An introduction to Cryptocurrencies

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Bartering

Trade through bartering:

Figure: http://www.forbes.com/

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problem: meet of demand

Commodity money

Use an intermediate commodity as ‘store-of-value’

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- in Japan rice
- in India cowry shells

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Meet of demands problem solved!

Currency

Money as an abstract form of value.

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- Electronic payment systems

Double spending

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- centralized control: ask the bank whether to accept a transaction or not
- too much power in one actor e.g. Wikileaks
- Why not make this system decentralized?

Cryptocurrency

A cryptocurrency is a medium of exchange using cryptography to secure the transactions and to control the creation of new units.

Main properties

- Trust Distribution
- Verifiability
- Pseudonimity/Anonymity/Traceability

Bitcoin

Currently most popular cryptocurrency.

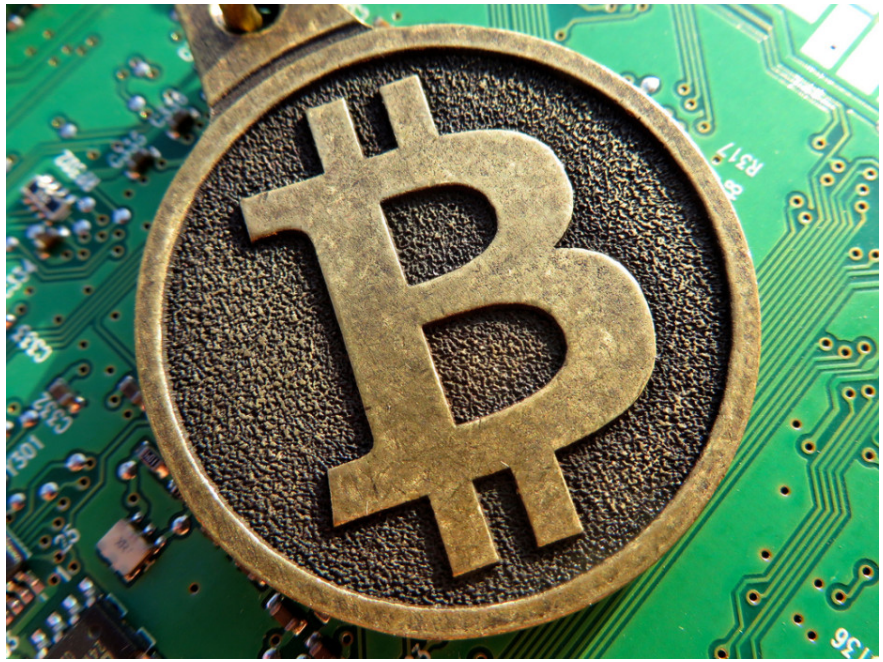

Figure: https://www.flickr.com/photos/btckeychain/

- Introduced by Satoshi Nakamoto in 2008.
- 1 Btc = 730$
- Distributed public ledger of transactions open to anyone

