ISAP

Towards Side-channel Secure AE

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Introduction

Problem: side-channel attacks

Countermeasures: hiding, masking, TI ...

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Reduce overhead of countermeasures

- ASCON, KETJE/KEYAK, PRIMATES, SCREAM, ...

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Can we do more?

- LR and MR AE [Ber+16]
- ISAP

ISAP

Authenticated encryption scheme

- Following requirements of CAESAR call
- No assumptions on choice of the nonce

Provides protection against DPA for:

- Encryption
- Decryption

Solely based on sponges

- Limits the attack surface against SPA

SPA and DPA

Simple Power Analysis (SPA)

- Observe device processing the same or a few inputs
- Techniques directly interpreting measurements

Differential Power Analysis (DPA)

- Observe device processing many different inputs
- Allows for the use of statistical techniques

Is DPA Still a Threat?

- A. Moradi and T. Schneider Improved Side-Channel Analysis Attacks on Xilinx Bitstream Encryption of 5, 6, and 7 Series COSADE 2016
- E. Ronen, C. O'Flynn, A. Shamir, and A.-O. Weingarten IoT Goes Nuclear: Creating a ZigBee Chain Reaction Cryptology ePrint Archive, Report 2016/1047, 2016

What to do Against DPA?

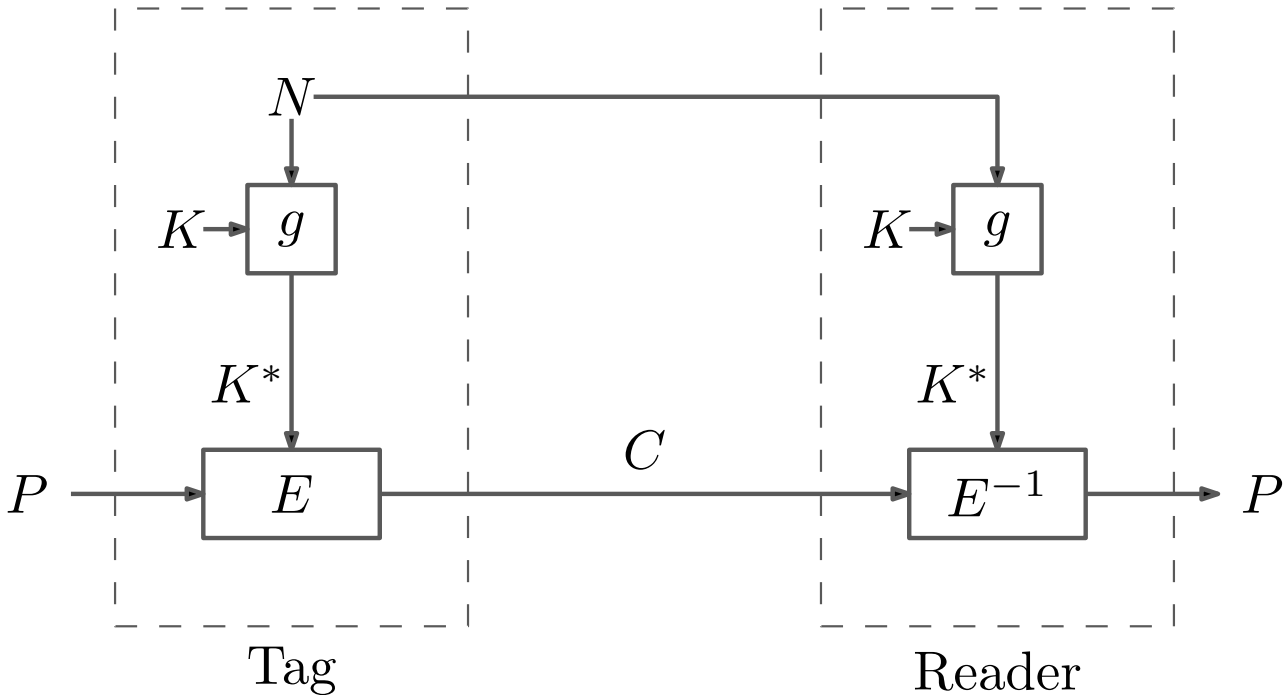
Implementation

- Hiding
- Masking
- Threshold implementations

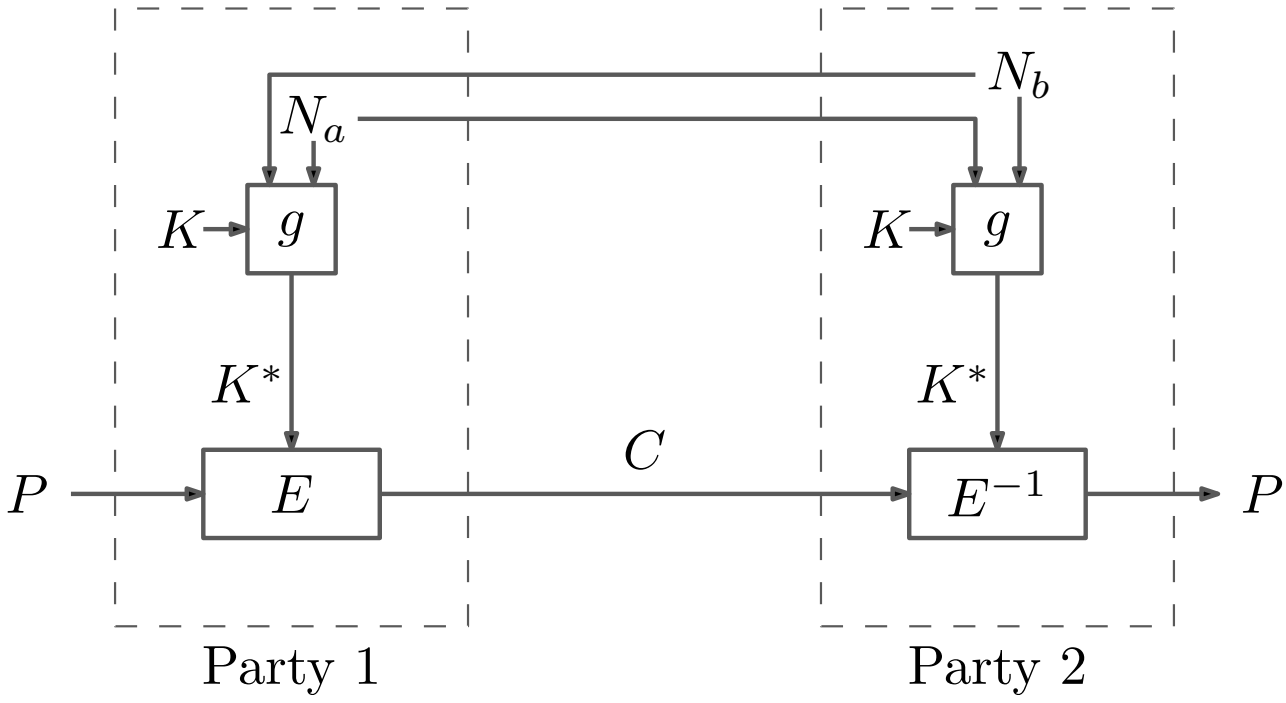
Scheme

- Fresh re-keying
- Leakage resilient cryptography

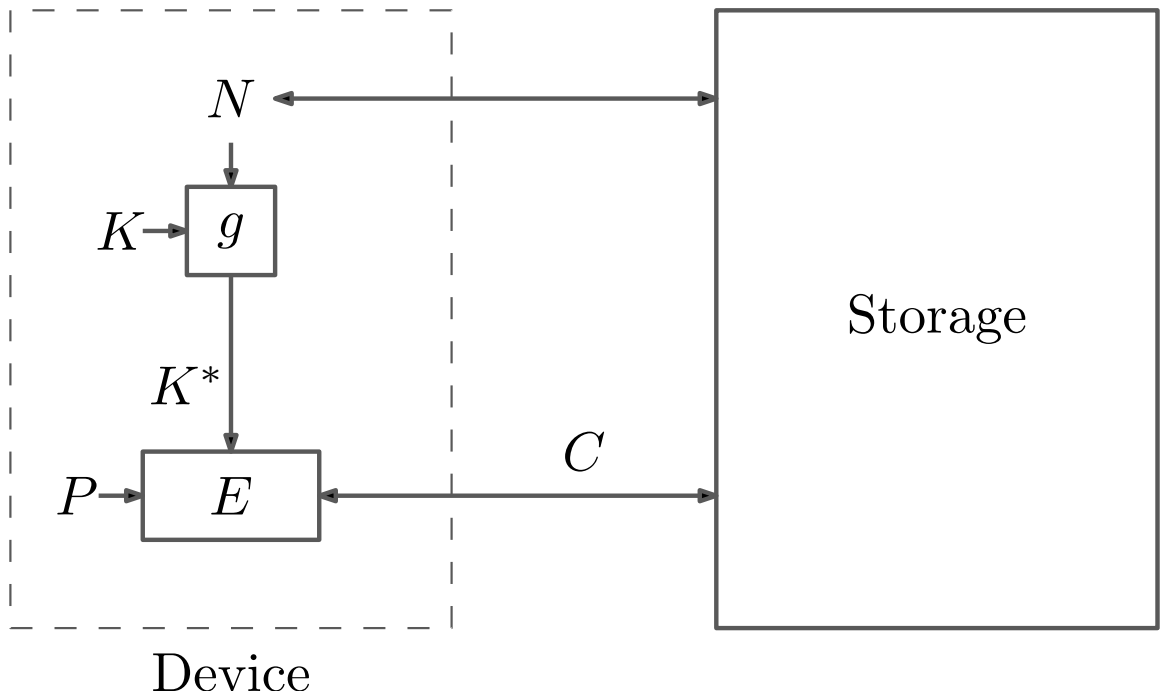
Fresh Re-keying [Med+10]



Fresh Re-keying [Med+11]



What About Storage?



- Encryption still fine
- Decryption causes problems

How to Protect Decryption?

Solely rely on implementation countermeasures

