Blockstream

Blockstream RESEARCH

Cryptography Basics for Bitcoiners

Jonas Nick
nickler.ninja
@n1ckler

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Kyiv Bitcoin Meetup

Cryptography shifts the balance of power

What is needed is an electronic payment system based on cryptographic proof instead of trust [...].

- Satoshi


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BITCOIN COMMUNITY
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- blog.blockstream.com
- twitter.com/blksresearch

Warm Up

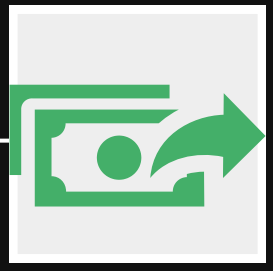
bitcoin.pdf

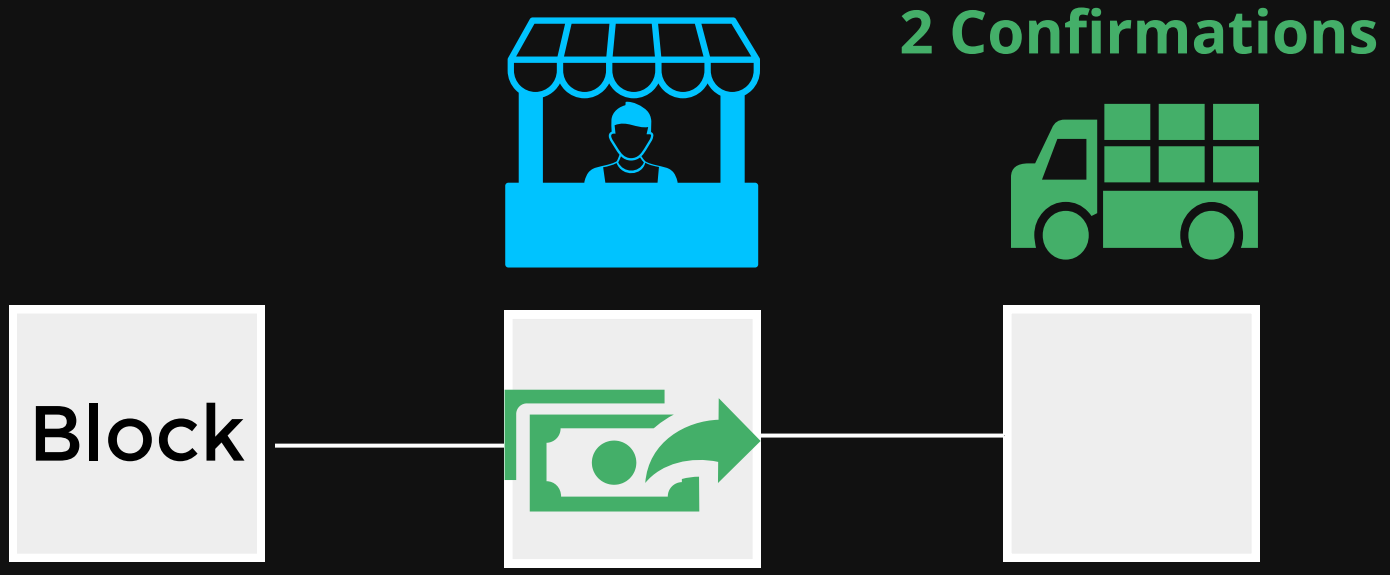
11. Calculations

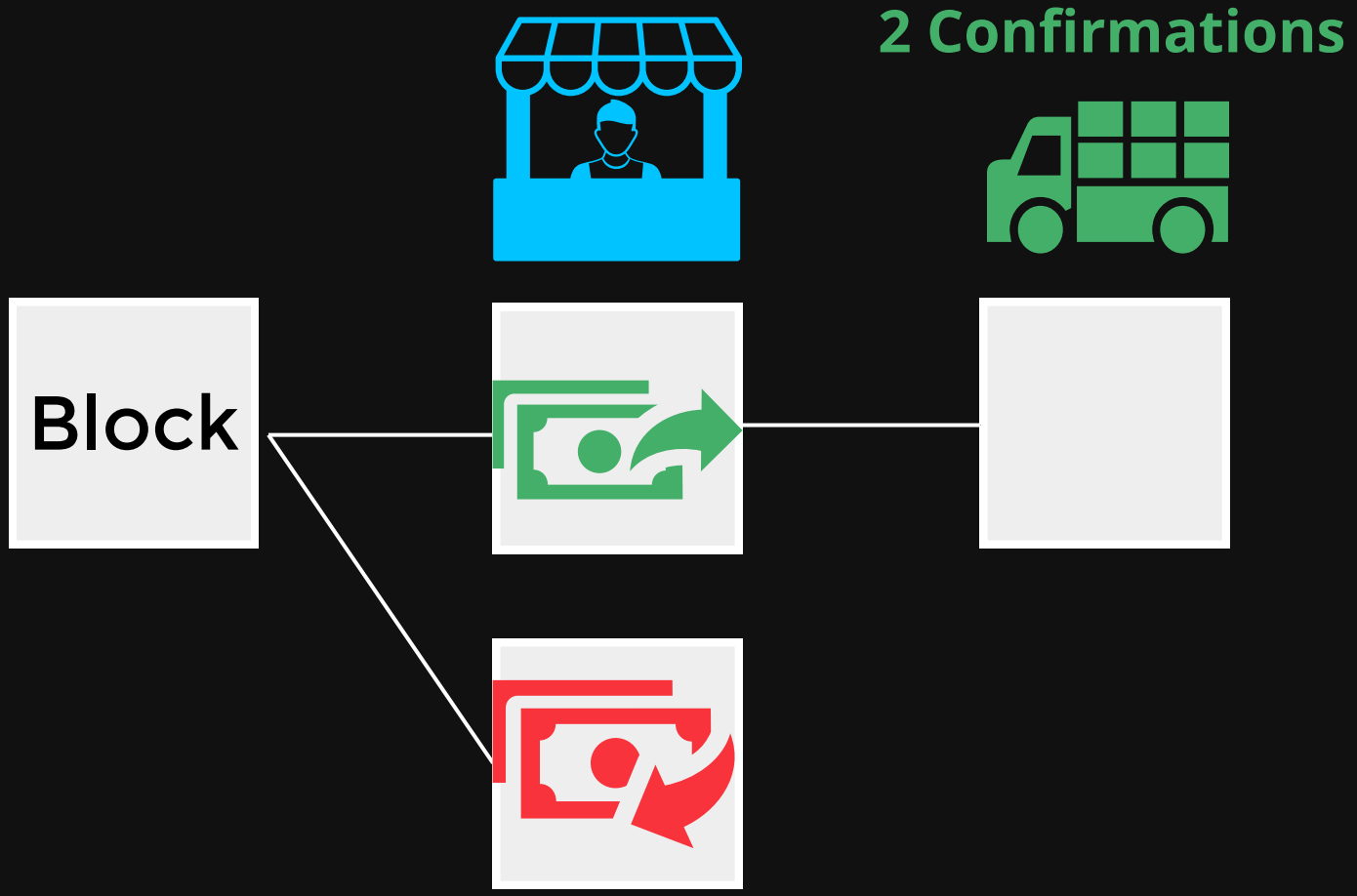
We consider the scenario of an attacker trying to generate an alternate chain faster than the honest chain. Even if this is accomplished, it does not throw the system open to arbitrary changes, such

