draft-weis-tcp-auth-auto-ks-00

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Overview

- The TCP Extended Authentication (TCP-EA) Option (draft-bonica-tcp-auth-04) specifies how to manipulate a set of MAC session keys.
  - The MAC keys are entered into the router configuration manually, and stored in a key chain
- Manual keys are non-optimal with respect to security and operations.
- This draft proposes an optional automated key selection mechanism for the TCP-EA Option that improves both security and operational complexity.

History

- This work was first published in draft-weis-tcp-mac-option-00
- We subsequently agreed to make it an extension of draft-bonica-tcp-auth-04

Goals

- Improve the operational characteristics of MAC session keys.
  - Human generated keys (especially those based on passwords) are never as good as randomly generated keys.
  - Requiring an operational staff to continually add new keys is both an operational problem and a security risk.
- Do this without introducing a heavy-weight out-of-band negotiation protocol.
  - Automatic Key Selection must be light-weight, in terms of complexity.
- Enable use of better performing MAC algorithms not suitable for use with manual keying.

Our Proposal

- A light weight mechanism whereby one TCP endpoint pushes a MAC session key to its peer.
  - The SYN segment of an Active Open is an obvious time to push a key. Other events may require new keys as well.
- The MAC key is encrypted for confidentiality using a “Key Encrypting Key” (KEK)
  - This KEK is a strong key, and does not need to be changed frequently.

Still using a long term key! What’s different?

- Less burden on the operations staff!
  - Because the KEK is not a session key, it does not need to be changed frequently.
  - The KEK can be rolled over when necessary using the key rollover scheme described in TCP-EA.
- Better MAC keys!
  - The generated MAC keys are of better quality than ones chosen by operations staff.
  - The MAC keys will be automatically rolled over based on a variety of policies

Fitting into TCP-EA

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Kind      |     Length    |T|K|   Alg ID  |Res|  Key ID   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                    Authentication Data                        |
|                            //                                 |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

- The “K” bit is set to 1
- The Authentication Data field definition is enhanced to include the encrypted key along with the output of the MAC algorithm.

Resulting Packet Format

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Kind      |      Length   |T|1|   Alg ID  |Res|  Key ID   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                  Message Authentication Code                  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Res|KEK Alg ID |Res|KEK Key ID |    Encrypted Key              ~
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Sender Processing

- When a TCP endpoint needs to choose a new MAC key it takes the following steps:
  - Randomly generates a MAC key using a strong RNG or PRNG algorithm and places it in a TCP-EA key chain
  - Encrypts the MAC key with the KEK, and places it in the TCP-EA payload
  - Creates the packet:
    - Sets the K bit to 1
    - Performs the MAC calculation described in Section 7 of TCP-EA

