Introduction to Blockchain

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Why we are here?

Syllabus

- NFT fundamentals
- ICO schemes
- Web3 enthusiasm
- Crypto trading
  - 100x leverage
- GameFi tokenomics
- Arbitrage
- Rug Pull

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- NFT fundamentals
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True syllabus

- Basic cryptography
- Bitcoin
- Consensus algorithms
- Ethereum Virtual Machine (EVM)
- Smart contracts
- DeFi patterns
- DEX protocols
- Lending protocols
- Bridges
- Layer 2 solutions

Homework

- In the format of CTF (Capture The Flag) challenges.
- Start after 4th lecture.
- Soft and hard deadlines on tasks.

Exam

- The exam will be conducted in an oral format.
- The list of questions will be provided in advance.

Evaluation

$$O_{total} = [0.7 \cdot O_{hw} + 0.3 \cdot O_{exam}]$$
$$[O_{hw}] \geq 8 \Rightarrow O_{total} = [O_{hw}]$$

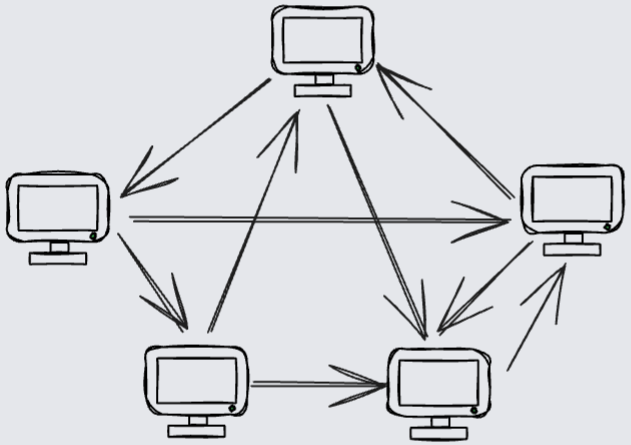
Questions?

Agenda today

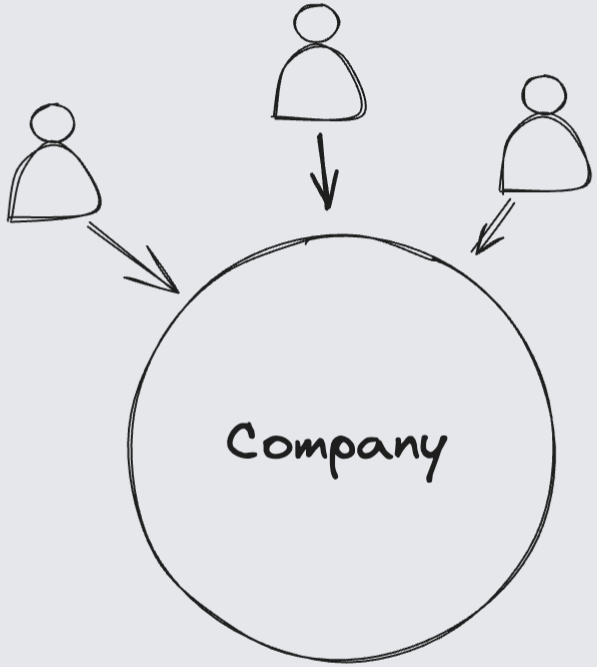
- History
- What is a blockchain?
- Cryptography background
- Crypto wallets

