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1632

Revocable Timed-Release Encryption

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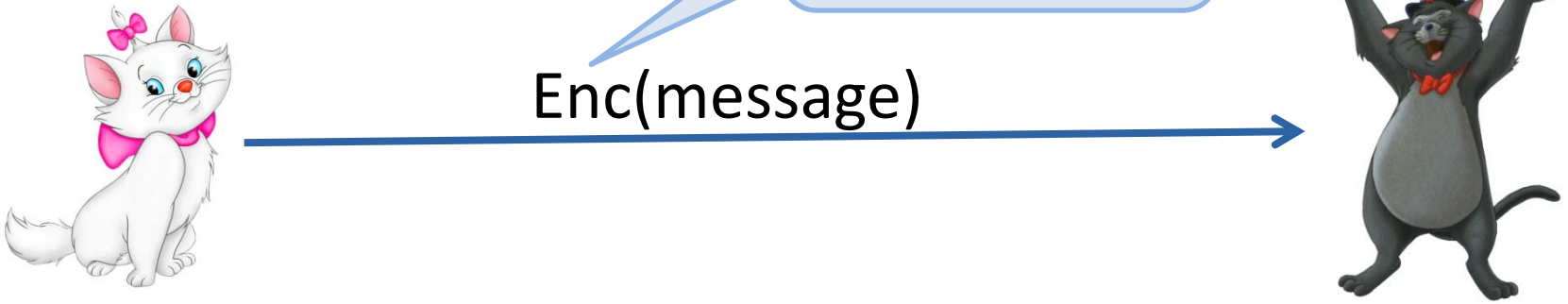
Motivation

- Want to send a message
- Opens at a particular date
- No earlier opening!

Time Vaults

Physical solution:

Digital solution:



Required properties

- Can be decrypted in time t
- Cannot be opened in time (much) smaller t

Challenges:

- Very precise hardness assumptions
- Knowledge of adversary hardware
- Non-parallelisable
- Quantum secure

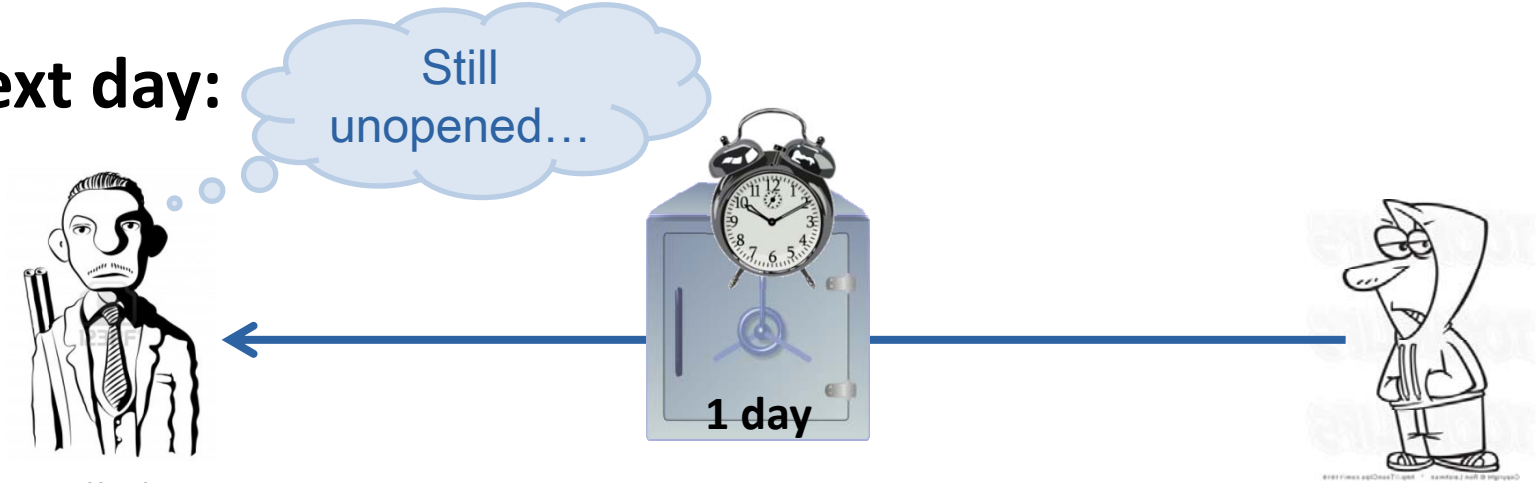
For this talk: Assume that's solved.

