Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Block-Cipher Cascading Strikes Back: Tight Bounds for Security Amplification

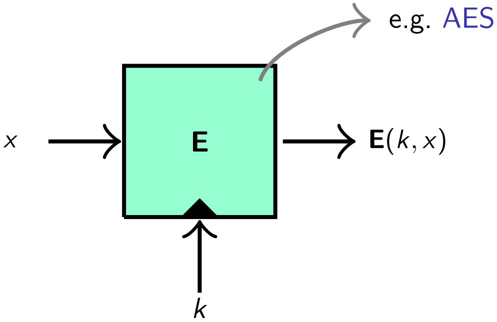
Stefano Tessaro

ETH Zurich

Rump Session EUROCRYPT 2010

Motivation: Block Ciphers

Block Cipher



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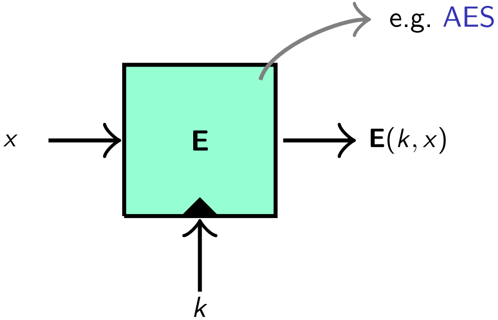
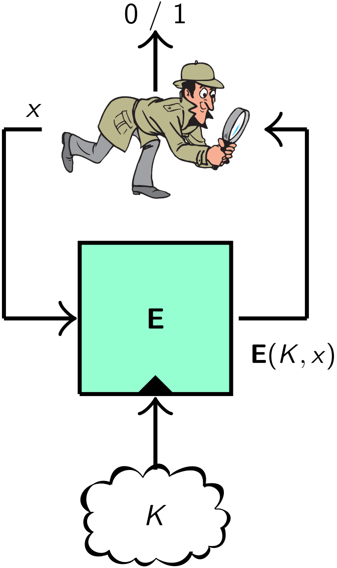


Security notion: **Pseudorandom Permutation**

Motivation: Block Ciphers – Pseudorandom Permutations



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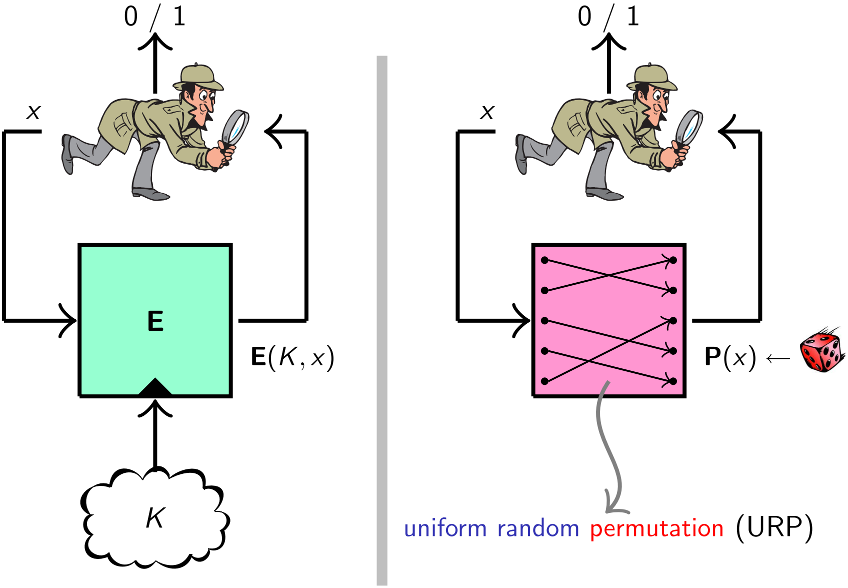

uniform random permutation (URP)

