Cryptography against
CONTINUAL MEMORY LEAKAGE

Zvika Brakerski
(Weizmann)

Yael Kalai
(Microsoft Research)

Jonathan Katz
(Maryland)

Vinod Vaikuntanathan
(IBM T J Watson)

Secrets

Information accessible to one party and not to other(s)

essential to cryptography!

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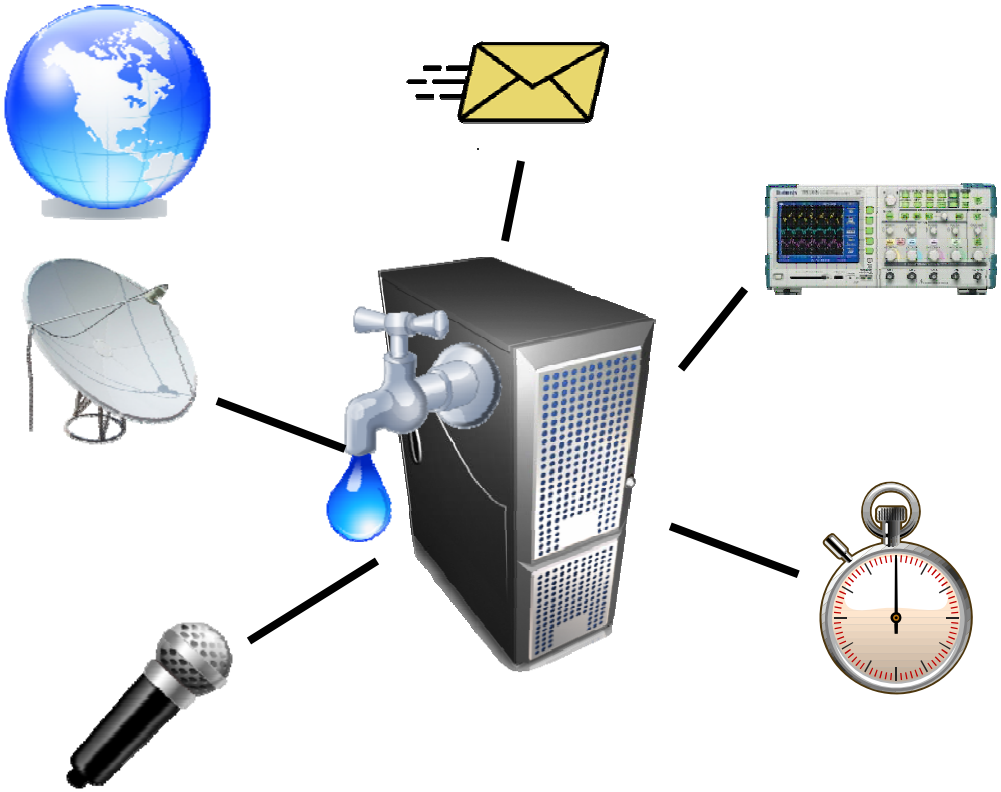
Theory

Real life



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essential to cryptography!

Theory

Real life

Secrets leak!

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- From **EVERYWHERE**
  - HD, RAM, cache, registers, randomness…
- **ALL THE TIME**
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“Only Computation Leaks”

[Micali-Reyzin’04]

“Memory Leakage”

[Akavia-Goldwasser-V’09] inspired by cold-boot attacks [HSH+08]

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Assumes a form of secure memory

Which does NOT leak as long as no computation is done on the data

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Everything leaks

… but only ONE-SHOT

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+ Work on restricted leakage functions [Riv,CDHKS,ISW,FRRTV]

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This work:

remove these restrictions!

