The ARIA Algorithm and Its Use with
the Secure Real-Time Transport Protocol (SRTP)

Abstract

   This document defines the use of the ARIA block cipher algorithm
   within the Secure Real-time Transport Protocol (SRTP). It details
   two modes of operation (CTR and GCM) and the SRTP key derivation
   functions for ARIA. Additionally, this document defines DTLS-SRTP
   protection profiles and Multimedia Internet KEYing (MIKEY) parameter
   sets for use with ARIA.

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1. Introduction

   This document defines the use of the ARIA block cipher algorithm
   [RFC5794] in the Secure Real-time Transport Protocol (SRTP) [RFC3711]
   for providing confidentiality for Real-time Transport Protocol (RTP)
   [RFC3550] traffic and for RTP Control Protocol (RTCP) [RFC3550]
   traffic.

1.1. ARIA

   ARIA is a general-purpose block cipher algorithm developed by Korean
   cryptographers in 2003. It is an iterated block cipher with 128-,
   192-, and 256-bit keys and encrypts 128-bit blocks in 12, 14, and 16
   rounds, depending on the key size. It is secure and suitable for
   most software and hardware implementations on 32-bit and 8-bit
   processors. It was established as a Korean standard block cipher
   algorithm in 2004 [ARIAKS] and has been widely used in Korea,
   especially for government-to-public services. It was included in
   Public-Key Cryptography Standards (PKCS) #11 in 2007 [ARIAPKCS]. The
   algorithm specification and object identifiers are described in
   [RFC5794].

1.2. Terminology

   The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT",
   "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and
   "OPTIONAL" in this document are to be interpreted as described in BCP
   14 [RFC2119] [RFC8174] when, and only when, they appear in all
   capitals, as shown here.

2. Cryptographic Transforms

   Block ciphers ARIA and AES share common characteristics including
   mode, key size, and block size. ARIA does not have any restrictions
   for modes of operation that are used with this block cipher. We
   define two modes of running ARIA within SRTP: (1) ARIA in Counter
   Mode (ARIA-CTR) and (2) ARIA in Galois/Counter Mode (ARIA-GCM).

2.1. ARIA-CTR

   Section 4.1.1 of [RFC3711] defines AES-128 counter mode encryption,
   which it refers to as "AES_CM". Section 2 of [RFC6188] defines
   "AES_256_CM" in SRTP. ARIA counter modes are defined in the same
   manner except that each invocation of AES is replaced by that of ARIA
   [RFC5794] and are denoted by ARIA_128_CTR and ARIA_256_CTR,
   respectively, according to the key lengths. The plaintext inputs to
   the block cipher are formed as in AES-CTR (AES_CM, AES_256_CM) and
   the block cipher outputs are processed as in AES-CTR. Note that,

   ARIA-CTR MUST be used only in conjunction with an authentication
   transform.

   Section 3.2 of [RFC6904] defines AES-CTR for SRTP header extension
   keystream generation. When ARIA-CTR is used, the header extension
   keystream SHALL be generated in the same manner except that each
   invocation of AES is replaced by that of ARIA [RFC5794].

2.2. ARIA-GCM

   Galois/Counter Mode [GCM] [RFC5116] is an Authenticated Encryption
   with Associated Data (AEAD) block cipher mode. A detailed
   description of ARIA-GCM is defined similarly as AES-GCM found in
   [RFC5116] and [RFC5282].

   [RFC7714] describes the use of AES-GCM with SRTP. The use of ARIA-
   GCM with SRTP is defined the same as AES-GCM except that each
   invocation of AES is replaced by ARIA [RFC5794]. When encryption of
   header extensions [RFC6904] is in use, a separate keystream to
   encrypt selected RTP header extension elements MUST be generated in
   the same manner defined in [RFC7714] except that AES-CTR is replaced
   by ARIA-CTR.

