No More Guesswork: Ready-to-Use Distributed Key Generation

Jonas Nick, Tim Ruffing

Threshold Signatures

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t-of-n

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Correctness

t honest signers
can produce
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t-of-n

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t-of-n

Unforgeability

$t - 1$ malicious signers
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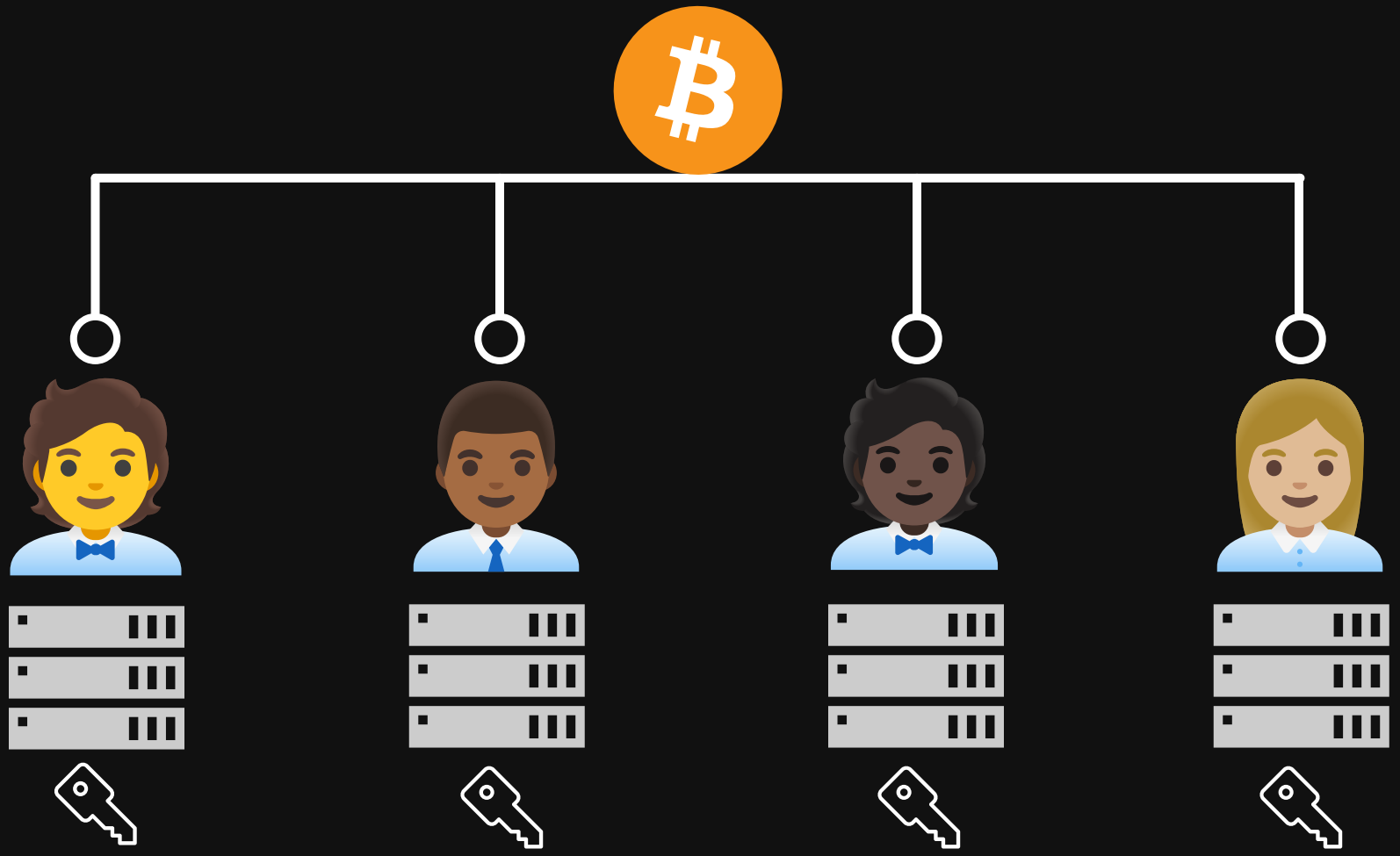
a valid signature.