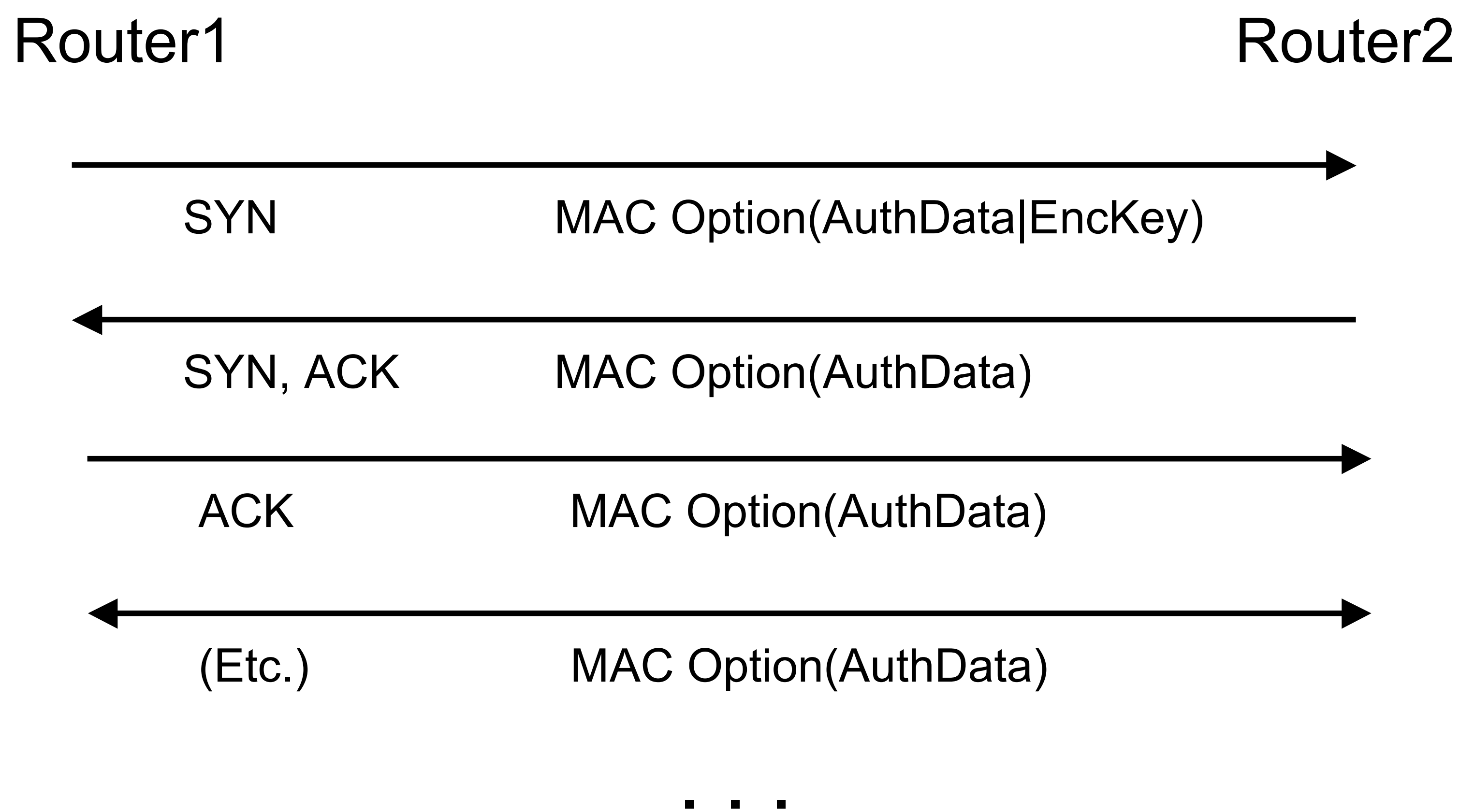
Receiver Processing

- Anytime a TCP endpoint receives a TCP-EA packet with the K bit set to 1:
  - Extract and decrypt the MAC key with the KEK matching the KEK Key ID in the segment
  - Performs the MAC calculation described in Section 7 of TCP-EA.
  - If the decrypted key authenticates the packet, places the new MAC key in a TCP-EA key chain.

When should a new MAC key be chosen?

- When no key is available, or when policy says a key is about to expire.
- Possible keying events:
  - At the beginning of the TCP session
  - When a TCP sequence number wraps
  - Due to time-based or volume-based policy.

Example: Beginning of a TCP session



Better performing MAC algorithms

- All MAC algorithms take as inputs a key and the data to be authenticated
- Some MAC algorithms add a third argument called a “nonce”. The nonce is a value that MUST be used only once with that particular key.
  - Using the same {key, nonce} twice can result in a catastrophic cryptographic weakness
  - But these algorithms are optimized in h/w or s/w and tend to be better performing

Nonces

- The most obvious means of generating a set of non-repeating nonces is to use a sequence number.
  - But it must be carried in the packet
  - Using the TCP Sequence Number may be tempting, but isn't sufficiently trustable.
    - I.e., it is a value not under the control of the TCP-EA Option code, so it can't guarantee non-repeatability.

Packet Format including a Sequence Number

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Kind      |     Length    |T|0|   Alg ID  |Res|  Key ID   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                        Sequence Number                        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                 Message Authentication Code                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Of course, when K=1 then an encrypted key payload will also be included.

MAC Algorithms using Nonces

The draft specifies the following algorithms that take a nonce as input:

- AES-128-GMAC-96
  - Optimized for implementation in h/w
- AES-128-UMAC-96
  - Optimized for implementation in s/w

Questions?