3. Key Derivation Functions

   Section 4.3.3 of [RFC3711] defines the AES-128 counter mode key
   derivation function, which it refers to as "AES-CM PRF". Section 3
   of [RFC6188] defines the AES-256 counter mode key derivation
   function, which it refers to as "AES_256_CM_PRF". The ARIA-CTR
   Pseudorandom Function (PRF) is defined in a same manner except that
   each invocation of AES is replaced by that of ARIA. According to the
   key lengths of the underlying encryption algorithm, ARIA-CTR PRFs are
   denoted by "ARIA_128_CTR_PRF" and "ARIA_256_CTR_PRF". The usage
   requirements of [RFC6188] and [RFC7714] regarding the AES-CM PRF
   apply to the ARIA-CTR PRF as well.

4. Protection Profiles

   This section defines SRTP protection profiles that use the ARIA
   transforms and key derivation functions defined in this document.
   The following list indicates the SRTP transform parameters for each
   protection profile. Those are described for use with DTLS-SRTP
   [RFC5764].

   The parameters cipher_key_length, cipher_salt_length,
   auth_key_length, and auth_tag_length express the number of bits in
   the values to which they refer. The maximum_lifetime parameter
   indicates the maximum number of packets that can be protected with

   each single set of keys when the parameter profile is in use. All of
   these parameters apply to both RTP and RTCP, unless the RTCP
   parameters are separately specified.

   SRTP_ARIA_128_CTR_HMAC_SHA1_80
         cipher: ARIA_128_CTR
         cipher_key_length: 128 bits
         cipher_salt_length: 112 bits
         key derivation function: ARIA_128_CTR_PRF
         auth_function: HMAC-SHA1
         auth_key_length: 160 bits
         auth_tag_length: 80 bits
         maximum_lifetime: at most 2^{31} SRTCP packets and
                                    at most 2^{48} SRTP packets

   SRTP_ARIA_128_CTR_HMAC_SHA1_32
         cipher: ARIA_128_CTR
         cipher_key_length: 128 bits
         cipher_salt_length: 112 bits
         key derivation function: ARIA_128_CTR_PRF
         auth_function: HMAC-SHA1
         auth_key_length: 160 bits
         SRTP auth_tag_length: 32 bits
         SRTCP auth_tag_length: 80 bits
         maximum_lifetime: at most 2^{31} SRTCP packets and
                                    at most 2^{48} SRTP packets

   SRTP_ARIA_256_CTR_HMAC_SHA1_80
         cipher: ARIA_256_CTR
         cipher_key_length: 256 bits
         cipher_salt_length: 112 bits
         key derivation function: ARIA_256_CTR_PRF
         auth_function: HMAC-SHA1
         auth_key_length: 160 bits
         auth_tag_length: 80 bits
         maximum_lifetime: at most 2^{31} SRTCP packets and
                                    at most 2^{48} SRTP packets

SRTP_ARIA_256_CTR_HMAC_SHA1_32
        cipher: ARIA_256_CTR
        cipher_key_length: 256 bits
        cipher_salt_length: 112 bits
        key derivation function: ARIA_256_CTR_PRF
        auth_function: HMAC-SHA1
        auth_key_length: 160 bits
        SRTP auth_tag_length: 32 bits
        SRTCP auth_tag_length: 80 bits
        maximum_lifetime: at most 2^31 SRTCP packets and
                                at most 2^48 SRTP packets

SRTP_AEAD_ARIA_128_GCM
        cipher: ARIA_128_GCM
        cipher_key_length: 128 bits
        cipher_salt_length: 96 bits
        aead_auth_tag_length: 128 bits
        auth_function: NULL
        auth_key_length: N/A
        auth_tag_length: N/A
        key derivation function: ARIA_128_CTR_PRF
        maximum_lifetime: at most 2^31 SRTCP packets and
                                at most 2^48 SRTP packets

SRTP_AEAD_ARIA_256_GCM
        cipher: ARIA_256_GCM
        cipher_key_length: 256 bits
        cipher_salt_length: 96 bits
        aead_auth_tag_length: 128 bits
        auth_function: NULL
        auth_key_length: N/A
        auth_tag_length: N/A
        key derivation function: ARIA_256_CTR_PRF
        maximum_lifetime: at most 2^31 SRTCP packets and
                                at most 2^48 SRTP packets

The ARIA-CTR protection profiles use the same authentication
transform that is mandatory to implement in SRTP: HMAC-SHA1 with a
160-bit key.

