Single-Device Threshold Implementations

National Institute of Standards and Technology
U.S. Department of Commerce

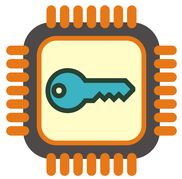
Computer Security Division (NIST-ITL)

INFORMATION TECHNOLOGY LABORATORY

NIST Threshold Cryptography Project — Single-Device Track

Crypto is ubiquitous in today's IT devices

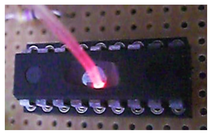
- In smartphones for communication
- In hardware drives for storage
- In smartcards for authentication



How can these devices protect the secrets therein?

Attackers can often exfiltrate secret keys from devices!

"Belcore attack" (1997)



Cold-Boot attacks (2009)

ZigBee chain reaction (2017)

Heartbleed bug (2014)

Meltdown (2017)

Spectre (2017)

Foreshadow (2018)

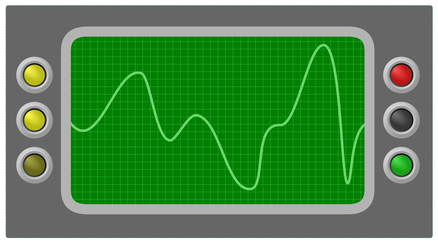
MDS (2019)

Two main categories of attacks:

- **Leakage:** derive secrets from side-channels
- **Fault injection:** interfere with the computation

A typical attack: differential power-analysis

Measure the power consumption during a crypto operation

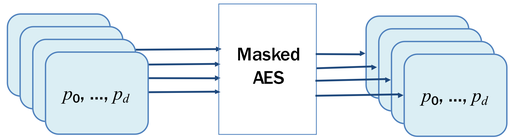


Collect many *traces* and detect the consumption difference between processing a 0 or a 1 for each bit of the secret key.

The Threshold Implementation approach

- *Share* each secret-input bit into several random bits
- Probing any wire or tile will only reveal random bits

Masked input and output bits



Tiles

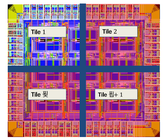


Image credit: V. Rijmen (slides at single-device workshop)

Protecting AES in hardware is of utmost importance!

AES is the Advanced Encryption Standard ... pervasive in crypto circuits.

Engaging with the community

Our positioning of the problem (NISTIR 8214A) led to a workshop (organized by KU-Leuven) focused on **single-device threshold AES**:

Online Workshop on Threshold Schemes for NIST-approved Symmetric Block Ciphers in a Single-Device Setting — July 7–9, 2020

https://www.esat.kuleuven.be/cosic/cosicevent/online-workshop-on-threshold-schemes-for-nist-approved-symmetric-block-ciphers-in-a-single-device-setting/

Key take-aways / questions:

- Big differentiation between leakage-only and combined attacks
- What protective schemes are really relevant to the industry?
- Benchmarking is needed (how many traces to break a protection?)
- Need verification tools to check correctness of threshold design

Our approach to standardization

- Devise two reference attack models for evaluation of proposals
- Develop threshold guidelines with potential to improve best-practices
- Integrate proposed techniques in the crypto validation pipeline

Contact: threshold-crypto@nist.gov

TC forum: https://list.nist.gov/tc-forum

Webpage: https://csrc.nist.gov/Projects/Threshold-Cryptography

Poster produced for the NIST-ITL Virtual Science Day 2020 (October 29)