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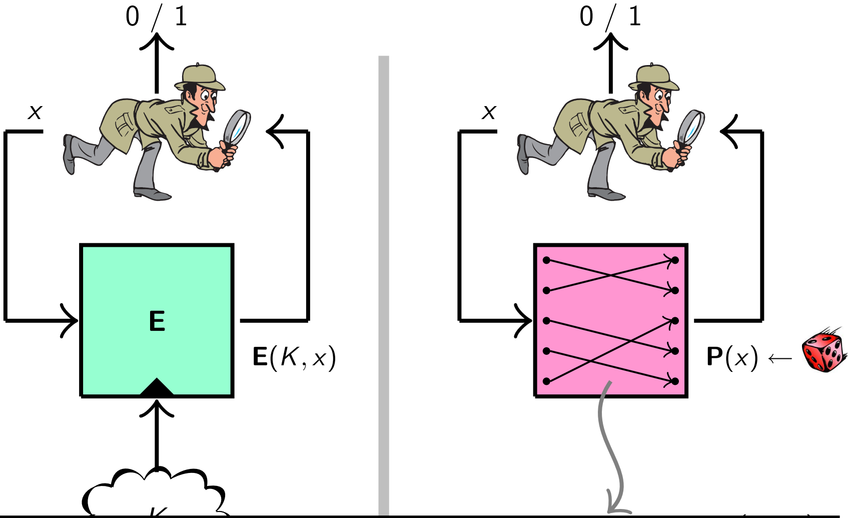
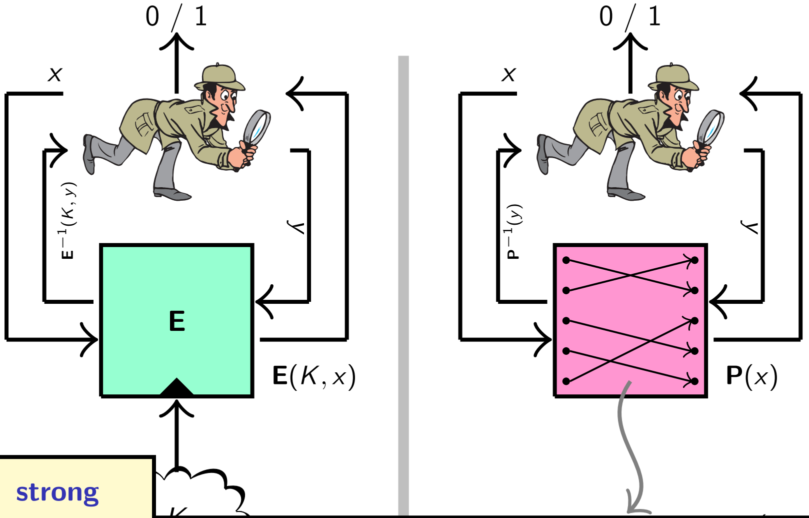


E **PRP** $\Longleftrightarrow$ $\forall$ eff. : distinguishing advantage is **negligible**.

Motivation: Block Ciphers – Strong Pseudorandom Permutations



strong

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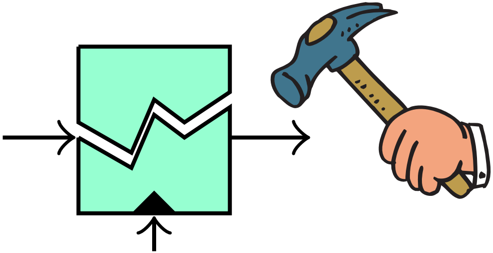
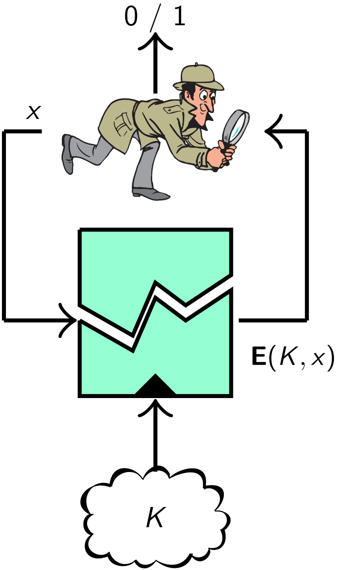
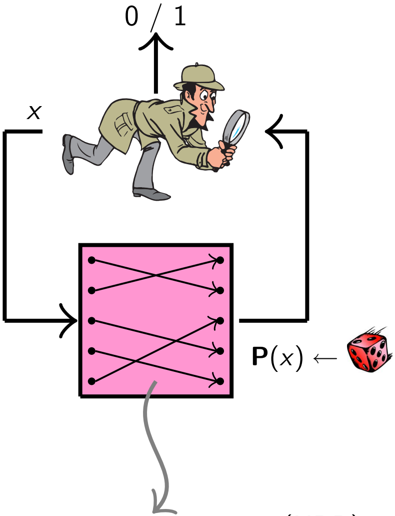
Cryptanalysis

Block Ciphers get broken!