Example Application: 2-of-3 Personal Wallet

Example Application: 3-of-4 Shared Wallet



Schnorr-compatible Threshold Signatures

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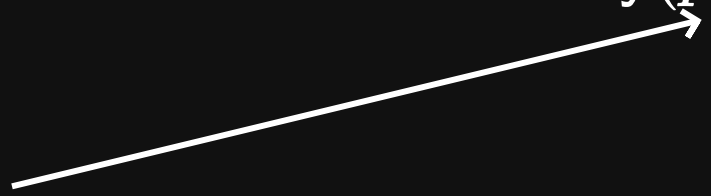

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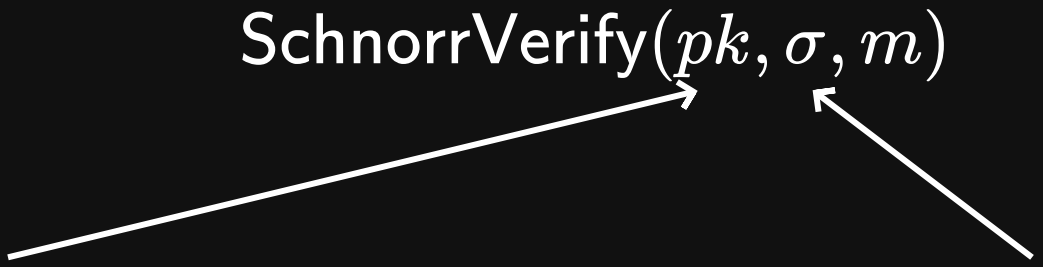

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Schnorr-compatible threshold signatures are indistinguishable from ordinary signatures on the Bitcoin blockchain.

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    - So, 2 signers assumed to be honest, which is not the majority.

There are (almost) no real-world deployments. Why?

Real-World Cryptography Stack

Layer
Deployments
Implementations
Standards and Specifications
Papers and Proofs

Real-World Cryptography Stack

Layer	**FROST signing**
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Standards and Specifications	
Papers and Proofs	KG (SAC'20), BCKMTZ (CRYPTO'22), CG**R**S (CRYPTO'23)

RFC 9591 (IRTF/CFRG)

Internet Research Task Force (IRTF)
Request for Comments: 9591
Category: Informational
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Zcash Foundation
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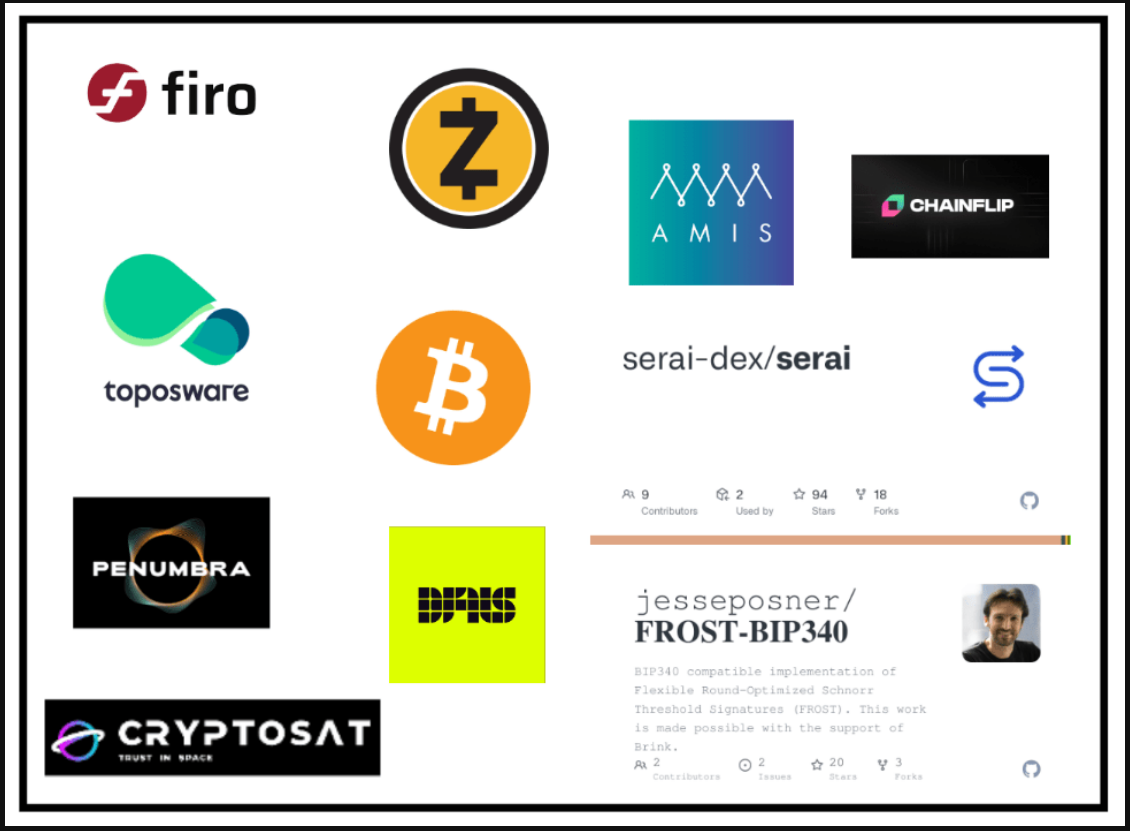
University of Waterloo
C. A. Wood
Cloudflare

