Special Publication on Authenticated Encryption

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NIST

National Institute of Standards and Technology

Technology Administration, U.S. Department of Commerce

Outline

- Authenticated Encryption (AE)
- NIST-approved AE primitives
- Permutation-based AE modes
- NIST's plan and timeline
- Call for feedback

Authenticated Encryption

An Authenticated Encryption (AE) algorithm provides *message integrity* **AND** *confidentiality*.

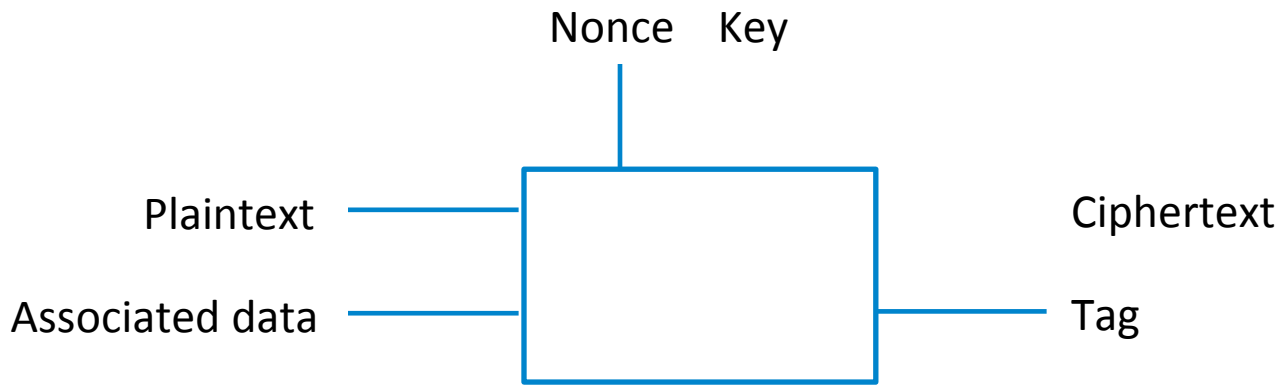
Approach I:

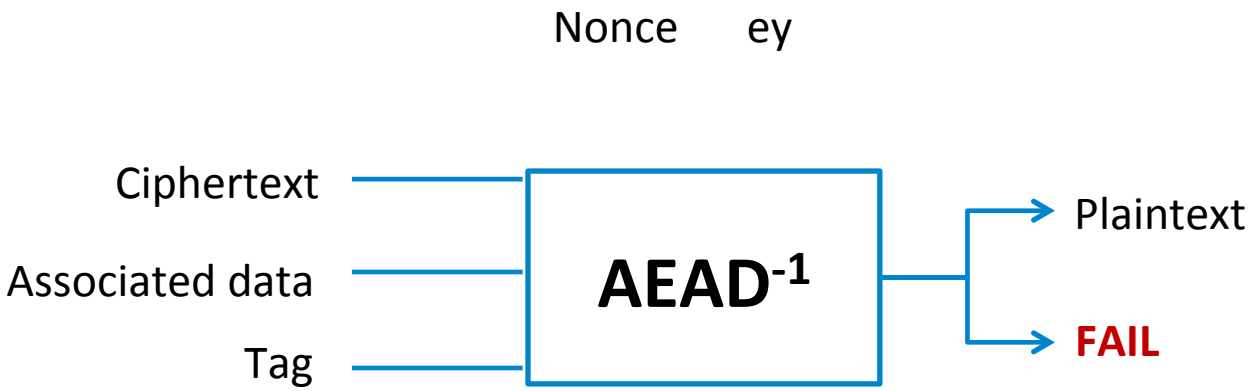
Authenticate using a MAC (e.g., HMAC) and encrypt using a block cipher (e.g., AES-CBC).

Approach II:

Use a dedicated AE algorithm.

Generic Structure





NIST Approved AE Algorithms

Based on block ciphers

- **SP 800-38C** specifies **CCM** mode of AES:
  - Combination of counter mode for privacy and cipher block chaining technique for authentication
- **SP 800-38D** specifies **GCM** (Galois/Counter Mode) of AES:
  - Combination of counter mode for privacy and universal hashing over binary Galois Field for authentication.
- **SP 800-38F** specifies Key Wrapping modes:
  - **KW**/**KWP** using AES
  - **TKW** using Triple DES

NIST's Plan

- In 2012, Keccak is selected as SHA-3, due to security/performance advantages and extra features, such as its built-in AE mode.

