

ASCON

Submission to the CAESAR Competition

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DIAC 2014

Our Team

- Christoph Dobraunig
- Maria Eichlseder
- Florian Mendel
- Martin Schläffer



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Main Design Goals

- Security
- Efficiency
- Simplicity
- Scalability
- Online
- Single pass
- Lightweight
- Side-Channel Robustness

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General Overview

- Nonce-based AE scheme
- Sponge inspired

	ASCON-128	ASCON-96
Security	128 bits	96 bits
State size (b)	320 bits	320 bits
Capacity (c)	256 bits	192 bits
Rate (r)	64 bits	128 bits

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Working Principle

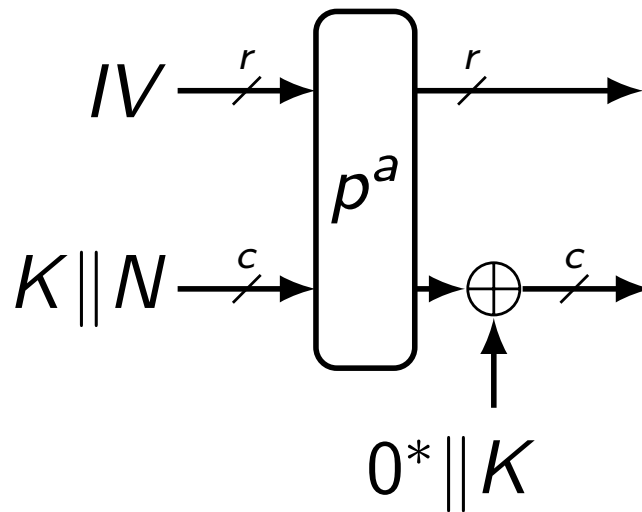
The encryption process is split into four phases:

- Initialization
- Associated Data Processing
- Plaintext Processing
- Finalization

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Initialization

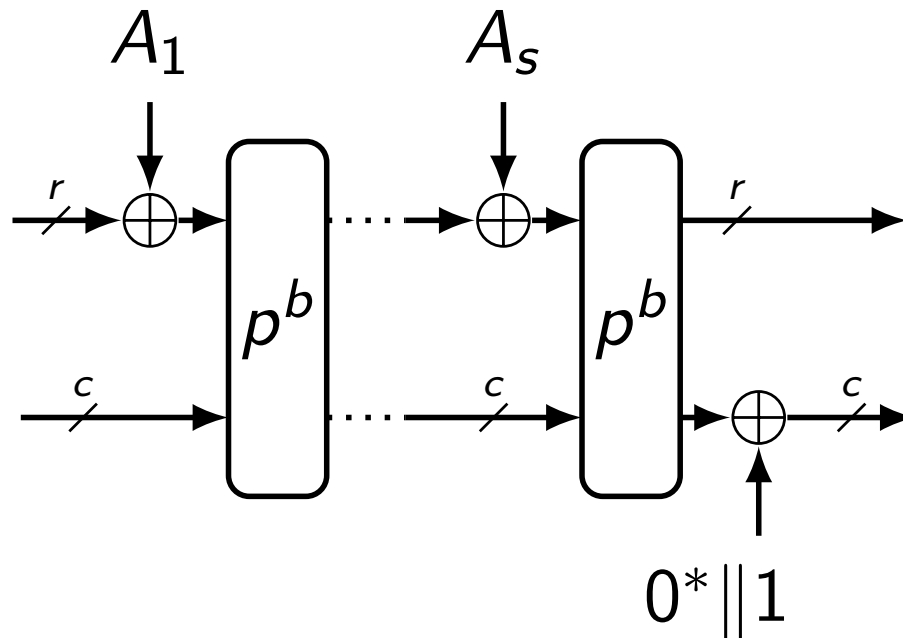
- **Initialization:** updates the 320-bit state with the key K and nonce N



