The Mother Of All Leakages: How to Simulate Noisy Leakages via Bounded Leakage (Almost) for Free

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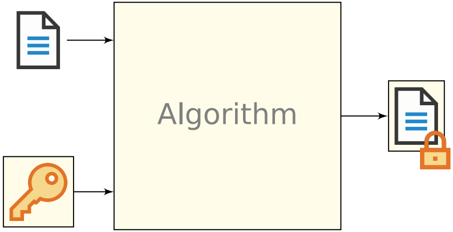
Leakage



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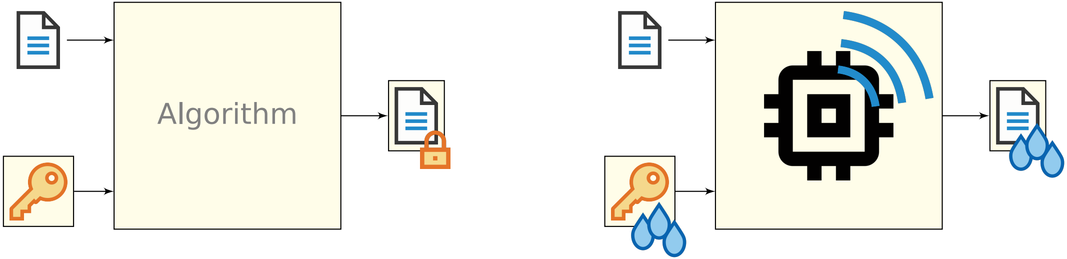

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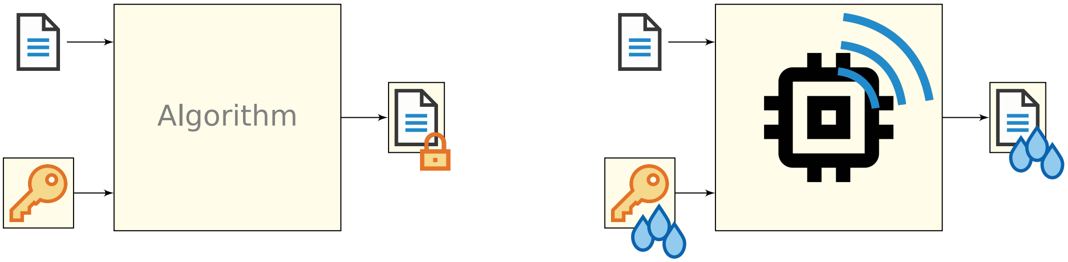
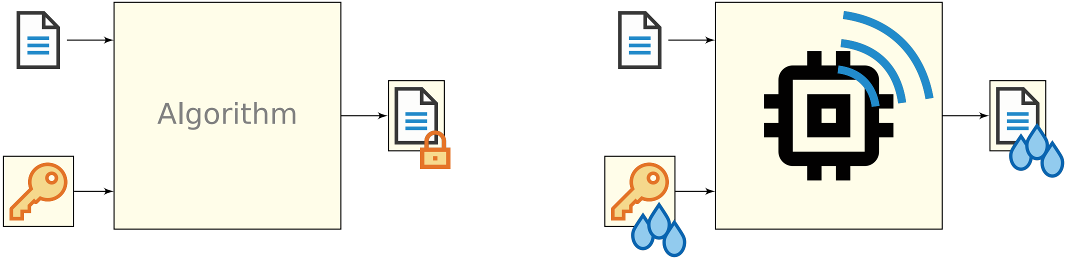


Definition

Given a random variable $X \leftarrow \mathcal{X}$, a leakage function is defined as $f : \mathcal{X} \rightarrow \mathcal{Z}$, where $\mathcal{Z} \subseteq \{0,1\}^*$.
The random variable $Z \leftarrow \mathcal{Z}$ such that $Z = f(X)$ is the *leakage* from X.



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What about $f(x) = x$? Not a valid leakage function!

We need some restrictions on the family $\mathcal{F}$ from which f is chosen...

