~~AEAD Key Usage Limits in OSCORE~~

Key Update for OSCORE

draft-hoeglund-core-oscore-key-limits-01

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Draft Overview (1/2)

- OSCORE (RFC8613) uses AEAD algorithms to provide security
  - Confidentiality and Integrity

- Need to follow limits in key usage and failed decryptions, before rekeying
  - Otherwise, it is possible to break the security properties of the AEAD algorithm
  - Reference **draft-irtf-cfrg-aead-limits-03**

- (1) AEAD limits and their impact on OSCORE
  - Defining appropriate limits for OSCORE
  - Originally starting from the same assumptions in TLS
  - Revisited based on John Mattsson's input at the April CoRE interim
    - https://datatracker.ietf.org/meeting/110/materials/slides-110-saag-analysis-of-usage-limits-of-aead-algorithms-00.pdf

Draft Overview (2/2)

- (2) Updates to OSCORE
  - Counters in the Security Context: key encryption use (q) and invalid decryptions (v)
  - Necessary steps to take during message processing (counting)
  - Update the keys when the limits are exceeded (rekeying)

- (3) Defined a new method for rekeying OSCORE (**new**)
  - Loosely inspired by Appendix B.2 of OSCORE
  - Goal: renew the Master Secret and Master Salt; derive new keys from those
  - Achieves Perfect Forward Secrecy

Key Limits (1/2)

- Selected fixed values for ‘q’, ‘v’, and ‘l’
  - q = 2^20, v = 2^20 and l = 2^8 // 'l' is the max message length in cipher blocks
  - Based on earlier discussions and John Mattsson’s presentation
- Table with ‘IA’ and ‘CA’ probabilities based on those values
  - These are based on the formulas in the CFRG document

Algorithm name	IA probability	CA probability
AEAD_AES_128_CCM	2^-68	2^-70
AEAD_AES_128_GCM	2^-99	2^-89
AEAD_AES_256_GCM	2^-99	2^-89
AEAD_CHACHA20_POLY1305	2^-75	-

Figure 1: Probabilities for algorithms based on chosen q, v and l values.

Integrity Advantage (IA): Probability of breaking integrity properties

Confidentiality Advantage (CA): Probability of breaking confidentiality properties

Key Limits (2/2)

- Specific look at AEAD_AES_128_CCM_8
  - Due to short Tag length the limits can be most problematic here
- Table with 'IA' and 'CA' probabilities for various values of 'q', 'v' and 'l'

'q', 'v' and 'l'	IA probability	CA probability
q=2^20, v=2^20, l=2^8	2^-44	2^-70
q=2^15, v=2^20, l=2^8	2^-44	2^-80
q=2^10, v=2^20, l=2^8	2^-44	2^-90
q=2^20, v=2^15, l=2^8	2^-49	2^-70
q=2^15, v=2^15, l=2^8	2^-49	2^-80
q=2^10, v=2^15, l=2^8	2^-49	2^-90
q=2^20, v=2^10, l=2^8	2^-54	2^-70
q=2^15, v=2^10, l=2^8	2^-54	2^-80
q=2^10, v=2^10, l=2^8	2^-54	2^-90

'q', 'v' and 'l'	IA probability	CA probability
q=2^20, v=2^20, l=2^6	2^-44	2^-74
q=2^15, v=2^20, l=2^6	2^-44	2^-84
q=2^10, v=2^20, l=2^6	2^-44	2^-94
q=2^20, v=2^15, l=2^6	2^-49	2^-74
q=2^15, v=2^15, l=2^6	2^-49	2^-84
q=2^10, v=2^15, l=2^6	2^-49	2^-94
q=2^20, v=2^10, l=2^6	2^-54	2^-74
q=2^15, v=2^10, l=2^6	2^-54	2^-84
q=2^10, v=2^10, l=2^6	2^-54	2^-94

Figure 2: Probabilities for AEAD_AES_128_CCM_8 based on chosen q, v and l values.