Note that SRTP protection profiles that use AEAD algorithms do not
specify an auth_function, auth_key_length, or auth_tag_length, since
they do not use a separate auth_function, auth_key, or auth_tag. The
term aead_auth_tag_length is used to emphasize that this refers to
the authentication tag provided by the AEAD algorithm and that this
tag is not located in the authentication tag field provided by SRTP/
SRTCP.

The PRFs for ARIA protection profiles are defined by ARIA-CTR PRF of
the equal key length with the encryption algorithm (see Section 2).
SRTP_ARIA_128_CTR_HMAC and SRTP_AEAD_ARIA_128_GCM MUST use the
ARIA_128_CTR_PRF key derivation function. And SRTP_ARIA_256_CTR_HMAC
and SRTP_AEAD_ARIA_256_GCM MUST use the ARIA_256_CTR_PRF key
derivation function.

MIKEY specifies the SRTP protection profile definition separately
from the key length (which is specified by the session encryption key
length) and the authentication tag length. The DTLS-SRTP [RFC5764]
protection profiles are mapped to MIKEY parameter sets as shown
below.

```
                             +--------------------------------------+
                             | Encryption | Encryption | Auth.      |
                             | Algorithm  | Key Length | Tag Length |
                             +======================================+
   SRTP_ARIA_128_CTR_HMAC_80 |  ARIA-CTR  | 16 octets  | 10 octets  |
   SRTP_ARIA_128_CTR_HMAC_32 |  ARIA-CTR  | 16 octets  |  4 octets  |
   SRTP_ARIA_256_CTR_HMAC_80 |  ARIA-CTR  | 32 octets  | 10 octets  |
   SRTP_ARIA_256_CTR_HMAC_32 |  ARIA-CTR  | 32 octets  |  4 octets  |
                             +======================================+
```

       Figure 1: Mapping MIKEY Parameters to ARIA-CTR with the HMAC
                               Algorithm

```
                             +--------------------------------------+
                             | Encryption | Encryption | AEAD Auth. |
                             | Algorithm  | Key Length | Tag Length |
                             +======================================+
       SRTP_AEAD_ARIA_128_GCM |  ARIA-GCM  | 16 octets  | 16 octets  |
       SRTP_AEAD_ARIA_256_GCM |  ARIA-GCM  | 32 octets  | 16 octets  |
                             +======================================+
```

       Figure 2: Mapping MIKEY Parameters to the ARIA-GCM Algorithm

5. Security Considerations

   At the time of publication of this document, no security problem has
   been found on ARIA. Previous security analysis results are
   summarized in [ATY].

   The security considerations in [GCM], [RFC3711], [RFC5116],
   [RFC6188], [RFC6904], and [RFC7714] apply to this document as well.
   This document includes crypto suites with authentication tags of a
   length less than 80 bits. These suites MAY be used for certain
   application contexts where longer authentication tags may be
   undesirable, for example, those mentioned in [RFC3711], Section 7.5.

   Otherwise, short authentication tags SHOULD NOT be used, since they
   may reduce authentication strength. See [RFC3711], Section 9.5 for a
   discussion of risks related to weak authentication in SRTP.

   At the time of publication of this document, SRTP recommends HMAC-
   SHA1 as the default and mandatory-to-implement MAC algorithm. All
   currently registered SRTP crypto suites except the GCM-based ones use
   HMAC-SHA1 as their HMAC algorithm to provide message authentication.
   Due to security concerns with SHA-1 [RFC6194], the IETF is gradually
   moving away from SHA-1 and towards stronger hash algorithms such as
   SHA-2 or SHA-3 families. For SRTP, however, SHA-1 is only used in
   the calculation of an HMAC, and no security issue is known for this
   usage at the time of this publication.