Block

Block




2 Confirmations
Block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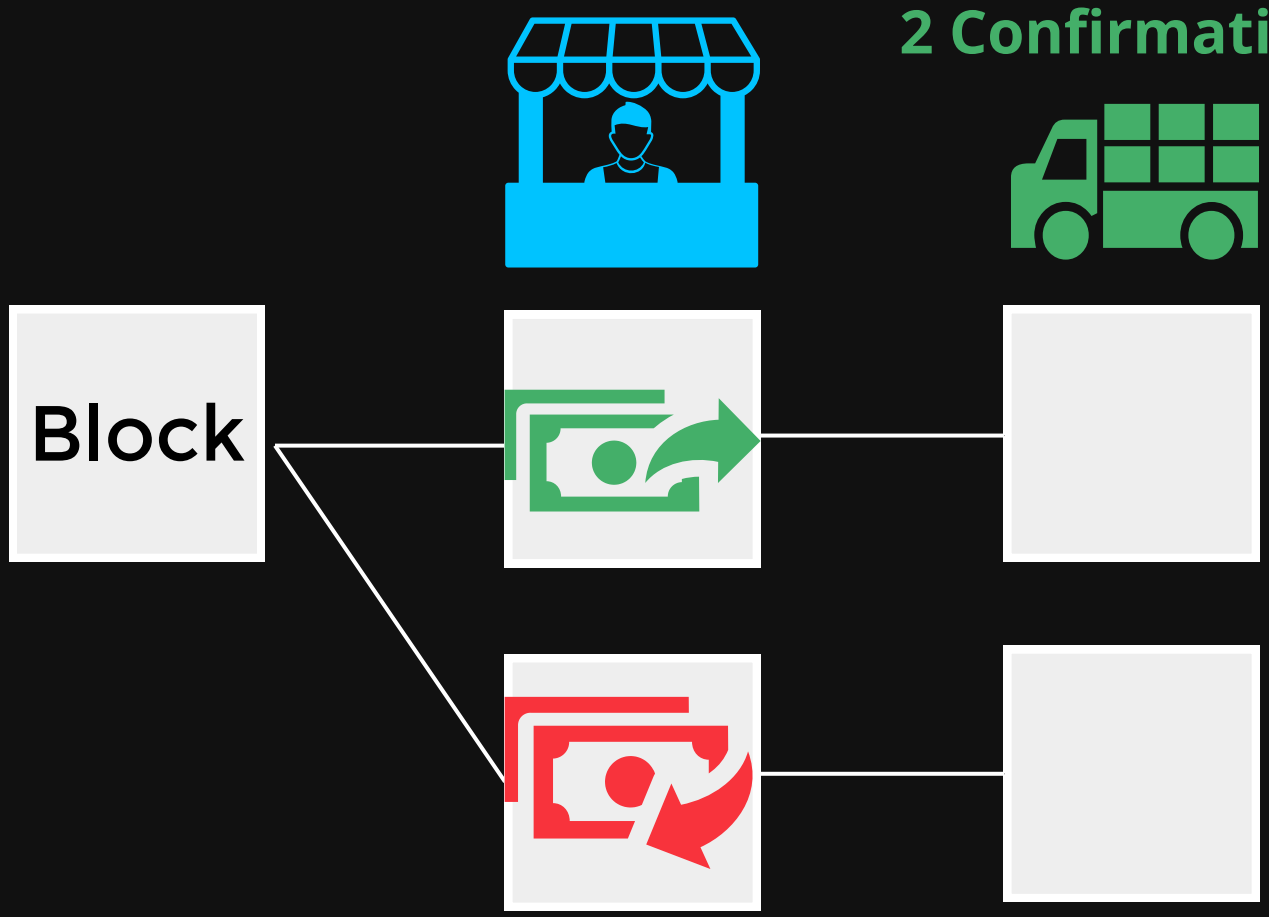
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