- From the considered values the best triple is (q = 2^20, v= 2^10, l = 2^8)
  - The question is if an IA of 2^-54 is good enough?

OSCORE Key Update method (1/3)

- Defined a new method for rekeying OSCORE
  - Client and server exchange two nonces R1 and R2
  - *UpdateCtx()* function for deriving new OSCORE Security Context using the nonces
  - Current Sec Ctx (to renew) ==> Intermediate Sec Ctx ==> **New Sec Ctx**

- Properties
  - Only one intermediate Security Context is derived
  - The ID Context does not change
  - Can be initiated by either the client or server
  - It is robust and secure against a peer rebooting
  - The procedure completes in one round-trip (after that, the new context can be used)
  - Compatible with possible prior key establishment through the EDHOC protocol

OSCORE Key Update method (2/3)

- Key update messages are OSCORE-protected and self-evident
- OSCORE Option: defined the use of flag bit 1 to signal presence of flag bits 8-15
- Defined flag bit 15 -- 'd' -- to indicate:
  - This is a OSCORE key update message
  - "id detail" is specified (length + value); used to transport a nonce for the key update

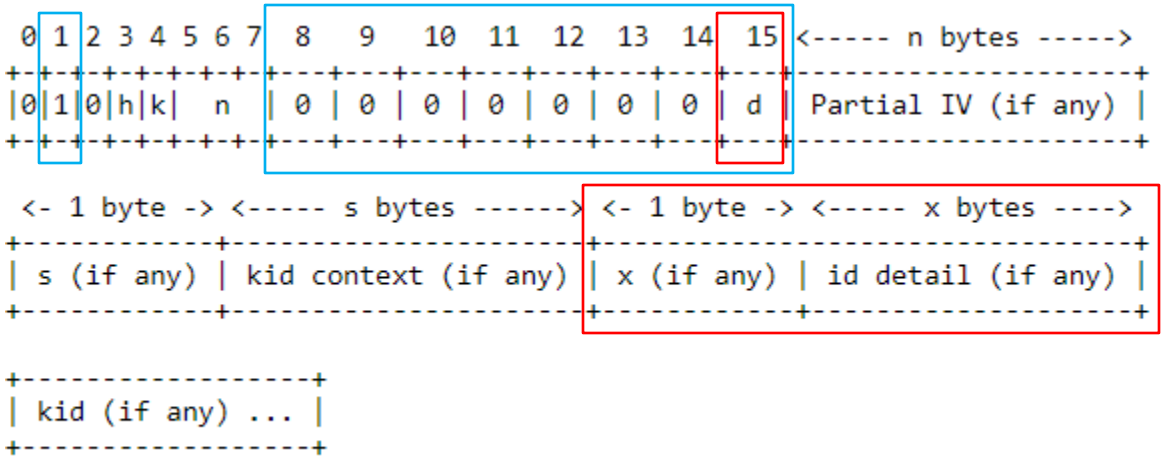
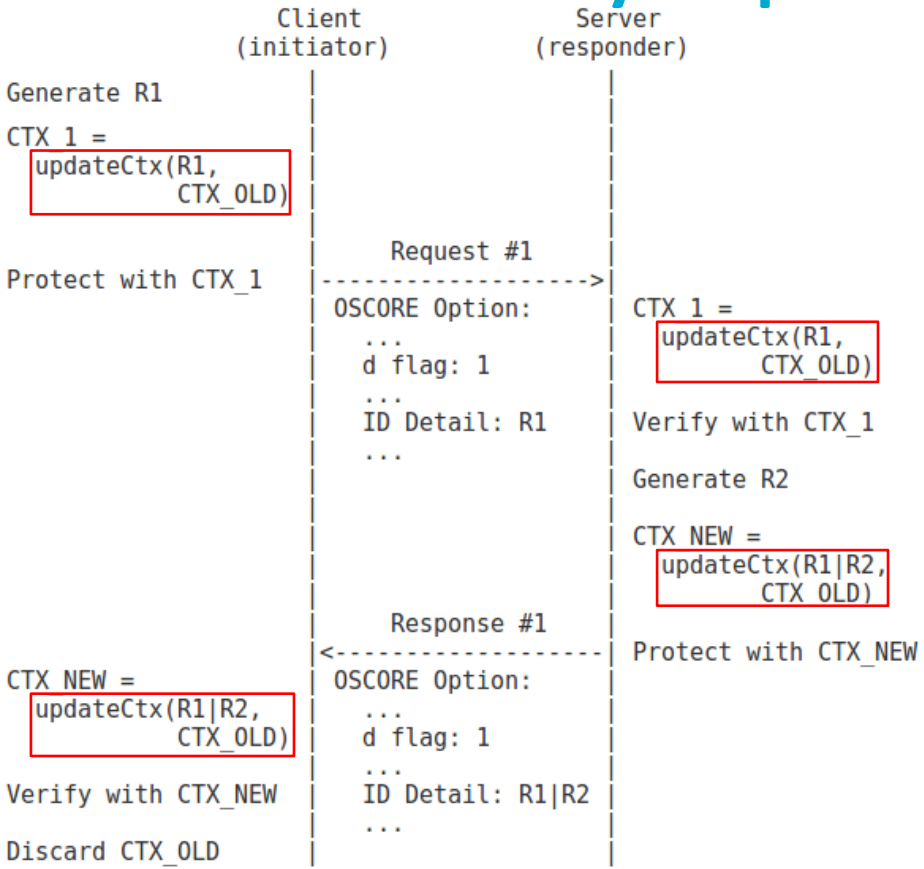


