He-HTLC: Revisiting Incentives in HTLC

Sarisht Wadhwa

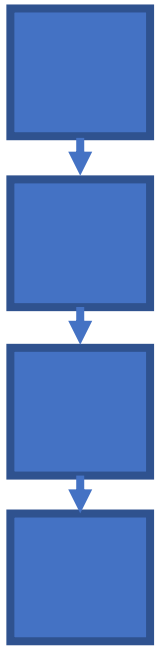
Joint work with Jannis Stöter, Fan Zhang, Kartik Nayak

Duke
UNIVERSITY

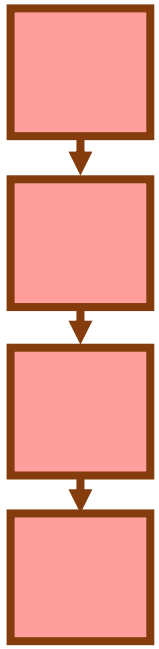
Cross-Chain Atomic Swap

Aim: Exchange assets on Chain 1 for some assets on Chain 2

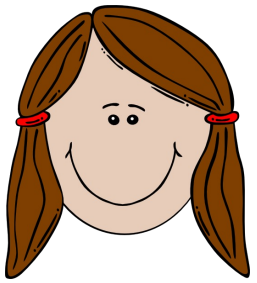
Bob



Ethereum



Bitcoin



Alice

HTLC: Hashed Time Lock Contract

Reveal secret to get paid

If no one releases secret until timeout, then refund.

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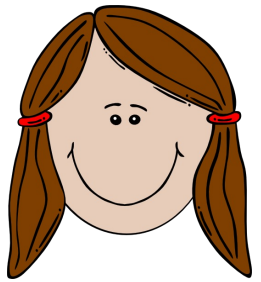
Bob
(Payer)

Deposit/create



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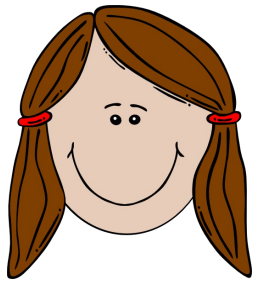

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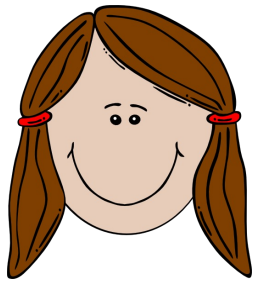

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Cross-Chain Atomic Swap

Both lock their assets in HTLCs using a common hashlock

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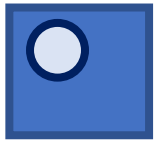

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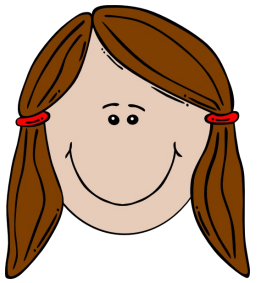

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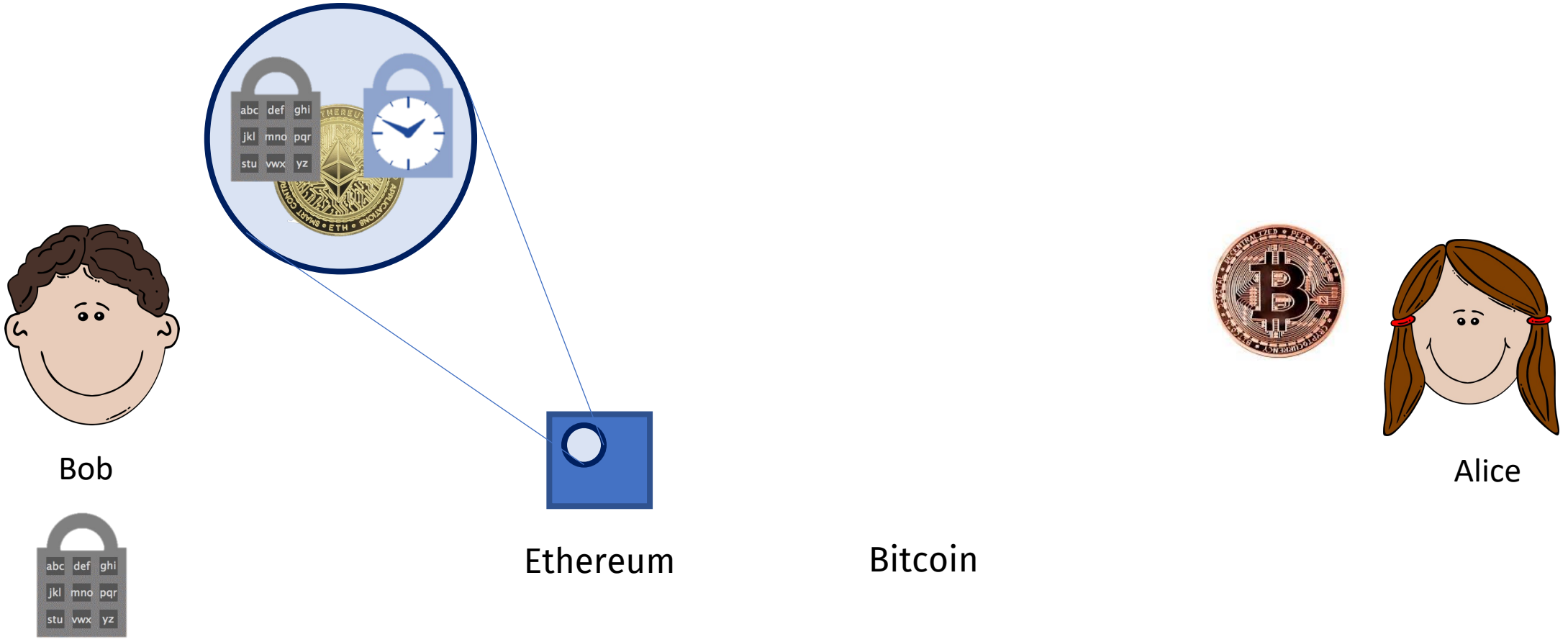