Distributed Ledger

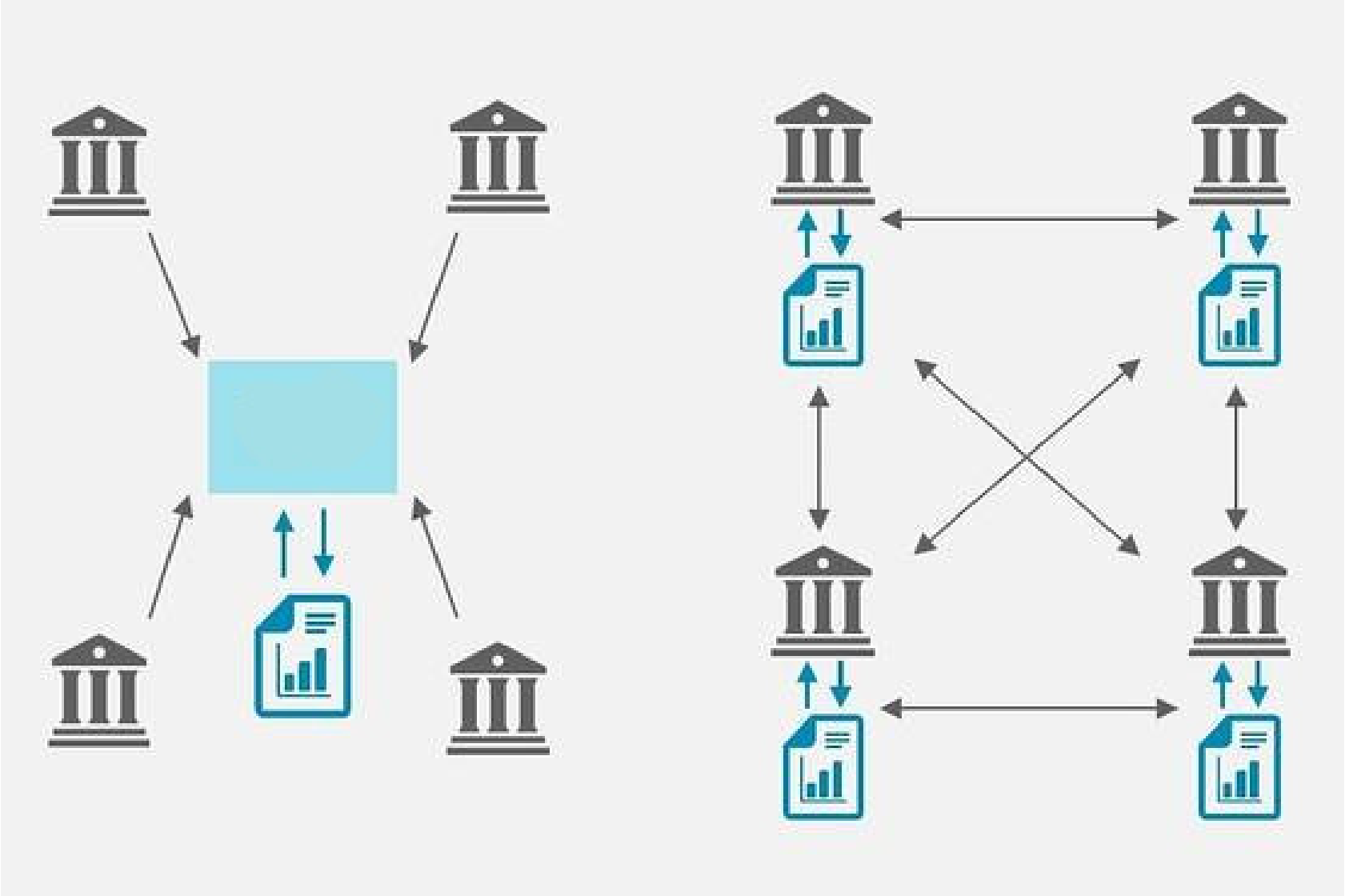

Figure: http://blogs.wsj.com/cio/2016/02/02/cio-explainer-what-is-blockchain/

Different roles of Bitcoin participants

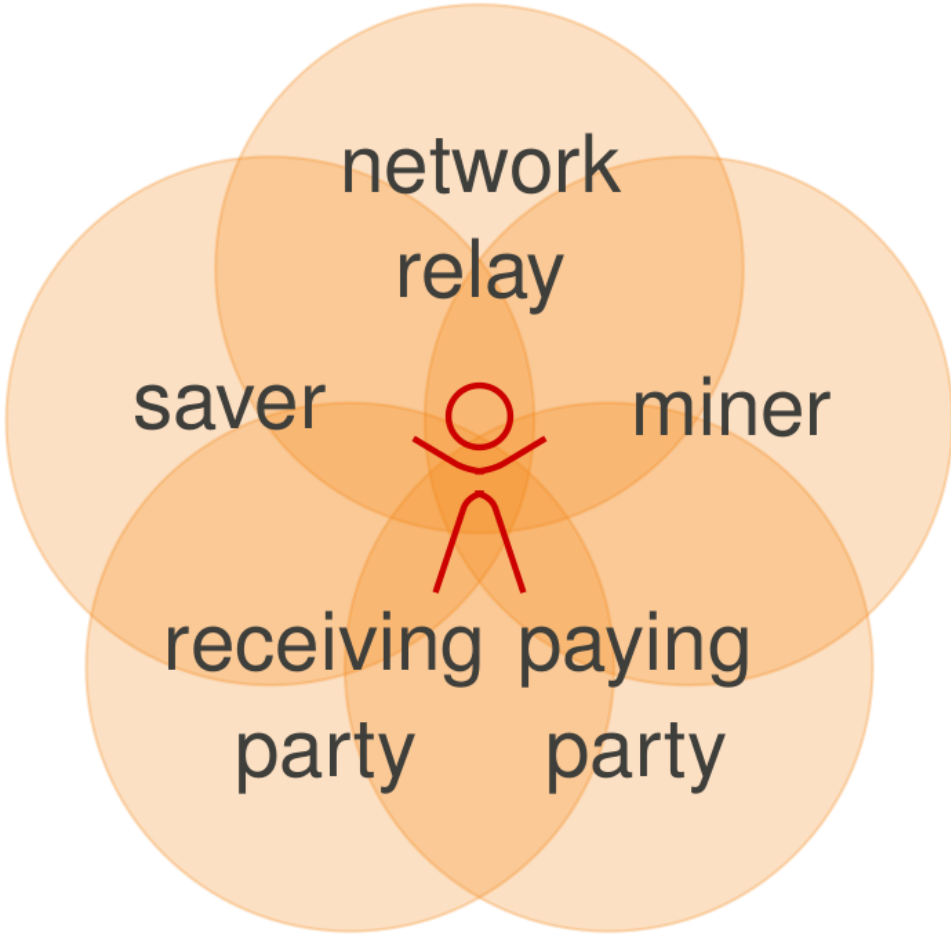

Figure: Rainer Bohme: The Bitcoin Economic Ecosystem

Transactions

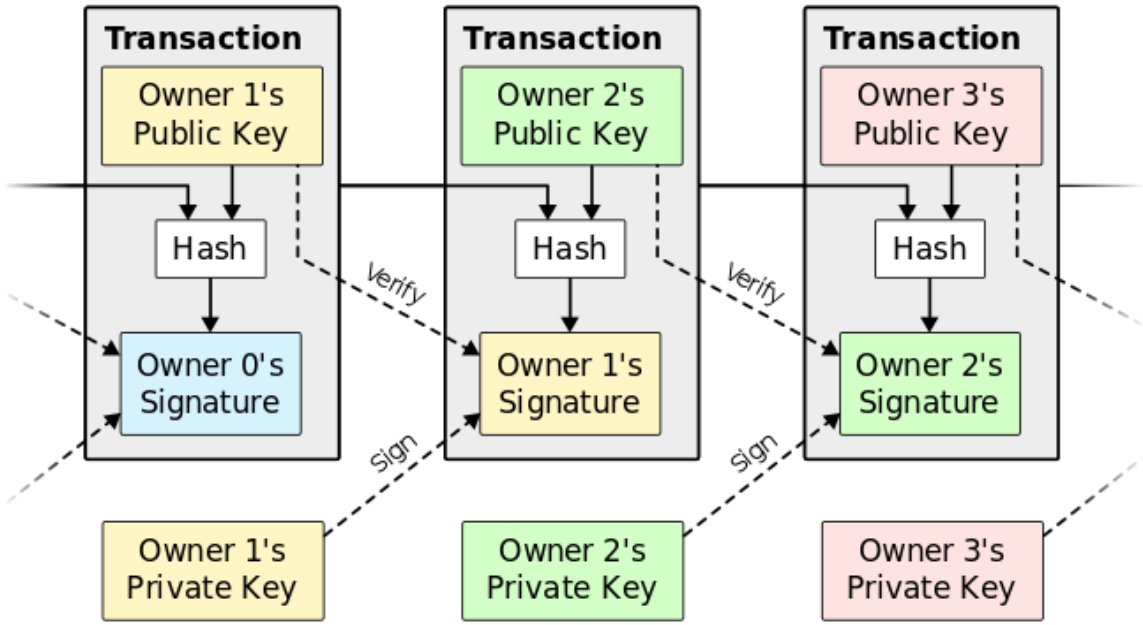

Figure: Satoshi Nakamoto: Bitcoin: A Peer-to-Peer Electronic Cash System

- an account is a pair of cryptographic keys
- coins are send from a public key to another public key
- transaction needs to be signed by the sender