Weak Block Ciphers





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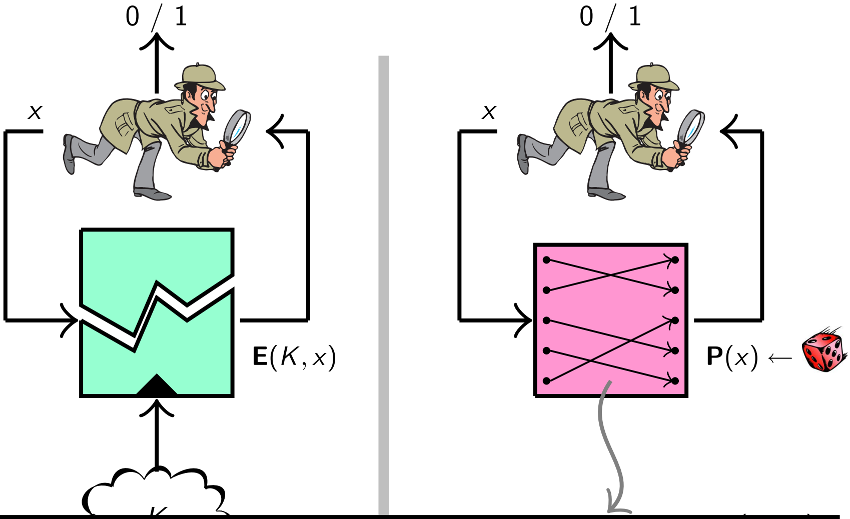

E $\mathcal{E}$-**PRP** $\iff \forall$ eff. : distinguishing advantage is $\leq \mathcal{E}$.

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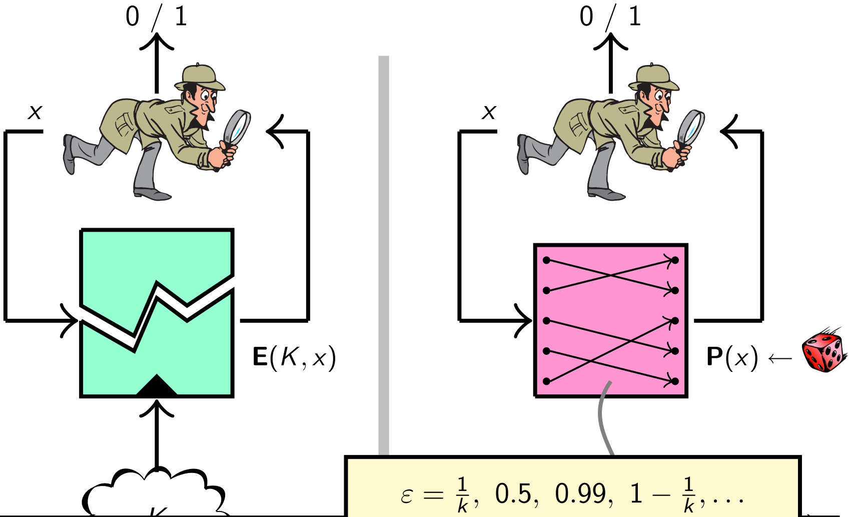

