

THE NEW GENERATION OF QUANTUM RESISTANT AND SOVEREIGN CRYPTOGRAPHY



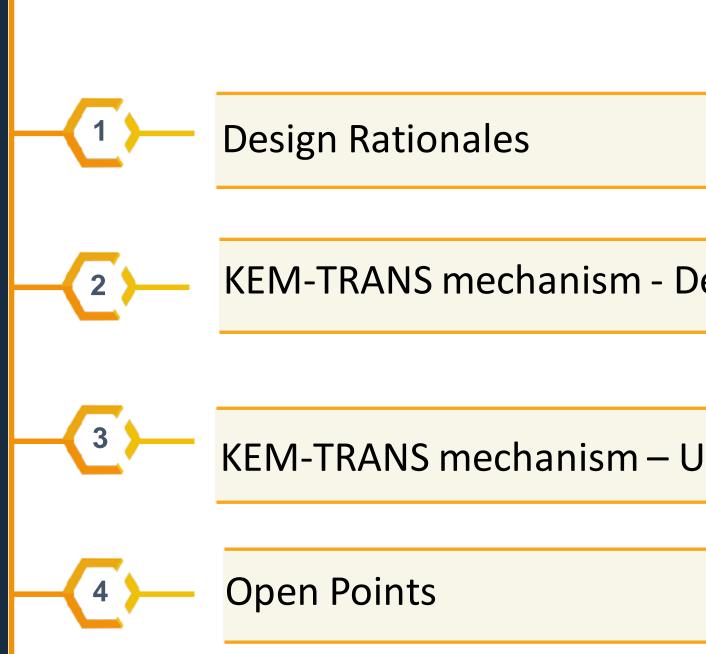
# Use of Post-Quantum KEM in the **Cryptographic Message Syntax (CMS)**

## IETF LAMPS 113

<u>draft-perret-prat-lamps-cms-pq-kem</u>

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#### **RFC Purpose:**

Define how to use a Key Encapsulation Mechanism algorithm (KEM) within the Cryptographic Message Syntax (CMS)

#### **CMS Context:**

One of the typical use case of the CMS Envelopped-Data Content is to:

- 1. randomly generate a CEK,
- 2. encrypt the data with a symmetric algorithm using this CEK
- 3. individually send the CEK to one or more recipients protected by asymmetric cryptography in a RecipientInfo object.

#### **Requirements:**

Need to define a new Key Transport mechanism fulfilling the following requirements:

- the Key Transport Mechanism SHALL be secure against quantum computers.
- the Key Transport Mechanism SHALL be able to take the Content-Encryption Key (CEK) as input.

=> Definition of the **KEM-TRANS mechanism** 





A key encapsulation mechanism (KEM) is an asymmetric cryptographic algorithm allowing secret sharing between two entities.

KEM consisting of 3 functions:

- Key generation **KeyGen()** :
  - Returns a public key and a private key (PK, SK)
- Encapsulation **Encaps**(PK):
  - Takes as input the public key
  - Returns a ciphertext CT and a shared secret SS
- Decapsulation **Decaps**(SK, CT):
  - Takes as input the private key and the ciphertext
  - Returns the shared secret SS

=> Impossible to encrypt a fixed CEK with KEM





A key derivation function (KDF) is a cryptographic algorithm that derives one or more secret keys from a secret value using a pseudorandom function.

KDF consists of 1 function:

- Key Derivation **Derive**(SS, KEK\_LEN) :
  - Takes as input a shared secret SS and the length of the output secret key KEK\_LEN
  - Returns a secret key KEK





A wrapping algorithm (WRAP) is a symmetric cryptographic algorithm protecting data in confidentiality and in integrity.

WRAP consists of 2 functions:

- Wrapping Wrap(KEK, K) :
  - Takes as input a wrapping key KEK and a plaintext key K
  - Returns a wrapped key WK
- Unwrapping **Unwrap**(KEK, WK):
  - Takes as input a wrapping key KEK and a wrapped key WK
  - Returns the plaintext key K





#### **Assumptions:**

Sender has been provided with :

- *recipPubKey*: the recipient's public key for KEM. ullet
- **K**: the keying data to be transported, length is compatible with the chosen WRAP algorithm.  $\bullet$

### Sender's operations:

- 1. (SS, CT) = KEM.encaps(recipPubKey)
- 2. KEK = KDF.derive(SS, kekLen)
- 3. WK = WRAP.wrap(KEK,  $\mathbf{K}$ )
- 4. EK = (WK || CT)

#### **Recipient's operations:**

- 1. (WK | | CT) = EK
- 2. SS = KEM.decaps(recipPrivKey, CT)
- 3. KEK = KDF.derive(SS, kekLen)
- **4. K** = WRAP.Unwrap(KEK, WK)

=> KEM-TRANS mechanism allows the transport of any keying data, including CMS CEK => KEM-TRANS mechanism can be instantiated with any KEM algorithm, including a Quantum-Safe KEM,

making the KEM-TRANS mechanism Quantum-Safe





#### **RecipientInfo Conventions:**

- RecipientInfo Type MUST be KeyTransRecipientInfo
- KeyTransRecipientInfo value MUST have the following values:
  - keyEncryptionAlgorithm.algorithm MUST be id-kem-trans OID (KEM-TRANS mechanism)
  - keyEncryptionAlgorithm.parameters MUST be a value of type GenericHybridParameters
  - encryptedKey MUST be the encrypted keying data (EK) output by the KEM-TRANS Mechanism

#### **Certificate Conventions:**

- Key Usage Extension MUST contain only the value *keyEncipherment*
- Subject Public Key Info MUST be set to *id-alg-xxx-kem* OID (KEM algorithm)



es: ns OID (KEM-TRANS mechanism) <sup>f</sup> type GenericHybridParameters output by the KEM-TRANS Mechanism

*herment* (KEM algorithm)



#### **RecipientInfo Conventions:**

3 possibilities to communicate info:

- Use KeyTransRecipientInfo (as it is done in RSA-KEM and in here)
- Define in this RFC a KemRecipientInfo as instance of OtherRecipientInfo
- Define in this RFC a new top-level KemRecipientInfo

#### **Certificate Conventions:**

Depend on the work item PQC-PKIX

#### New OIDs to be defined:

- id-kem-trans (KEM-TRANS mechanism)
- Several id-alg-xxx-kem (all the KEM algorithms)

### **Algorithm limitations:**

- Choice of KEM
- Choice of KDF
- Choice of WRAP



### here) RecipientInfo



# Thank you !

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