CAESAR candidate Marble

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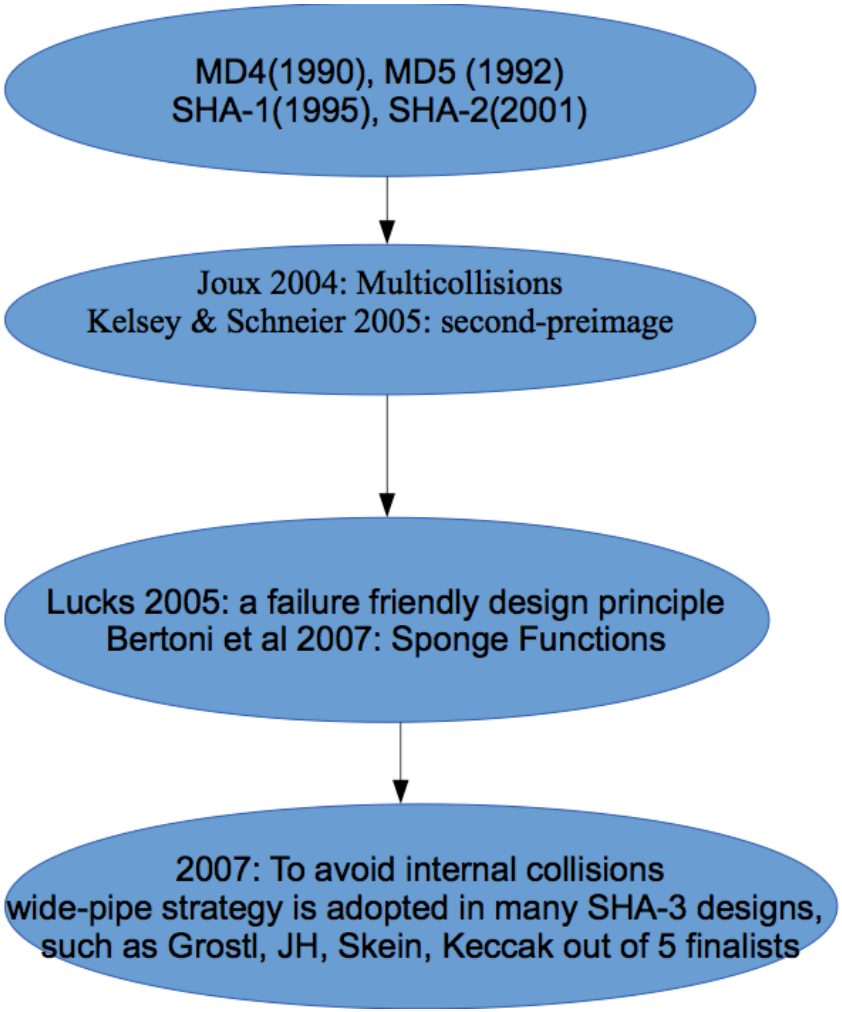
Design Goals

- Online
- Parallelizable
- Software oriented
- Decryption-misuse resistant, unverified plaintext release
- Nonce-misuse resistant, or nonce-free
- Low setup overhead
- Support of extreme usecases
- Full security