Our Model: Continual Memory Leakage

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$L_1(sk)$

1 0 1

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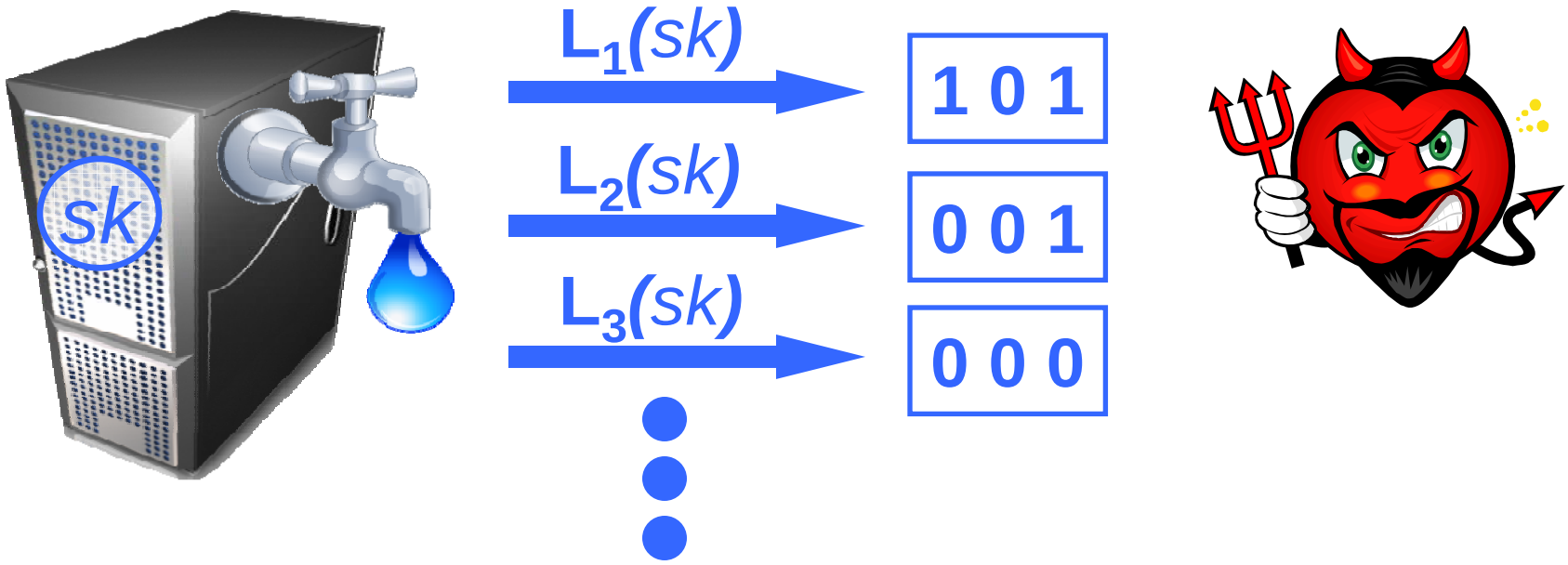

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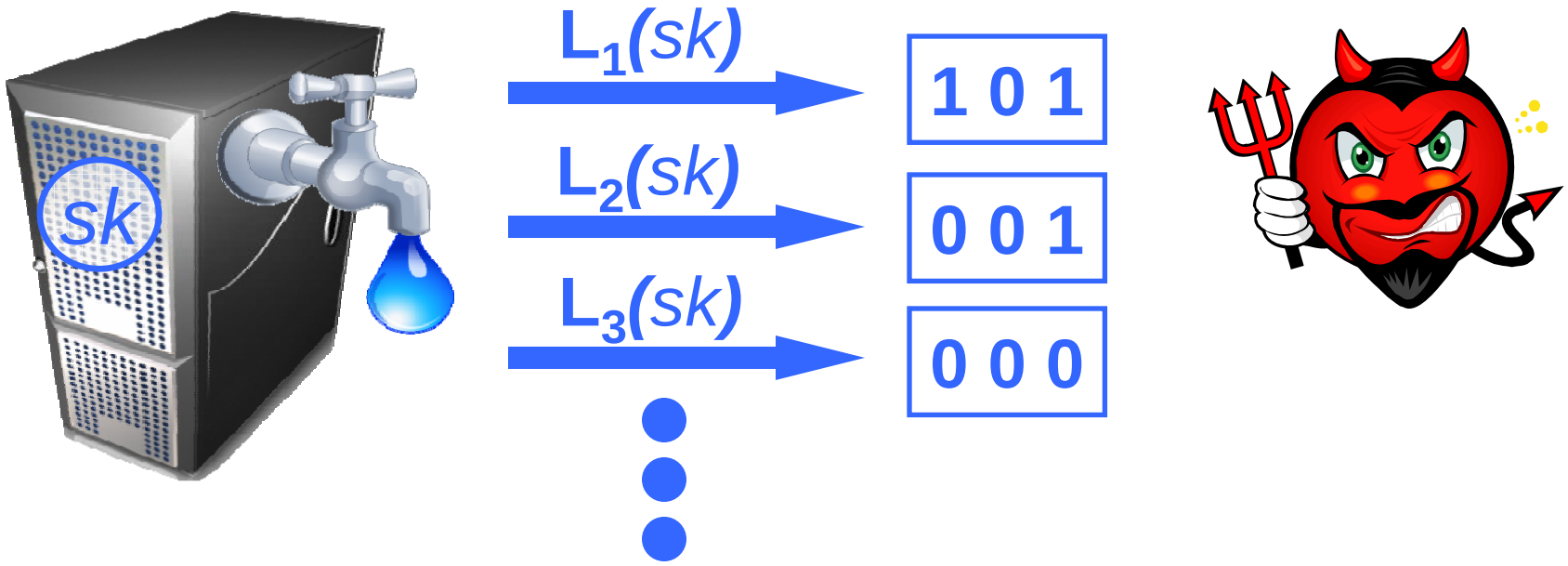

Can we protect against continual leakage?

