KEM-based Authentication for EDHOC

draft-pocero-authkem-edhoc-00

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Motivation

- The urgency of the post-quantum transition makes it critical to adapt EDHOC for quantum resistance
- The PQC signature-base EDHOC, using NIST standardized signature schemes, introduces significant overhead
  - Long key sizes and signatures
  - High processing times
  - High memory overhead
- A KEM-based authentication method for EDHOC enables signature-free authentication

Theoretical Foundation - PQNoise

XX:

$-> e$

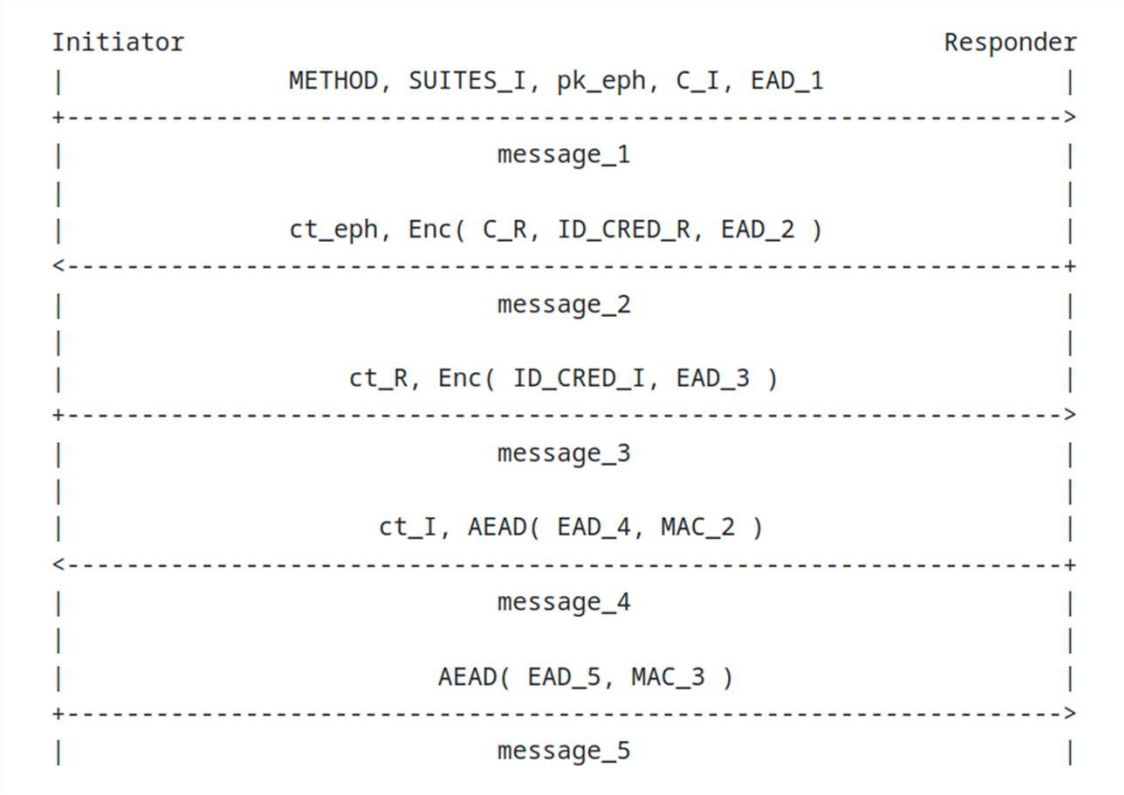
$<- e, ee, s, es$

$-> s, se$

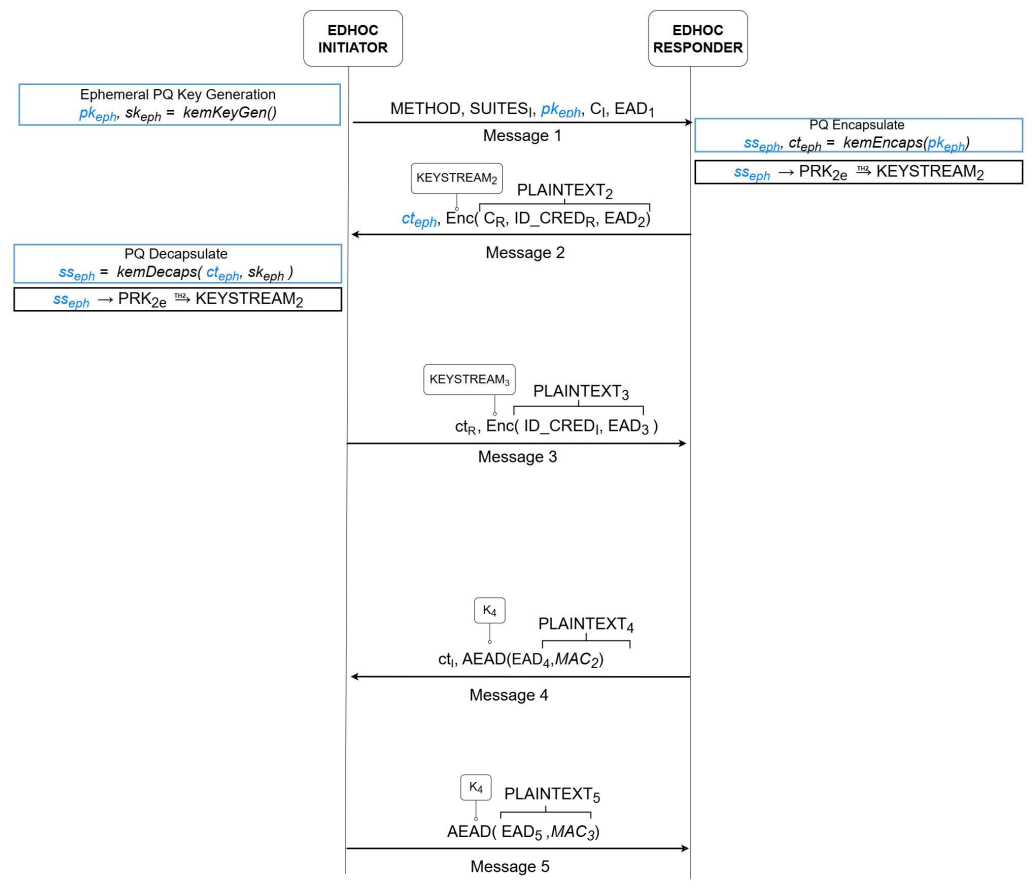

```
pqXX:
-> e
<- ekem, s
-> skem, s
<- skem
```