- Costly
- Makes re-keying for encryption kind of obsolete

Limit to one decryption

- Keep track of the nonce
- Re-encrypt data
- Time consuming
- Damaging

Multiple Decryption

Retain principles of fresh re-keying allowing multiple decryption

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DPA protection in storage settings

- A. Moradi and T. Schneider Improved Side-Channel Analysis Attacks on Xilinx Bitstream Encryption of 5, 6, and 7 Series COSADE 2016

DPA protection in unidirectional/broadcast settings

- E. Ronen, C. O'Flynn, A. Shamir, and A.-O. Weingarten IoT Goes Nuclear: Creating a ZigBee Chain Reaction Cryptology ePrint Archive, Report 2016/1047, 2016

Priciple of ISAP's Decryption

"Bind" the session key to the data that is decrypted

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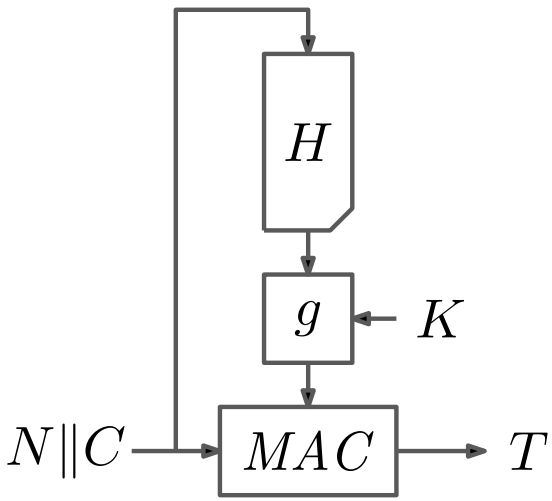