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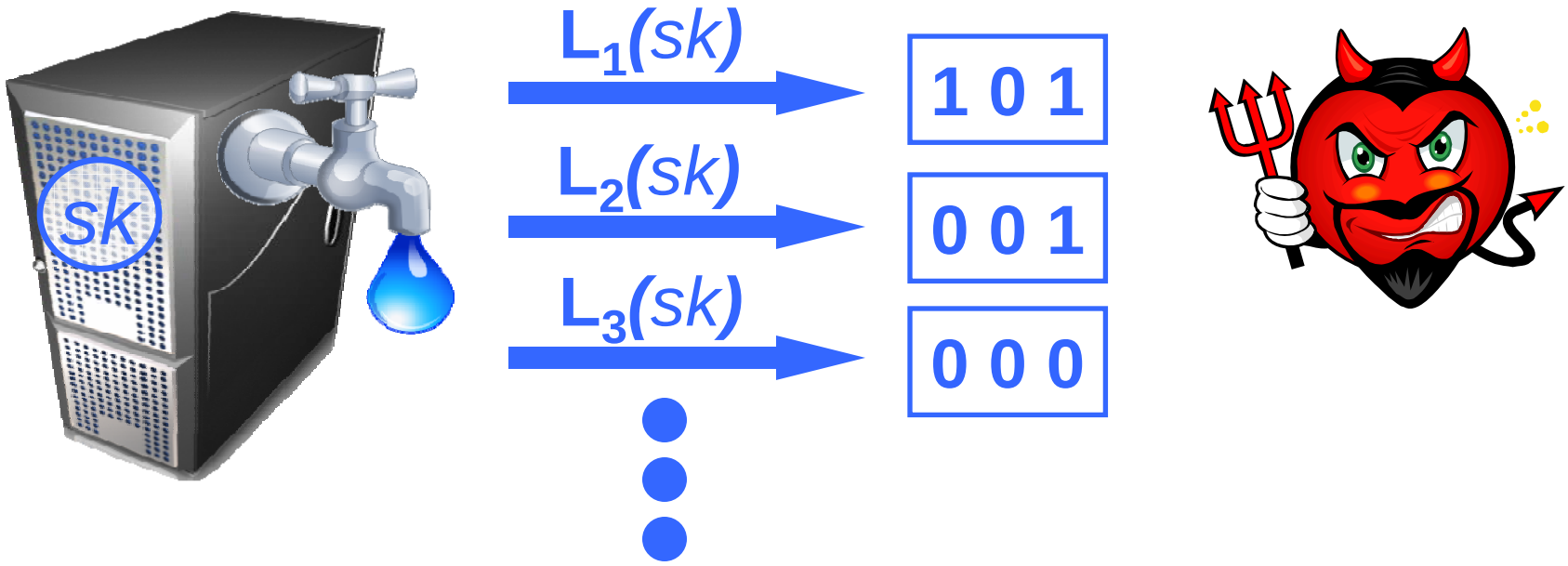

Can we protect against continual leakage?

Need to (periodically) update ***SK***.