6. IANA Considerations

6.1. DTLS-SRTP

   DTLS-SRTP [RFC5764] defines a DTLS-SRTP "SRTP protection profile".
   In order to allow the use of the algorithms defined in this document
   in DTLS-SRTP, IANA has added the following protection profiles below
   to the "DTLS-SRTP Protection Profiles" registry (see
   <http://www.iana.org/assignments/srtp-protection/>) created by
   [RFC5764]:

      SRTP_ARIA_128_CTR_HMAC_SHA1_80 = {0x00, 0x0B}
      SRTP_ARIA_128_CTR_HMAC_SHA1_32 = {0x00, 0x0C}
      SRTP_ARIA_256_CTR_HMAC_SHA1_80 = {0x00, 0x0D}
      SRTP_ARIA_256_CTR_HMAC_SHA1_32 = {0x00, 0x0E}
      SRTP_AEAD_ARIA_128_GCM = {0x00, 0x0F}
      SRTP_AEAD_ARIA_256_GCM = {0x00, 0x10}

6.2. MIKEY

   [RFC3830] and [RFC5748] define encryption algorithms and PRFs for the
   SRTP policy in MIKEY. In order to allow the use of the algorithms
   defined in this document in MIKEY, IANA has updated the "Multimedia
   Internet KEYing (MIKEY) Payload Name Spaces" registry (see
   <http://www.iana.org/assignments/mikey-payloads/>.)

IANA has registered the following two encryption algorithms in the
"Encryption algorithm (Value 0)" subregistry within the "MIKEY
Security Protocol Parameters" registry:

```
+---------------+-------+
| SRTP encr alg | Value |
+---------------+-------+
|    ARIA-CTR   |   7   |
|    ARIA-GCM   |   8   |
+---------------+-------+
```

The default session encryption key length is 16 octets.

IANA has registered the following PRF in the "SRTP Pseudo Random
Function (Value 5)" subregistry within the "MIKEY Security Protocol
Parameters" registry:

```
+----------+-------+
| SRTP PRF | Value |
+----------+-------+
| ARIA-CTR |   2   |
+----------+-------+
```

7. References

7.1. Normative References

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Appendix A. Test Vectors

   All values are in hexadecimal and represented by the network order
   (called big endian).

A.1. ARIA-CTR Test Vectors

   Common values are organized as follows:

      Rollover Counter: 00000000
      Sequence Number: 315e
      SSRC: 20e8f5eb
      Authentication Key: f93563311b354748c978913795530631
                                16452309
      Session Salt: cd3a7c42c671e0067a2a2639b43a
      Initialization Vector: cd3a7c42e69915ed7a2a263985640000
      RTP Header: 8008315ebf2e6fe020e8f5eb
      RTP Payload: f57af5fd4ae19562976ec57a5a7ad55a
                                5af5c5e5c5fdf5c55ad57a4a7272d572
                                62e9729566ed66e97ac54a4a5a7ad5e1
                                5ae5fdd5fd5ac5d56ae56ad5c572d54a
                                e54ac55a956afd6aed5a4ac562957a95
                                16991691d572fd14e97ae962ed7a9f4a
                                955af572e162f57a956666e17ae1f54a
                                95f566d54a66e16e4afd6a9f7ae1c5c5
                                5ae5d56afde916c5e94a6ec56695e14a
                                fde1148416e94ad57ac5146ed59d1cc5