> *" … NIST may consider standardizing additional constructions based on the KECCAK permutation, such as an authenticated-encryption mode, in the future. "*
>
> *- from* "NISTIR 7896 - *Third-Round Report of the SHA-3 Cryptographic Hash Algorithm Competition*" (Nov, 2012):

NIST's Plan (cont.)

Underlying Permutation:

- Draft *FIPS 202 SHA-3 Standard* specifies the family of the KECCAK-*f* [*b*] permutations with width *b*= {25, 50, 100, 200, 400, 800, 1600}.
- KECCAK-*f* [1600] (with 24 rounds) is well-analyzed and is believed to have a high security margin.
- Single primitive for hashing and AE

NIST's Plan (cont.)

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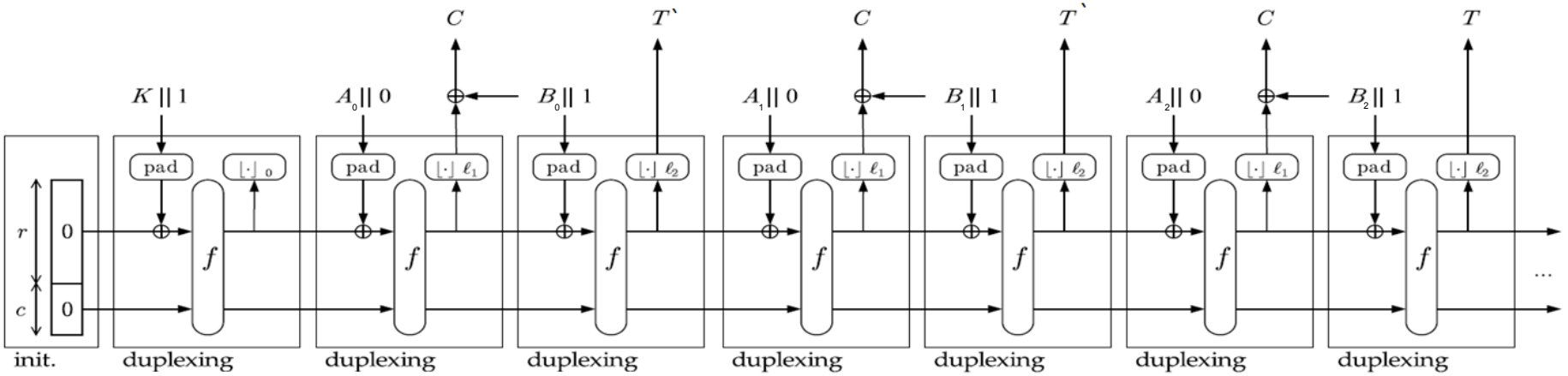
AE Mode:

- Various permutation-based AE modes, including some of the CAESAR submissions (e.g., DUPLEXWRAP, MONKEYWRAP, PPAE, APE). However, we do not to want to influence the CAESAR competition.
- Initial plan is to approve the AE mode SPONGEWRAP.

SPONGEWRAP

Proposed by the KECCAK team at SAC'11



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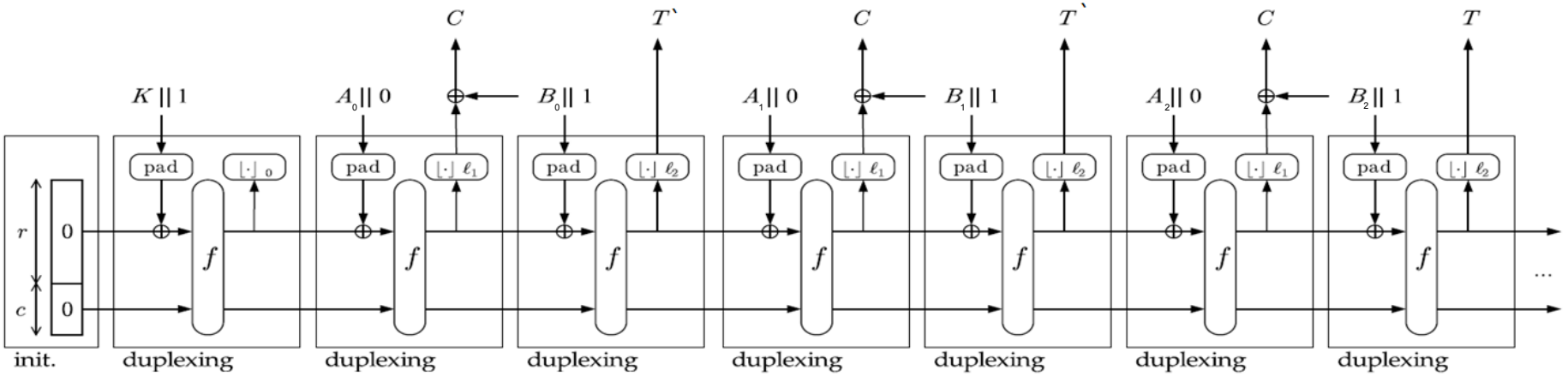