Transactions

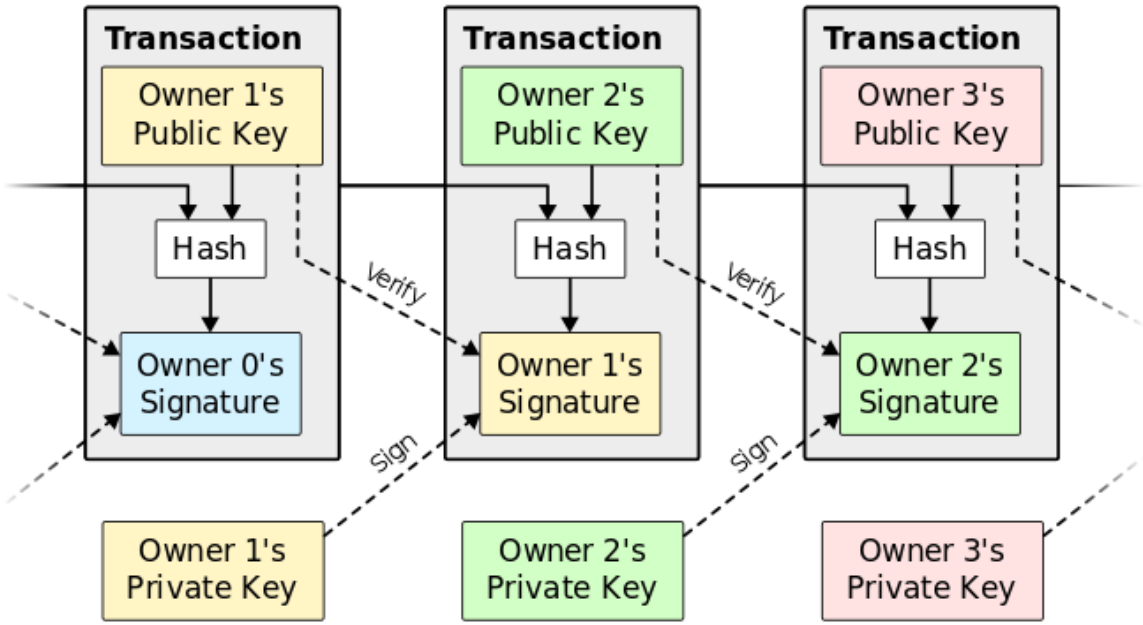

Figure: Satoshi Nakamoto: Bitcoin: A Peer-to-Peer Electronic Cash System

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- coins are send from a public key to another public key
- transaction needs to be signed by the sender
- order of transactions matters!