      Note:
      SSRC = Synchronization Source

A.1.1. SRTP_ARIA_128_CTR_HMAC_SHA1_80

      Session Key: 0c5ffd37a11edc42c325287fc0604f2e

      Encrypted RTP Payload: 1bf753f412e6f35058cc398dc851aae3
                                a6ccdcb463fbed9cfb3de2fb76fdffa9
                                e481f5efb64c92487f59dabbc7cc72da
                                092485f3fbad87888820b86037311fa4
                                4330e18a59a1e1338ba2c21458493a57
                                463475c54691f91cec785429119e0dfc
                                d9048f90e07fecd50b528e8c62ee6e71
                                445de5d7f659405135aff3604c2ca4ff
                                4aaca40809cb9eee42cc4ad232307570
                                81ca289f2851d3315e9568b501fdce6d

```
     Authenticated Portion || Rollover Counter:
                            8008315ebf2e6fe020e8f5eb1bf753f4
                            12e6f35058cc398dc851aae3a6ccdcb4
                            63fbed9cfb3de2fb76fdffa9e481f5ef
                            b64c92487f59dabbc7cc72da092485f3
                            fbad87888820b86037311fa44330e18a
                            59a1e1338ba2c21458493a57463475c5
                            4691f91cec785429119e0dfcd9048f90
                            e07fecd50b528e8c62ee6e71445de5d7
                            f659405135aff3604c2ca4ff4aaca408
                            09cb9eee42cc4ad23230757081ca289f
                            2851d3315e9568b501fdce6d00000000

     Authentication Tag:        f9de4e729054672b0e35
```

A.1.2. SRTP_ARIA_256_CTR_HMAC_SHA1_80

```
     Session Key:               0c5ffd37a11edc42c325287fc0604f2e
                                3e8cd5671a00fe3216aa5eb105783b54

     Encrypted RTP Payload:     c424c59fd5696305e5b13d8e8ca76566
                                17ccd7471088af9debf07b55c750f804
                                a5ac2b737be48140958a9b420524112a
                                e72e4da5bca59d2b1019ddd7dbdc30b4
                                3d5f046152ced40947d62d2c93e7b8e5
                                0f02db2b6b61b010e4c1566884de1fa9
                                702cdf8157e8aedfe3dd77c76bb50c25
                                ae4d624615c15acfdeeb5f79482aaa01
                                d3e4c05eb601eca2bd10518e9d46b021
                                16359232e9eac0fabd05235dd09e6dea

     Authenticated Portion || Rollover Counter:
                                8008315ebf2e6fe020e8f5ebc424c59f
                                d5696305e5b13d8e8ca7656617ccd747
                                1088af9debf07b55c750f804a5ac2b73
                                7be48140958a9b420524112ae72e4da5
                                bca59d2b1019ddd7dbdc30b43d5f0461
                                52ced40947d62d2c93e7b8e50f02db2b
                                6b61b010e4c1566884de1fa9702cdf81
                                57e8aedfe3dd77c76bb50c25ae4d6246
                                15c15acfdeeb5f79482aaa01d3e4c05e
                                b601eca2bd10518e9d46b02116359232
                                e9eac0fabd05235dd09e6dea00000000

     Authentication Tag:        192f515fab04bbb4e62c
```

A.2. ARIA-GCM Test Vectors

   Common values are organized as follows:

        Rollover Counter: 00000000
        Sequence Number: 315e
        SSRC: 20e8f5eb
        Encryption Salt: 000000000000000000000000

        Initialization Vector: 000020e8f5eb00000000315e
        RTP Payload: f57af5fd4ae19562976ec57a5a7ad55a
                                 5af5c5e5c5fdf5c55ad57a4a7272d572
                                 62e9729566ed66e97ac54a4a5a7ad5e1
                                 5ae5fdd5fd5ac5d56ae56ad5c572d54a
                                 e54ac55a956afd6aed5a4ac562957a95
                                 16991691d572fd14e97ae962ed7a9f4a
                                 955af572e162f57a956666e17ae1f54a
                                 95f566d54a66e16e4afd6a9f7ae1c5c5
                                 5ae5d56afde916c5e94a6ec56695e14a
                                 fde1148416e94ad57ac5146ed59d1cc5
        Associated Data: 8008315ebf2e6fe020e8f5eb

   The encrypted RTP payload is longer than the RTP payload by exactly
   the GCM authentication tag length (16 octets).