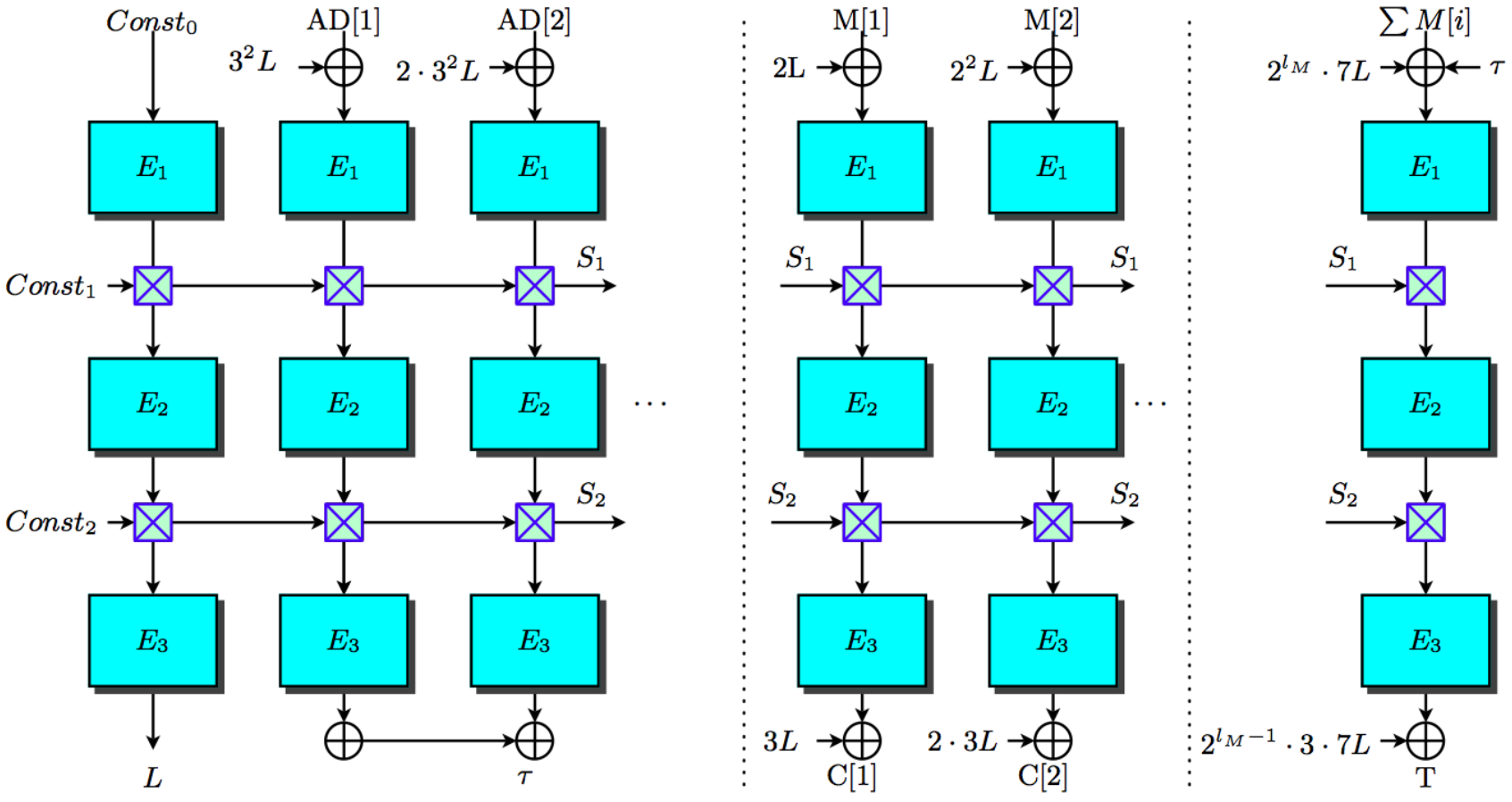
The need of “wide-pipe”



Lesson from hash function development

use double or even larger internal state to avoid internal collisions

Design Overview



- E_1, E_2, E_3 are block-ciphers
- $\texttt{TRANS}(x, y)$: a transition function with MDS property.
- '$\cdot$' multiplication is in $\texttt{GF}(2^{128})$.

Recommended Parameters

Choices are made to optmize the software performance:

- E_1, E_2, E_3 are 4-round AES, every message block is processed by 12 AES rounds.
- $\texttt{TRANS}(x, y) = (x + y, 3 \cdot x + y)$, division-free for the inverse computation.

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- Better security margin with AES for E_1, E_2, E_3, yet with a speed of 3.0 cpb.

Usecases

In addition to the usual use, Marble supports many extreme usecases:

- Encryption/Decryption only (opting out the tag)
- Integrity of associated data only.
- Integrity of message — MAC only (opt out the ciphertext).