Another application

meets with mafia

"a friend"

Next day:



still alive

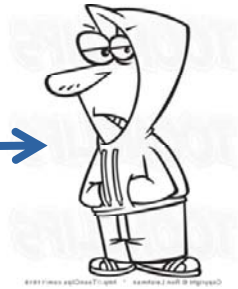
"a friend"

Using digital time vaults…

meets with mafia

Enc(msg)

(2 days)



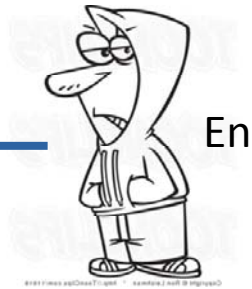
“a friend”

Next day:

still alive

Enc(msg)

(1 day)



Enc(msg)

“a friend”

Revocable time vaults

- Physical time vaults have “revocability”
  - Before timeout, possible to “give back”
  - Recipient can keep time vault, but will be detected
- Digital time vaults:
  - Recipient can always keep copy
  - And continue decrypting the copy

Quantum No Cloning?

Example applications

Deposits: Put digital money in TRE. Hand it back upon return.

- Useful for fair MPC also?

Data retention with verifiable deletion: Keep user data for legally mandated time, provably delete afterwards.

Unknown recipient encryption: Send a message to unknown recipient. Recipient knows no-one else got it.

- More unexpected applications of revocable TRE?

Quantum Time Vaults

$\mathbf{Enc}(B)$ $|msg\rangle_B$

- Message *msg*
- Random basis *B*

Classical time vault

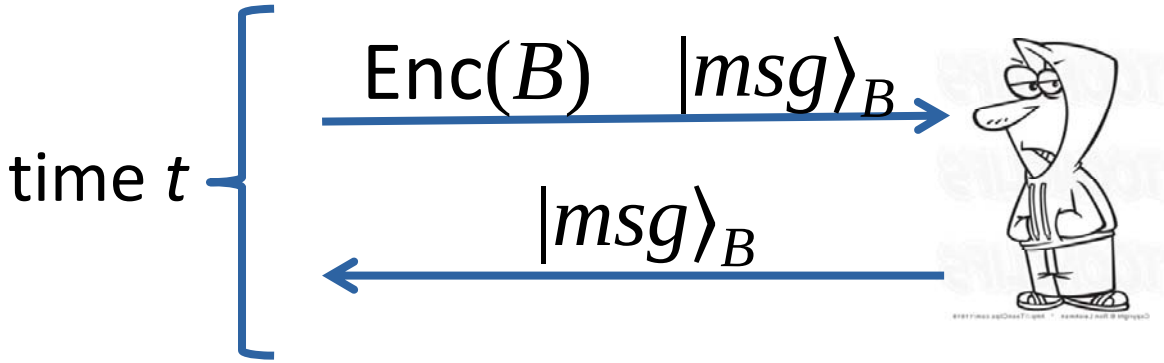
Quantum encoded msg

Revocation:

$|msg\rangle_B$

- Check if state unmodified

Naïve Proof



Recipient does not know B before time t

⇒ Can't copy msg before time t (no cloning)