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$L_1(sk_1)$

1 0 1

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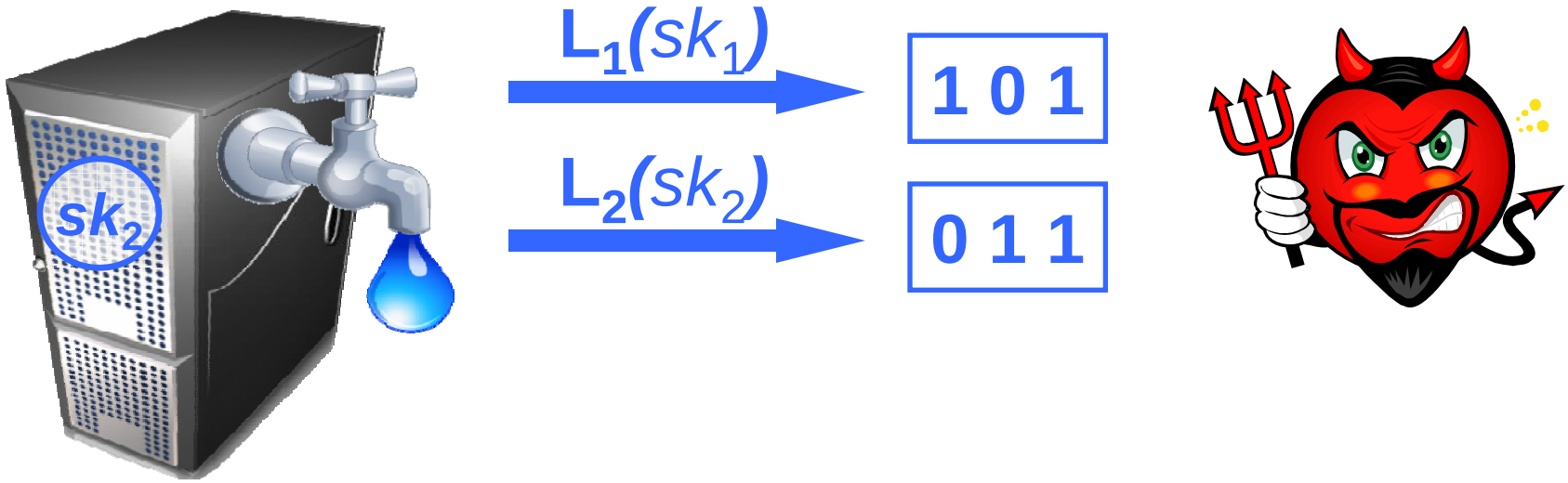

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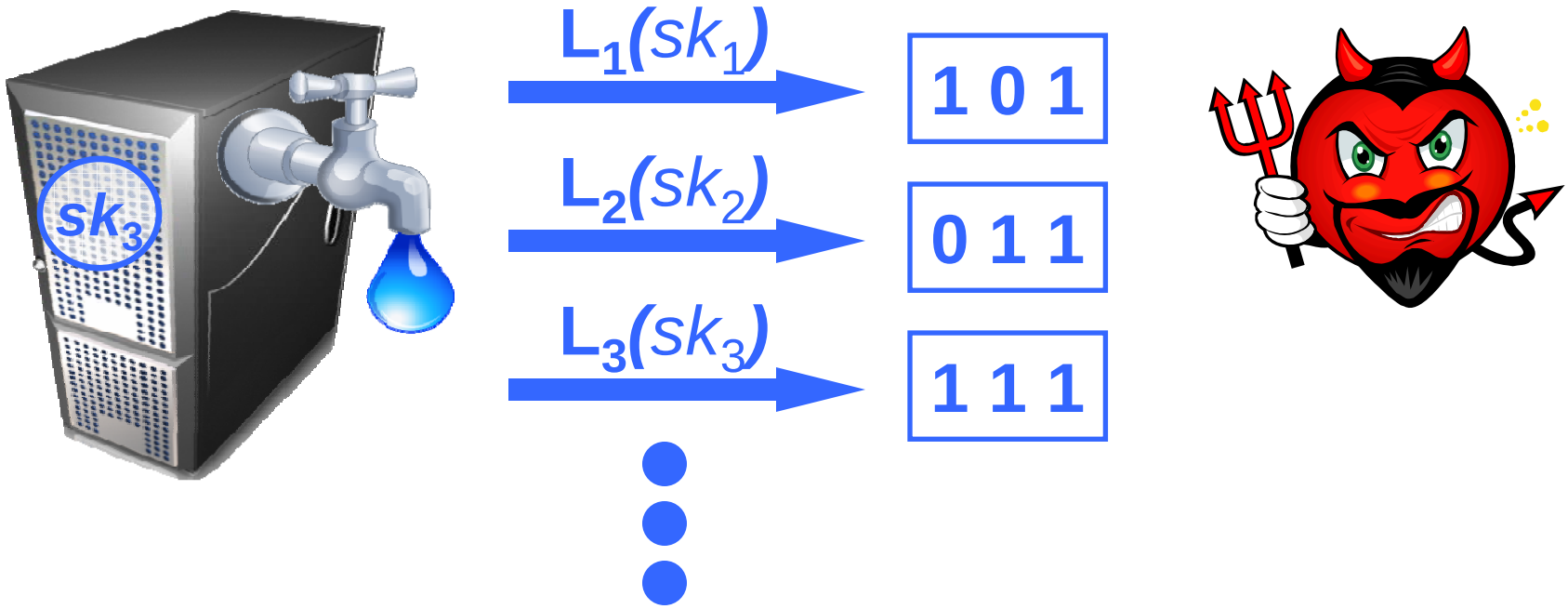