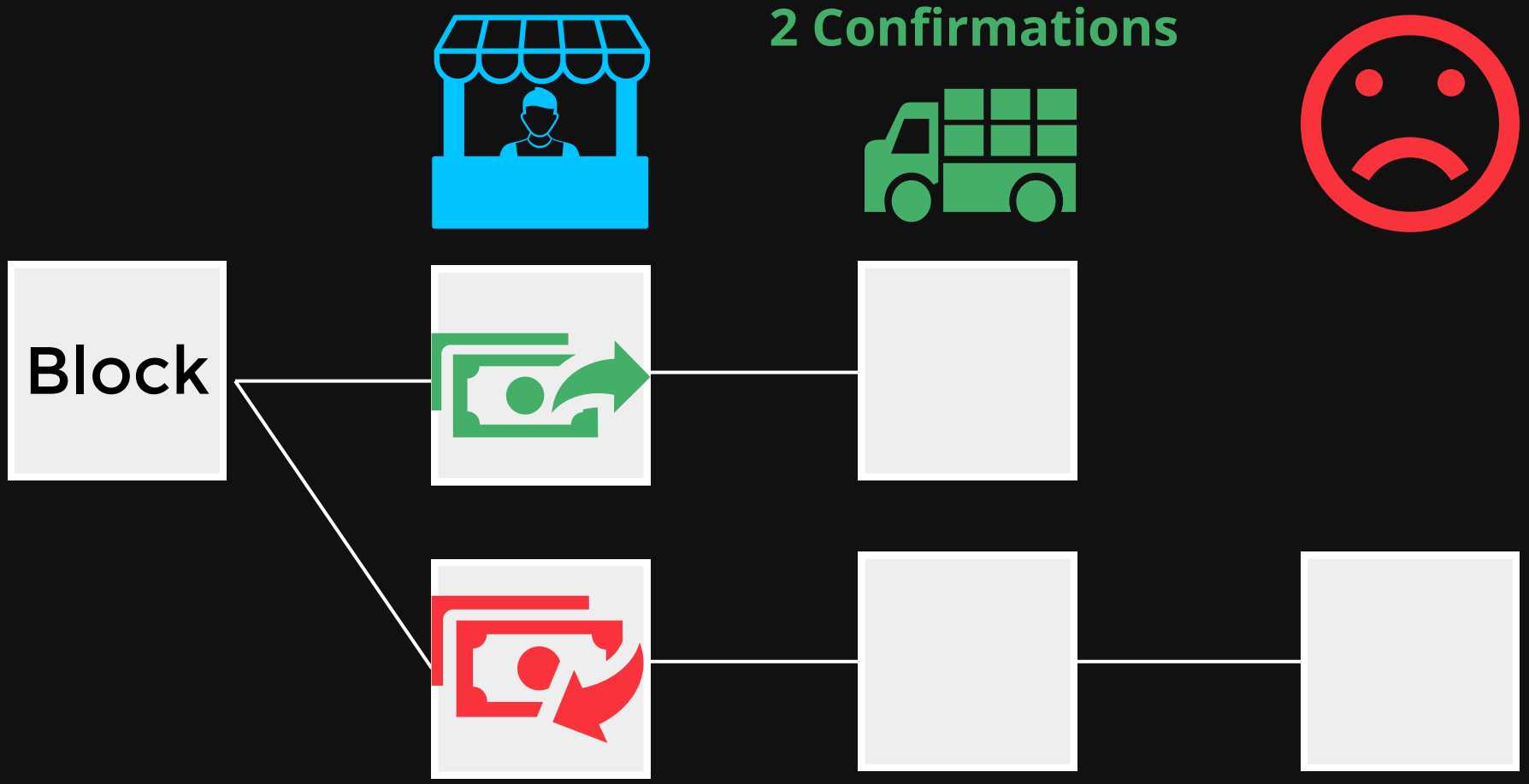
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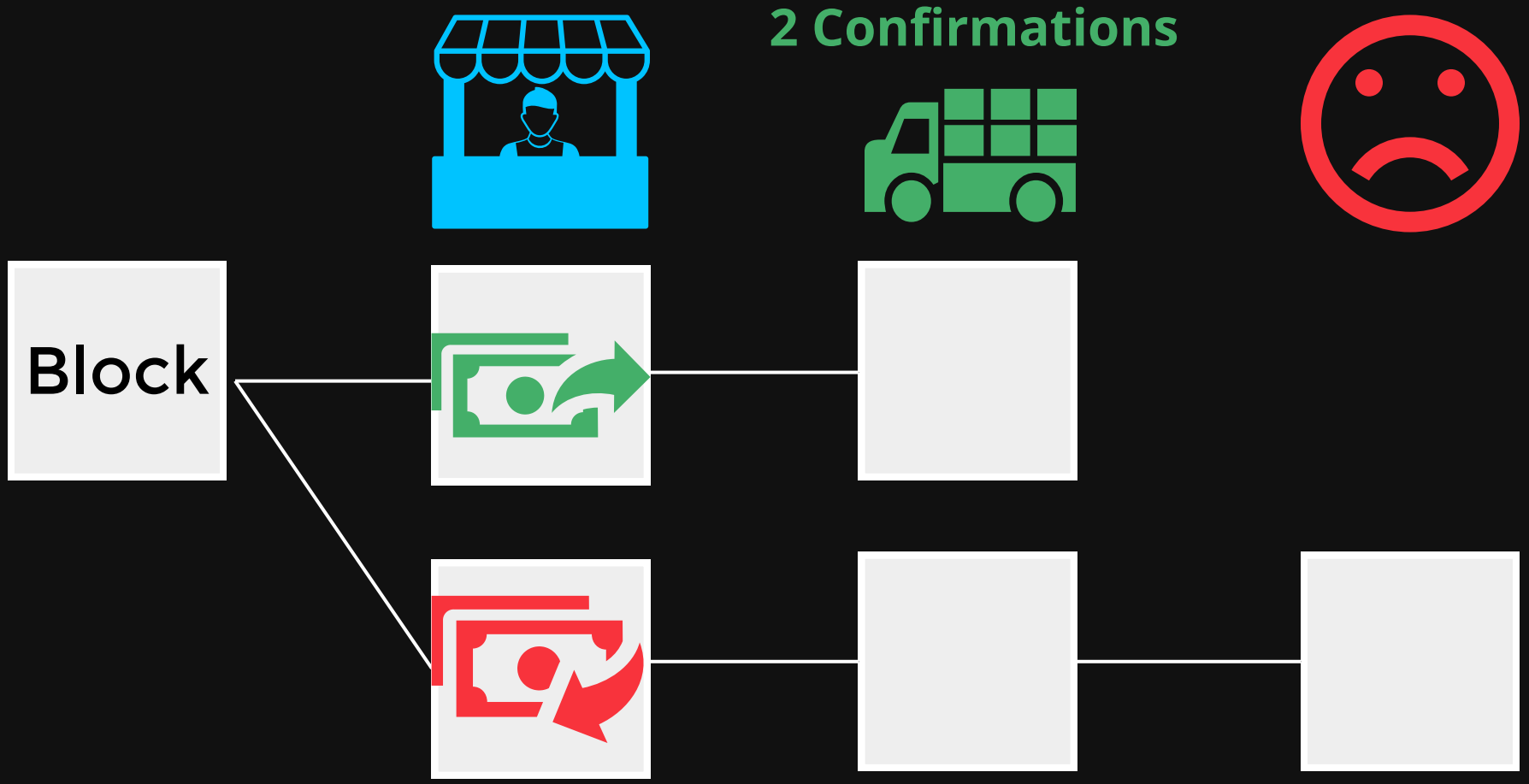
Double Spending