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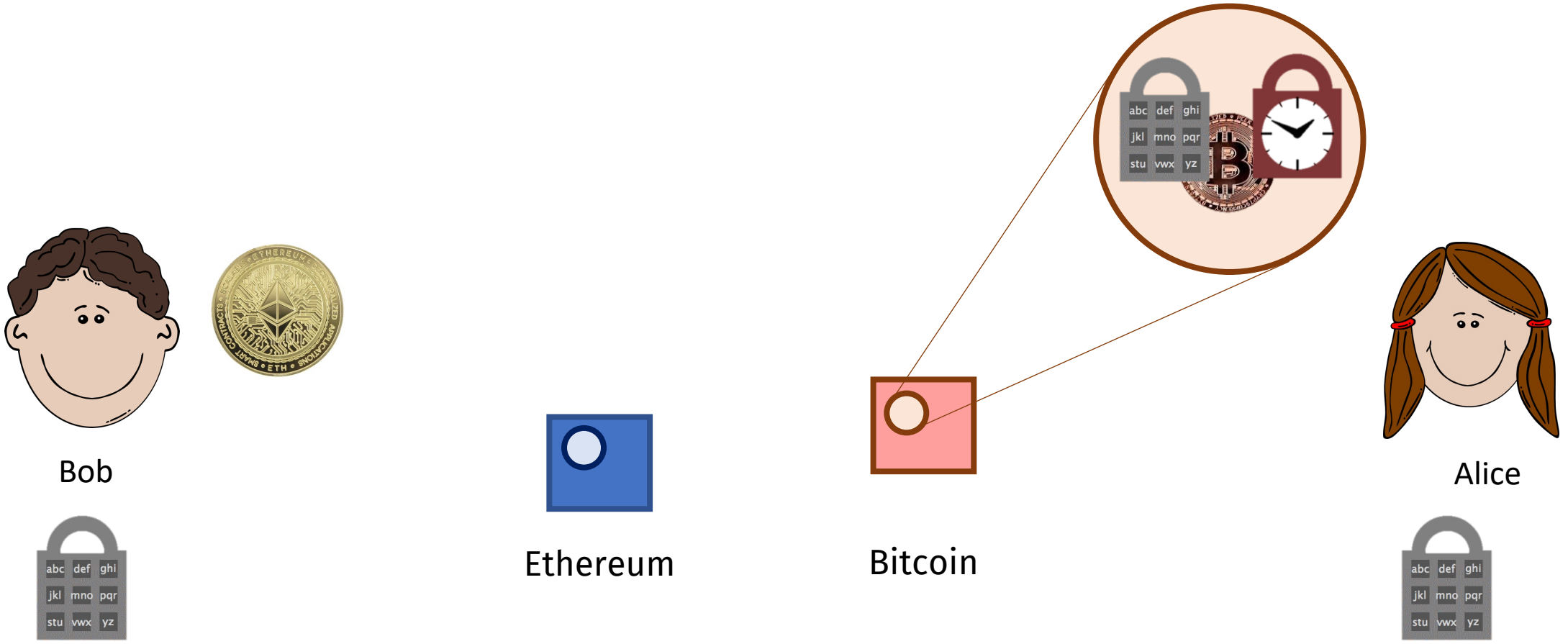
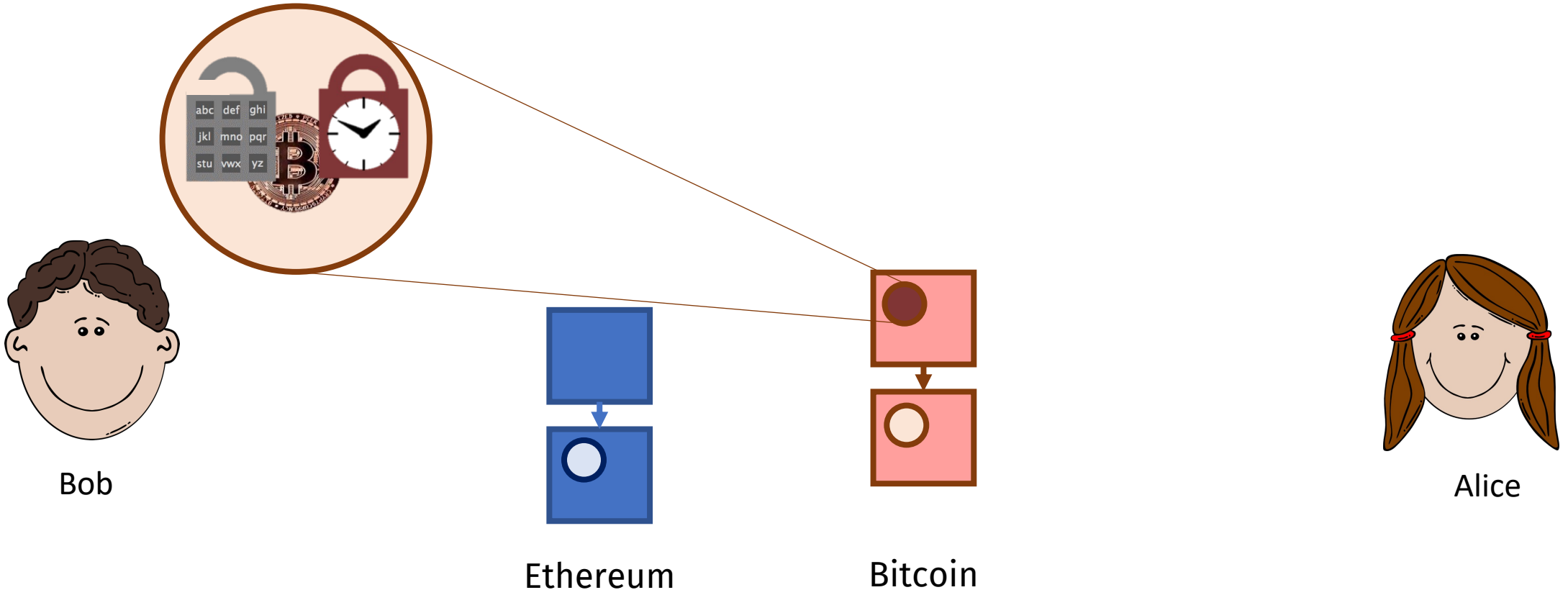


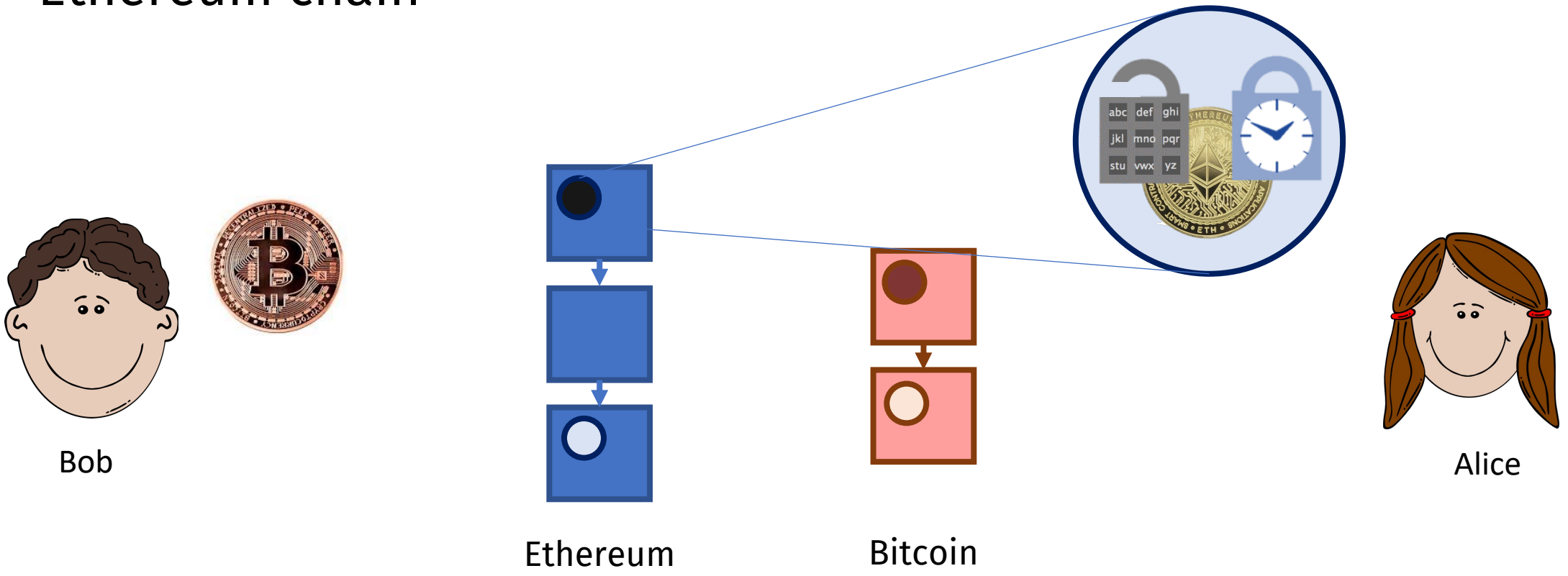
Cross-Chain Atomic Swap

Bob knows how to open the hashlock, and does so on Bitcoin



Cross-Chain Atomic Swap

Alice learns how to open the hashlock from Bob, and does so for the Ethereum chain