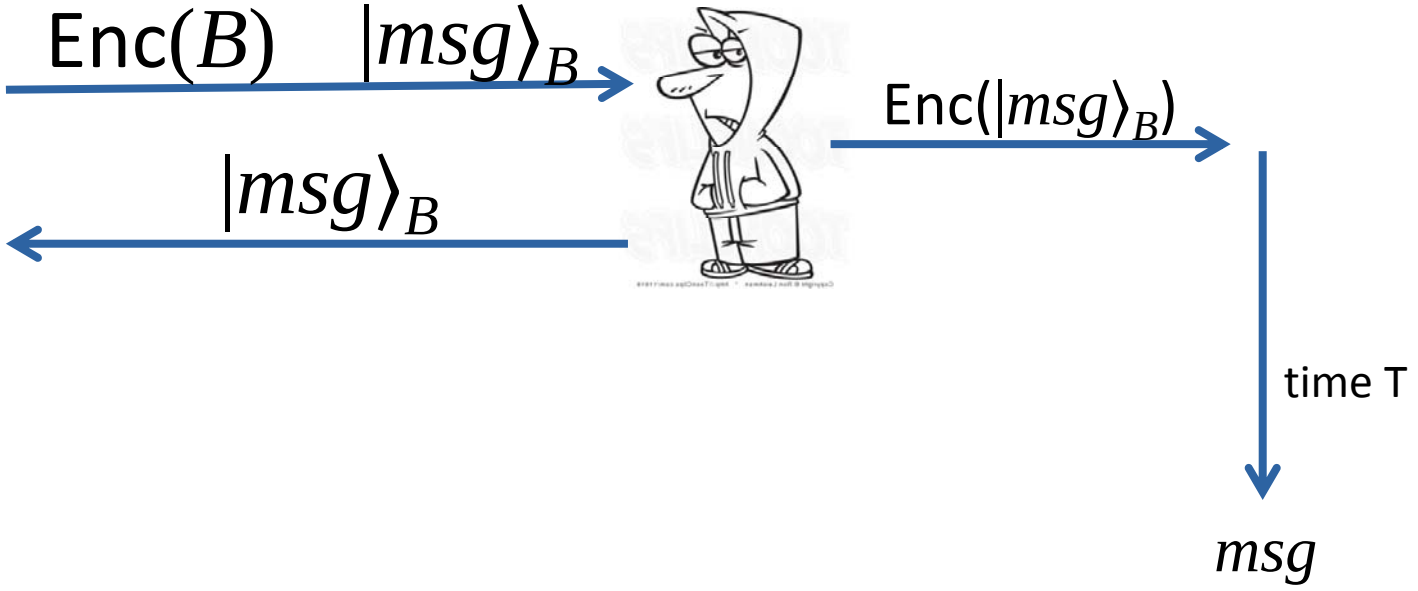
⇒ Won't have msg after revocation

⇒ Secure

"Theorem": Without knowing B, impossible to transform $|msg\rangle_B$ into $|msg\rangle_B, |msg\rangle_B$

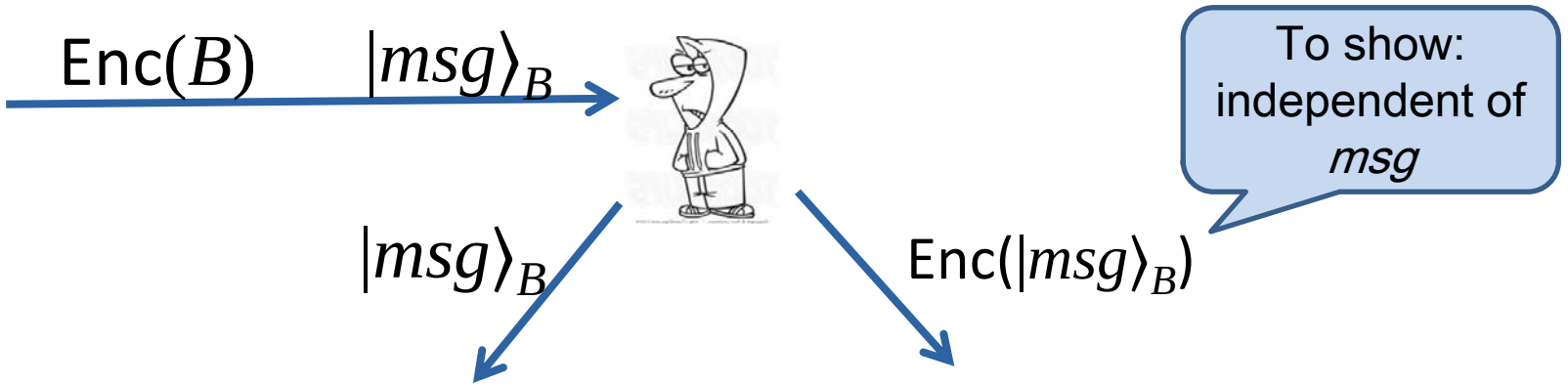
Naïve Proof – criticism

Perhaps “encrypted cloning” is possible?