A.2.1. SRTP_AEAD_ARIA_128_GCM

        Key: e91e5e75da65554a48181f3846349562

        Encrypted RTP Payload: 4d8a9a0675550c704b17d8c9ddc81a5c
                                 d6f7da34f2fe1b3db7cb3dfb9697102e
                                 a0f3c1fc2dbc873d44bceeae8e444297
                                 4ba21ff6789d3272613fb9631a7cf3f1
                                 4bacbeb421633a90ffbe58c2fa6bdca5
                                 34f10d0de0502ce1d531b6336e588782
                                 78531e5c22bc6c85bbd784d78d9e680a
                                 a19031aaf89101d669d7a3965c1f7e16
                                 229d7463e0535f4e253f5d18187d40b8
                                 ae0f564bd970b5e7e2adfb211e89a953
                                 5abace3f37f5a736f4be984bbffbedc1

A.2.2. SRTP_AEAD_ARIA_256_GCM

        Key: 0c5ffd37a11edc42c325287fc0604f2e
                                  3e8cd5671a00fe3216aa5eb105783b54

        Encrypted RTP Payload: 6f9e4bcbc8c85fc0128fb1e4a0a20cb9
                                  932ff74581f54fc013dd054b19f99371
                                  425b352d97d3f337b90b63d1b082adee
                                  ea9d2d7391897d591b985e55fb50cb53
                                  50cf7d38dc27dda127c078a149c8eb98
                                  083d66363a46e3726af217d3a00275ad
                                  5bf772c7610ea4c23006878f0ee69a83
                                  97703169a419303f40b72e4573714d19
                                  e2697df61e7c7252e5abc6bade876ac4
                                  961bfac4d5e867afca351a48aed52822
                                  e210d6ced2cf430ff841472915e7ef48

A.3. Key Derivation Test Vectors

   This section provides test vectors for the default key derivation
   function that uses ARIA in Counter Mode. In the following, we walk
   through the initial key derivation for the ARIA Counter Mode cipher
   that requires a session encryption key of 16/24/32 octets according
   to the session encryption key length, a 14-octet session salt, and an
   authentication function that requires a 94-octet session
   authentication key. These values are called the cipher key, the
   cipher salt, and the auth key in the following. The test vectors are
   generated in the same way with the test vectors of key derivation
   functions in [RFC3711] and [RFC6188] but with each invocation of AES
   replaced with an invocation of ARIA.

A.3.1. ARIA_128_CTR_PRF

   The inputs to the key derivation function are the 16-octet master key
   and the 14-octet master salt:

     master key: e1f97a0d3e018be0d64fa32c06de4139
     master salt: 0ec675ad498afeebb6960b3aabe6

     index DIV kdr: 000000000000
     label: 00
     master salt: 0ec675ad498afeebb6960b3aabe6
     ----
     xor: 0ec675ad498afeebb6960b3aabe6   (x, PRF input)

     x*2^16:   0ec675ad498afeebb6960b3aabe60000 (ARIA-CTR input)

     cipher key: dbd85a3c4d9219b3e81f7d942e299de4 (ARIA-CTR output)

ARIA-CTR protection profile requires a 14-octet cipher salt while
ARIA-GCM protection profile requires a 12-octet cipher salt.

```
index DIV kdr:                    000000000000
label:                    02
master salt:  0ec675ad498afeebb6960b3aabe6
----------------------------------------------
xor:          0ec675ad498afee9b6960b3aabe6     (x, PRF input)

x*2^16:       0ec675ad498afee9b6960b3aabe60000 (ARIA-CTR input)

              9700657f5f34161830d7d85f5dc8be7f (ARIA-CTR output)

cipher salt:  9700657f5f34161830d7d85f5dc8     (ARIA-CTR profile)
              9700657f5f34161830d7d85f         (ARIA-GCM profile)
index DIV kdr:                    000000000000
label:                    01
master salt:  0ec675ad498afeebb6960b3aabe6
----------------------------------------------
xor:          0ec675ad498afeeab6960b3aabe6     (x, PRF input)

x*2^16:       0ec675ad498afeeab6960b3aabe60000 (ARIA-CTR input)
```