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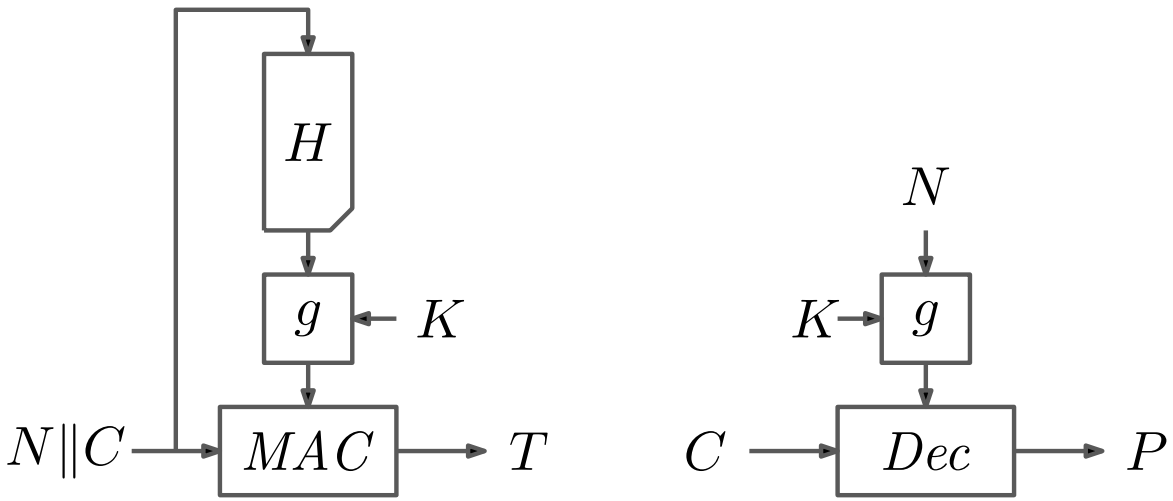
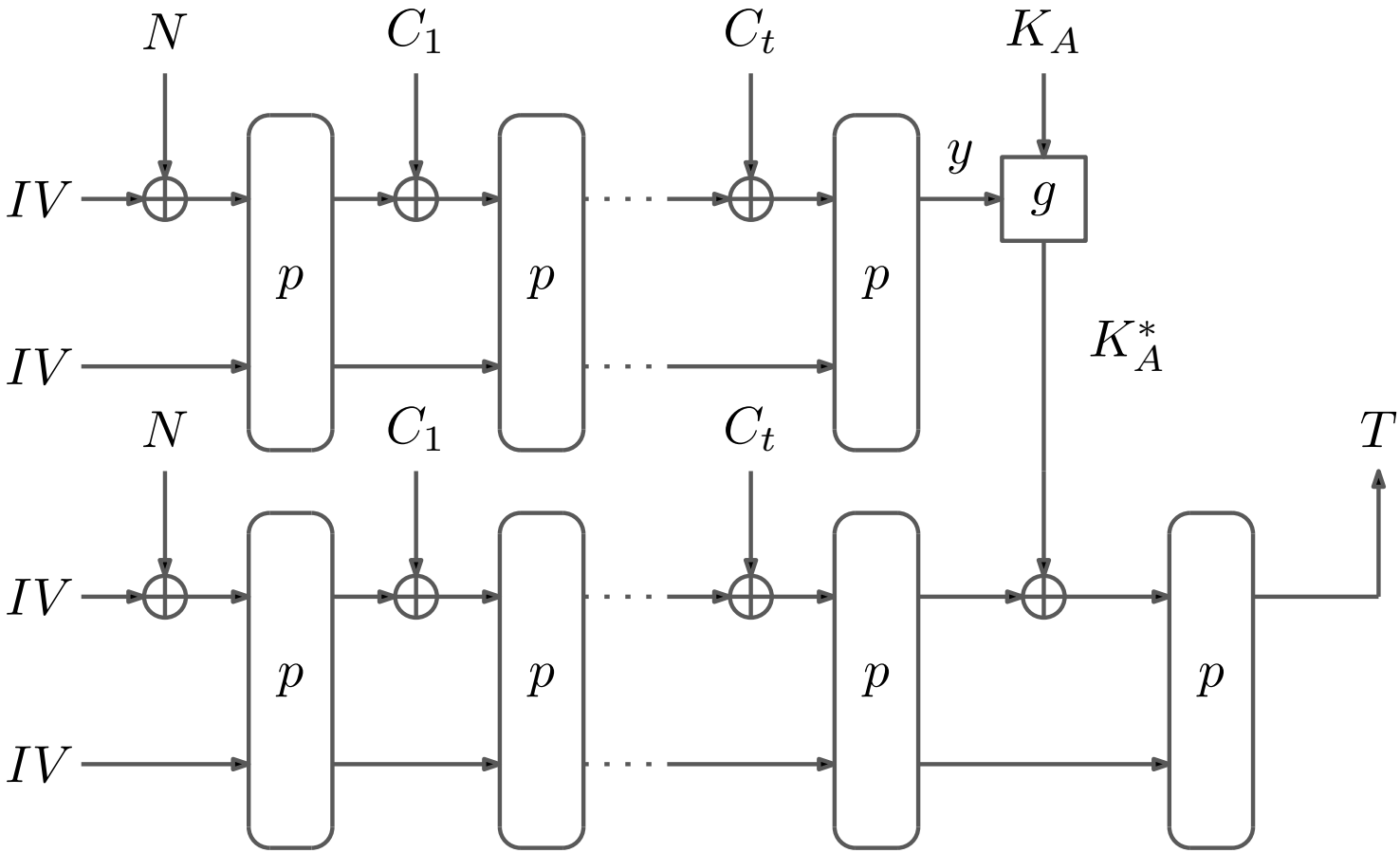