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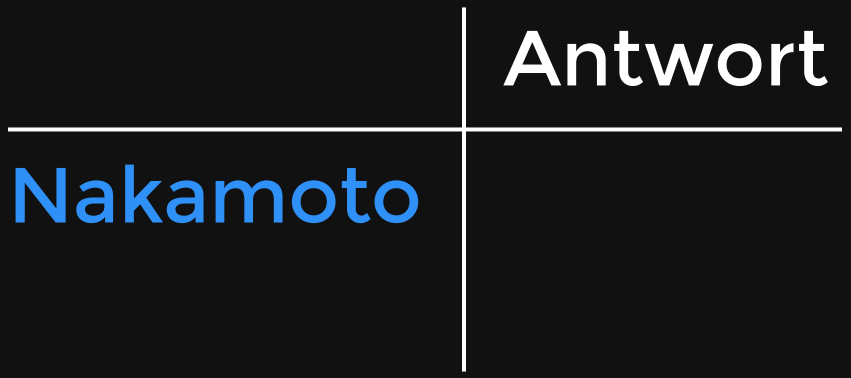

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The authors differ in their model of the attacker

Without understanding the model, the result is worthless.

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For example, both models ignore whether attacking is a rational strategy in the first place.

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the scientific study of techniques for securing digital information, transactions, and distributed computations.

From: Introduction to Modern Cryptography, J. Katz, Y. Lindell

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Definitions, models, assumptions and precise security proofs play a central role

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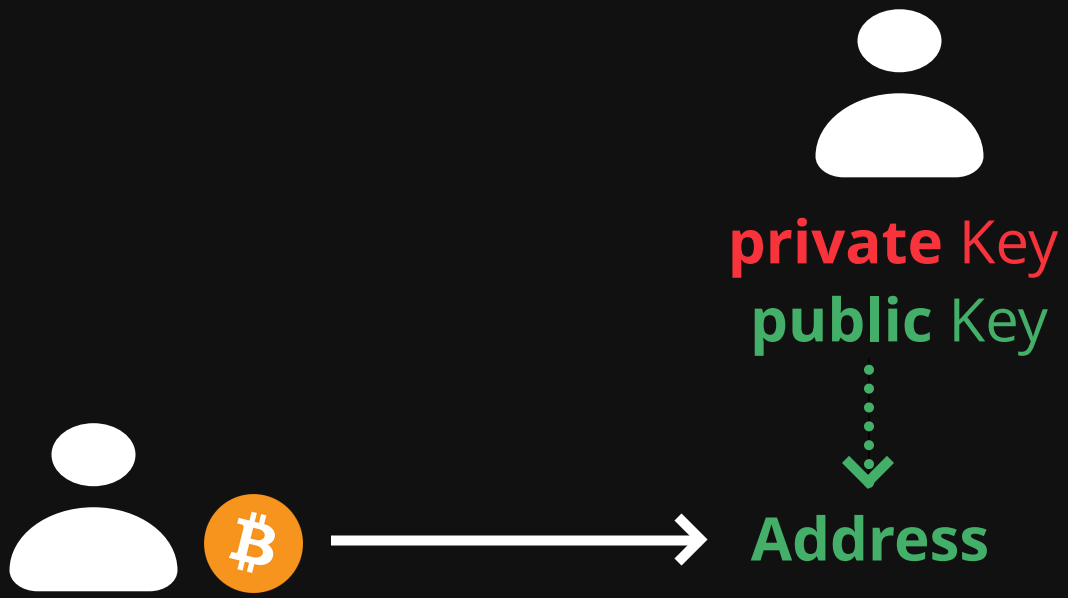