Blocks of transactions

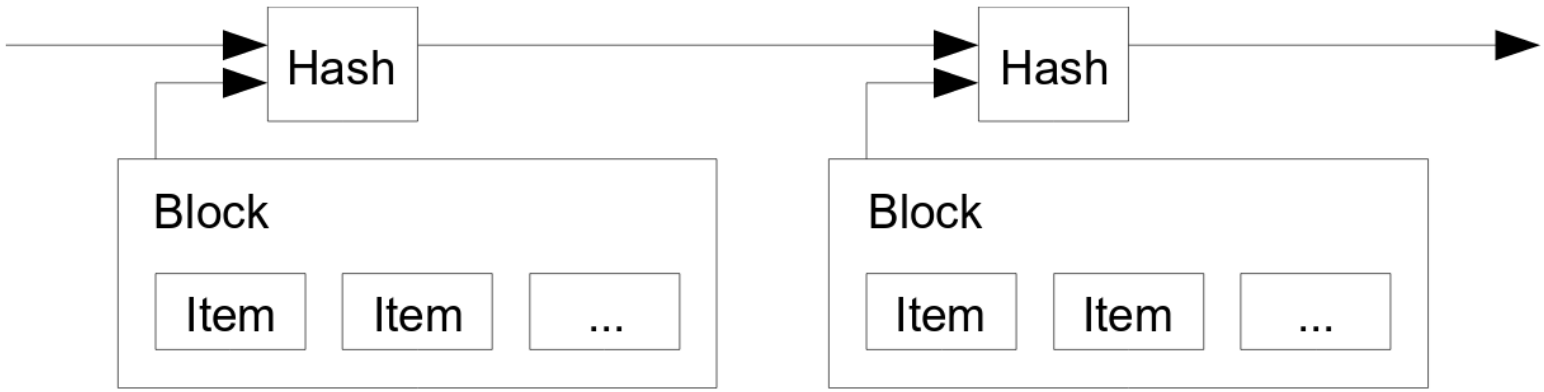
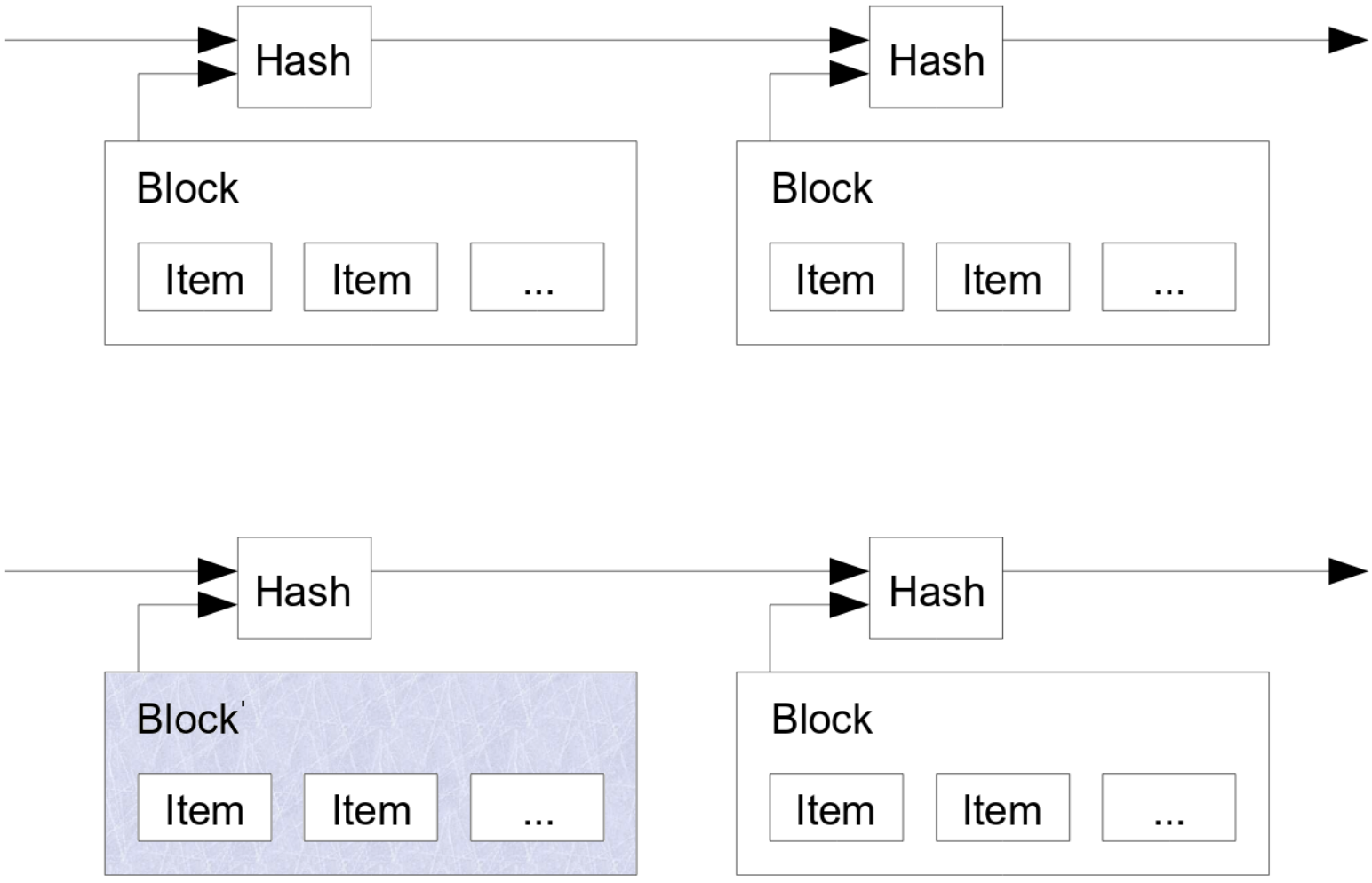


Figure: Satoshi Nakamoto: Bitcoin: A Peer-to-Peer Electronic Cash System

- each block depends on the hash of the previous block
- a chain of blocks contains the whole history of transactions

Append-only log



Cannot replace an earlier block due to collision resistance!

Permissionless

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- problem: Sybil attack

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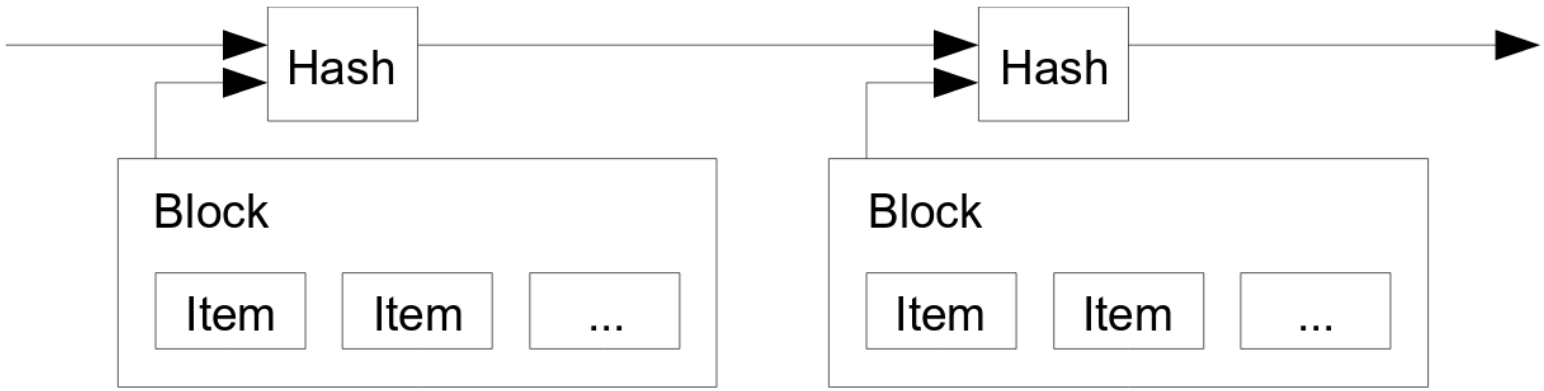
- solution: spend some kind of limited resource to be eligible

Proof of Work [Dwork,Naor '92]

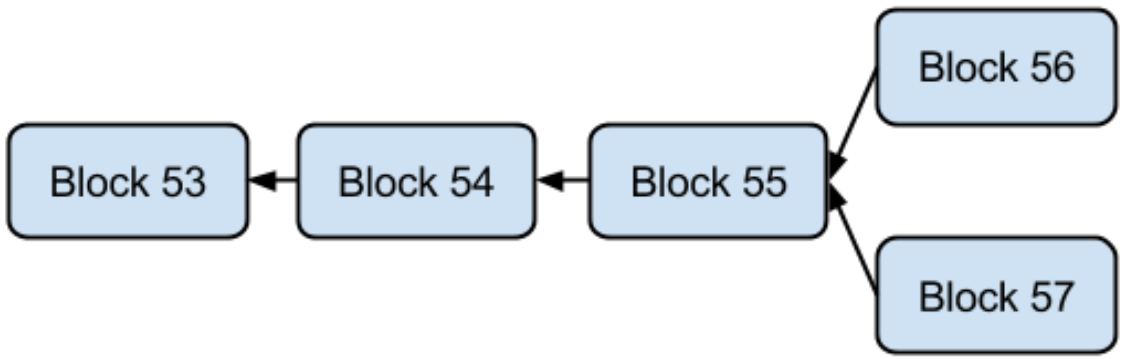
A proof that an amount of computational work has been done.