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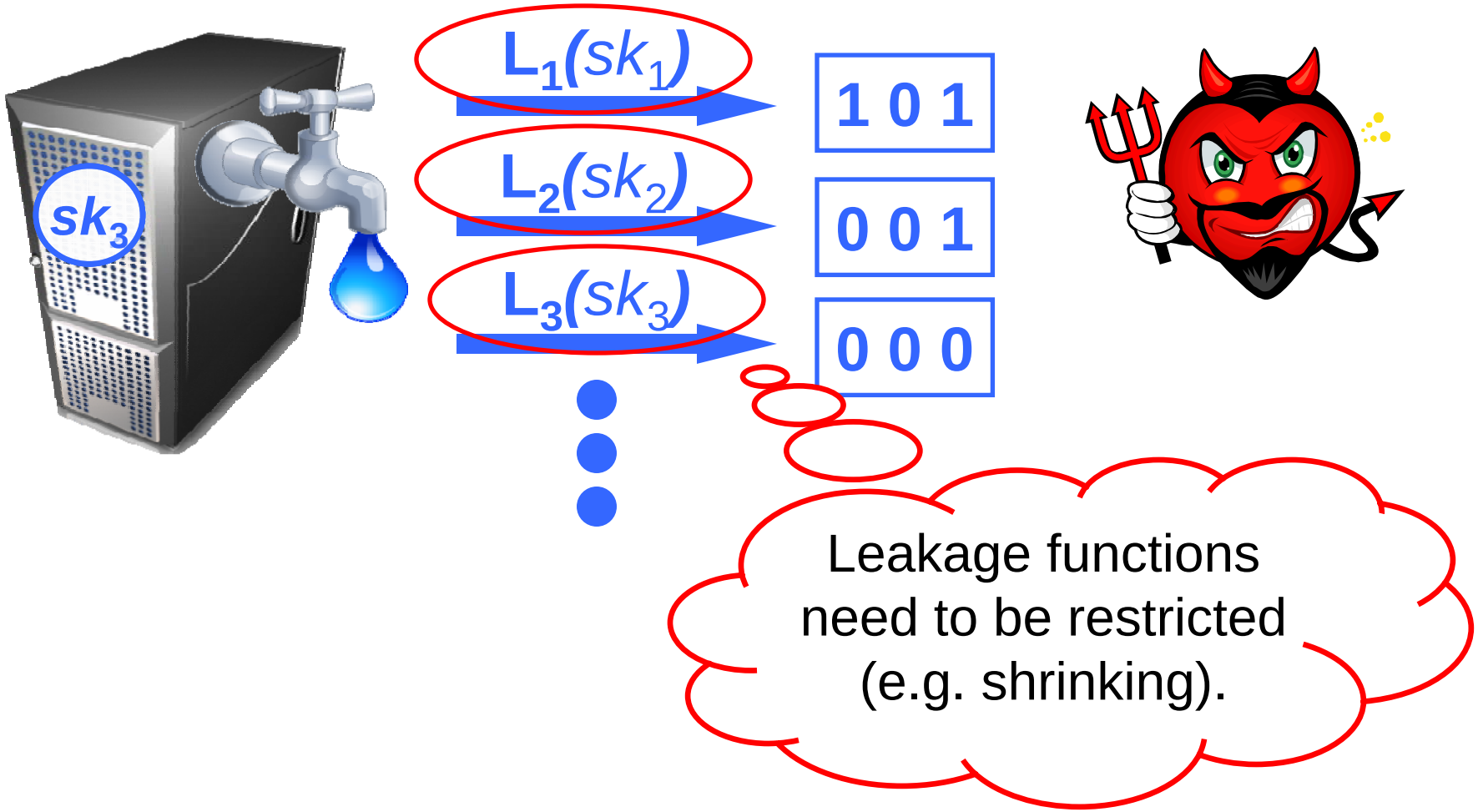