Leakage models

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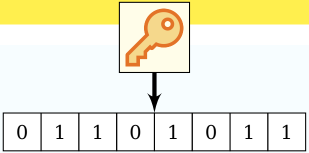

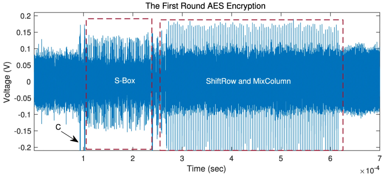

Picture from: *Efficient electro-magnetic analysis of a GPU bitsliced AES implementation [GZC20]*

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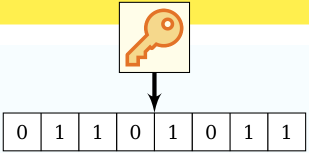
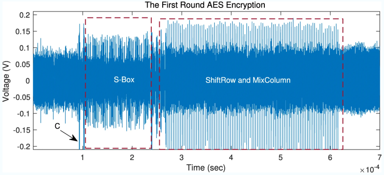


Noisy leakage: The output Z of f is large, but contains a small amount of information about X.



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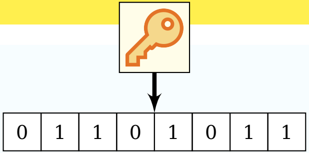

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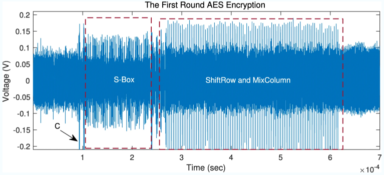
- **U***niform-Noisy leakage:* [DHLW10]
- **S***tatistical-***D***istance-Noisy leakage:* [DDF14, DDF19]
- **M***utual-***I***nformation-Noisy leakage:* [PGMP19]

And much more...



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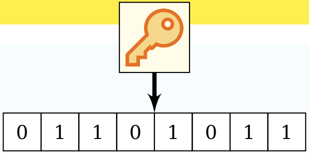

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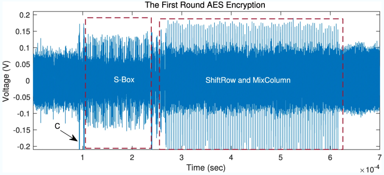

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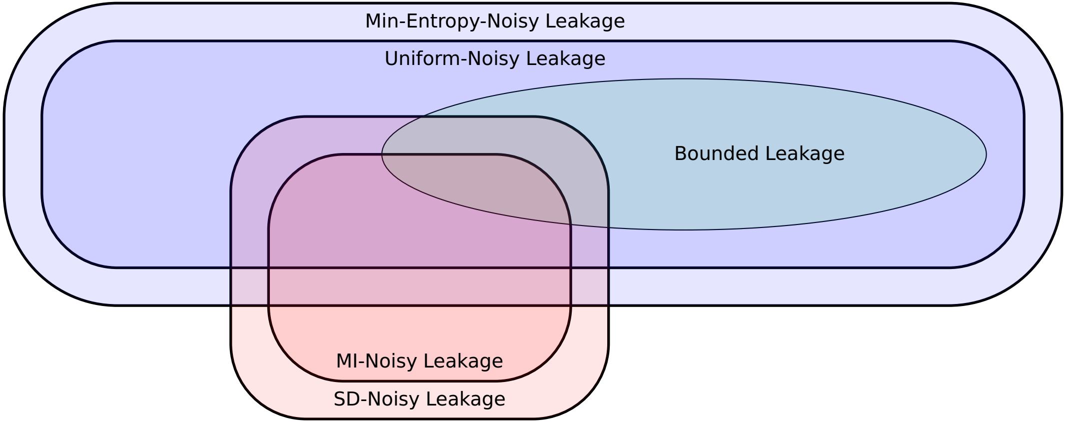
Separations: we give a full picture of separations between all leakage families.

- *SD-ME Separation:* **SD**-noisy leakage is not contained in **ME**-noisy leakage.
- *SD-MI Separation:* **SD**-noisy leakage and **MI**-noisy leakage are not equivalent.