The Flexible Round-Optimized Schnorr Threshold (FROST) Protocol for Two-Round Schnorr Signatures

Implementations



*From: Lessons Learned from Multi-Party Schnorr Signatures at RWC'23 (Crites, Komlo, **Ruffing**)*

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secp256k1-zkp Public

A fork of libsecp256k1 with support for advanced and experimental features such as Confidential Assets and MuSig2

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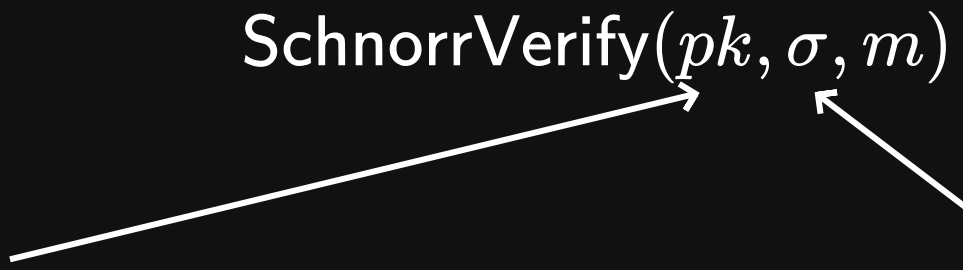
github.com/BlockstreamResearch/

Schnorr-compatible Threshold Signatures



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Key generation for FROST signing is out of scope for this document.

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Just implement DKG!

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- DKG should work in the asynchronous setting.
- **PedPop** [KG20]: Pedersen DKG [Ped91] with Proofs of Possession
  - 2 rounds
  - Not a general-purpose DKG, but proven secure in combination with FROST

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What does that mean exactly?

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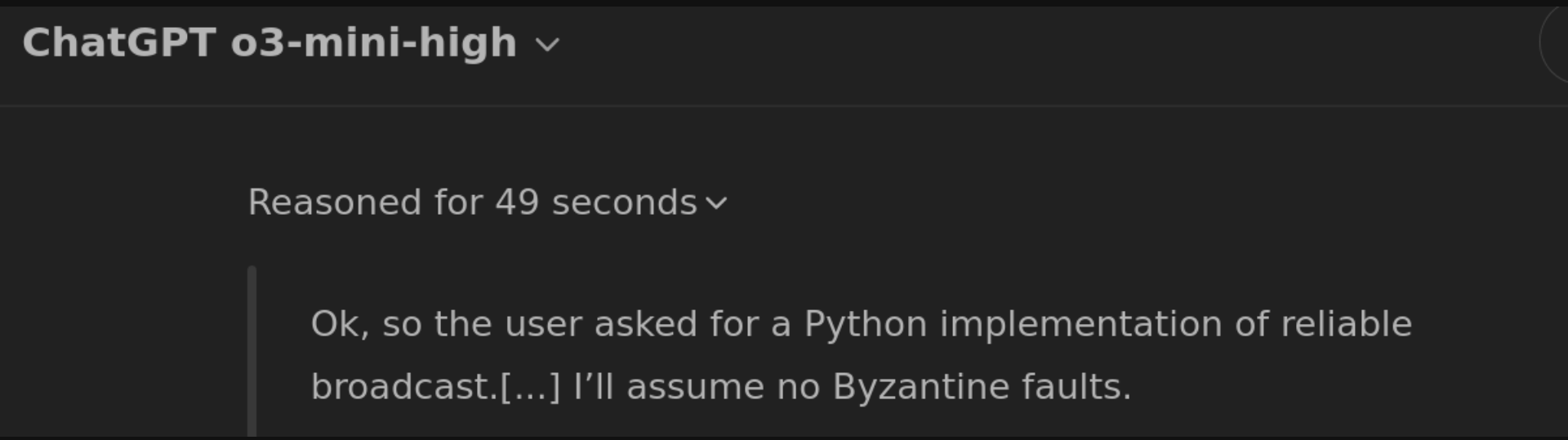