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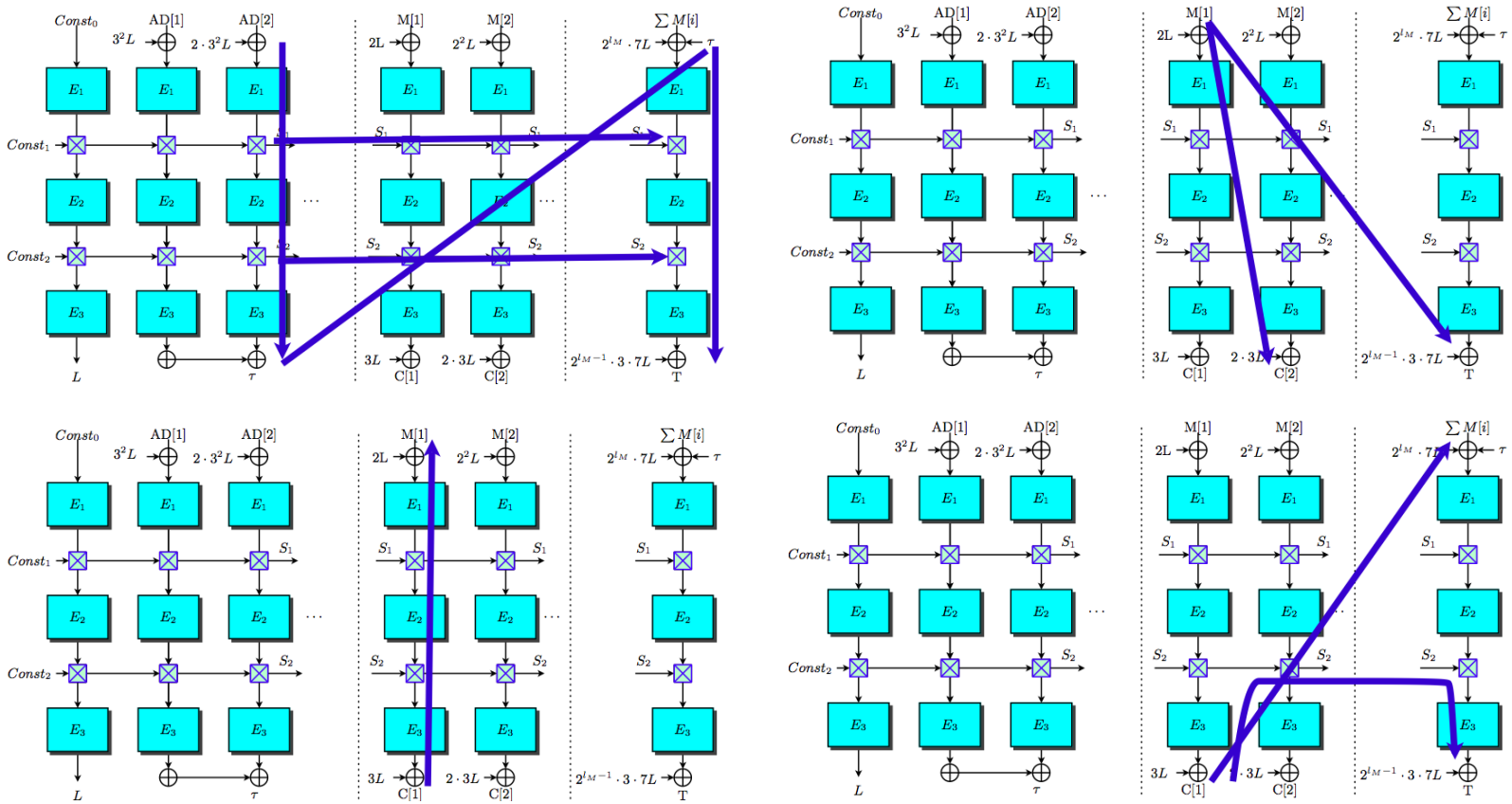
Privacy in nonce-misuse scenario: prefixed message blocks share the same ciphertext prefix.

Security Evaluations



- Differential/Linear Cryptanalysis: any complete path will involve at least **12** rounds AES, with 75 active sboxes.
- Inner collisions: collision on single chain is NOT “detectable”; collision on double chains requires 2^n.
- Nandi’s attack does not apply even with complexity 2^n due to the $2n$-bit chain.

Security Proof

We welcome security proof of Marble mode, when the three block ciphers are idealized.

Future work

- Hardware implementations
- Improving the software implementations with AES-NI
- Implementations without AES-NI
- Implementations for Atmel AVR
- Security proof when the underlying blockciphers are ideal, extend tag-splitting to arbitary-length message to avoid XLS.

Thank you!

Questions?