Hardware Security

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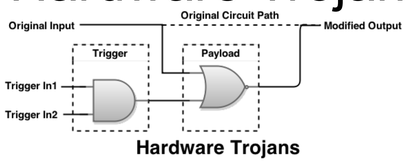
Hardware Trojan Detection



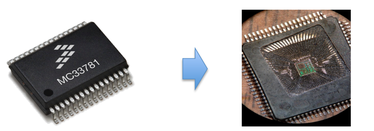
Hardware Trojans

May be inserted at:

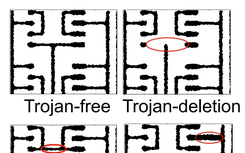
- Design-Time
- Fab-Time
- Test-Time

Foundry-inserted Trojans

Reverse-engineering (RE)

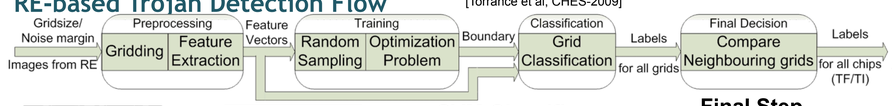


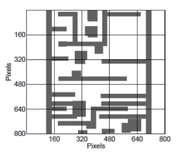
[Torrance et al, CHES-2009]

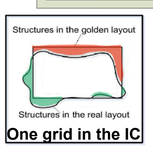


Trojan-free Trojan-deletion Trojan-addition Parametric

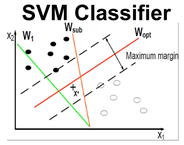
RE-based Trojan Detection Flow



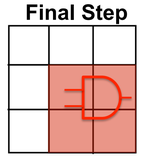




SVM Classifier



Final Step

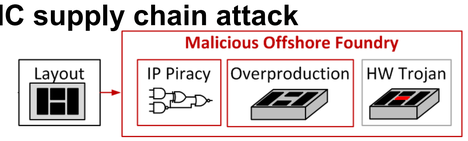


Results

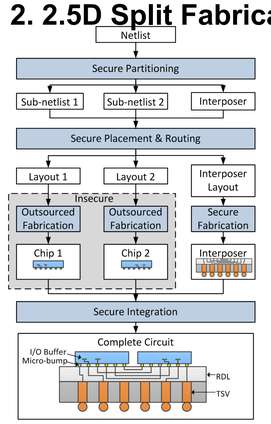
- Detect three kinds
- Accuracy > 99.6%
- False positive <1%

Hardware IP Protection

1.IC supply chain attack

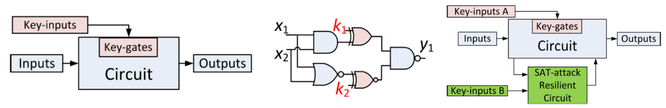


2. 2.5D Split Fabrication



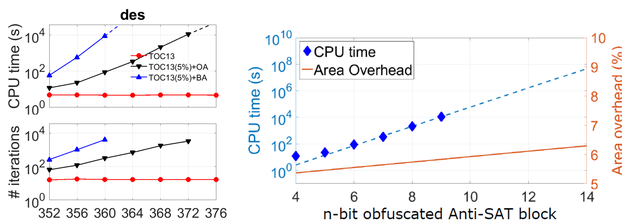
- **2.5D Split fabrication:** The interposer layer can be fabricated separately in a trusted foundry
- **Security-aware Design Flow**
- **Secure partitioning:** function obfuscation
- **Secure Placement:** layout obfuscation

3. Logic Locking



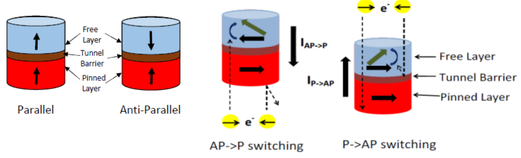
Anti-SAT block: the number of SAT attack iteration λ is an exponential function of key-size k

$$\lambda \geq \lambda_l = \frac{2^{2n}-2^n}{p(2^n-p)} \approx \frac{2^{2n}-2^n}{1\times(2^n-1)} \approx 2^n$$