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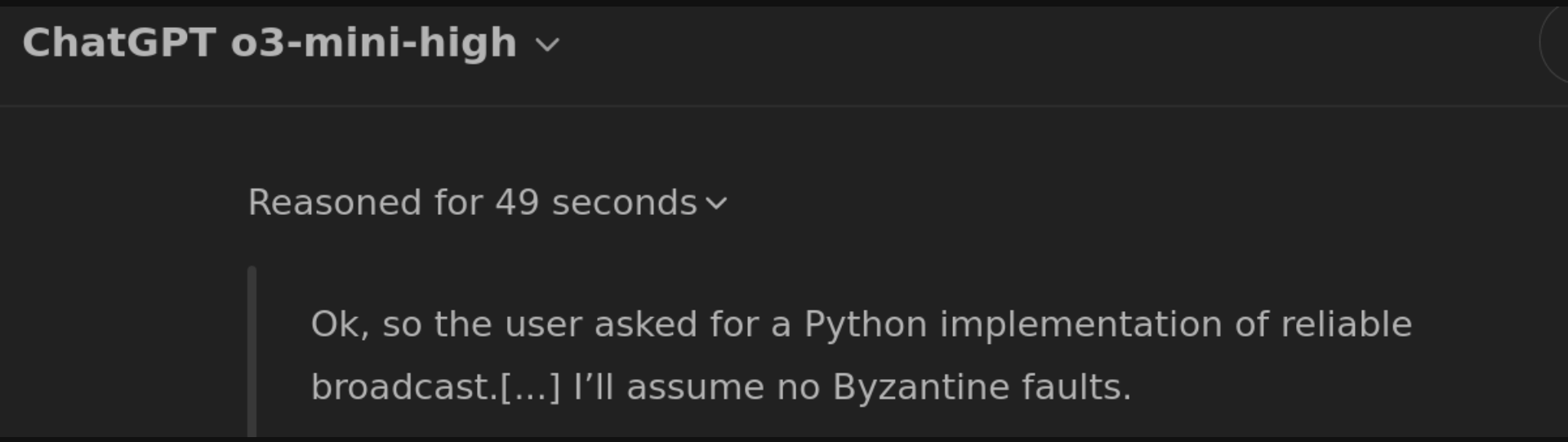

ChatGPT models interpret "reliable" simply as
guaranteed message delivery,
overlooking malicious senders entirely.

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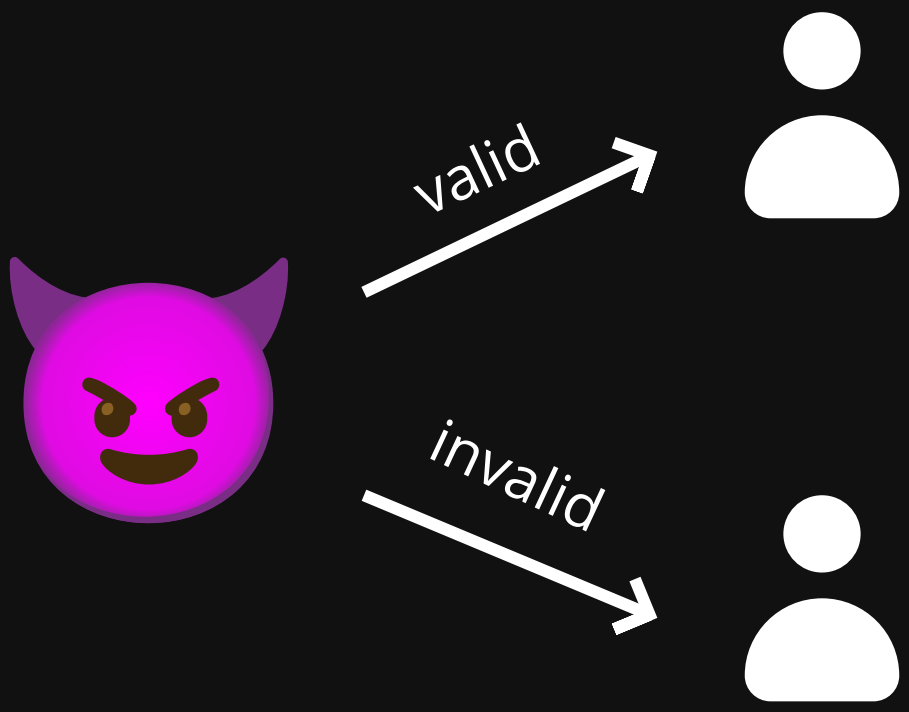
A secure broadcast channel in the context of multi-party computation protocols such as FROST has the following properties:

1. Consistent. Each participant has the same view of the message sent over the channel.
2. Authenticated. Players know that the message was in fact sent by the claimed sender. In practice, this requirement is often fulfilled by a PKI.
3. Reliable Delivery. Player i knows that the message it sent was in fact received by the intended participants.
4. Unordered. The channel does not guarantee ordering of messages.

Resulting DKG Is Still Broken

2-of-3 Example



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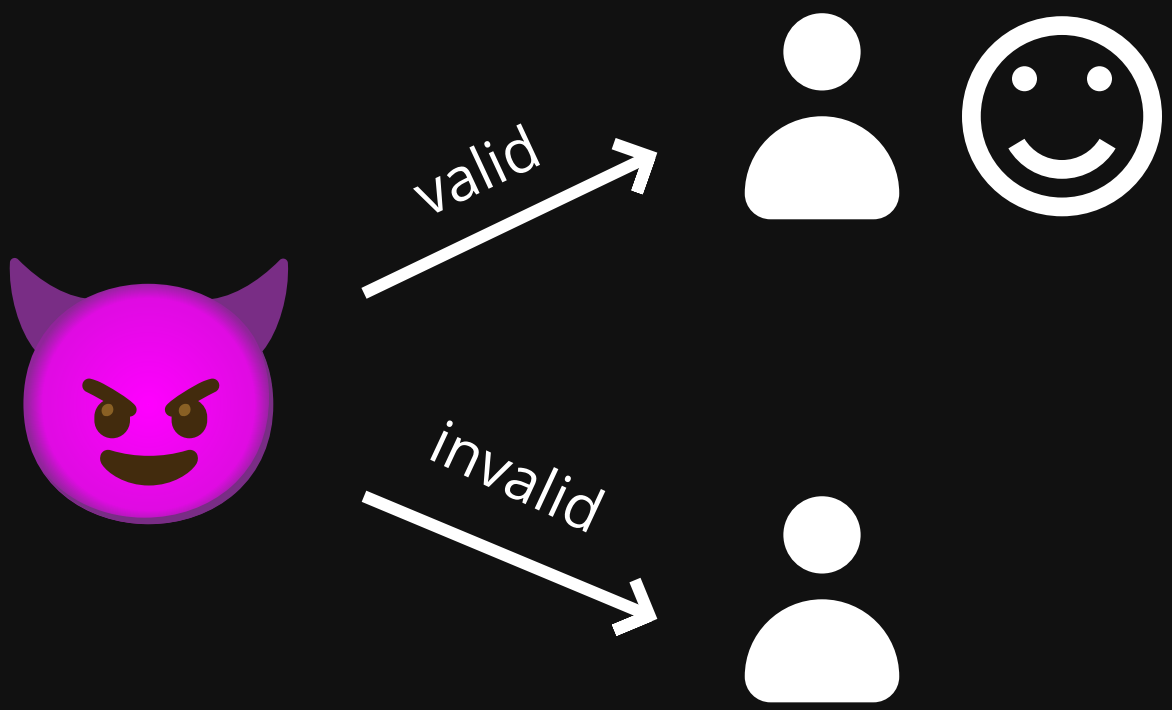

