Bundesamt
für Sicherheit in der
Informationstechnik

FIRST TALK

A Stochastic Approach in Side-Channel Analysis in the Presence of Masking

W. Schindler

Bundesamt für Sicherheit in der Informationstechnik
(BSI), Bonn, Germany

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Power attacks on a block cipher implementation protected by masking

- (Classical) template attacks: most powerful attack, but gigantic workload (= # of measurements) for profiling
- Second order DPA: no profiling, but only little efficient

The Stochastic Approach (Example: Power attack on AES)

$x \in \{0,1\}^8$ (known) part or the plaintext or ciphertext

$z \in \{0,1\}^8$ masking value

$k \in \{0,1\}^8$ subkey

t time

Time t: $I_t(x,z;k) = h_t(x,z;k) + R_t$

Random variable (depends on x,z,k)

deterministic part (depends on x,z,k)

Random variable $E(R_t) = 0$

quantifies the random-ness of the side-channel signal at time t

Noise

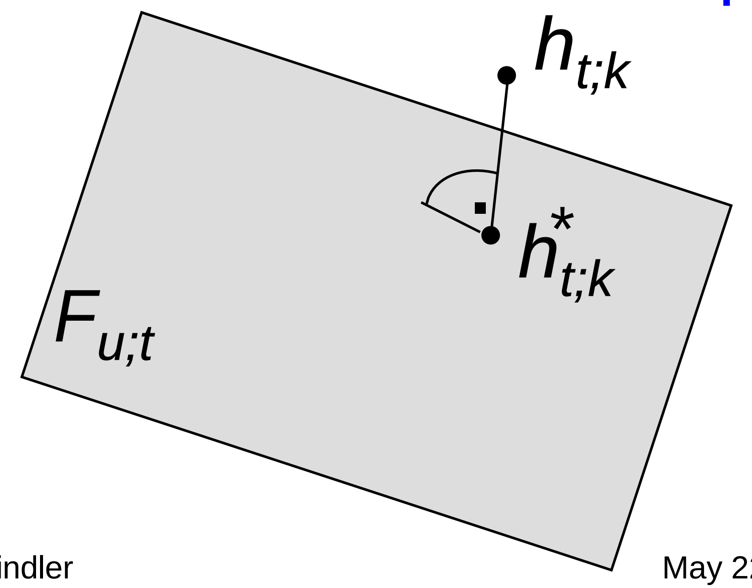
1st Profiling Step: Estimation of $h_t(.,.,.)$

- Naïve Approach: Estimate $h_t(x,z;k) = E(I_t(x,z;k))$ independently for each triple $(x,z;k) \in \{0,1\}^8 \times \{0,1\}^8 \times \{0,1\}^8$ for all $t \in \{t_1,t_2,\ldots,t_m\}$ (relevant instants)

- Drawback: Gigantic number of measurements

More efficient procedure

- For any fixed subkey k interpret the function $h_{t;k}(\cdot,\cdot)\colon \{0,1\}^8 \times \{0,1\}^8 \to R$, $h_{t;k}(\cdot,\cdot) = h_t(\cdot,\cdot;k)$, as an element of a real vector space *F*.
- Approximate $h_{t;k}(\cdot,\cdot)$ by its image $h^*_{t;k}$ under the orthogonal projection onto a suitably chosen low-dimensional vector subspace $F_{u;t}$



geometric

visualization

- (clou) The image $h^*_{t;k}$ minimizes a functional on the vector subspace $F_{u;t}$

$h^*_{t;k}$ can be determined without knowing h (.,..,.k)

- (Qualitative) conjectures on the reasons for the leakage signal → subspace $F_{u;t}$
- Typical vector space dimensions (→ Example)
  - $\dim(F) = 2^{16}$
  - $\dim(F_{u;t}) = 9$ or 17

Comparison with Template Attacks

Non-masking case:

- introduced by Schindler, Lemke, Paar (CHES 2005)
- extensive experimental studies by Gierlichs, Lemke, Paar (CHES 2006)
  - Compared to template attacks:
    reduces the number of measurements in the profiling phase up to factor 50

Masking case:

The advantages of the stochastic approach are even by an order of magnitude larger than in the non-masking case.

Summary

The stochastic approach

- reduces the profiling workload by order(s) of magnitude
- combines engineer's insight into the reasons for the leakage (→ suitability of the subspace $F_{u;t}$) with precise stochastic methods (→ optimal approximator in $F_{u;t}$)
- identifies and quantifies those properties that have significant impact on the side-channel signal
- supports constructively the design of security implementations

Contact

Bundesamt für Sicherheit in der Informationstechnik (BSI)

Werner Schindler
Godesberger Allee 185-189
53175 Bonn

Tel: +49 (0)3018-9582-5652
Fax: +49 (0)3018-10-9582-5652

Werner.Schindler@bsi.bund.de
www.bsi.bund.de
www.bsi-fuer-buerger.de

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SECOND TALK

A Stochastic Model for Particular Designs of Physical RNGs with Robust Entropy Estimators