Relations between leakage models



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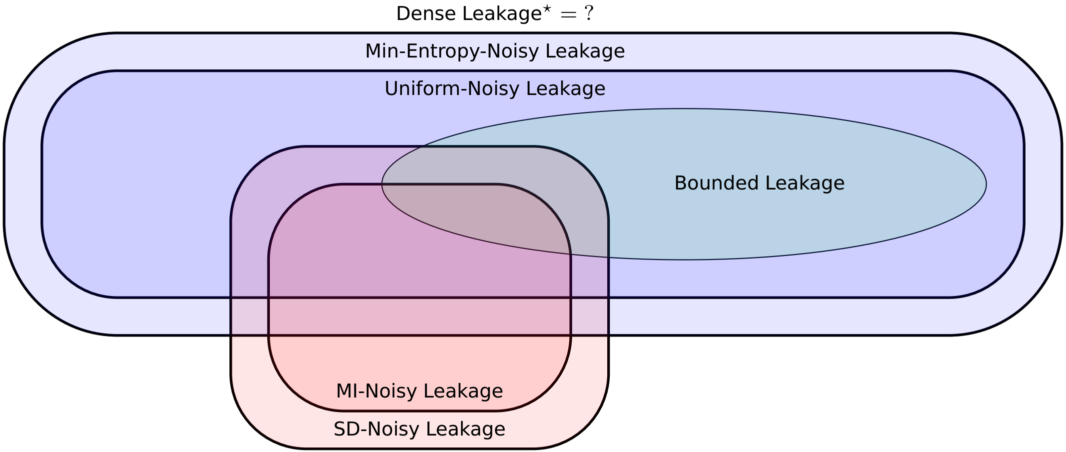

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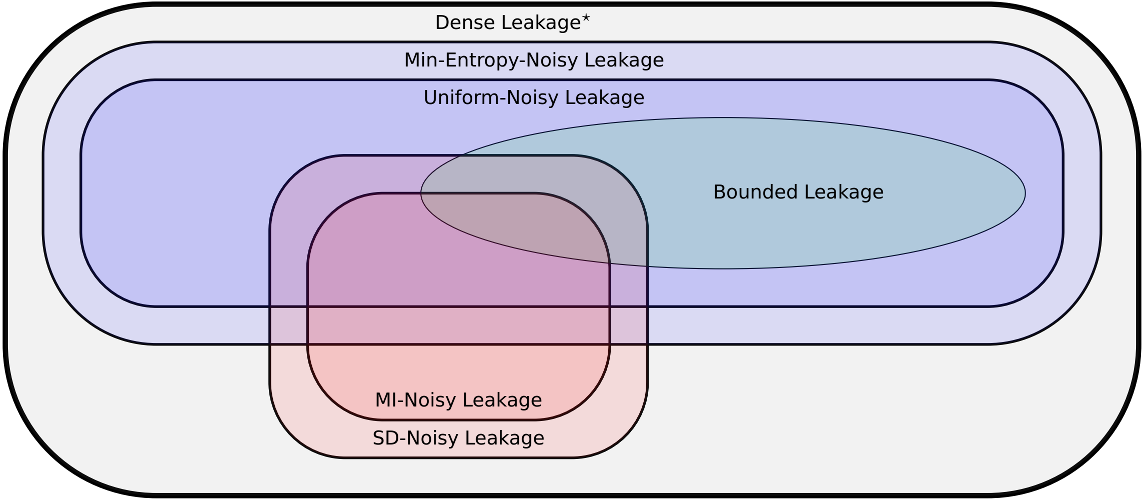

Simulating dense leakage

Simulation paradigm: we say that $\mathcal{F}(X)$ is ε-simulatable from $\mathcal{G}(X)$ if, for all $f \in \mathcal{F}(X)$, there exists Sim_f such that

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Theorem: For arbitrary X and for any $\varepsilon \in (0,1]$, the set of dense leakages $\mathsf{Dense}_{p,\gamma,\delta}(X)$ is $(\varepsilon + \varepsilon^{1/4\delta} + \gamma + p)$-simulatable from $\mathsf{Bounded}_\ell(X)$ with

$$\ell = \log(1/\delta) + \log\log(1/\varepsilon) + 2\log\left(\frac{1}{1-\gamma}\right) + 2$$

Conclusions

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Thank You!