- Static-DH method of EDHOC: based on Noise XX pattern:
  - Supports mutual authentication without pre-shared knowledge.
  - Static public keys can be transmitted during the handshake
  - Incremental channel security guarantees
- The PQ translations of noise pattern from [PQNoise-CCS2]
  - Add up to one round trip

Overview


Initiator
Responder
METHOD, SUITES_I, pk_eph, C_I, EAD_1
message_1
ct_eph, Enc(C_R, ID_CRED_R, EAD_2)
message_2
ct_R, Enc(ID_CRED_I, EAD_3)
message_3
ct_I, AEAD(EAD_4, MAC_2)
message_4
AEAD(EAD_5, MAC_3)
message_5

Overview - Ephemeral KEM



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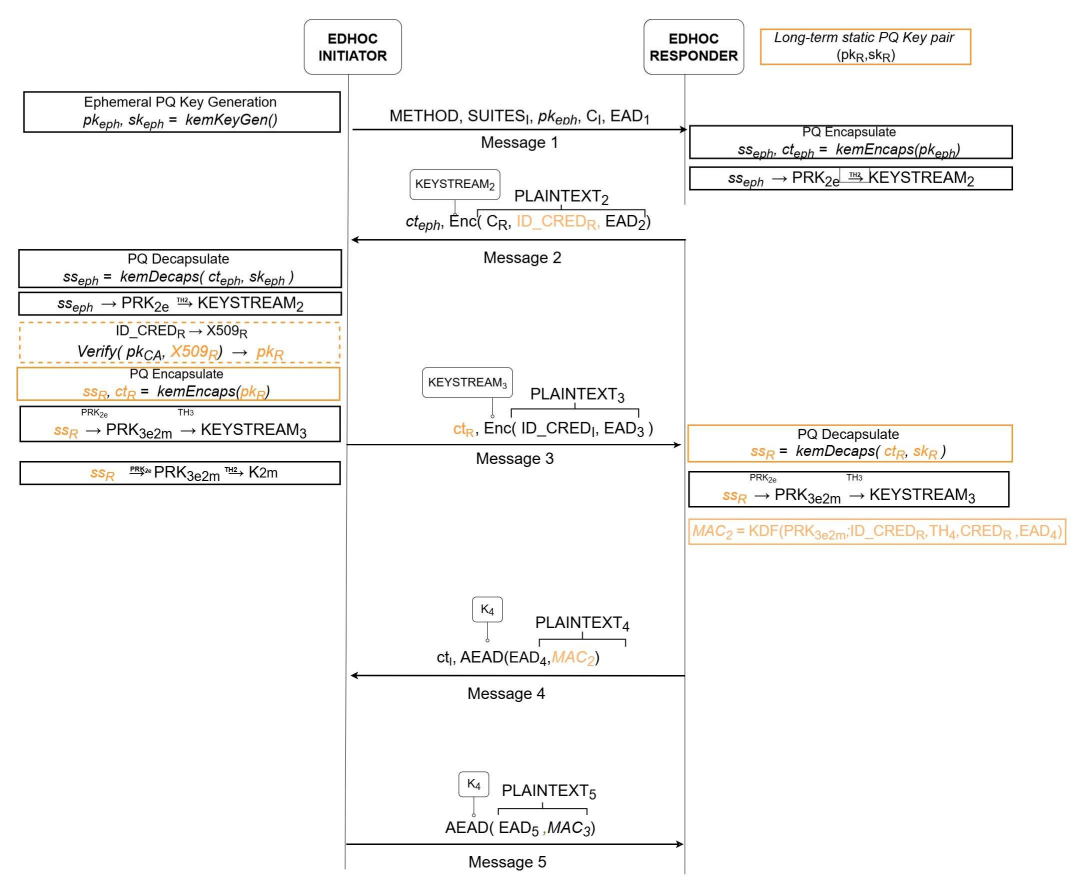
Overview – KEM-based authentication for the Responder



