Encryption Key Derivation in the Cryptographic Message Syntax (CMS) using HKDF with SHA-256

draft-ietf-lamps-cms-cek-hkdf-sha256-01

IETF 119

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Summary of the attack disclosed by Falko and Johannes

Attacker intercepts a CMS Authenticated-Enveloped-Data content [RFC5083] that uses either AES-CCM or AES-GCM [RFC5084].

Then, the attacker turns the intercepted content into a "garbage" CMS Enveloped-Data content [RFC5652] that is composed of AES-CBC guess blocks.

Then, send the "garbage" to the victim, and the victim shares the result of the decryption with the attacker. If any of the transformed plaintext blocks match Ht, then the attacker learns the plaintext for that block.

Mitigation of the attack

The attack is thwarted if the identifier for the encryption algorithm cannot be changed.

Internet-Draft has three parts:

- Assign OID for an algorithm identifier to indicate this mitigation is being used, and the parameters contain the actual encryption algorithm identifier
- Potential recipients include the OID (no parameters) in S/MIME Capabilities to advertize support for this mitigation
- Encryption with CEK’ = HKDF(CEK, AlgorithmIdentifier)

Example (1 of 2)

```
CEK = c702e7d0a9e064b09ba55245fb733cf3

The AES-128 CGM AlgorithmIdentifier:
 algorithm=2.16.840.1.101.3.4.1.6
 parameters=GCMParameters:
  aes-nonce=0x5c79058ba2f43447639d29e2

In hex: 301b06096086480165030401063 00e040c5c79058ba2f43447639d29e2

CEK' = HKDF(CEK, AlgorithmIdentifier)
CEK' = 4ae85bd6d45e990a401e5f8fc093d6d2
```

Example (2 of 2)

```
CEK = c702e7d0a9e064b09ba55245fb733cf3

The AES-128 CBC AlgorithmIdentifier:
 algorithm=2.16.840.1.101.3.4.1.2
 parameters=AES_IV=0x651f722ffd512c52fe072e507d72b377

In hex:
301d06096086480165030401020410651f722ffd512c52fe072e507d72b377

CEK' = HKDF(CEK, AlgorithmIdentifier)
CEK' = 474fd8239b7fa5e011862a59465ab369
```