Proof idea

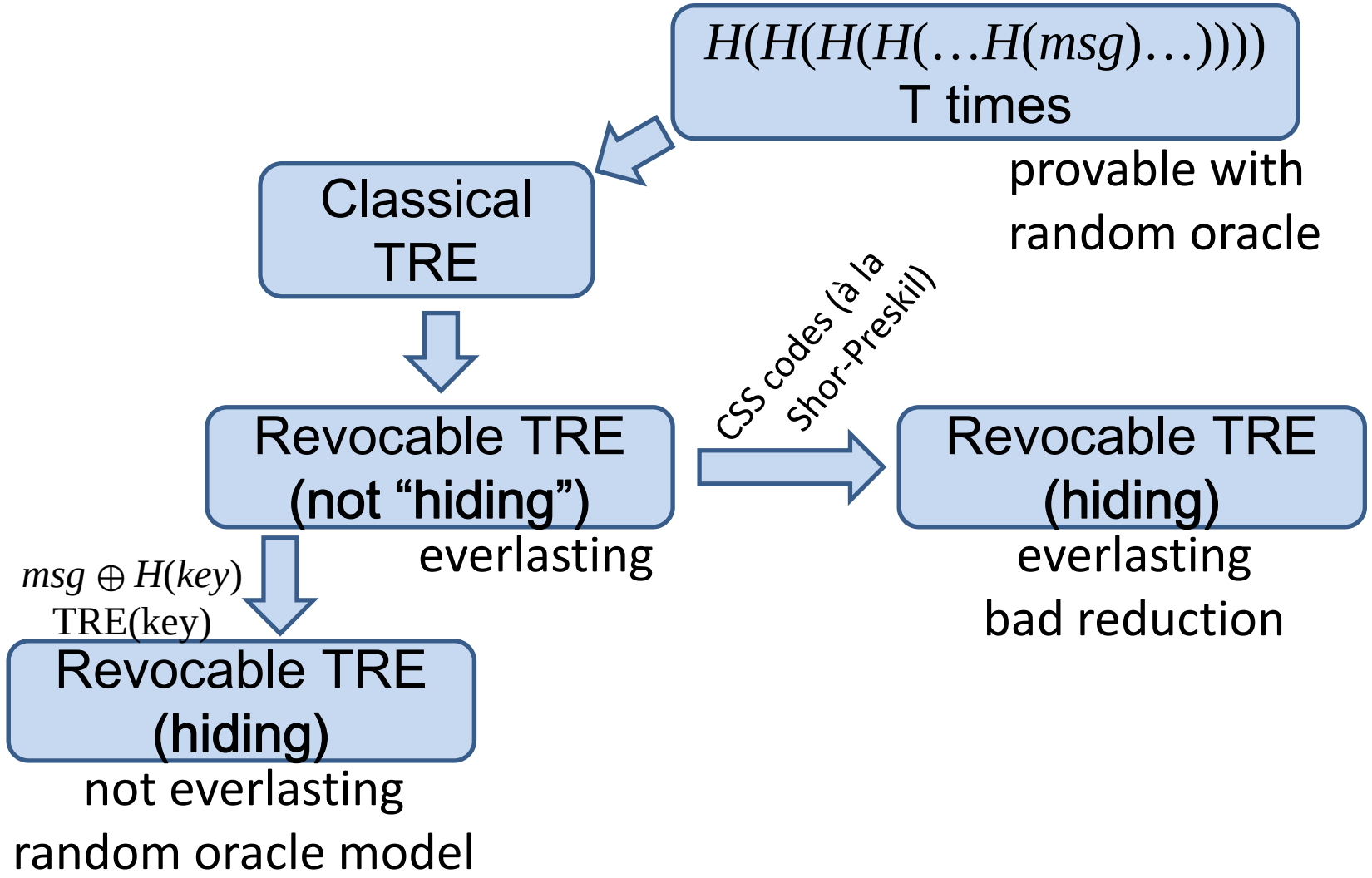
- Need to show: no "encrypted cloning"



- "Independence of msg": not T-time testable
- "$|msg\rangle_B$" maximally entangled with environment: T-time testable!

$\Rightarrow$ Unentangled with Enc($|msg\rangle_B$)

The big picture



Conclusions

- Revocable time vaults
  - Gap between quantum and classical crypto
- Useful building block in crypto protocols?
  - Unknown recipient encryption
- Technique: Giving back data → other applications?

Open questions

- Classical TRE schemes.
  - $H(H(H(H(\ldots H(msg)\ldots))))$: encryption takes long
  - Rivest-Shamir-Wagner: not quantum secure

- Efficient reduction for revocable hiding TRE in standard model.

I thank for your attention

Logo soup

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