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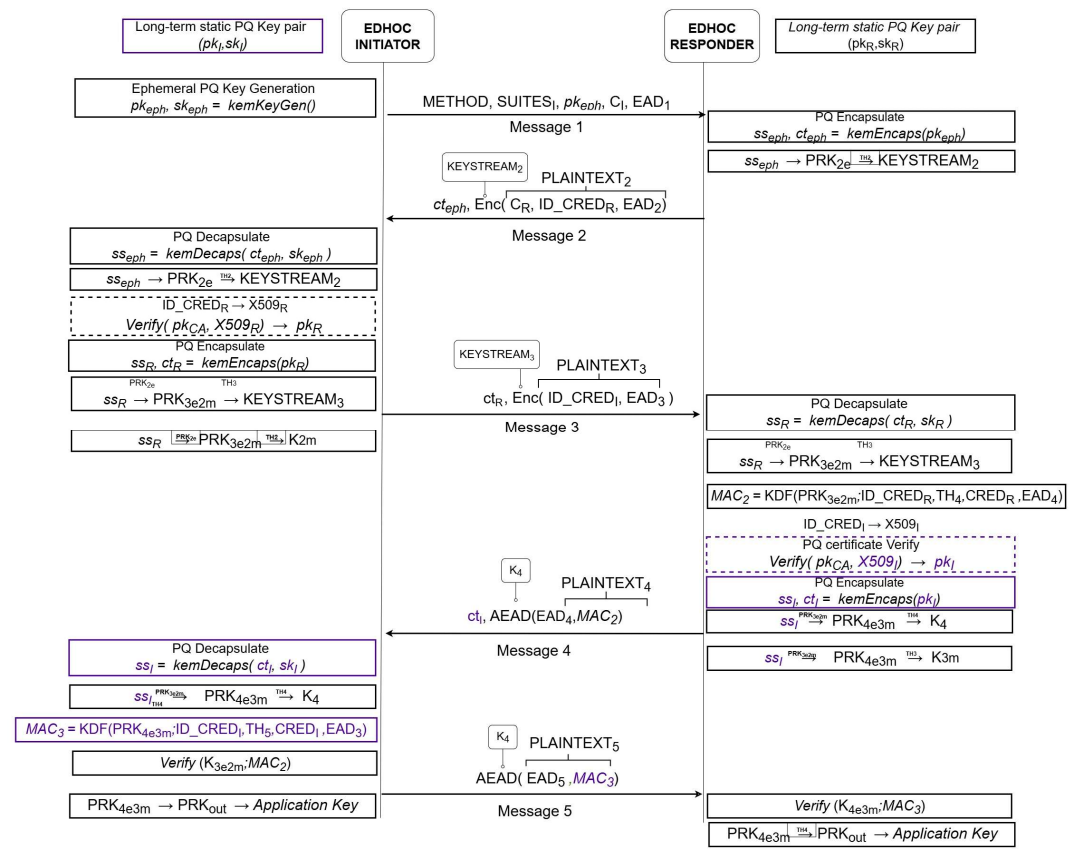
Overview – KEM-based authentication for the Initiator