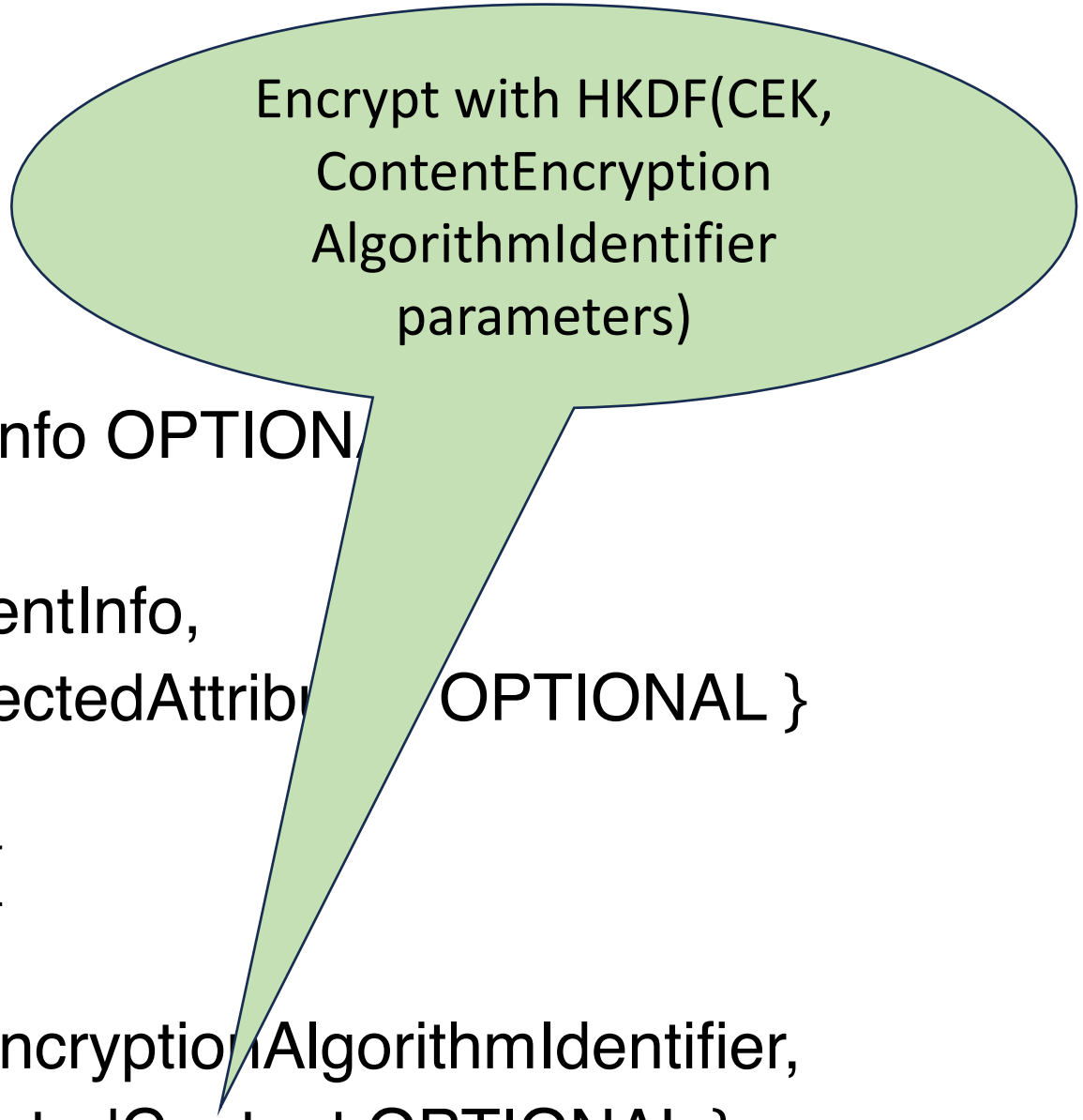
EnvelopedData

```
EnvelopedData ::= SEQUENCE {
   version CMSVersion,
   originatorInfo [0] IMPLICIT OriginatorInfo OPTIONAL,
   recipientInfos RecipientInfos,
   encryptedContentInfo EncryptedContentInfo,
   unprotectedAttrs [1] IMPLICIT UnprotectedAttributes OPTIONAL }

EncryptedContentInfo ::= SEQUENCE {
   contentType ContentType,
   contentEncryptionAlgorithm ContentEncryptionAlgorithmIdentifier,
   encryptedContent [0] IMPLICIT EncryptedContent OPTIONAL }
```

New OID goes here;
parameters contain the
actual encryption algorithm

EnvelopedData




```
EnvelopedData ::= SEQUENCE {
   version CMSVersion,
   originatorInfo [0] IMPLICIT OriginatorInfo OPTIONAL,
   recipientInfos RecipientInfos,
   encryptedContentInfo EncryptedContentInfo,
   unprotectedAttrs [1] IMPLICIT UnprotectedAttributes OPTIONAL }

EncryptedContentInfo ::= SEQUENCE {
   contentType ContentType,
   contentEncryptionAlgorithm ContentEncryptionAlgorithmIdentifier,
   encryptedContent [0] IMPLICIT EncryptedContent OPTIONAL }
```

EncryptedData and AuthEnvelopedData

- Like EnvelopedData, the EncryptedData and AuthEnvelopedData content types use EncryptedContentInfo.

- The same new OID is carried in the same place.

- Encryption takes place with CEK’ = HKDF(CEK, AlgorithmIdentifier).

Works with all flavors of RecipientInfo

- KeyTransRecipientInfo [RFC5652]
- KeyAgreeRecipientInfo [RFC5652]
- KEKRecipientInfo [RFC5652]
- PasswordRecipientinfo [RFC5652]
- KeyTransPSKRecipientInfo [RFC8696]
- KeyAgreePSKRecipientInfo [RFC8696]
- KEMRecipientInfo [I-D.ietf-lamps-cms-kemri]

Design Rationale

- Use HKDF with SHA-256, and avoid negotiation of a KDF

- If the attacker removes the OID from the ContentEncryptionAlgorithmIdentifier, then the recipient will use a different key to try to decrypt the content
  - The attack fails
  - The recipient is denied access to the "garbage” message content

- If the attacker changes the ContentEncryptionAlgorithmIdentifier parameters, then the recipient will use a different key to try to decrypt the content
  - The attack fails
  - The recipient is denied access to the "garbage” message content

Way Forward

- Publish an Internet-Draft with this mitigation

- Early assignment of the new OID

- Gain development and deployment experience
- Publish as standards-track RFC
- Publish rfc8551bis to require this mitigation (S/MIME 4.1)

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