Side-channel Attack on Emerging Technology

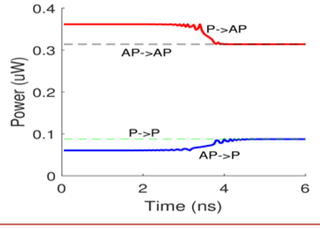
1. Magnetic Tunnel Junction



2. MTJ Switching Characteristics

Spin polarized current can switch states through spin-torque transfer (STT)

Power profiles due to AP to P & P to AP are different !



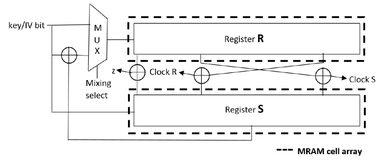
3. Proposed Power Model

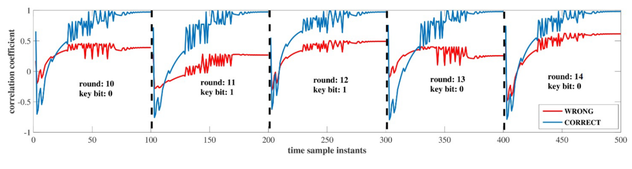
(a) Vertical alignment of power traces

(b) Net variation in power of an MRAM cell:

$$\Delta P_{total}^{align} \propto at_{10} - bt_{01}$$

4. Correlation Power Analysis Attack

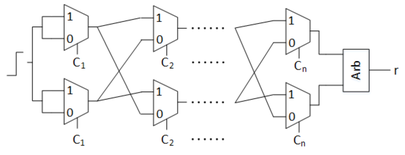




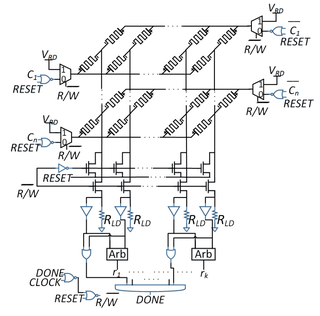
LP Based Attack on Physical Unclonable Functions

Target PUFs

The Arbiter PUF



Memristor Crossbar PUF

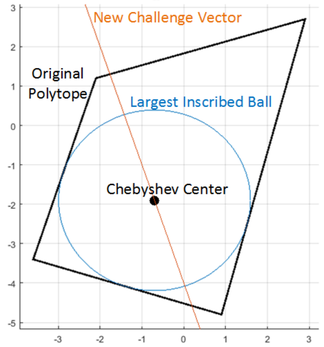


The response is

$$r = \begin{cases} 1 \text{ if } \vec{\Phi}^T \cdot \vec{D} > 0 \\ 0 \quad \text{otherwise} \end{cases}$$

$\vec{\Phi}$: the *feature vector,*

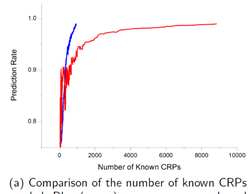
$\vec{D}$: the *weight vector.*



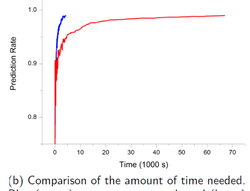
$$\max_{\hat{D},\rho} \rho$$

$$\text{subject to} \quad -r_j \hat{\Phi}_j^T (\hat{D} + \rho \frac{\hat{\Phi}_j}{\| \hat{\Phi}_j \|}) \leq 0$$

$$d_{lb,j} \leq \hat{d}_j \leq d_{ub,j} \quad \text{for} \quad j = 1, 2, \ldots, n+1$$



(a) Comparison of the number of known CRPs needed. Blue (upper) curve: our approach; red (lower) curve: ML approach.



(b) Comparison of the amount of time needed. Blue (upper) curve: our approach; red (lower) curve: ML approach.

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