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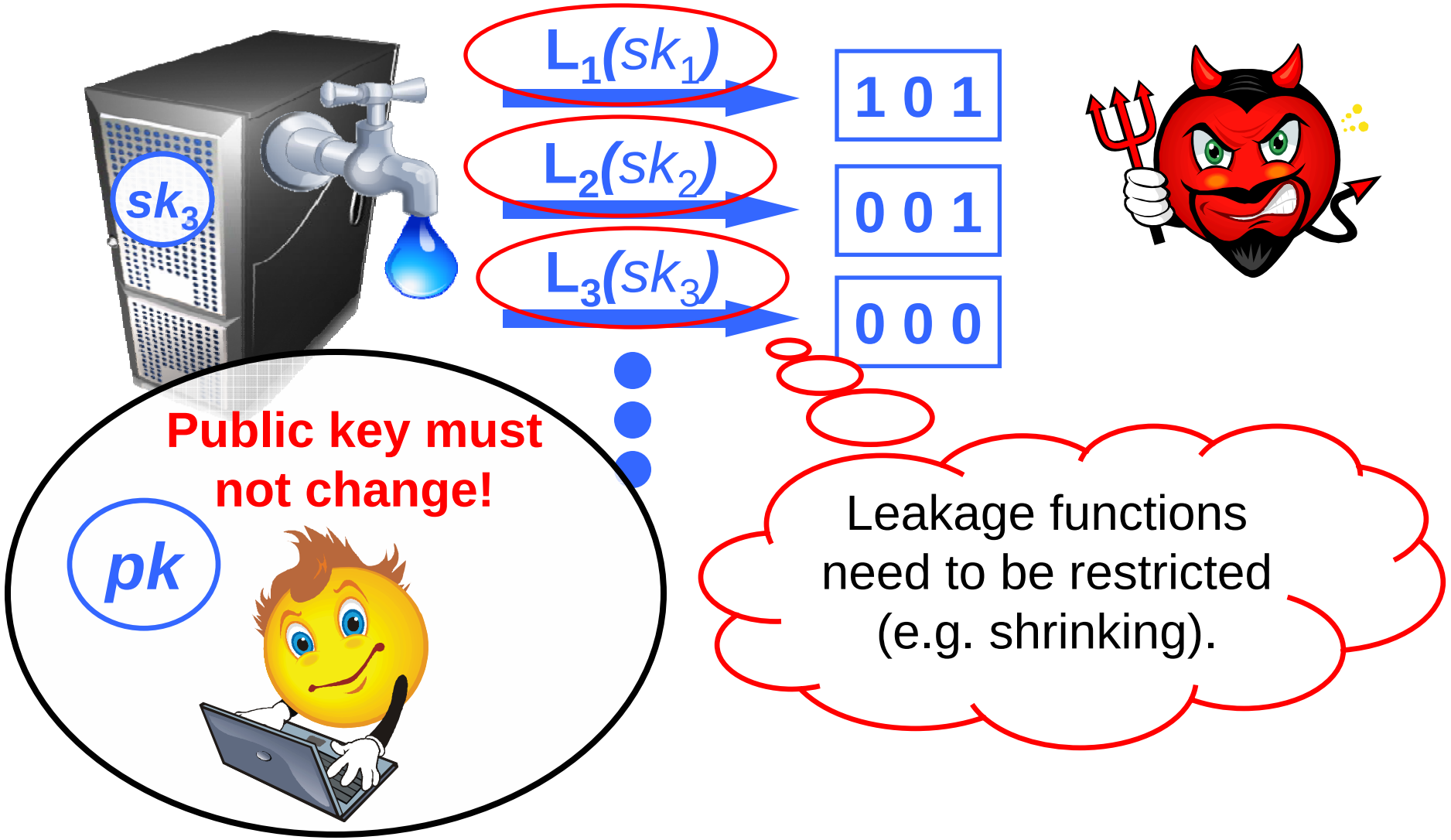

Features of Continual Memory Leakage (CML)

- Leakage function applied to **entire** memory
- Key updates are oblivious to users (public key doesn't change).
- Leakage can occur at any time point!
  - Including during key updates.
  - Including during decrypting/signing.
- Total amount of leakage – **unbounded**.
  - Only the rate (leaked bits/sec) is bounded.

Our Results: Cryptography in the CML Model

- **Public-key encryption.**
  - **Linear assumption:** leakage rate (1/2-o(1)).
  - **SXDH assumption:** leakage rate (1-o(1)).
  - **KeyGen and Update:** logarithmic no. of bits.
- Identity based encryption.
- Encryption $\Rightarrow$ Signatures.

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Previously not known even in the Micali-Reyzin model!

(under standard assumptions)