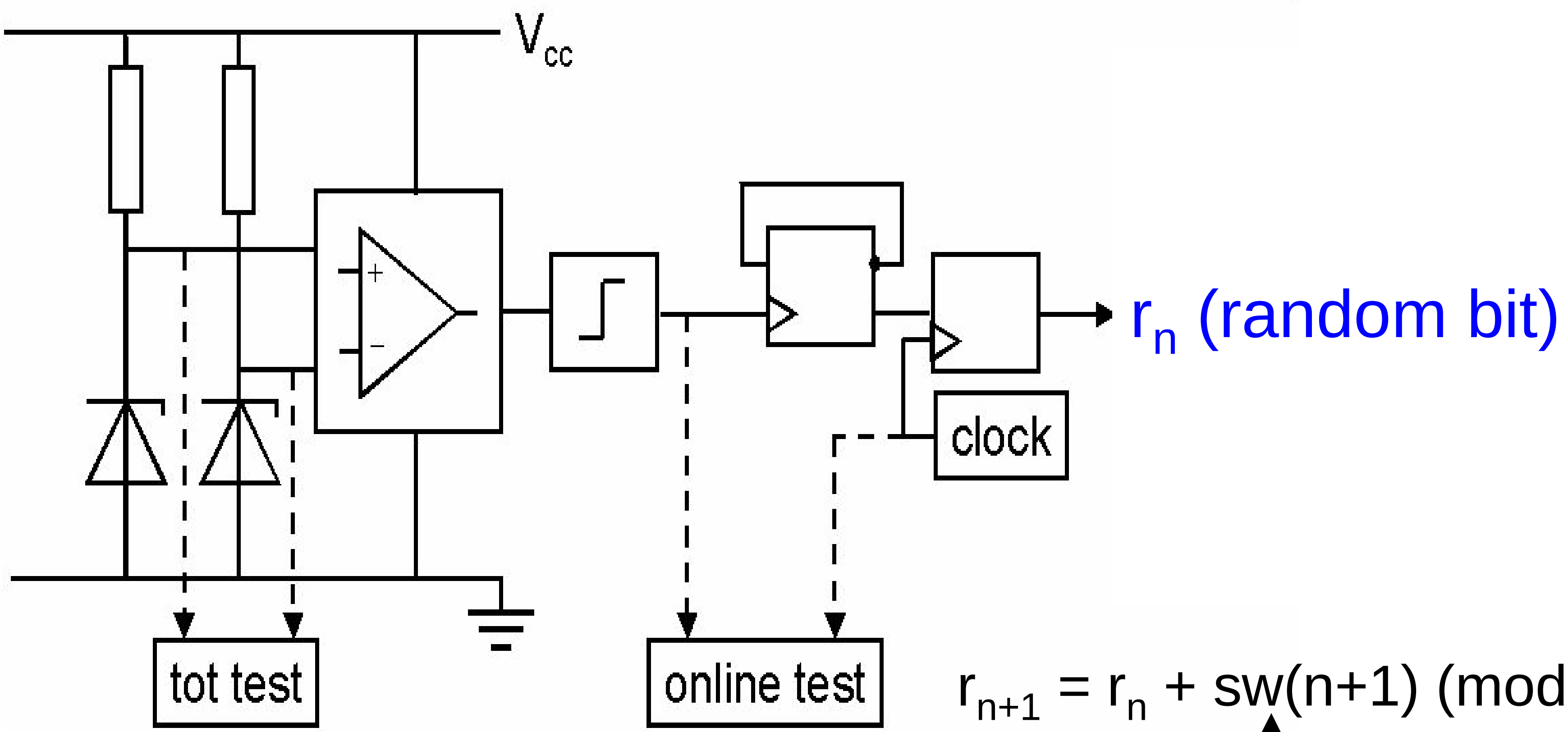
Wolfgang Killmann [1], Werner Schindler [2]

[1] T-Systems GEI GmbH
Bonn, Germany

[2] Bundesamt für Sicherheit in der Informationstechnik (BSI)
Bonn, Germany

Barcelona, May 22, 2007

Generic Design



$$r_{n+1} = r_n + sw(n+1) \pmod 2$$

\# switches in
time period n+1

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Summary

- Goal: Determine the conditional entropy

  $H(R_{n+1} \mid R_1, ..., R_n)$

- We formulated and analysed a stochastic model of the noise source.
- We derived robust entropy estimators, yielding practically useful lower entropy bounds.

Practical experiments:

10^5 random bits / sec (limitations by the USB interface)

entropy / random bit $> 1 - 10^{-5}$

Contact

Wolfgang Killmann
T-Systems, GEI GmbH,
Bonn, Germany
wolfgang.killmann@t-systems.com

Werner Schindler
Bundesamt für Sicherheit in der
Informationstechnik (BSI),
Bonn, Germany
Werner.Schindler@bsi.bund.de