$\varepsilon = \frac{1}{k},\ 0.5,\ 0.99,\ 1 - \frac{1}{k}, \ldots$

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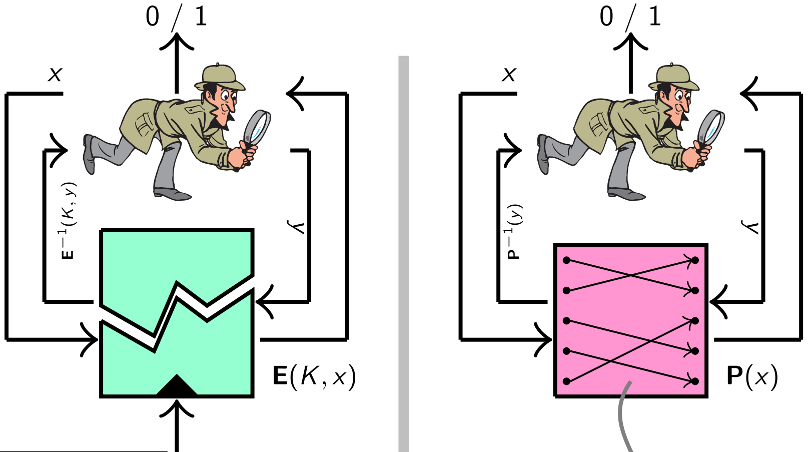

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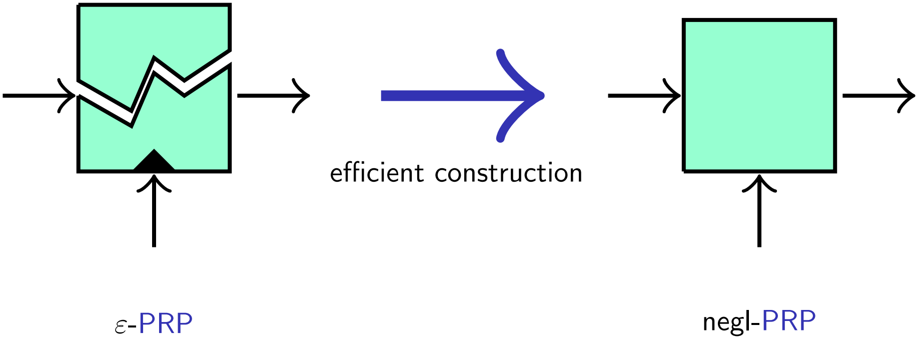
E ε-**PRP** $\iff \forall$ eff. : distinguishing advantage is $\leq \varepsilon$.

Security Amplification

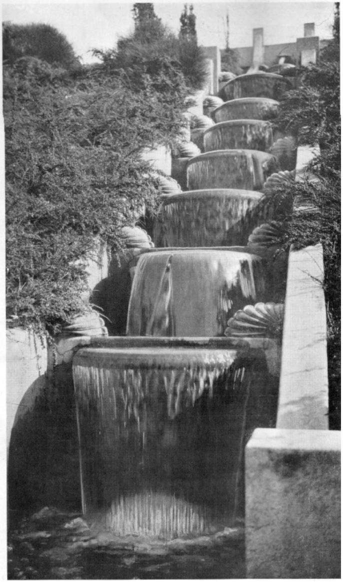


efficient construction

ε-PRP

negl-PRP

Cascades of Block Ciphers



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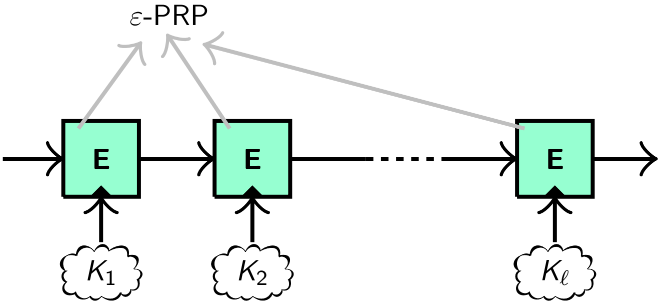

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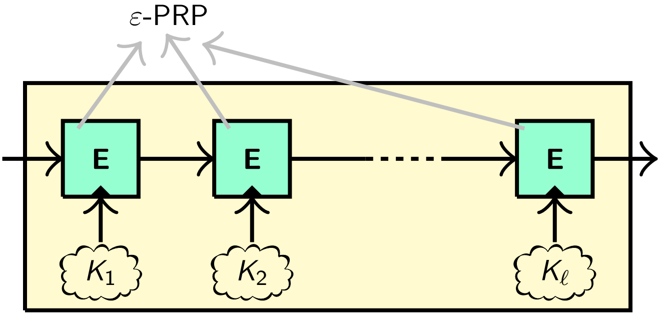

