Lightweight AKE for OSCORE Requirements

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Background

- LAKE is about specifying a lightweight authenticated key exchange protocol for OSCORE (RFC 8613)
- The requirements for the lightweight AKE are based on the conditions for deploying OSCORE in constrained environments (RFC 7228)
- This is not a new subject in the IETF
  - On the agenda for ACE WG F2F meetings at IETF 96–99, 101–103
  - Extensively discussed in SecDispatch 2019, dedicated virtual interim March 5
  - BoF@IETF105

Requirements

- OSCORE Related
- Authentication
- Credentials
- Crypto Properties
- Application Data
- Lightweight

OSCORE Related

- At the end of the AKE the two parties shall agree on
  - OSCORE Master Secret with PFS and good amount of randomness
  - OSCORE Sender IDs of peer endpoint, arbitrarily short
  - COSE algorithms to use with OSCORE

- The AKE shall reuse CBOR, CoAP and COSE primitives and algorithms for low code complexity of a combined OSCORE and AKE implementation

- The AKE shall support the same transport as OSCORE, in particular CoAP.
- The AKE shall not duplicate functionality supported by the transport.
- The transport is assumed to handle:
  - packet loss, reordering, and duplication
  - message fragmentation
  - denial of service protection

Authentication, Credentials, Crypto Properties 1(2)

- The AKE shall support mutual authentication using PSK, RPK, and public key certificates
  - Different public key credentials for different endpoints
    - e.g. certificates for the initiator and RPK for the responder
  - Support for different identification of credentials including key identifier, hash, certificate, URL

- The AKE shall support identity protection
  - public keys: against active attackers of one of the peers and against passive attackers of the other peer
  - symmetric keys: PSK identifier against active attackers

- The AKE shall support negotiation of COSE crypto algorithms
  - used with OSCORE (COSE AEAD algorithm and HMAC-based HKDF)
  - used in the AKE (AEAD algorithm, KDF, signature algorithm, DH algorithm, …)
- Algorithm selection shall be protected against downgrade attacks

Authentication, Credentials, Crypto Properties 2(2)

- Compromise of the long-term keys shall not enable
  - an attacker to compromise past session keys (Perfect Forward Secrecy)
  - a passive attacker to compromise future session keys.

- The AKE shall provide Key Compromise Impersonation (KCI) resistance.

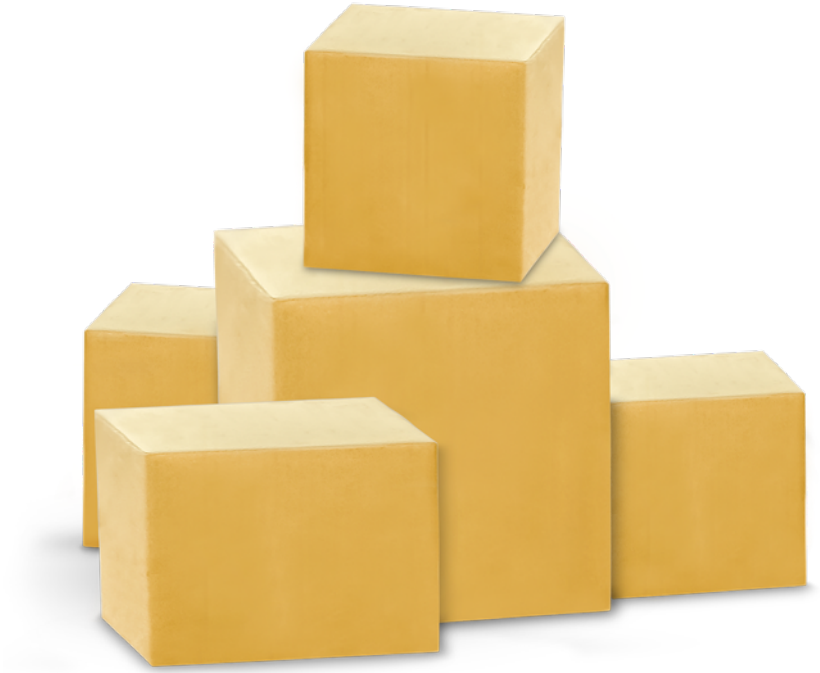
- The AKE shall protect against misbinding attacks and reflection attacks such the Selfie attack

Application Data

- The AKE shall support transport of Application Data to support a reduced total no. of round trips/no. of messages, and combined features, e.g. authorization together with authentication

- Example of Application Data:
  - Authorization information such as PoP Token, Authorization Voucher
  - Certificate Enrolment request, such as CSR

(Discussion of application data later in this meeting.)



Lightweight

- The AKE shall have as few round trips/messages as possible
- The messages shall be as small as reasonably achievable and fit into as few LoRaWAN packets and 6TiSCH frames as possible
- The amount of new code required on end systems which already have an OSCORE stack shall be as small as reasonably achievable

AKE Frequency

- Can we estimate how often we need to run the AKE/how many times during device lifetime?
- Not in general. Note that:

1. For some use cases, already one execution of the AKE is too heavy.
   - parallel executions of the AKE in a network formation loads down the network, or
   - the duty cycle makes he completion time too long for even one run of the protocol.