ISAP's Authentication/Verification



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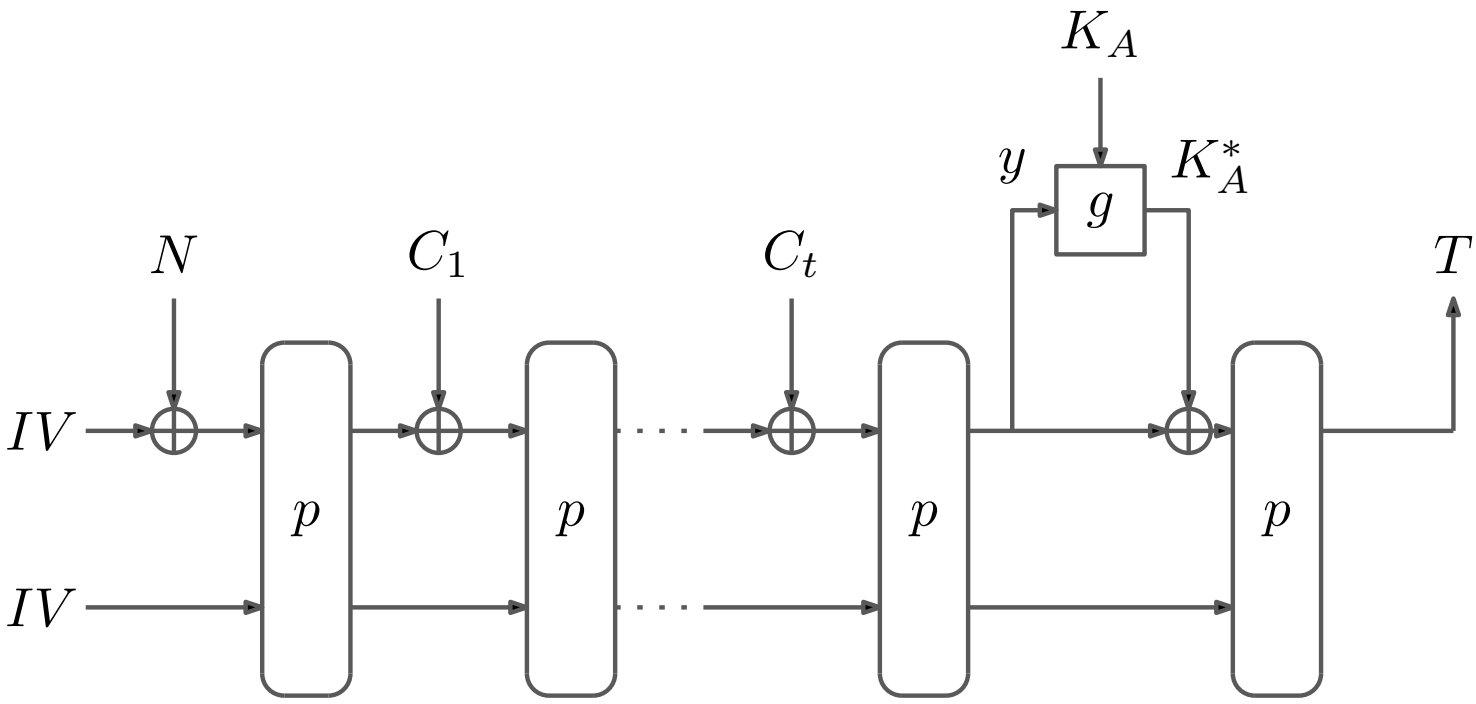
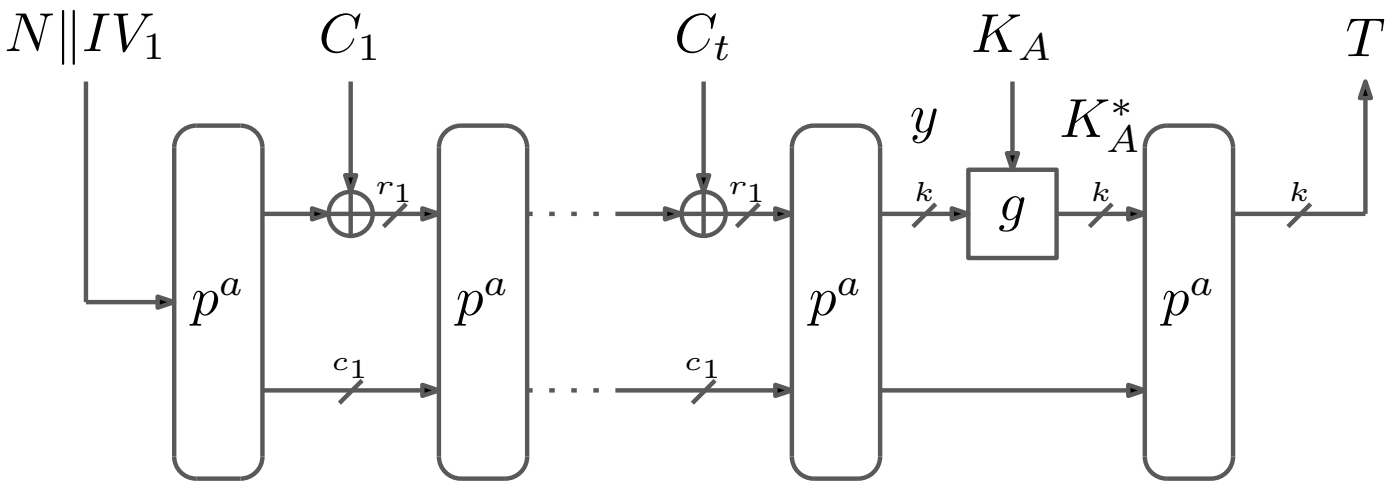