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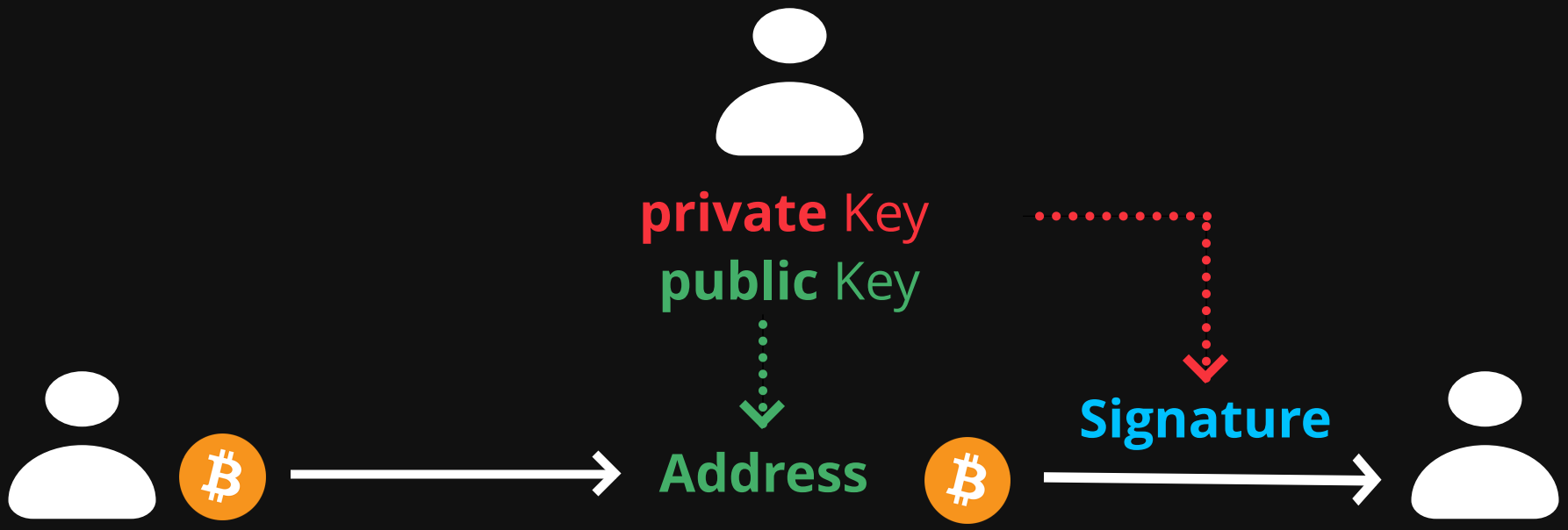

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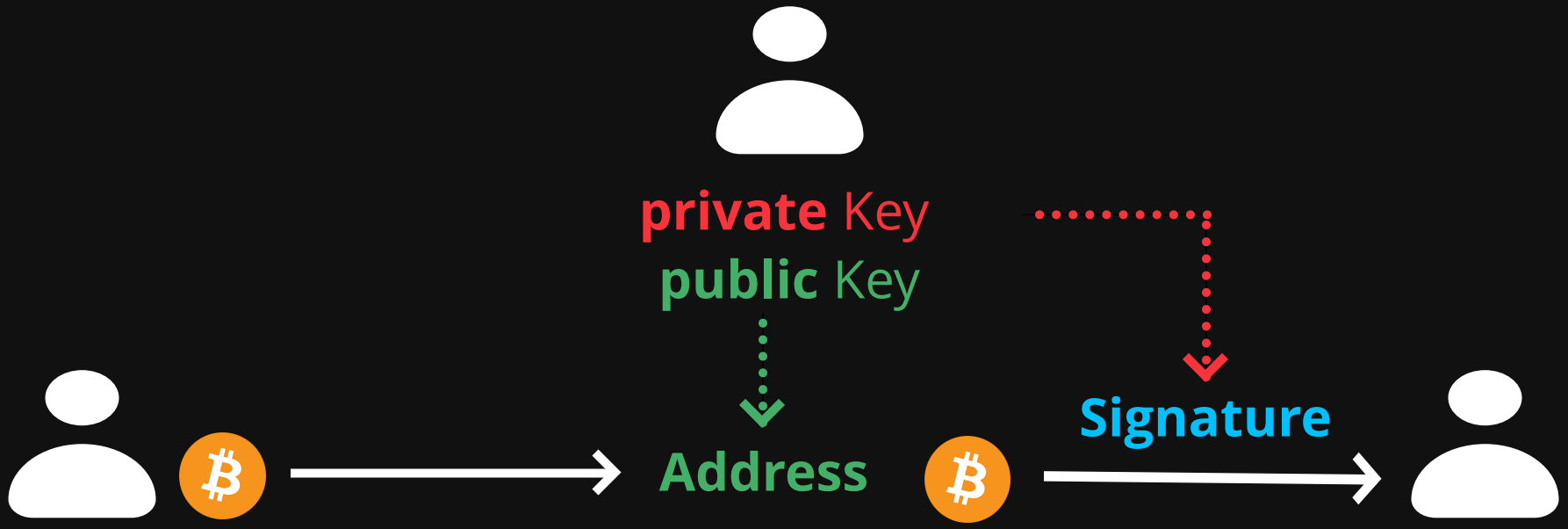

They consist of three parts...