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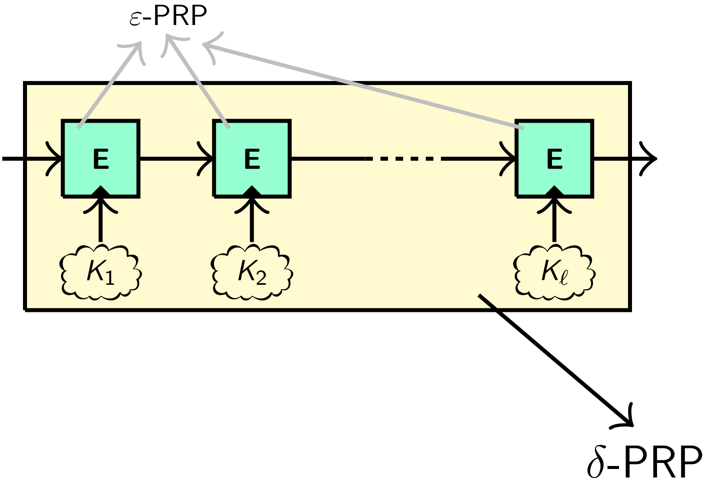

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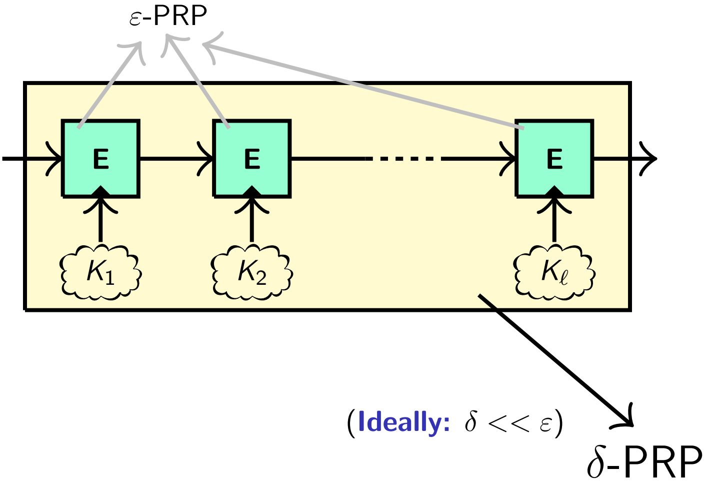
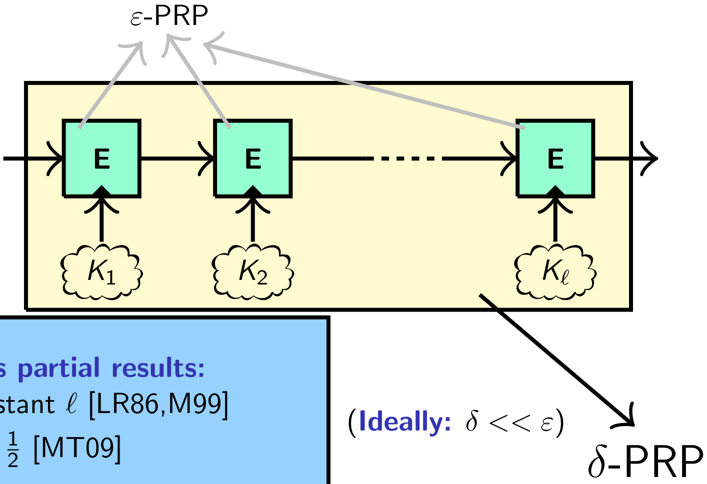


(**Ideally:** $\delta << \varepsilon$)