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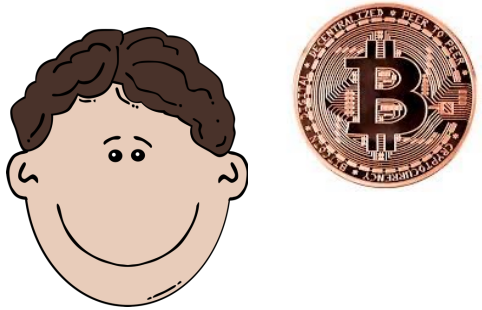

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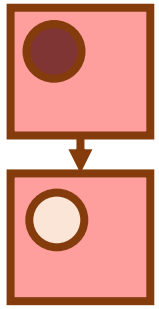

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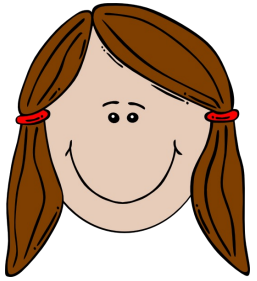

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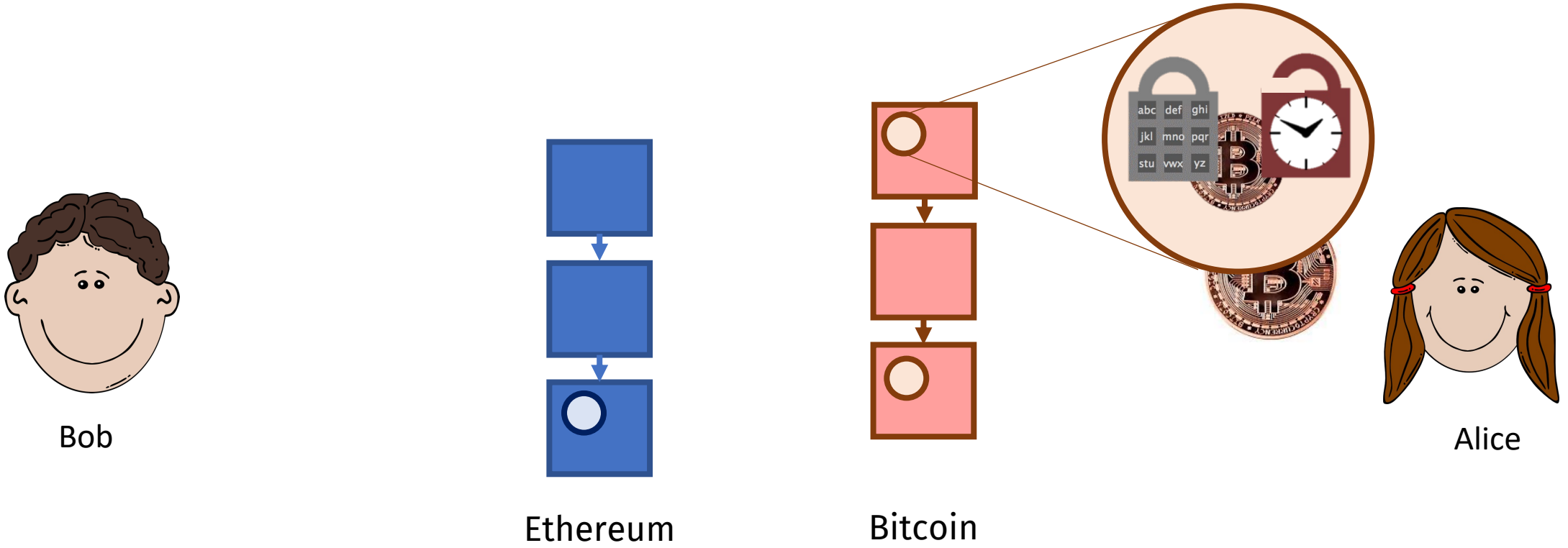
If Bob doesn't reveal the hashlock, then first, timelock on Alice's contract expires.



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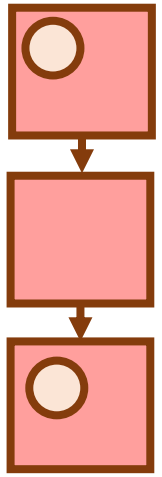

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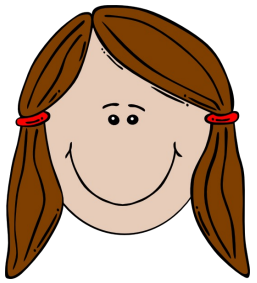

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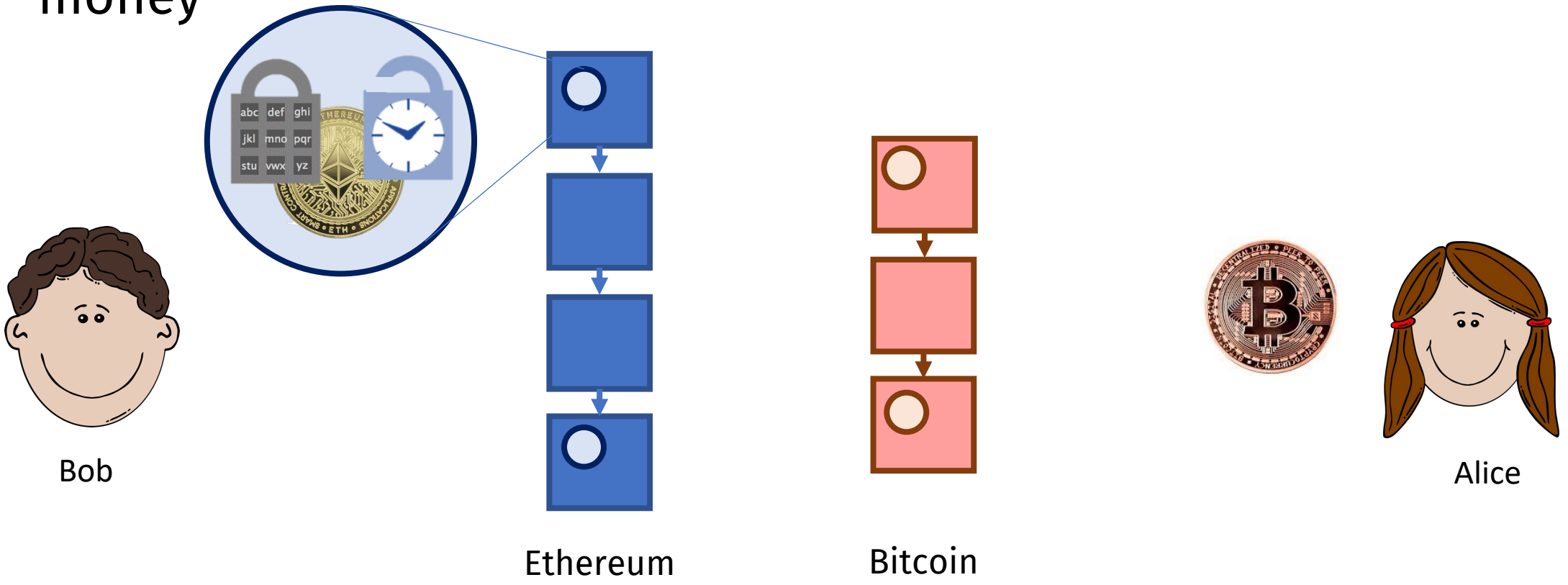
Cross-Chain Atomic Swap