Figure 3: The OSCORE option value, including 'id detail'

OSCORE Key Update method (3/3)




```
updateCtx( N, CTX_IN ) {

  CTX_OUT       // The new Security Context
  MSECRET_NEW   // The new Master Secret
  MSALT_NEW     // The new Master Salt
  if <the original Security Context was established through EDHOC> {
    EDHOC-KeyUpdate( N )
    // This results in updating the key PRK_4x3m of the EDHOC session,
    // i.e., PRK_4x3m = Extract( N, PRK_4x3m )

    MSECRET_NEW = EDHOC-Exporter( "OSCORE Master Secret", key_length )
      = EDHOC-KDF(PRK_4x3m, TH_4, "OSCORE Master Secret", key_length )

    MSALT_NEW = EDHOC-Exporter( "OSCORE Master Salt", salt_length )
      = EDHOC-KDF( PRK_4x3m, TH_4, "OSCORE Master Salt", salt_length )

  }
  else {
    Master Secret Length = < Size of CTX_IN.MasterSecret in bytes >

    MSECRET_NEW = HKDF-Expand-Label(CTX_IN.MasterSecret, Label,
                                    N, Master Secret Length)
                = HKDF-Expand(CTX_IN.MasterSecret, HkdfLabel,
                              Master Secret Length)

    MSALT_NEW = N;
  }
  < Derive CTX_OUT using MSECRET_NEW and MSALT_NEW,
    together with other parameters from CTX_IN >
  Return CTX OUT;

}
```

Summary and Next Steps

- Twofold update to OSCORE
  - Tracking and reacting to defined key limits, to preserve security of the AEAD cipher
  - New efficient key update procedure (rekeying) with Perfect Forward Secrecy
    - Initially planned as a separate draft
    - Preference at the April CoRE interim to have it in this document
- Take and adopt feedback on the new key limits and especially for CCM_8
- Main next steps are tracked as Gitlab issues in [1]
- Need for reviews, on both key limits and key update

[1] https://gitlab.com/rikard-sics/draft-hoeglund-oscore-rekeying-limits/

Thank you!

Comments/questions?

https://gitlab.com/rikard-sics/draft-hoeglund-oscore-rekeying-limits/