- Hash (SHA-256) must be less than 2^{68}
- 1 block is generated every 10 minutes.
- Difficulty is adjusted every 2016 blocks.

Agreement

problem: more than one chains can be created



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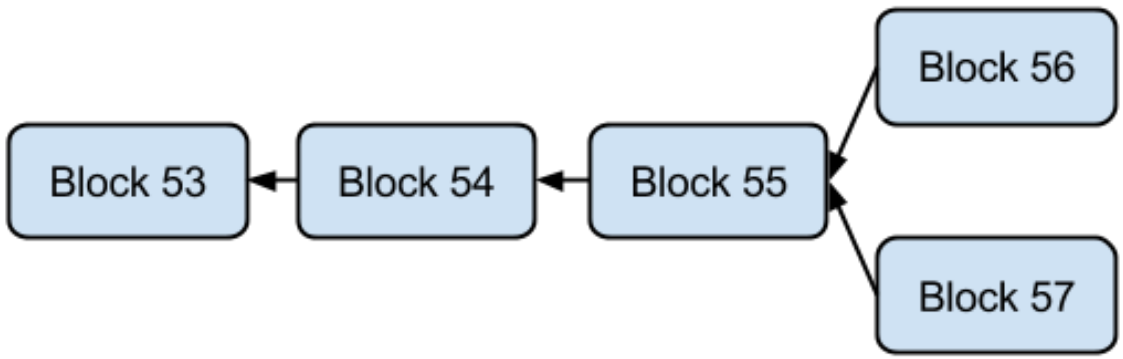

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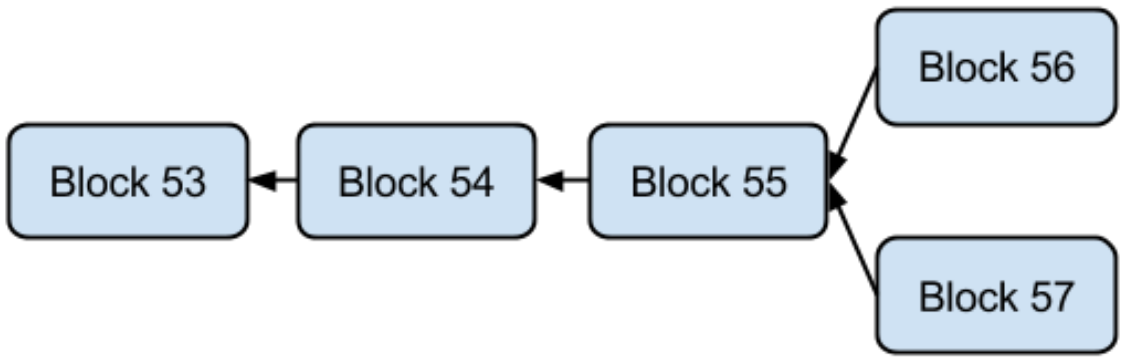
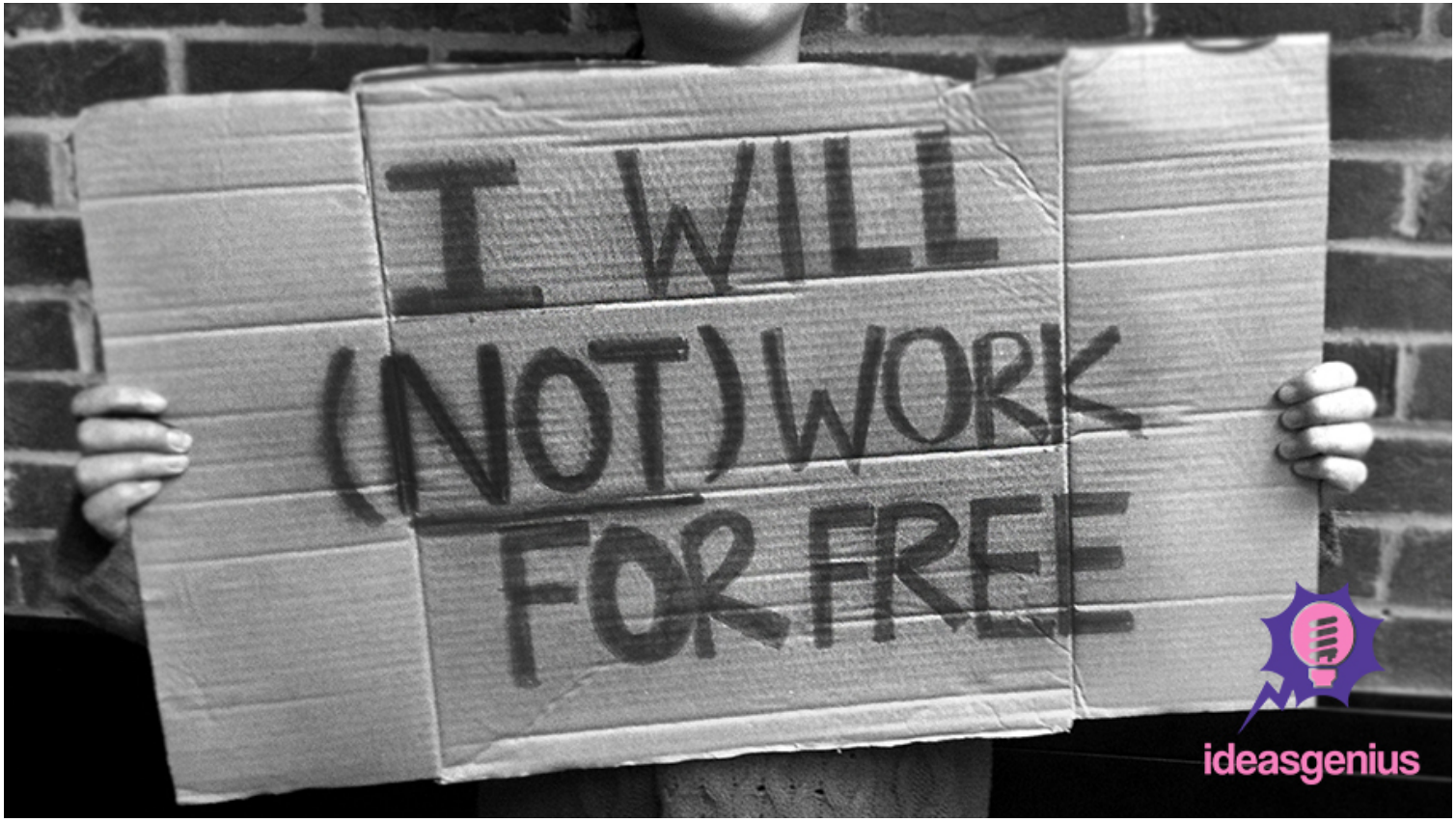