Eventually, the other timelock also expires, and Bob gets back the money



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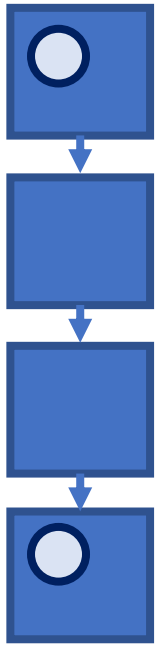

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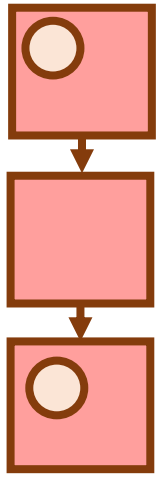

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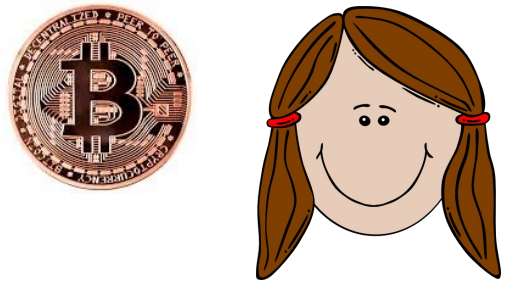

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Bribery: A Problem with HTLC [HZ'20, WHF'19]

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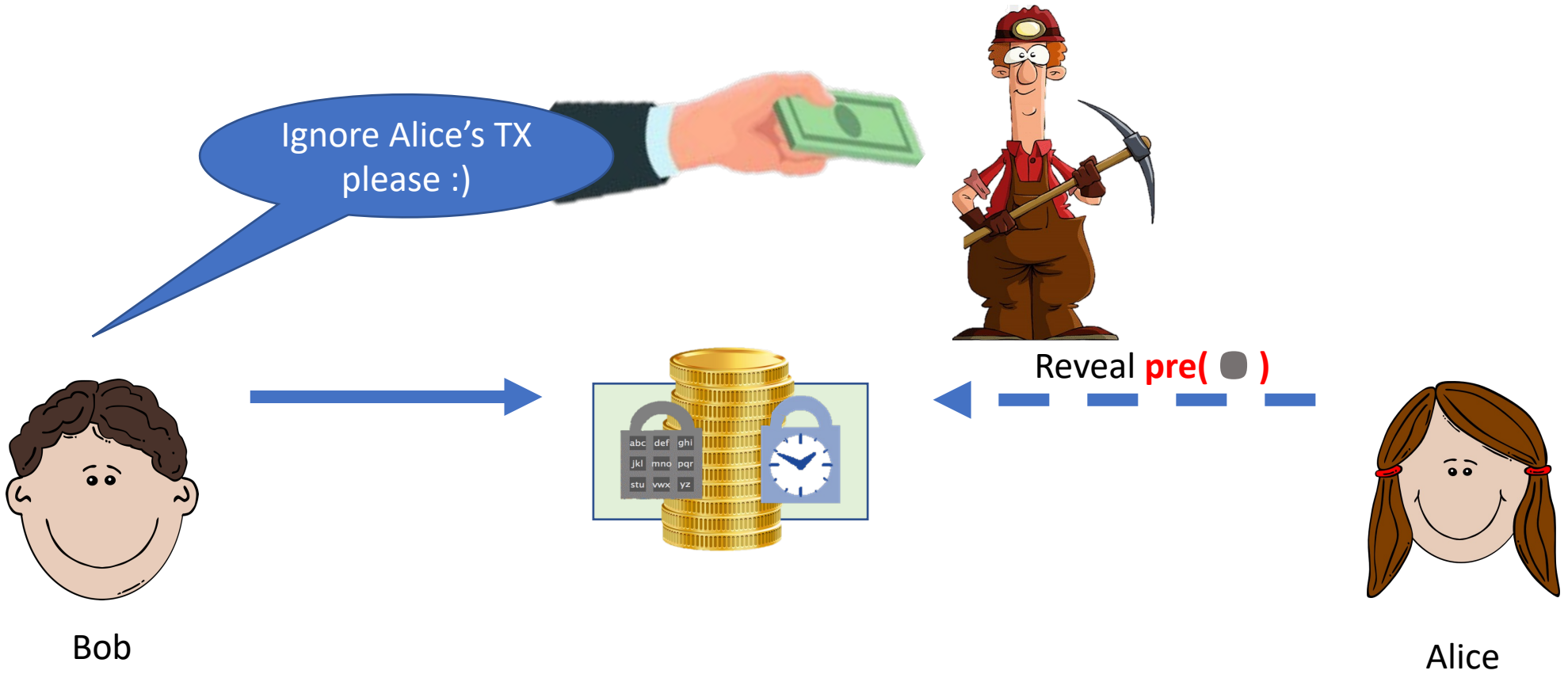