2. If a device reboots it may not be able to recover the security context, e.g. due to lack of persistent storage, and is required to establish a new security context for which an AKE is preferred. Reboot frequency may be difficult to predict in general.

3. To limit the impact of a key compromise, BSI, NIST and ANSSI and other organizations recommend frequent renewal of keys by means of a Diffie-Hellman key exchange.

Even if we are unable to give precise numbers, a lightweight AKE
- reduces the time for network formation and for AKE runs in challenging radio technologies
- allows devices to more quickly re-establish security in case of reboots, and
- allows us to support recommendations of frequent key renewal

Discussion Topics

- ☆ Static DH requirements
- ☆ Confidentiality protection of PSK identifier
- ☆ Security properties of application data

Static DH Requirements 1(2)

- Static DH keys shall be supported
  - At least for RPK
  - Significant improvement in overhead

	PSK	RPK (Sign)	RPK (ECDH)
message_1	40	38	38
message_2	45	114	56
message_3	11	80	22
Total	96	232	116

Example: Message sizes with EDHOC-00

```
Party U                                                   Party V
|              TYPE, SUITES_U, G_X, C_U                         |
+-------------------------------------------------------------->|
|                       message_1                               |
|                                                               |
|  C_U, G_Y, C_V, AEAD( K_2; ID_CRED_V, AEAD(G_VX; CRED_V, TH_2) )  |
|<--------------------------------------------------------------+
|                       message_2                               |
|                                                               |
|        C_V, AEAD(K_3; ID_CRED_U, AEAD(G_UY; CRED_V, TH_2) )    |
+-------------------------------------------------------------->|
|                       message_3                               |
```

MAC instead of signature

Static DH Requirements 2(2)

- Both signature and static DH based authentication needs to be supported
  - Cannot assume static DH keys as the only type of public-key credentials
  - Common X.509 settings use public signature keys

- Support for mixed public key credentials
  - In terms of RPK / certificates (as mentioned previously)
  - Also in terms of static DH keys / public signature keys

```
Party U                                                          Party V
|                   TYPE, SUITES_U, G_X, C_U                          |
+-------------------------------------------------------------------->|
|                          message_1                                  |
|                                                                     |
|     C_U, G_Y, C_V, AEAD( K_2; ID_CRED_V, Sig(V; CRED_V, TH_2))      |
|<--------------------------------------------------------------------+
|                          message_2                                  |
|                                                                     |
|        C_V, AEAD(K_3; ID_CRED_U, AEAD(G_UY; CRED_V, TH_2) )         |
+-------------------------------------------------------------------->|
|                          message_3                                  |
```

Or vice versa

Confidentiality Protection of PSK Identifier

- ID-PSK may be encrypted in message 3
- Does not provide authentication of responder (party V)
- Adding a message conflicts with requirement "few messages"

ID_PSK here instead of here

```
Party U                                                           Party V
|               TYPE, SUITES_U, G_X, C_U, UAD_1                         |
+---------------------------------------------------------------------->|
|                           message_1                                    |
|                                                                        |
|              C_U, G_Y, C_V, AEAD(K_2A; TH_2, UAD_2)                    |
|<-----------------------------------------------------------------------+
|                           message_2                                    |
|                                                                        |
|        C_V, AEAD(K_3A; TH_3, ID_PSK), AEAD(K_3B; TH_3, PAD_3)          |
+---------------------------------------------------------------------->|
|                           message_3                                    |
```

Identity Protection

- Sequence of desired goals where we may only be able to meet some level:
  - 0: all identifying information should be protected against passive network adversaries
  - 1: the identifying information of one device (say the initiator) must be protected from an active network attacker
  - 2: the identifying information of both devices must be protected from an active network attacker
  - 3: the identifying information of both devices must be deniable/repudiable, even if the peer is malicious

- Trade-offs
  - Identity protection of the symmetric protocol and authentication of responder/no. of messages
  - Disclosure of supported cipher suites vs. crypto agility
  - Connection ID could reveal information about the size of the server

Security Properties

- PFS against compromise of which key material
  - Loss of long-term key (initiator and/or responder)?
  - Loss of ephemeral key (initiator and/or responder)?
  - Bad RNG (initiator and/or responder)?

- Current assumption:
  - Protection against loss of long-term keys at the initiator and responder

- DISCUSS
  - Cost/benefit of protecting against loss of ephemeral key or bad RNG

Security Properties of Application Data

- Different requirements for application data (AD) in different messages:
  - AD1: unprotected
  - AD2: confidentiality/integrity protection against passive attacker
  - AD3: confidentiality/integrity protection

- AD must not violate AKE security properties
- Assumptions on AD shall be detailed by the specification