NIST plans to

- support 128- and 256- bit security levels, by using
  Capacity c = 2 x {security level} ,
- use multi-rate padding,
- support intermediate tags.

TIMELINE: Draft *Special Publication* for Authenticated Encryption – Q4 2014 for Public Comments

Call for Feedback

Q1) Based on the security proof of SPONGEWRAP, should we consider using lower capacities, i.e. $c = |K| +$ {max. online data complexity}? Can we assume maximum online data complexity is $\leq 2^{96}$?

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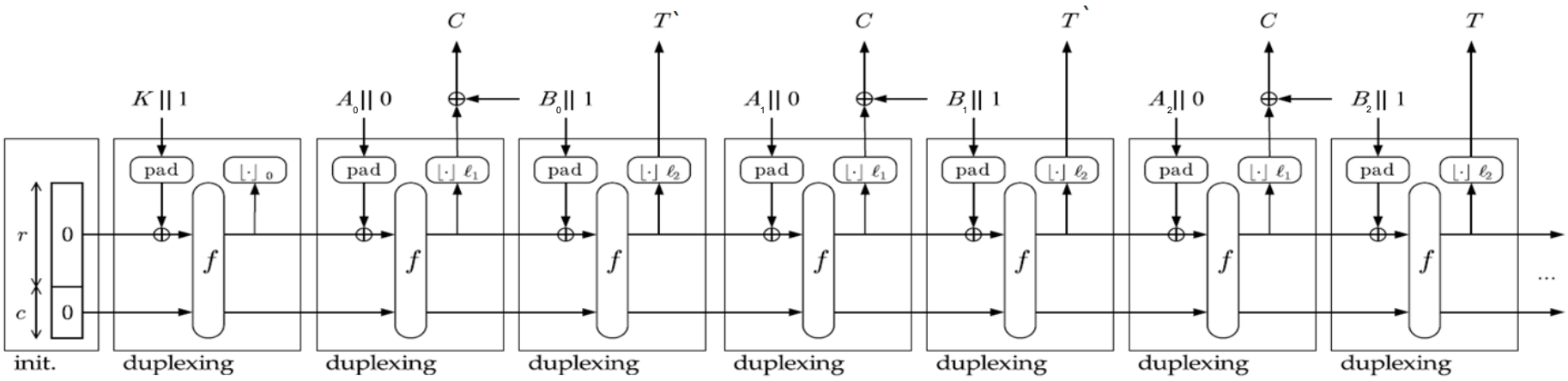
Q2) What should be the intermediate and final tag sizes? How frequent should the intermediate tags be given as output?



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Q4) Are there any other issues we need to consider?

References

- Draft FIPS PUB 202:
  SHA-3 Standard: Permutation-Based Hash and Extendable-Output Functions, 2014.
- NISTIR 7896:
  Third-Round Report of the SHA-3 Cryptographic Hash Algorithm Competition, 2012.
- G. Bertoni, J. Daemen, M. Peeters, and G. Van Assche,
  Duplexing the sponge: single-pass authenticated encryption and other applications,
  Selected Areas in Cryptography (SAC), 2011 (also in
  Second SHA-3 Candidate Conference, 2010)
- CAESAR Competition: http://competitions.cr.yp.to/caesar.html
- G. Bertoni, J. Daemen, M. Peeters, G. Van Assche:
  Duplexing the Sponge: Single-Pass Authenticated Encryption and Other
  Applications. Selected Areas in Cryptography 2011: 320-337

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QUESTIONS?

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