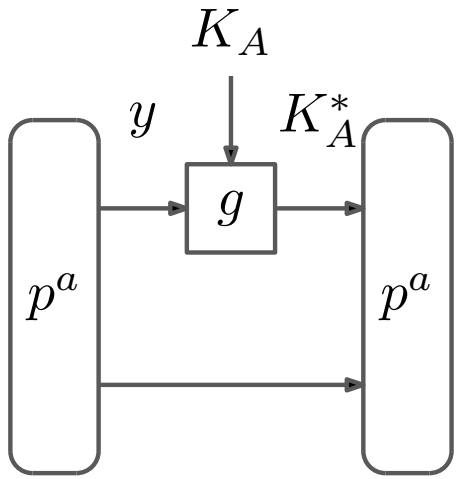
ISAP's Authentication/Verification

Use suffix MAC instead of hash-then-MAC



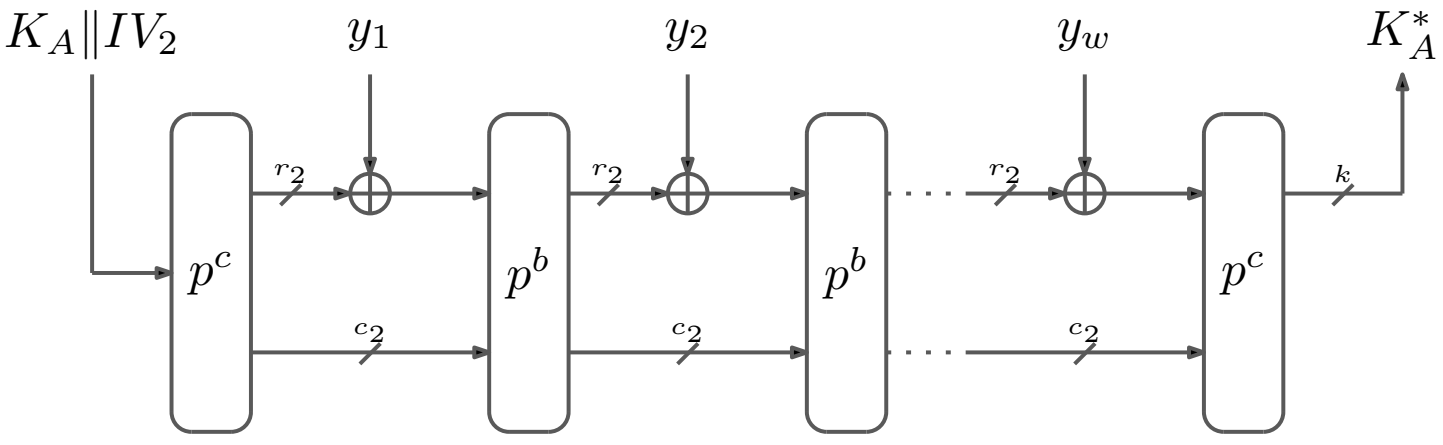
Possible *g* to Absorb Key

- Modular multiplication [Med+10]