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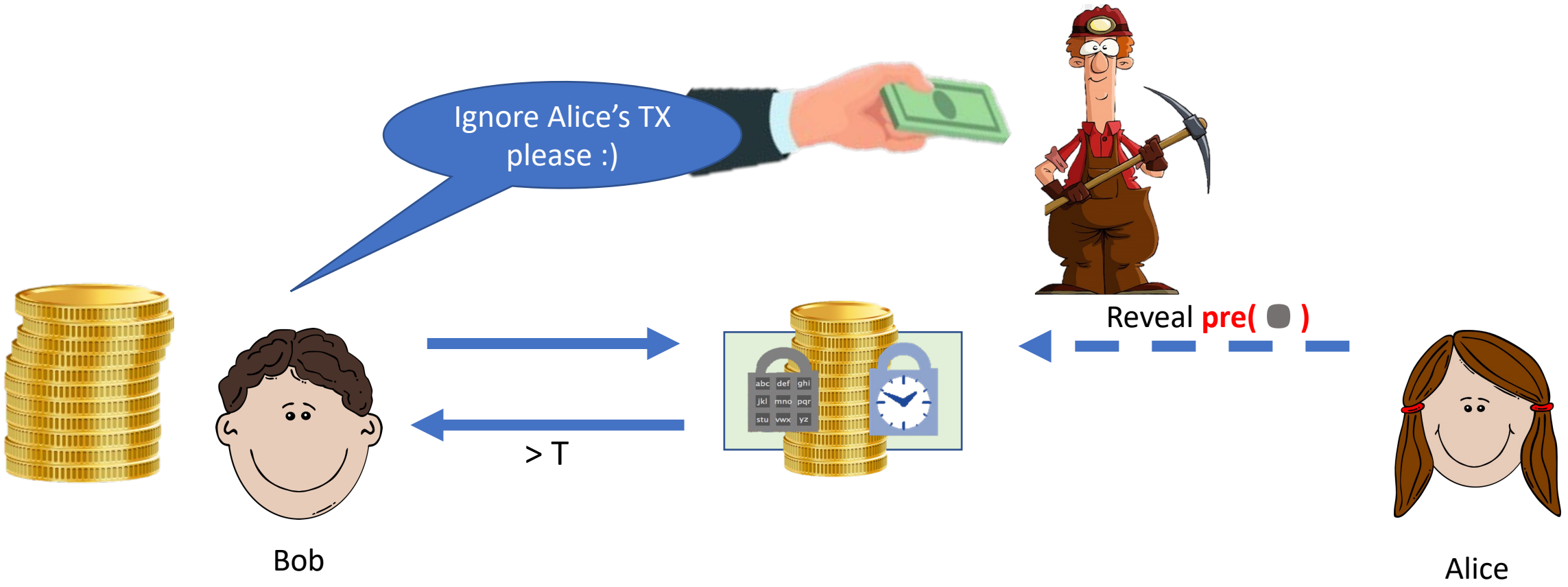

MAD-HTLC [TYME'21]

Make both Alice and Bob loose if anyone cheats – *Mutually Assured Destruction*

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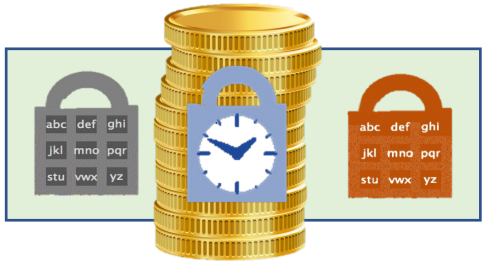
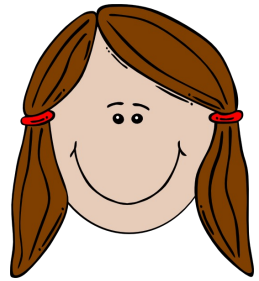
Deposit/create





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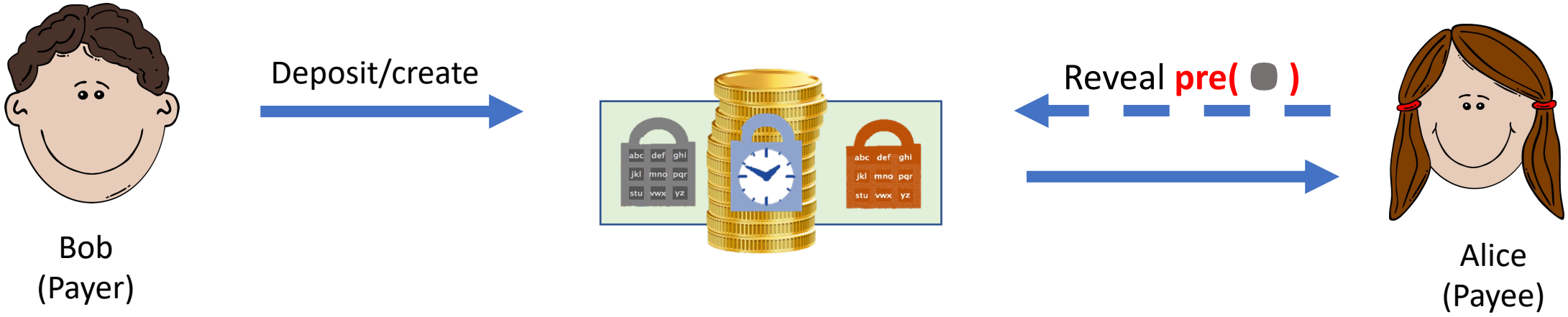

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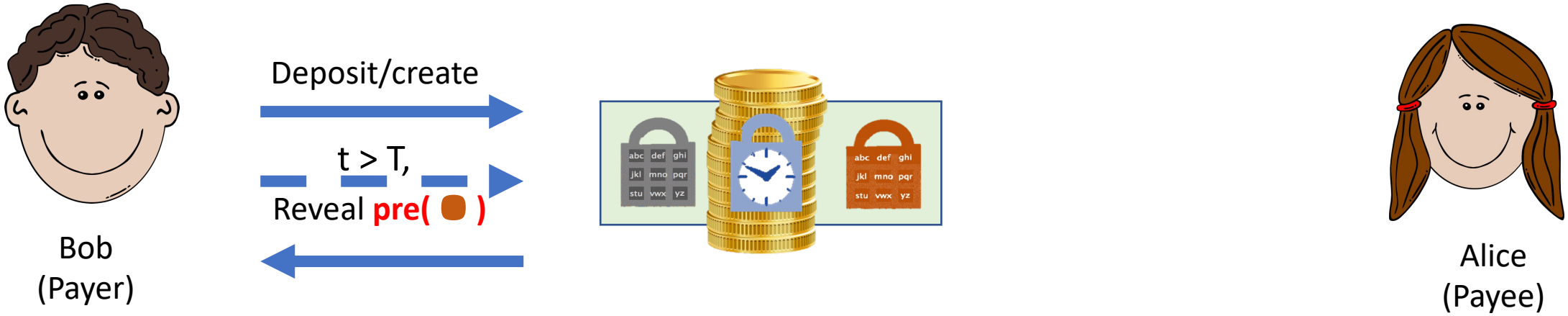

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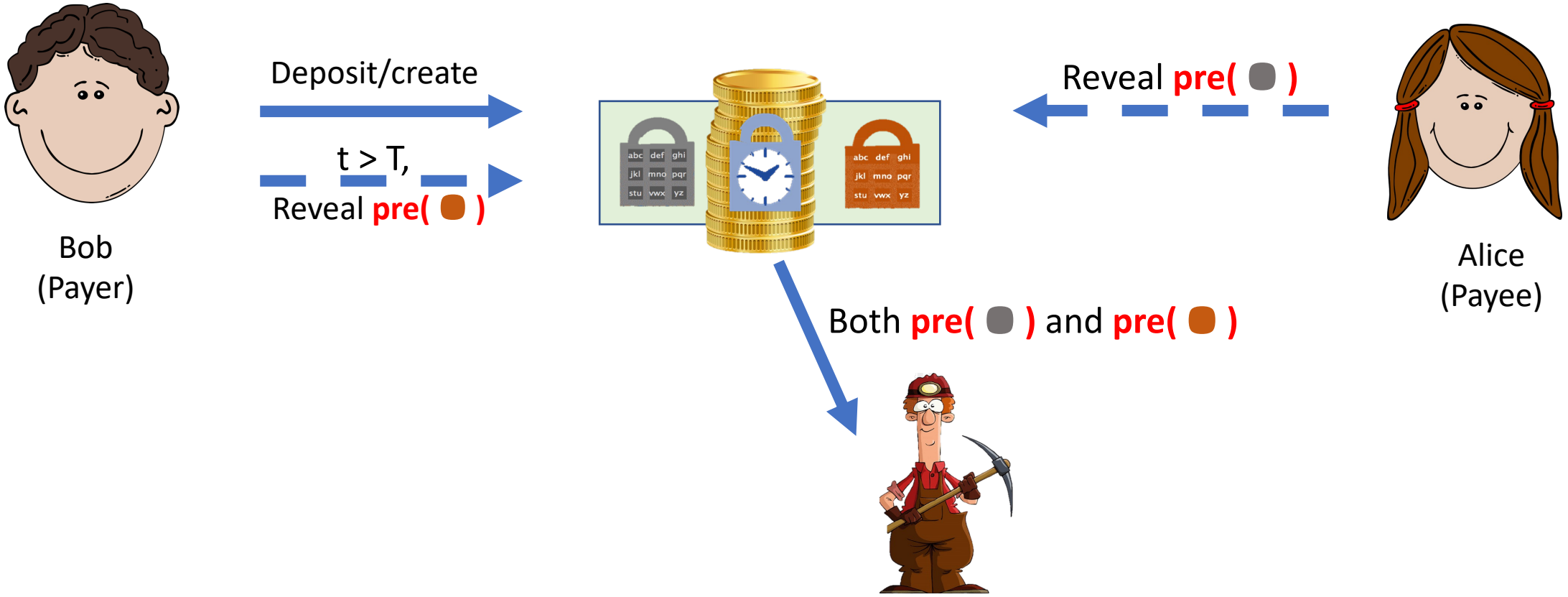