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Forgery: a valid signature for the public key of someone else

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  - Or the other way around: if problem X is hard, then the signature scheme is secure

The Security Proof

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Problem X

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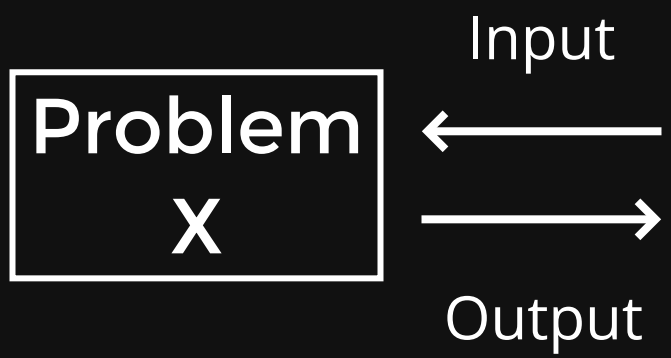
(Discrete logarithm on elliptic curve secp256k1)

The Security Proof



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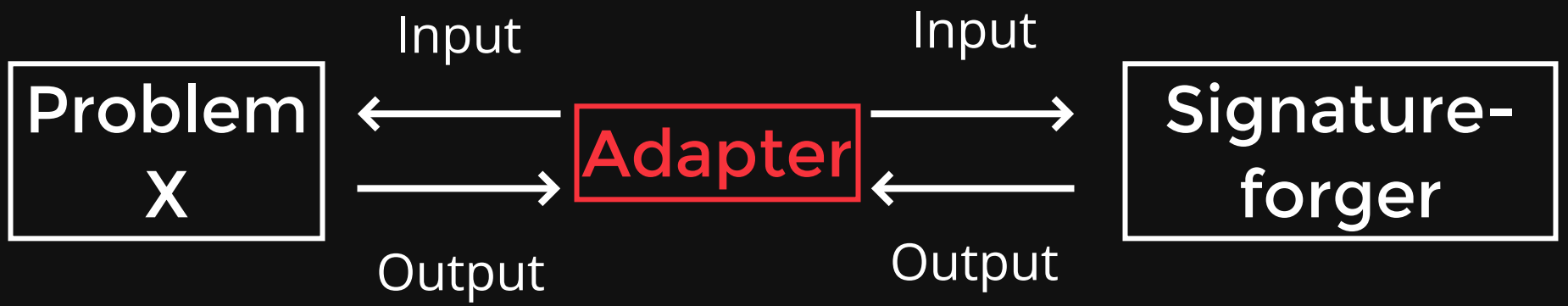

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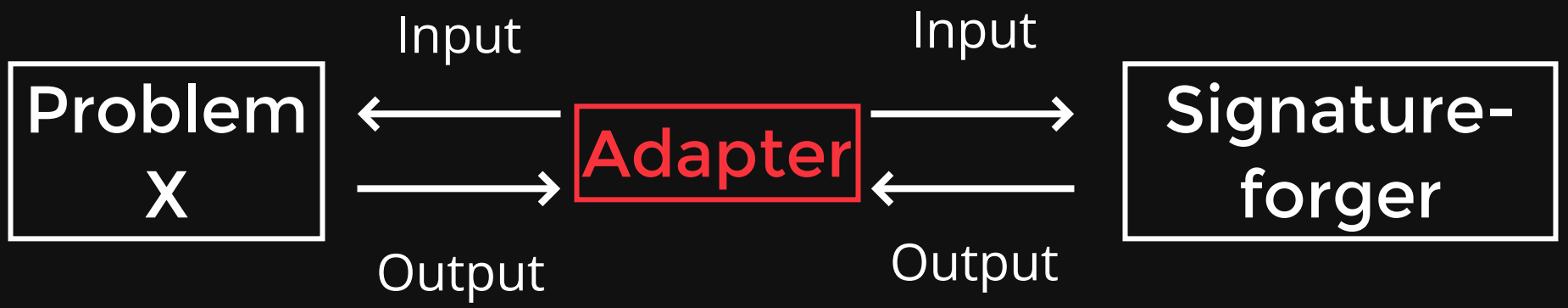

If there is a forger, we can solve problem X

Time to catch our breath...

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  - First versions o**f half-aggregation**, **discreet-log contracts**, **pay-to-contract** outright insecure
  - **BIP 32** (HD-Wallets) more complicated than necessary

Back to the real world

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Paper

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Paper

Bsp.: "Let $P \in \mathbb{G}$"

Back to the real world

Paper → Implementation

Bsp.: "Let $P \in \mathbb{G}$"

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unsigned char
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- In the future ideally: formal specifications, that allow provably correct implementations

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Hello,

We'd like to announce the release of version 0.3.2 of libsecp256k1:

https://github.com/bitcoin-core/secp256k1/releases/tag/v0.3.2

This is a bugfix release after 0.3.1. The impetus for this release is the discovery that GCC 13 became smart enough to optimize out a specific timing side-channel protection mechanism in the ECDH code that could leave applications vulnerable to a side-channel attack. This has been fixed in 0.3.2 [1].