- LPL and LWE [Dzi+16]
- Sponges [TS14]

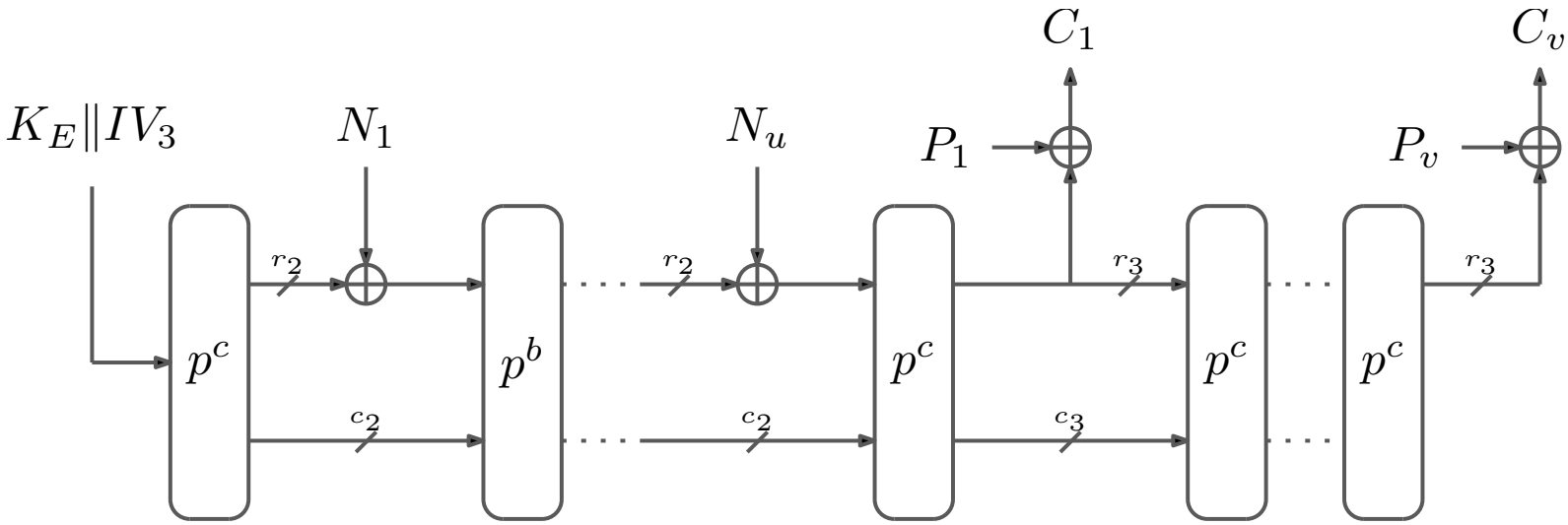


Absorbing the Key

Idea: Reduce rate to a minimum [TS14]
Related to the classical GGM construction [GGM86]