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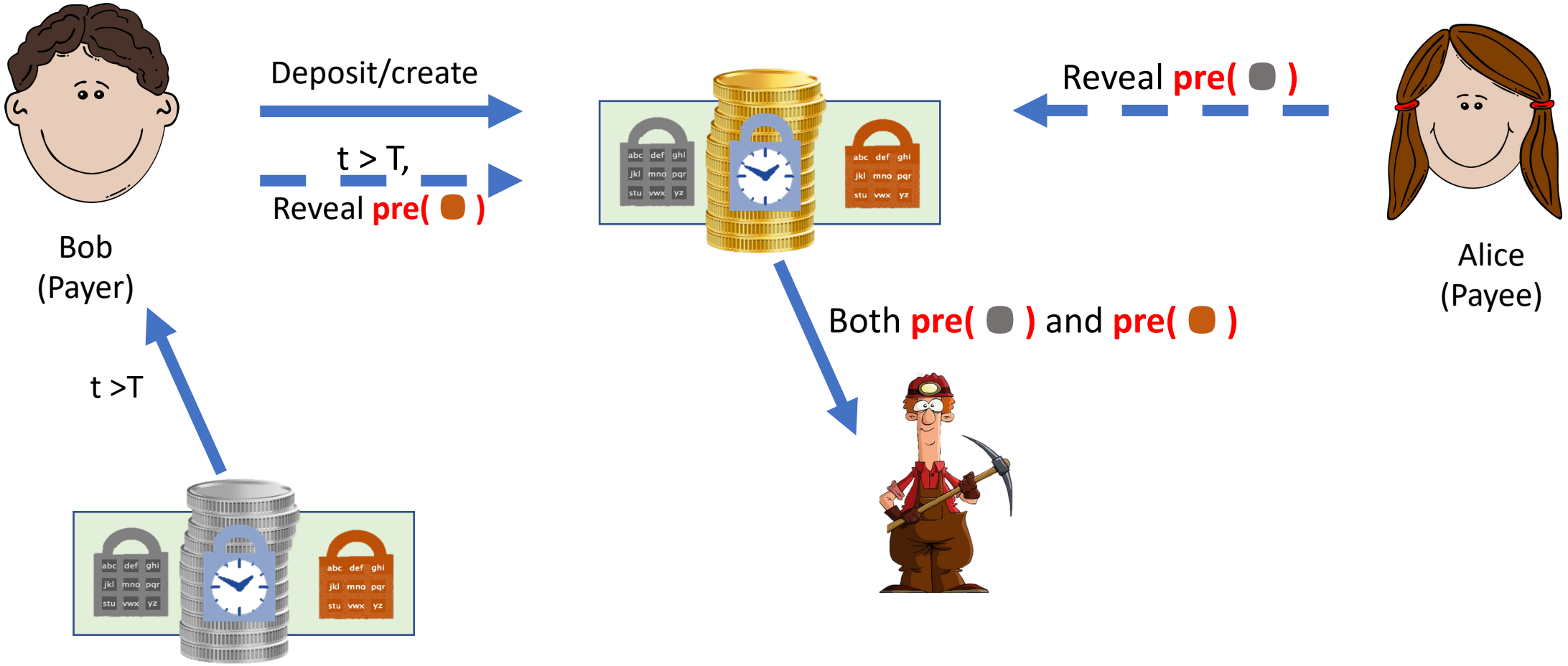

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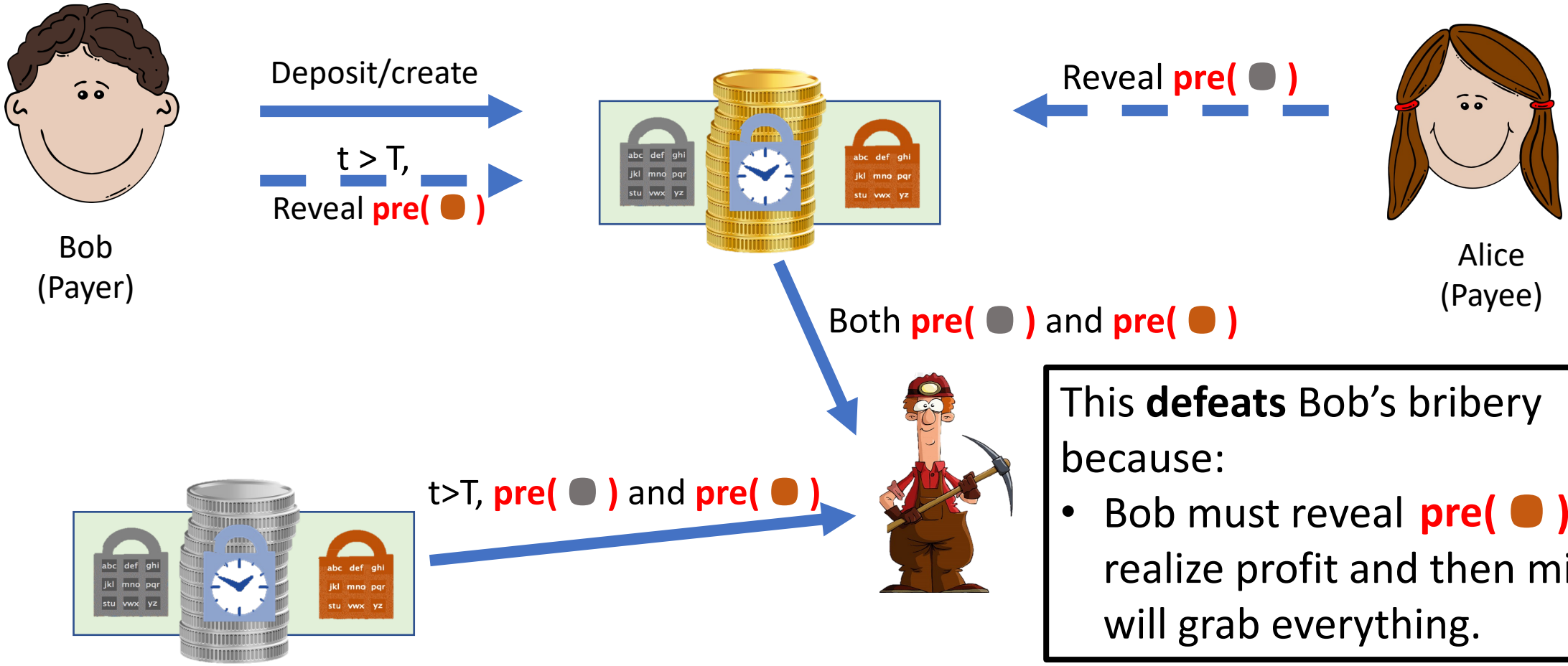


This **defeats** Bob's bribery because:

- Bob must reveal pre( ) to realize profit and then miners will grab everything.