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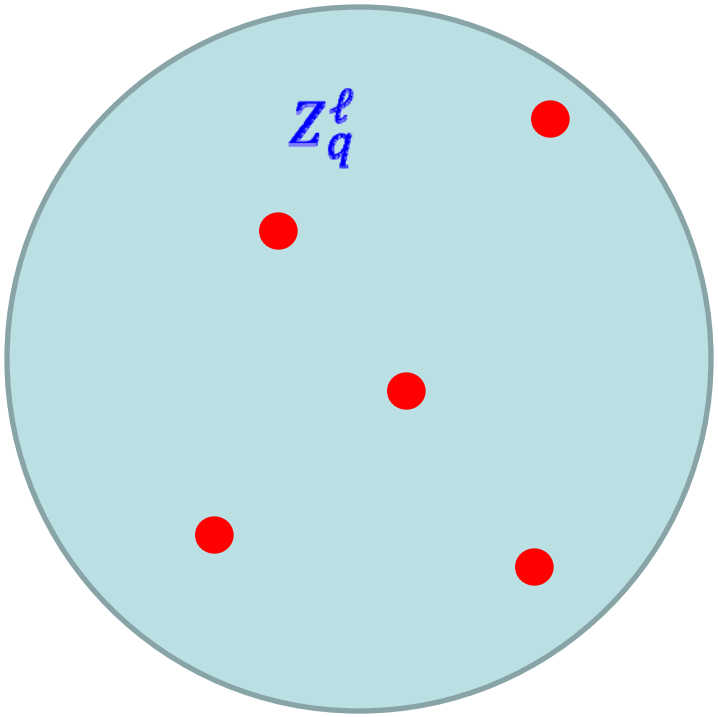
Concurrently [DHLW]: *efficient* signatures, ID schemes and AKA in the CML model under linear and SXDH.

- Different techniques (re-randomizable NIZK).

A Sneak Peek

Lemma: Random Subspaces are Leakage-Resilient



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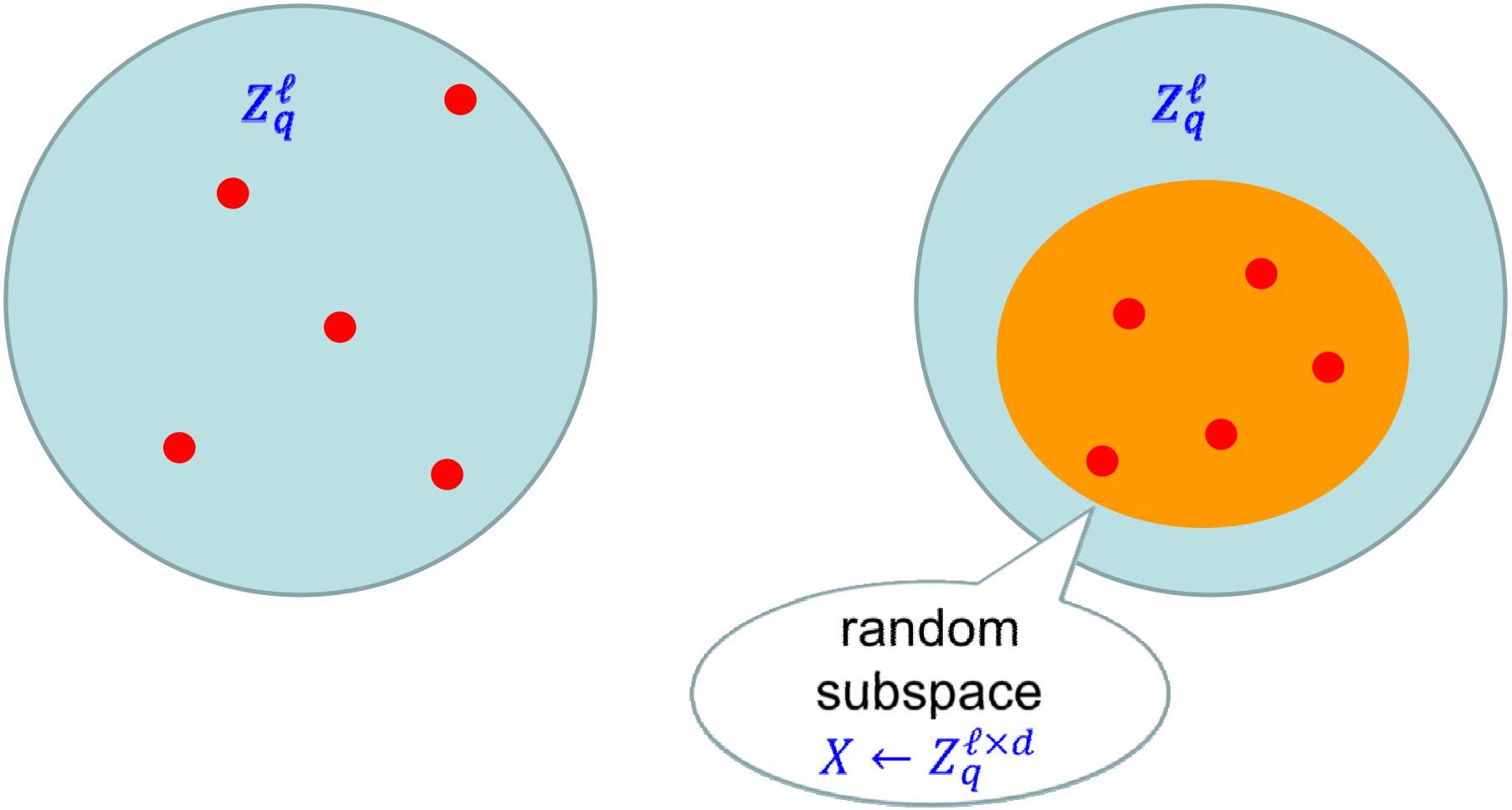