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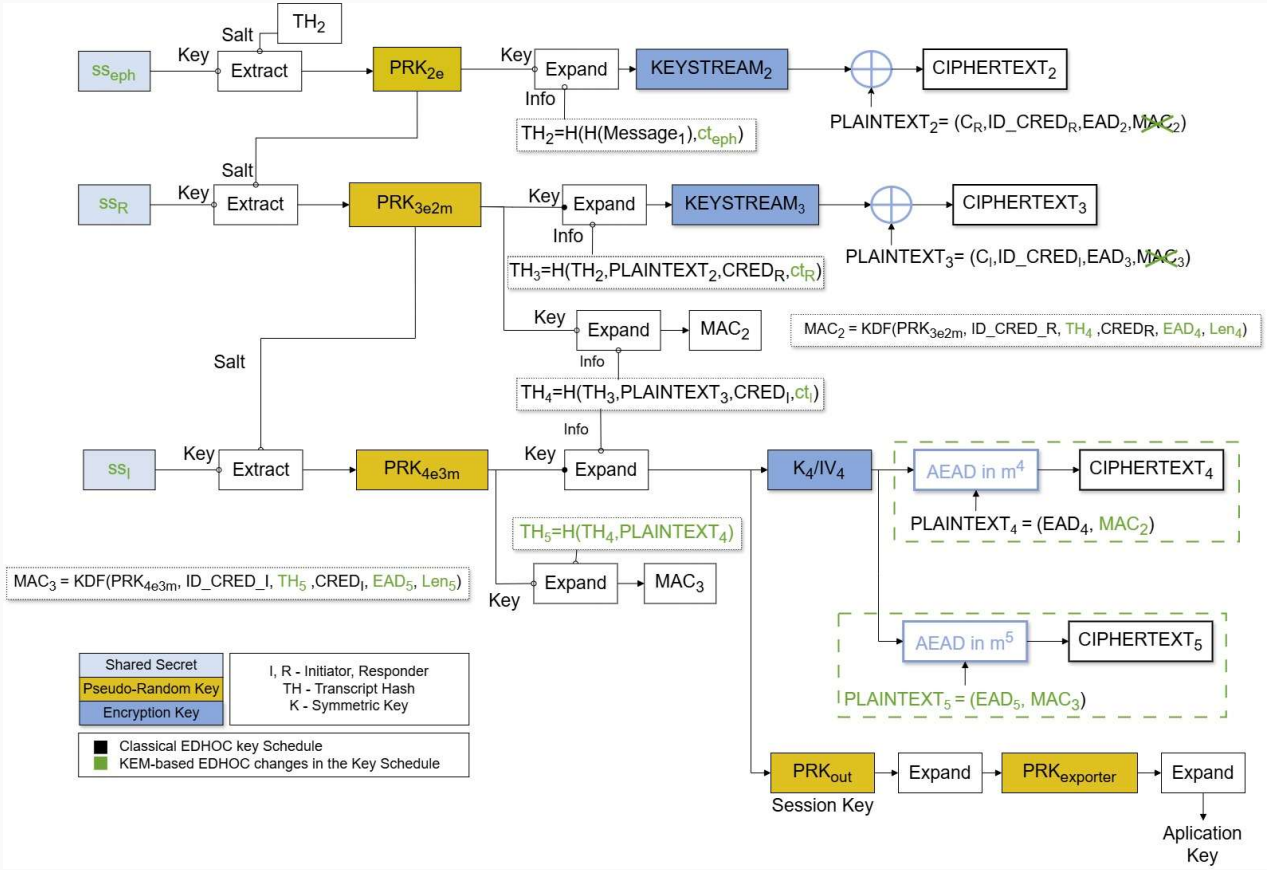
KEM-based authentication method – Key schedule



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Security Considerations

- The additional message_4 and message_5
  - Prove possession of the final session key
  - Ensure mutual authentication by using the final key derived from the three shared secrets
  - Include MAC_2 and MAC_3 to:
    - Provide credential binding: MAC's contexts contain the credentials sent in message_2 and message_3, respectively
    - Ensure all handshake integrity and authenticity: MAC's contexts contain the latest TH4 and TH5