Below, the auth key is shown on the left, while the corresponding
ARIA input blocks are shown on the right.

```
auth key                        ARIA input blocks

d021877bd3eaf92d581ed70ddc050e03  0ec675ad498afeeab6960b3aabe60000
f11257032676f2a29f57b21abd3a1423  0ec675ad498afeeab6960b3aabe60001
769749bdc5dd9ca5b43ca6b6c1f3a7de  0ec675ad498afeeab6960b3aabe60002
4047904bcf811f601cc03eaa5d7af6db  0ec675ad498afeeab6960b3aabe60003
9f88efa2e51ca832fc2a15b126fa7be2  0ec675ad498afeeab6960b3aabe60004
469af896acb1852c31d822c45799      0ec675ad498afeeab6960b3aabe60005
```

A.3.2. ARIA_256_CTR_PRF

   The inputs to the key derivation function are the 32-octet master key
   and the 14-octet master salt:

     master key: 0c5ffd37a11edc42c325287fc0604f2e
                  3e8cd5671a00fe3216aa5eb105783b54
     master salt: 0ec675ad498afeebb6960b3aabe6

     index DIV kdr: 000000000000
     label: 00
     master salt: 0ec675ad498afeebb6960b3aabe6
     ----
     xor: 0ec675ad498afeebb6960b3aabe6   (x, PRF input)

     x*2^16:   0ec675ad498afeebb6960b3aabe60000 (ARIA-CTR input)

     cipher key: 0649a09d93755fe9c2b2efba1cce930a (ARIA-CTR 1st output)
                  f2e76ce8b77e4b175950321aa94b0cf4 (ARIA-CTR 2nd output)

   ARIA-CTR protection profile requires a 14-octet cipher salt while
   ARIA-GCM protection profile requires a 12-octet cipher salt.

     index DIV kdr: 000000000000
     label: 02
     master salt: 0ec675ad498afeebb6960b3aabe6
     ----
     xor: 0ec675ad498afee9b6960b3aabe6   (x, PRF input)

     x*2^16:   0ec675ad498afee9b6960b3aabe60000 (ARIA-CTR input)

                  194abaa8553a8eba8a413a340fc80a3d (ARIA-CTR output)

     cipher salt: 194abaa8553a8eba8a413a340fc8   (ARIA-CTR profile)
                  194abaa8553a8eba8a413a34   (ARIA-GCM profile)

     index DIV kdr: 000000000000
     label: 01
     master salt: 0ec675ad498afeebb6960b3aabe6
     ----
     xor: 0ec675ad498afeeab6960b3aabe6   (x, PRF input)

     x*2^16:   0ec675ad498afeeab6960b3aabe60000 (ARIA-CTR input)

   Below, the auth key is shown on the left, while the corresponding
   ARIA input blocks are shown on the right.

     auth key   ARIA input blocks

     e58d42915873b71899234807334658f2   0ec675ad498afeeab6960b3aabe60000
     0bc460181d06e02b7a9e60f02ff10bfc   0ec675ad498afeeab6960b3aabe60001
     9ade3795cf78f3e0f2556d9d913470c4   0ec675ad498afeeab6960b3aabe60002
     e82e45d254bfb8e2933851a3930ffe7d   0ec675ad498afeeab6960b3aabe60003
     fca751c03ec1e77e35e28dac4f17d1a5   0ec675ad498afeeab6960b3aabe60004
     80bdac028766d3b1e8f5a41faa3c   0ec675ad498afeeab6960b3aabe60005

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