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Associated Data

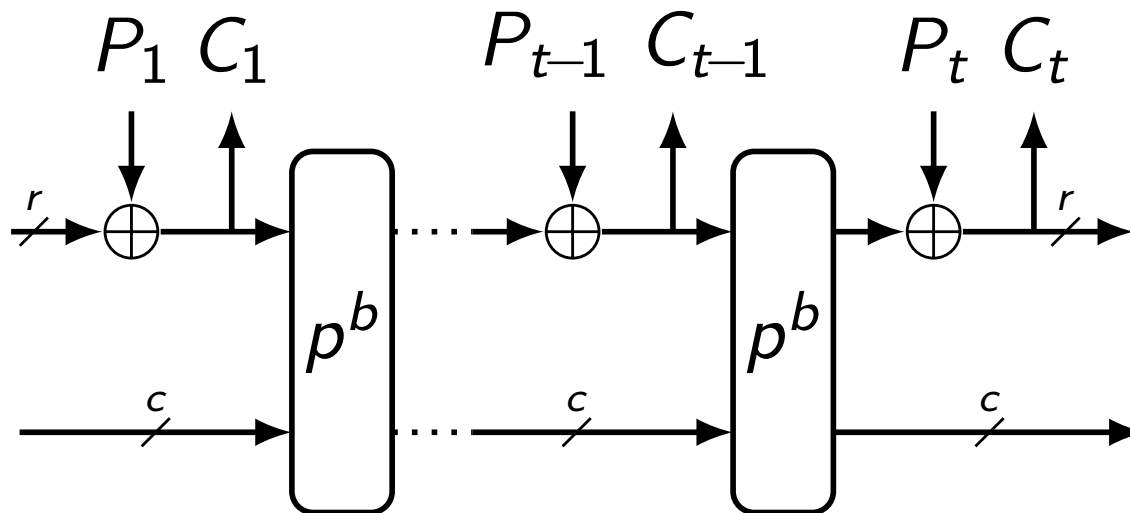
- **Associated Data Processing:** updating the 320-bit state with associated data blocks A_i



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Encryption

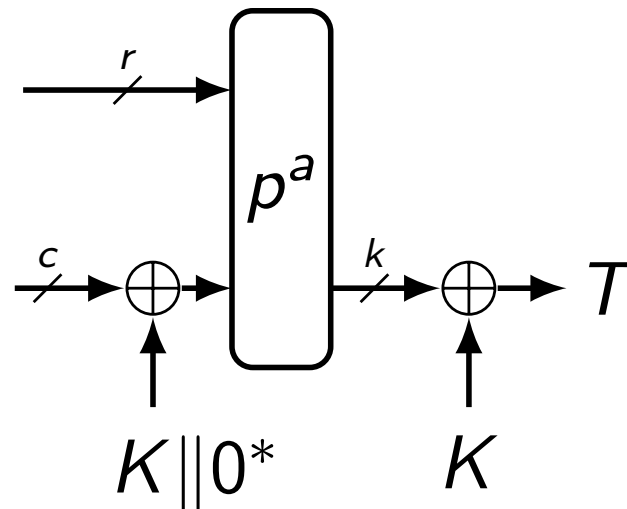
- **Plaintext Processing:** inject plaintext blocks P_i in the state and extract ciphertext blocks C_i



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Finalization

- **Finalization:** inject the key K and extracts a tag T for authentication

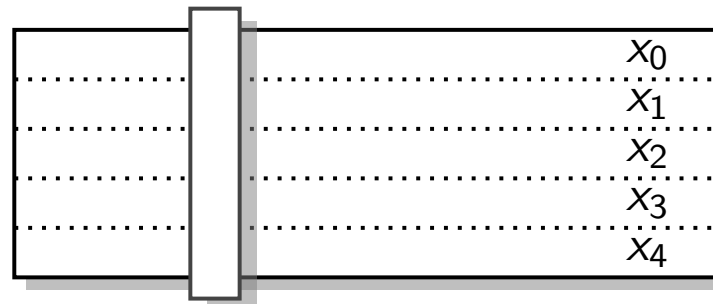


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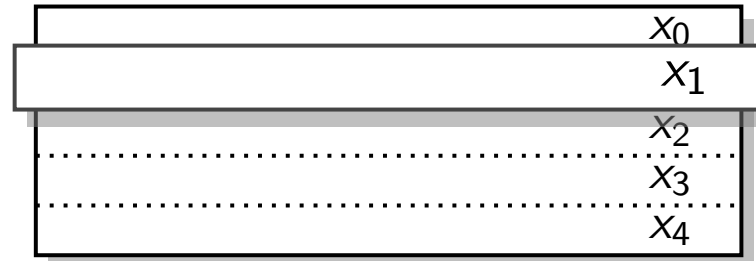
Permutation

- SP-Network:

– S-Layer:



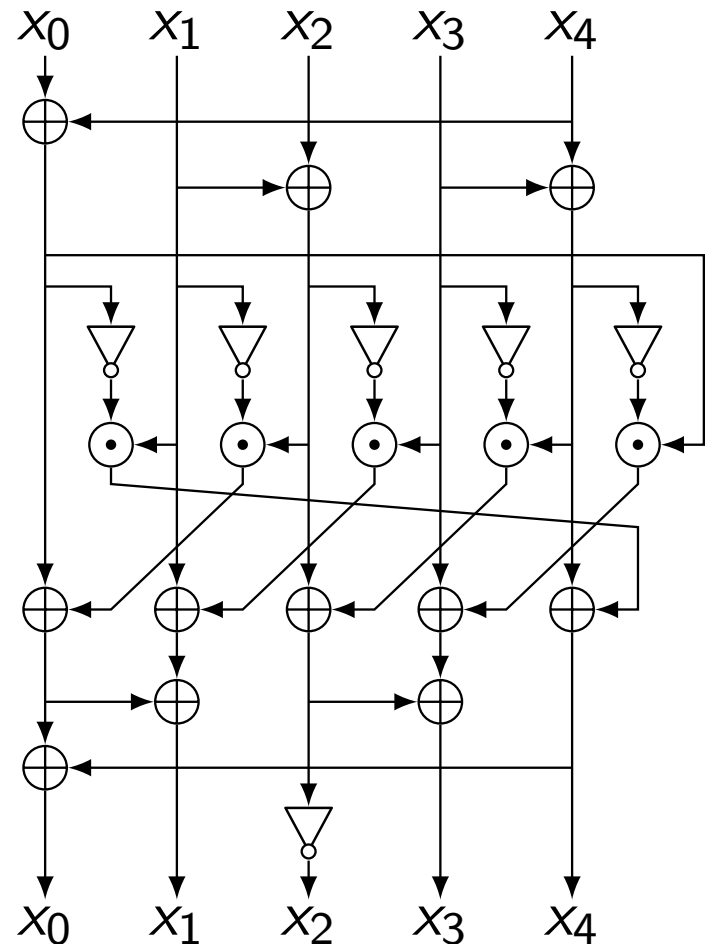
– P-Layer:



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Permutation: S-Layer

- Algebraic Degree 2
 - Ease TI (3 shares)
- Branch Number 3
 - Good Diffusion
- Bit-sliced Impl.



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Permutation: P-Layer

- Branch Number 4

$$\Sigma_0(x_0) = x_0 \oplus (x_0 \ggg 19) \oplus (x_0 \ggg 28)$$

$$\Sigma_1(x_1) = x_1 \oplus (x_1 \ggg 61) \oplus (x_1 \ggg 39)$$

$$\Sigma_2(x_2) = x_2 \oplus (x_2 \ggg 1) \oplus (x_2 \ggg 6)$$

$$\Sigma_3(x_3) = x_3 \oplus (x_3 \ggg 10) \oplus (x_3 \ggg 17)$$

$$\Sigma_4(x_4) = x_4 \oplus (x_4 \ggg 7) \oplus (x_4 \ggg 41)$$

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Security Analysis

- Differential Cryptanalysis
 - 5 rounds: > 64 active Sboxes
- Impossible Differential
 - up to 5 rounds
- Linear Cryptanalysis
 - 5 rounds: > 64 active Sboxes

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Security Analysis

- Differential Cryptanalysis

Rounds	Active Sboxes	Probability
1	1	2^{-2}
2	4	2^{-8}
3	15	2^{-30}
4	44	2^{-88}
5	74	2^{-148}

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Security Analysis

- Linear Cryptanalysis

Rounds	Active Sboxes	Correlation
1	1	2^{-2}
2	4	2^{-8}
3	13	2^{-26}
4	43	2^{-86}
5	70	2^{-140}

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Implementation/Performance

- Software
 - Intel Core2 Duo
 - ARM Cortex-A8
- Hardware
 - High-speed
 - Low-area

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Software Implementation

- Intel Core2 Duo

	64	512	1024	4096
ASCON-128 (cycles/byte)	22.0	15.9	15.6	15.2
ASCON-96 (cycles/byte)	17.7	11.0	10.5	10.3

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Hardware Implementation

- ASCON-128

	Variant 1	Variant 2
Area (kGE)	8.9	4
Throughput (MByte/s)	400	1

H. Gross, E. Wenger

Threshold implementation coming soon!

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Choice of Parameters

- Now: $(c,r) = (256, 64)$
 - Conservative choice
- Proposed: $(c,r) = (192,128)$ [BDPV11]
 - Significant speedup (factor 2)
 - Limit on data complexity 2^{64}
- Proposed: $(c,r) = (128,192)$ [JLM14]
 - Significant speedup (factor 3)
 - More analysis needed

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General Information

[Home](#)[Specification](#)[Implementation](#)[Analysis](#)[Resources](#)[Contact](#)

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Interesting Links

ASCON Resources

- [Specification \[v1.0\]](#)
- [Submission document \[v1.0\]](#)
- [GitHub repositories with implementations \[git collection\]](#)
 - [C \(reference / optimized\) \[git\] \[zip\]](#)
 - [Python \[git\] \[py\]](#)
 - [Java \[git\] \[zip\]](#)
 - [Hardware \[git\] \[zip\]](#)

Thank you!

<http://ascon.iaik.tugraz.at>