Contributions: Revisiting Incentives in HTLC

Attacks on HTLC Schemes

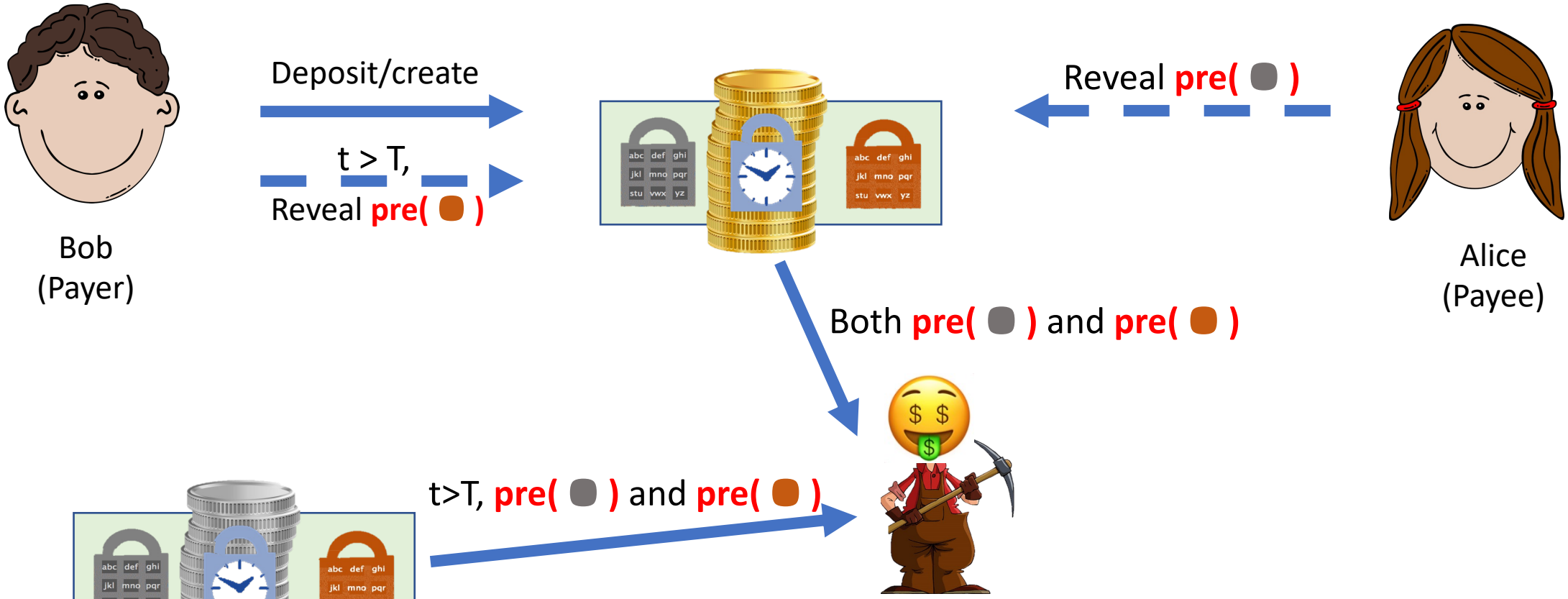
- Notion of actively rational miners
- Three reverse bribery attacks (RBA)
  - Success Independent RBA
  - Success Dependent RBA
  - Hybrid Attack

He-HTLC

An incentive-compatible HTLC scheme

MAD-HTLC: Is it Safe?

For a miner, achieving the following state is the best-case scenario.



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Deposit/create

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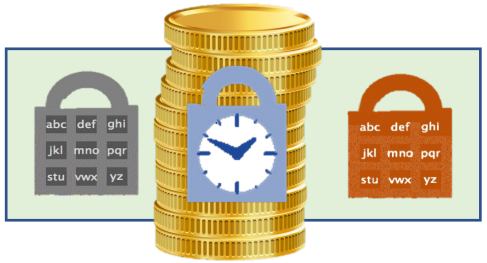

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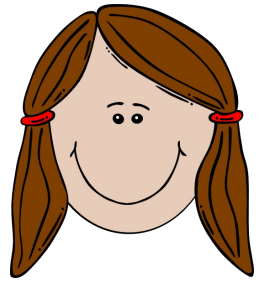

Alice
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Both pre(●) and pre(●)

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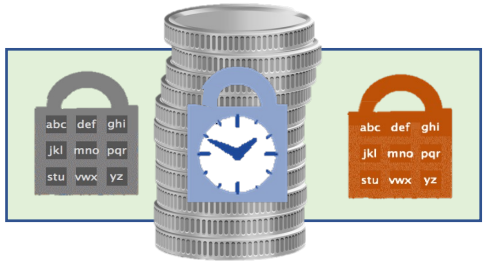

Are there some actions miner can take to ensure this state?

Passive vs Active Miners

Passive miners

- Focused on the mempool
- Confirming most profitable transactions

Active miners

- Engage in external protocols
- E.g., adding MEV software, open up direct channels to users, etc.

Reverse Bribery: Active Miners' Action

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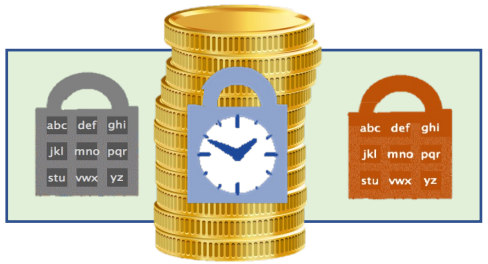
(Payer)

Deposit/create



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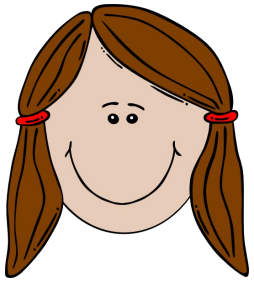