What is Bitcoin Cryptography?

on-chain

(Base Layer)

off-chain

("Layer 2")

---

on-chain

(Base Layer)

off-chain

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on-chain

(Base Layer)

validated by every Bitcoin node, consensus

off-chain ("Layer 2")	optional, settlement on base layer
on-chain (Base Layer)	validated by every Bitcoin node, consensus

(Multiparty-)
Payment Channels

Sidechains

Federated
E-Cash

off-chain

("Layer 2")

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Cryptography

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- "simple" to analyze and implement

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- allows better efficiency and privacy
- includes, for example, multisignatures, blind signatures, zero-knowledge proofs

Case study: Post-Quantum Cryptography

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CRYPTOGRAPHY

‘Post-Quantum’ Cryptography Scheme Is Cracked on a Laptop

6 |

Two researchers have broken an encryption protocol that many saw as a promising defense against the power of quantum computing.

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"Some people seem to be unable to rationally consider the possibility that NSA is sabotaging post-quantum cryptography."


ONE DOES NOT SIMPLY
MAKE BITCOIN QUANTUM-SECURE
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Outlook

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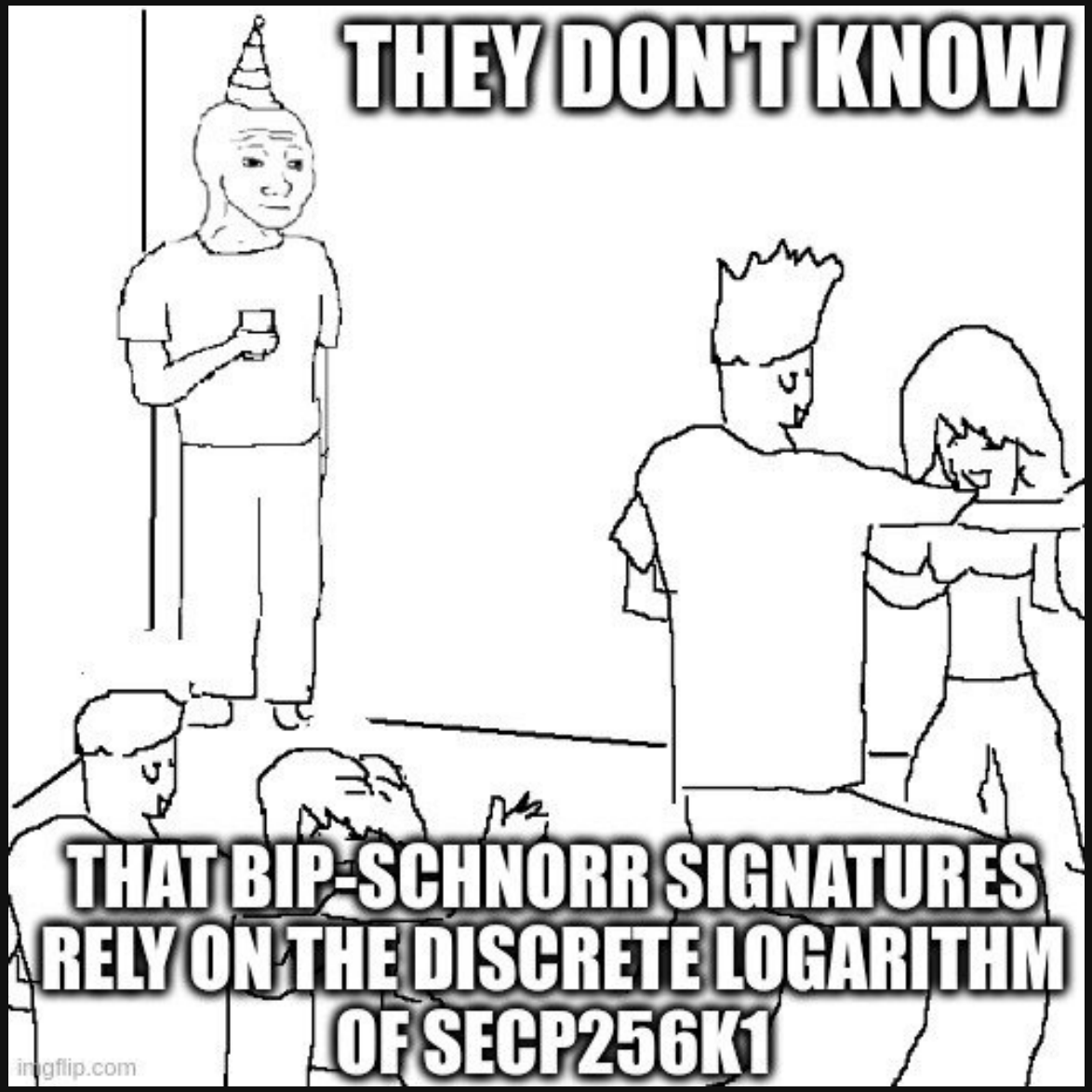
- Layer 2 Cryptography:
  - A vast field with many open questions for theory and practice



Slides: nickler.ninja/slides