- solution: pick the longest one
- Honest majority provably leads to consensus on transaction history! [Garay, Kiayias, Leonardos 2015]

Block rewards

problem: Why should anyone be a miner?



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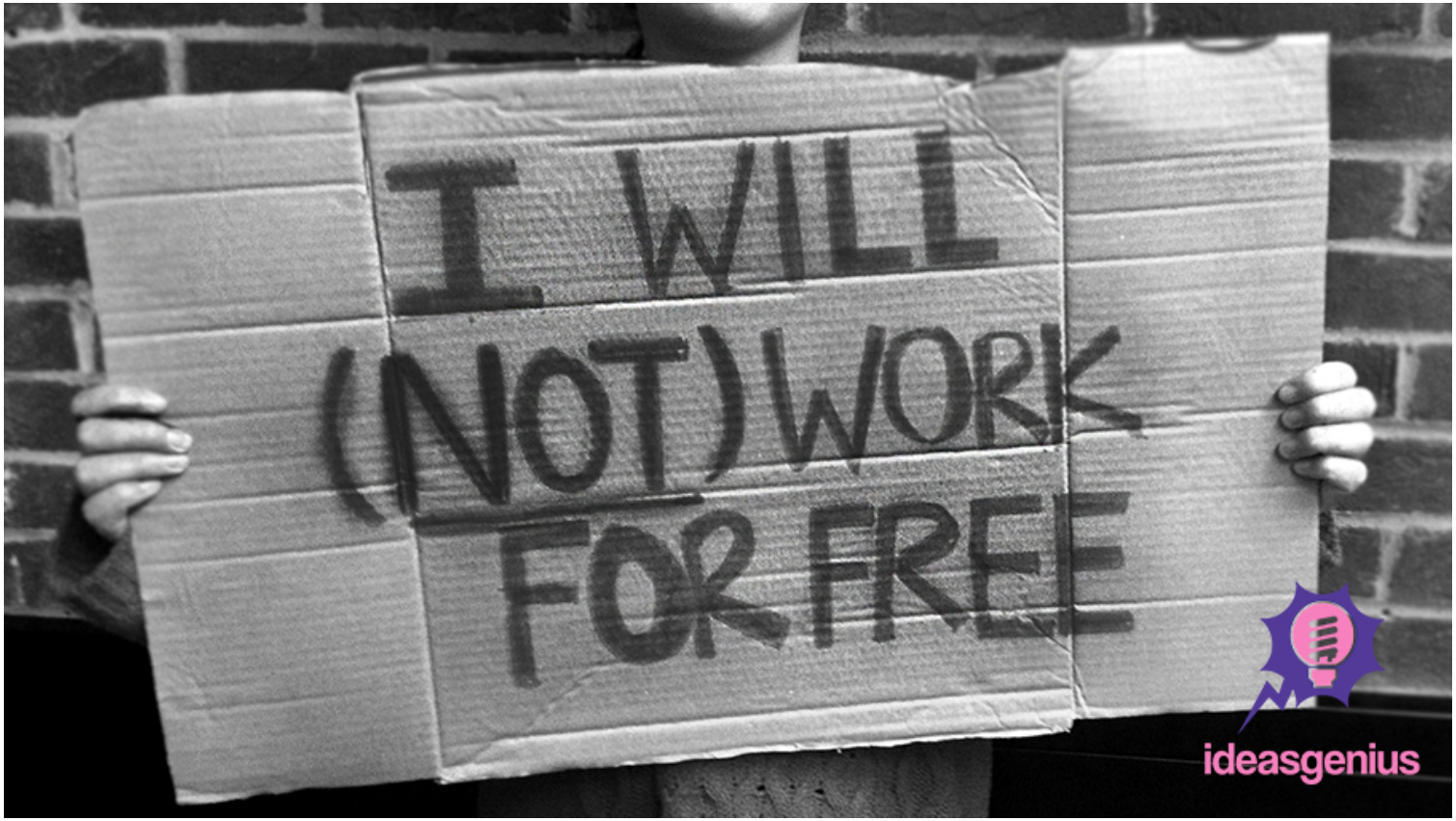