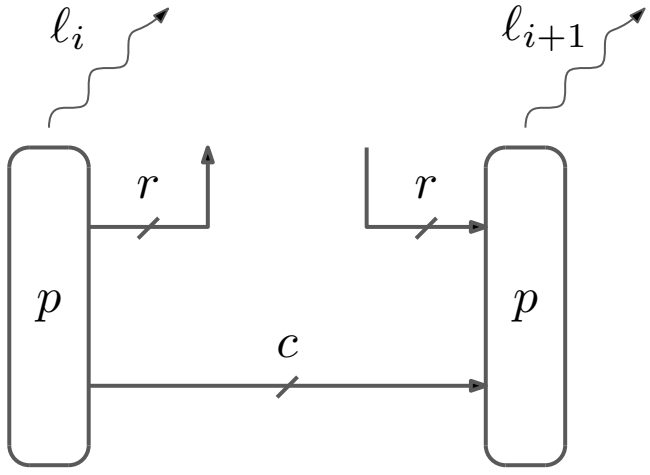
ISAP's En-/Decryption



Benefits of Sponges

- Well-studied and analyzed
- Allows to implement a wide range of primitives
- No inverse building blocks (permutation) needed
- No key schedule, key is injected once

Sponges and Side-channel Leakage



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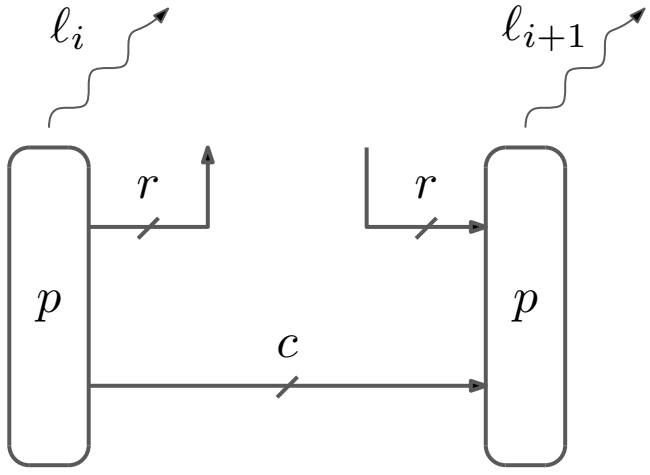

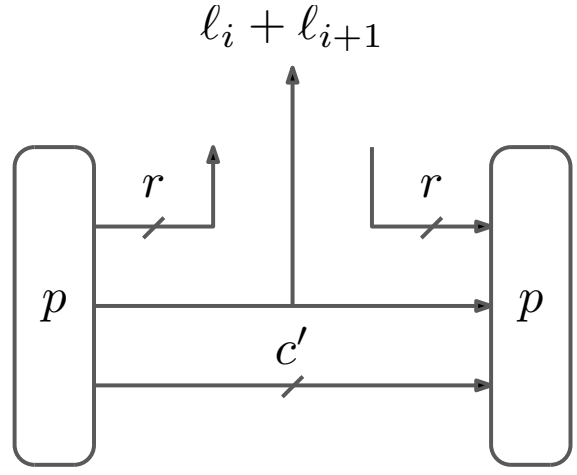

$$c' = c - (\ell_i + \ell_{i+1})$$

Instances

KECCAK-p[400,n_r] as permutation [Ber+14]

Name	Security level	Bit size of			Rounds		
	k	r_1	r_2	r_3	a	b	c
ISAP-128	128	144	1	144	20	12	12
TRUMPF-128	128	144	1	144	16	1	8

Implementation

One round per cycle

Function	Area [kGE]	Initialization [cycles]	Initialization [μs]	Runtime per Block [cycles]	Runtime per Block [μs]
ISAP-128	14.0	3 401	20.1	36	0.20
TRUMPF-128	14.0	564	3.3	28	0.16

Conclusion

- AE scheme following requirements of CAESAR call
- Provides protection against DPA
  - Encryption
  - Decryption
- Enables several use-cases
  - Multiple decryption of stored data
  - Unidirectional/Broadcast communication

Thank you

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