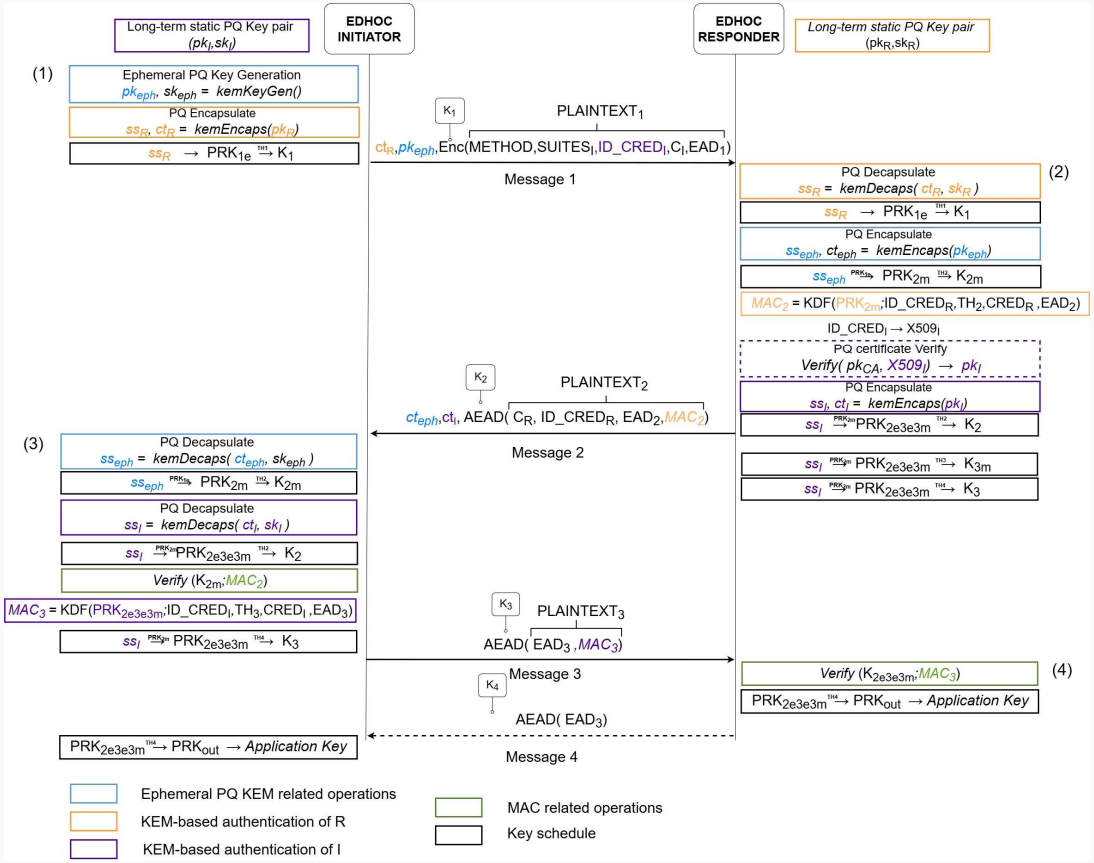
Security Considerations

- Security Achieved Upon Handshake Completion
  - Full forward secrecy
  - Explicit mutual authentication.
  - Integrity and Authenticity of the Handshake
  - Credential binding (A potential misbinding attack will not be detected until the handshake concludes)
- Security Precautions Until Handshake Completion
  - EAD data should be treated as unprotected
  - Keying materials should not be persistently stored

Security Considerations – Details to discuss

- Identity protection
  - Against passive attacks for the Responder
  - Against active attacks for the Initiator:
    - Credentials encrypted with a key combining both Responder's static shared secret and ephemeral shared secret → Only the Responder can decrypt (weaker forward secrecy)
- PRK_out and K_4 are expanded from the same PRK_4e3m and TH4
  - Drawback: Key confirmation implies the authentication of the handshake only until message 3
  - Advantage: MACs and encryption keys are exported from different THs

KEM-based Authentication for EDHOC in: Initiator-Known Responder (IKR) Scenarios



KEM-based Authentication for EDHOC in: Initiator-Known Responder (IKR) Scenarios

- Identity protection
  - Against active attacks for the Initiator: Credentials encrypted with a key that only the Responder can compute → no forward secrecy
  - Against active attacks for the Responder: Credentials encrypted with a key derived from the three shared secrets → perfect forward secrecy
- Pseudorandom Key confirmation via messages 2 and 3
- Reevaluate the need for message 4
  - K_4 and PRK_OUT are derived from (PRK_2e3e2m, TH4)
    - TH4 input contains ID_CRED_R and PLAINTXT_3
    - The confirmation of key possession → proves all handshakes' authenticity

Looking for feedback/adoption from the WG !

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