Cascades of Block Ciphers



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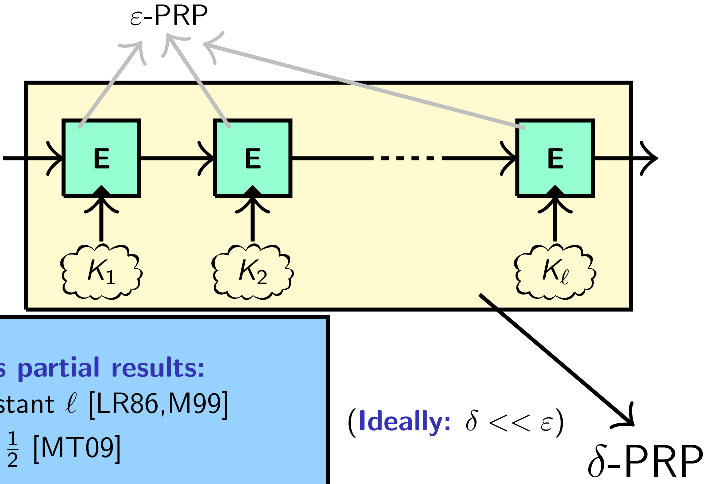
Previous partial results:

- constant ℓ [LR86,M99]
- $\varepsilon < \frac{1}{2}$ [MT09]

Our new bound: ℓ-cascade is $(\varepsilon^{\ell}(\ell-(\ell-1)\varepsilon)+\text{negl})$-PRP



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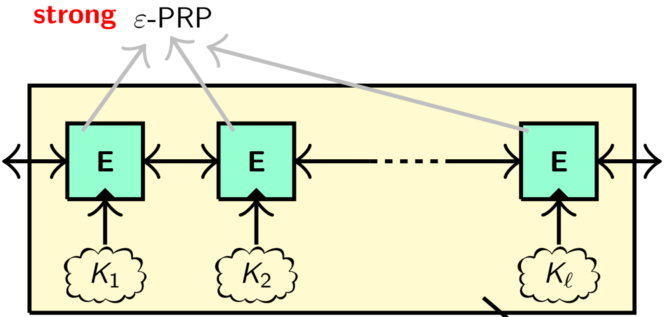

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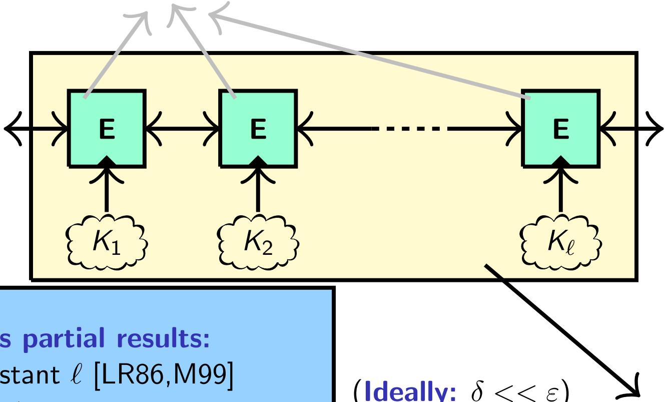

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Security amplification $\forall\ \varepsilon < 1 - \frac{1}{|\text{Domain}|}$

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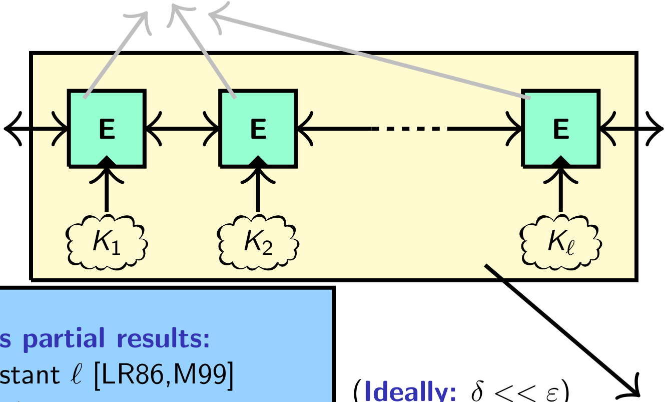

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Conclusions

Final Remarks

- Bounds are **tight**
- **New technique** based on **interactive Hardcore Lemma**

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Paper

"Security Amplification for the Cascade of Arbitrarily Weak PRPs:
Tight Bounds via the Interactive Hardcore Lemma"
`www.crypto.ethz.ch/publications/`