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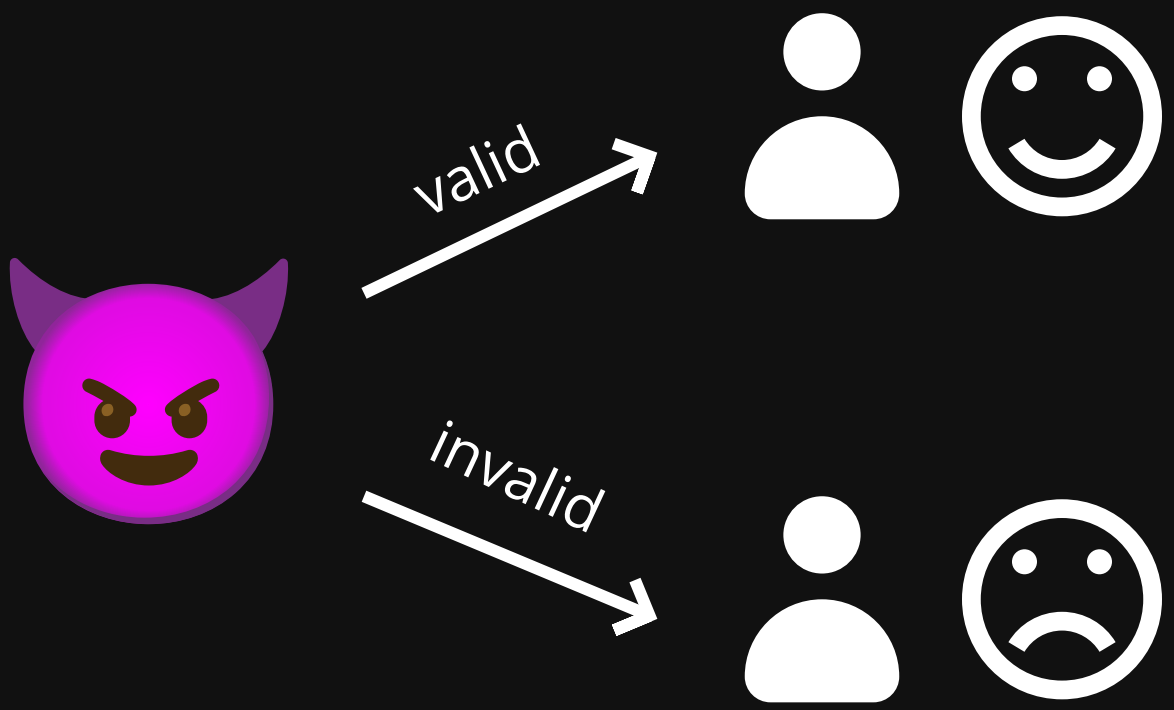

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DKG not succeeded

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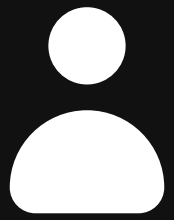
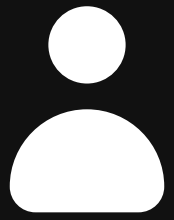
Money is lost forever.





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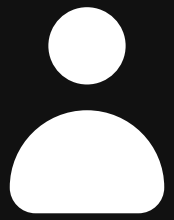

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...the result is still broken.

Our Solution: ChillDKG

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- **Agreement:** If some honest signer succeeds, then eventually all honest signers will succeed.

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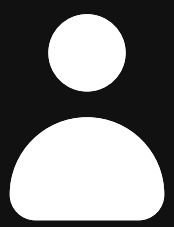

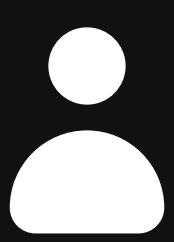

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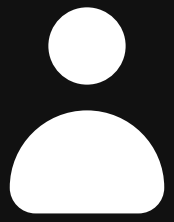

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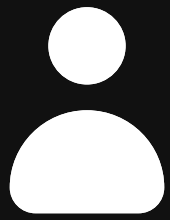
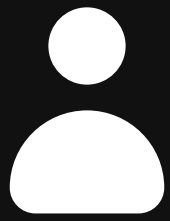


succeed!

certificate
= list of signatures



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  - Per DKG backup is just public data (**input** and certificate) instead of secret data.

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Feedback welcome!

me@real-or-random.org
jonasd.nick@gmail.com
x.com/blksresearch

Blockstream RESEARCH

You've unlocked the backup slides

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3. ChillDKG supports blaming misbehaving signers, which requires help from the DKG coordinator.