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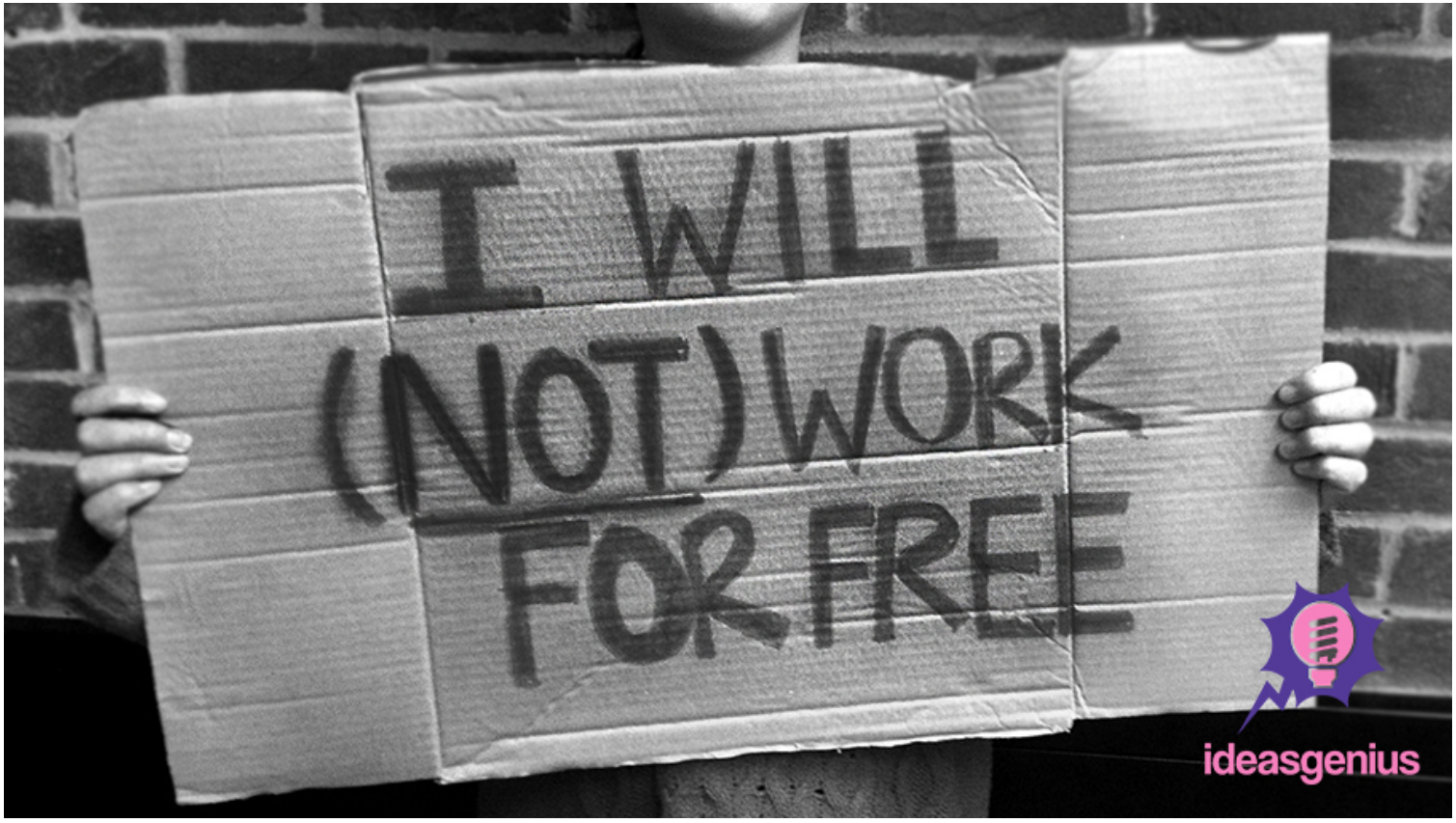
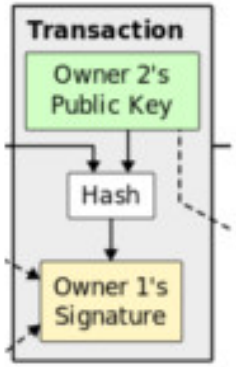


- solution: miners are rewarded for the blocks they mine.
- Rewards are halved every 4 years, currently $12.5 Btc \approx 8000\$$

