIME Clients

When a sending agent creates an encrypted message, it has to decide
which type of encryption algorithm to use. In general the decision
process involves information obtained from the capabilities lists
included in messages received from the recipient, as well as other
information such as private agreements, user preferences, legal
restrictions, etc. If users require IDEA for symmetric encryption,
it must be supported by the S/MIME clients on both the sending and
receiving side, and it must be set in the user preferences.

A. References

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    [SMIME3]   Dusse, S., Hoffman, P., Ramsdell, B. and J. Weinstein,
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    [PKCS7]   Kaliski, B., "PKCS #7: Cryptographic Message Syntax
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B. Comments on IDEA Security and Standards

    The IDEA algorithm was developed in a joint project involving the
    Swiss Federal Institute of Technology in Zurich (Dr. X. Lai and Prof.
    J.L. Massey) and Ascom Ltd. The aim of the project was to develop a
    strong encryption algorithm that could replace the DES algorithm.

    IDEA uses 128-bit secret keys and encrypts one 64-bit block at a time
    [IDEA]. It was particularly strengthened to protect against
    differential cryptoanalysis attacks. For the full 8-round IDEA there
    is no attack known which is better than exhaustive search on the
    total 128-bit key space.

    IDEA permits the implementation of standard Electronic Data
    Interchange applications. It has been entered in the ISO/IEC
    register for encryption algorithms and incorporated in the "SECURITY
    GUIDE LINES" code list by the UNI/EDIFACT "SECURITY JOINT WORKING
    GROUP".

C. Intellectual Property Rights Notice

    Ascom Ltd. holds the patent to IDEA. In accordance with the
    intellectual property rights procedures of the IETF standards
    process, Ascom offers a non-exclusive license under reasonable and
    non-discriminatory terms and conditions.

    IDEA(TM) is protected by international copyright law and in addition
    has been patented in several countries. Because Ascom wants to make
    this highly secure algorithm widely available, the non-commercial use
    of this algorithm is free.

   Any party wishing to know more about IDEA or to request a license
   should visit the web sites <http://www.media-crypt.com/>,
   <http://www.it-sec.com/> or send an e-mail to info@media-crypt.com or
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F. Full Copyright Statement

Acknowledgement