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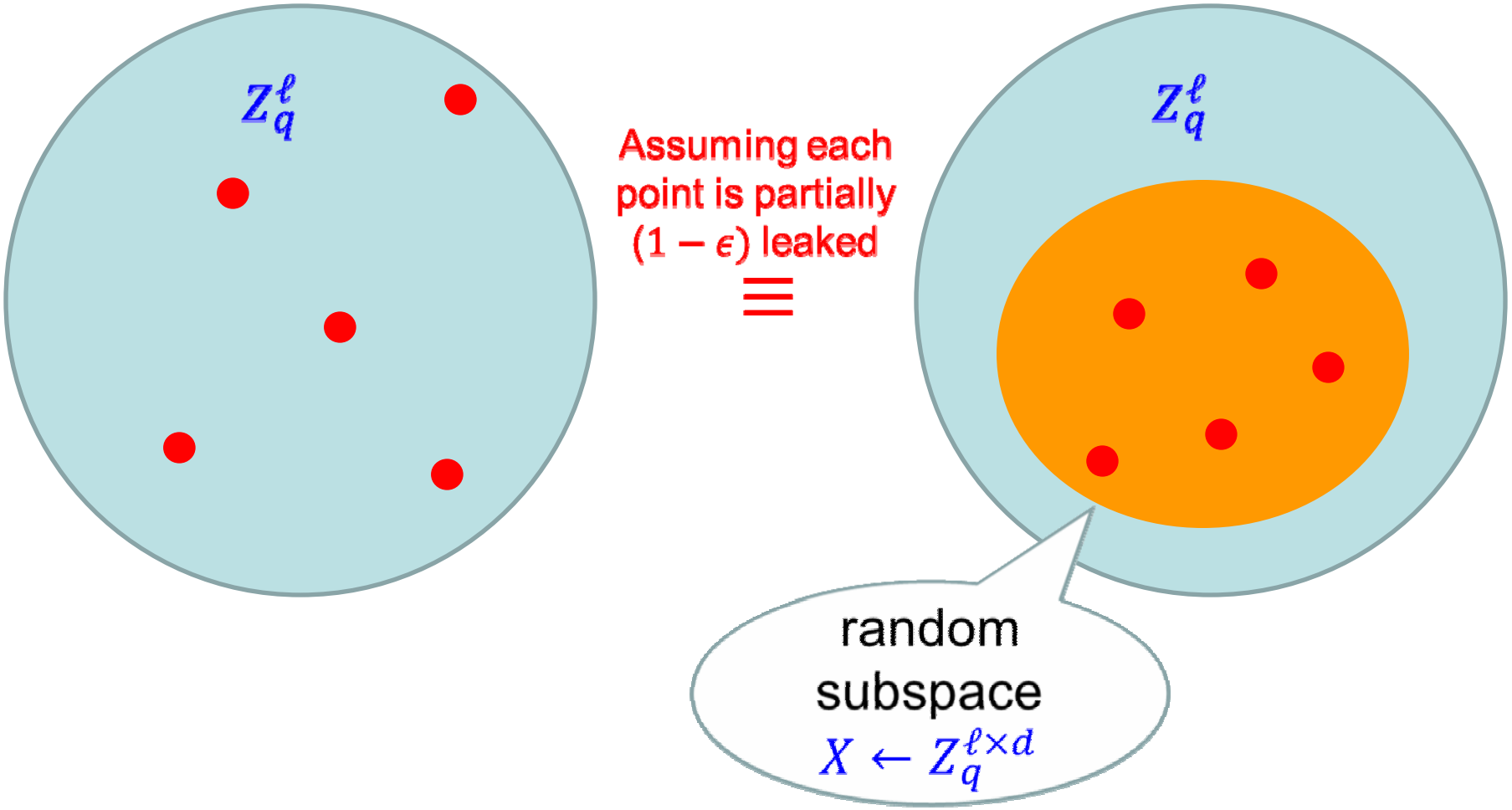

Paper on Eprint:

“Cryptography against Continual Memory Leakage”, http://eprint.iacr.org/2010/278.