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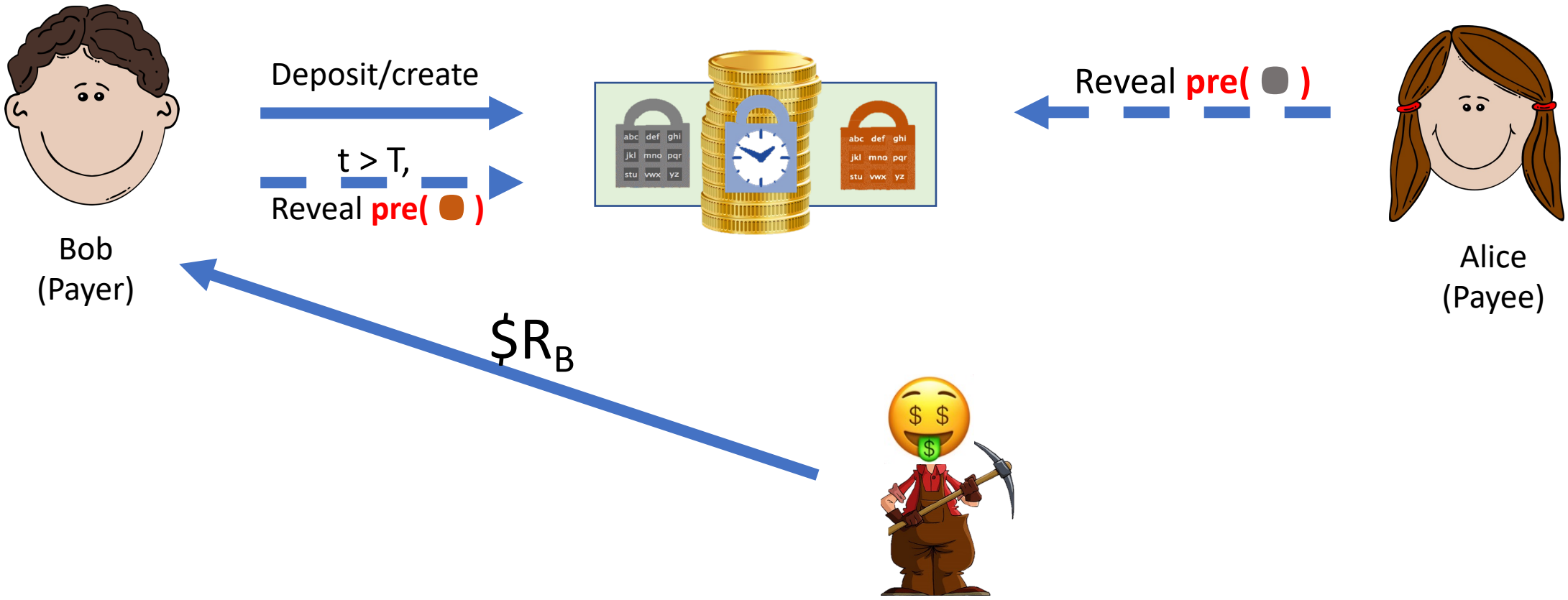

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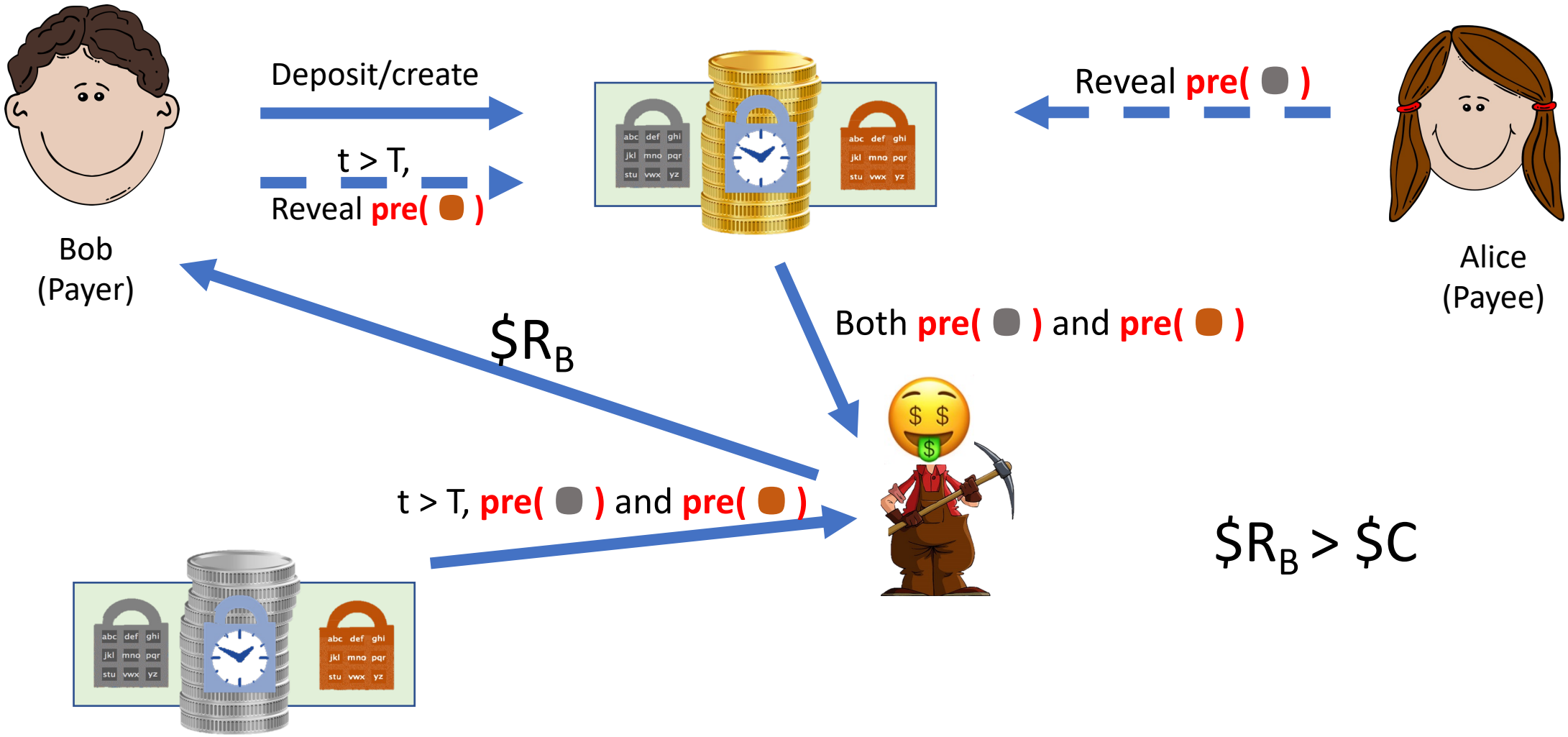

Attacks Based on Reverse Bribery (RBA)

- Success Independent RBA

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For details, let's chat in the poster session. (Poster 46)

Designing HTLC: Challenges

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Designing HTLC: Key Ideas

- **Bribery Resistance:** The payer must have a way to get back

Make payer bribe multiple miners, so that not all of them can be bribed!

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Burn the deposit ($\$V$) to avoid reverse bribery

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- ✓ No incentive-based attacks on HTLCs even with 100% active miners!

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- ✓ No incentive-based attacks on HTLCs even with 100% active miners!
- ✓ Low and user adjustable collateral ($\$C < \$V$)
- ✓ A lightweight Bitcoin implementation (no new op-codes)

(Poster ID: 46)

Thank You!

Contact : sarisht.wadhwa@duke.edu

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https://eprint.iacr.org/2022/546.pdf

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Thank You!

In proceedings for NDSS'23…

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