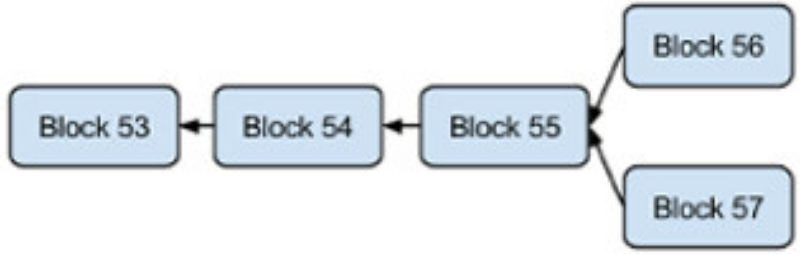


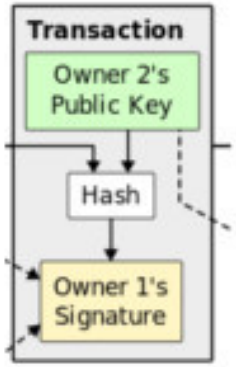
Owner 2's Private Key

broadcast

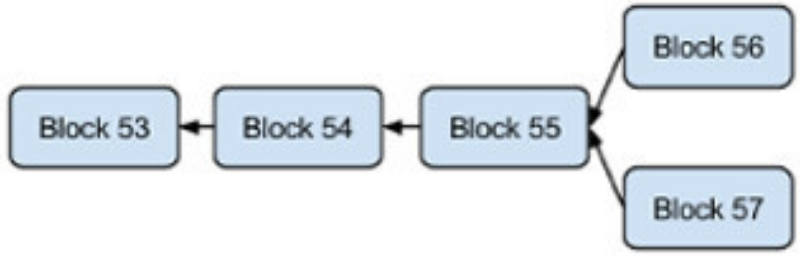
mine

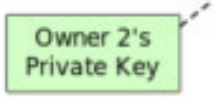
stabilize





transaction complete





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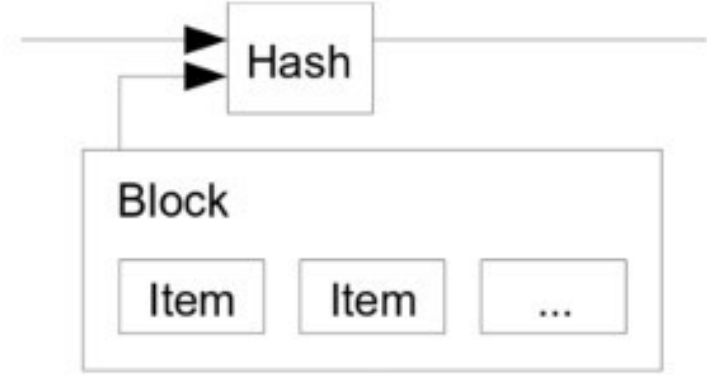

Sounds good! Many open challenges...

Transactions rate

problem: transaction rate on Bitcoin is too slow...

Figure: `http://believeinplace.com`

- Bitcoin: 7 tps
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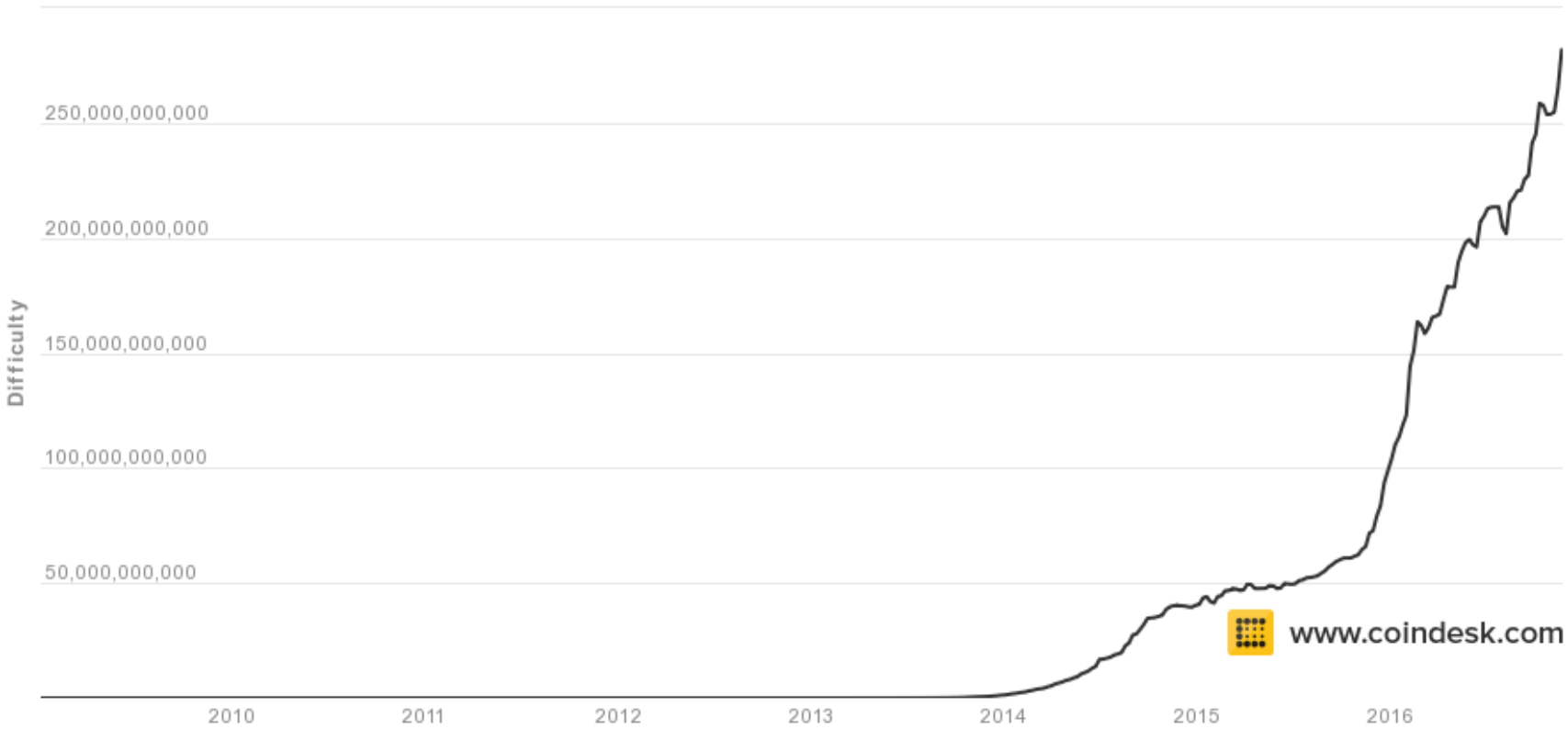
solution: Make block generation faster! Security deteriorates...

Difficulty through time



Energy Consumption

Finding small hashes requires energy.

By 2020 bitcoin is expected to need as much energy as Denmark!

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solution: Proof-of-Stake

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Certain coins may have been used in ‘illegal’ transactions

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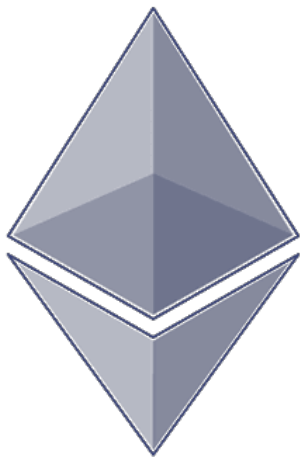
- solution: full anonymity! (see Zerocash and NIZK)

Altcoins

Many variants of Bitcoin offering exciting new possibilities



- Ethereum: Turing complete transaction system
- Namecoin: Decentralized DNS

Future

Can or should bitcoin replace national currencies?

Price history