History

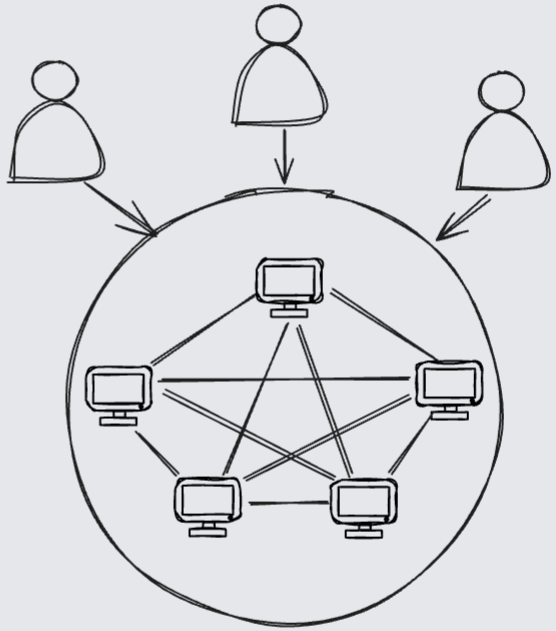
Three eras of networks



Protocol Networks

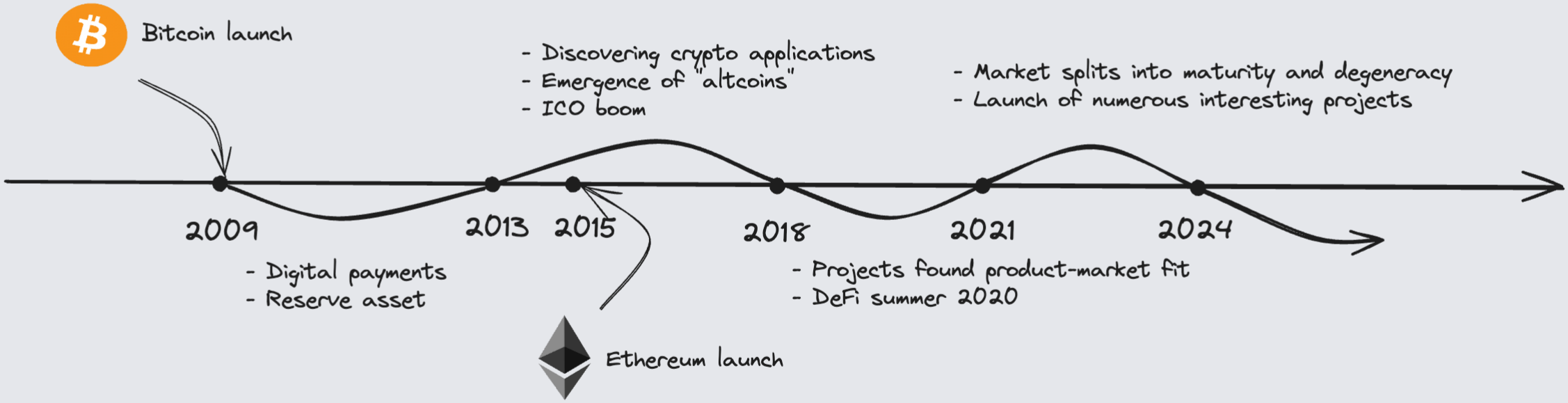


Corporate Networks

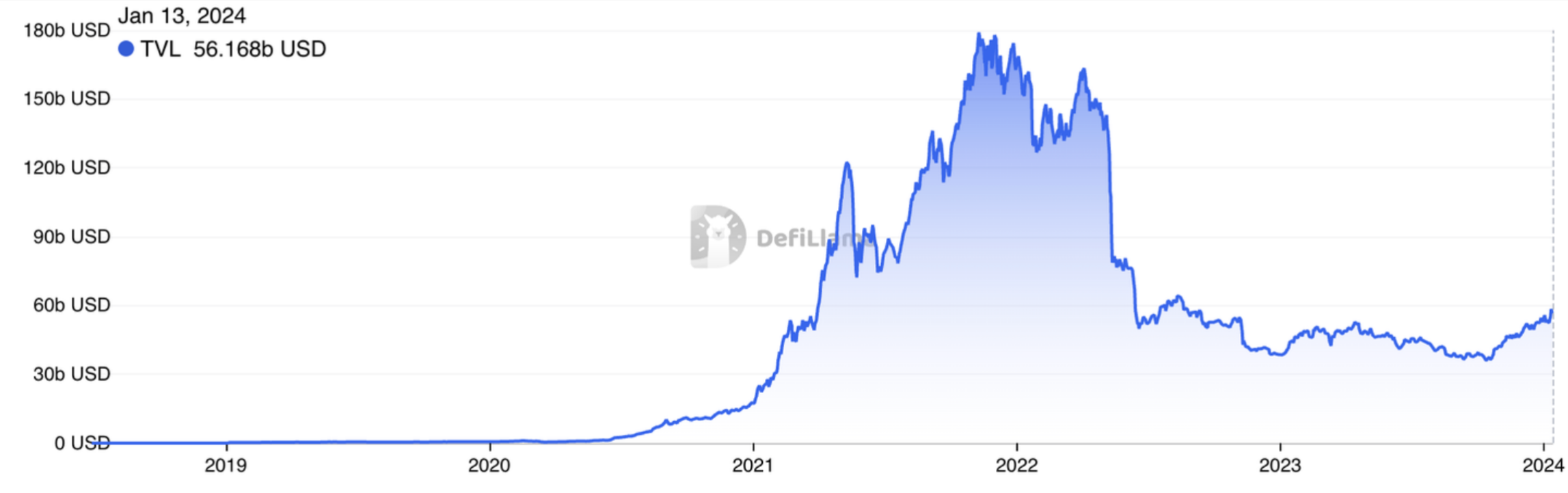


Blockchain Networks

Timeline


Bitcoin launch
- Discovering crypto applications
- Emergence of "altcoins"
- ICO boom
- Market splits into maturity and degeneracy
- Launch of numerous interesting projects
2009
2013
2015
2018
2021
2024
- Digital payments
- Reserve asset
- Projects found product-market fit
- DeFi summer 2020
Ethereum launch

TVL (Total Value Locked)

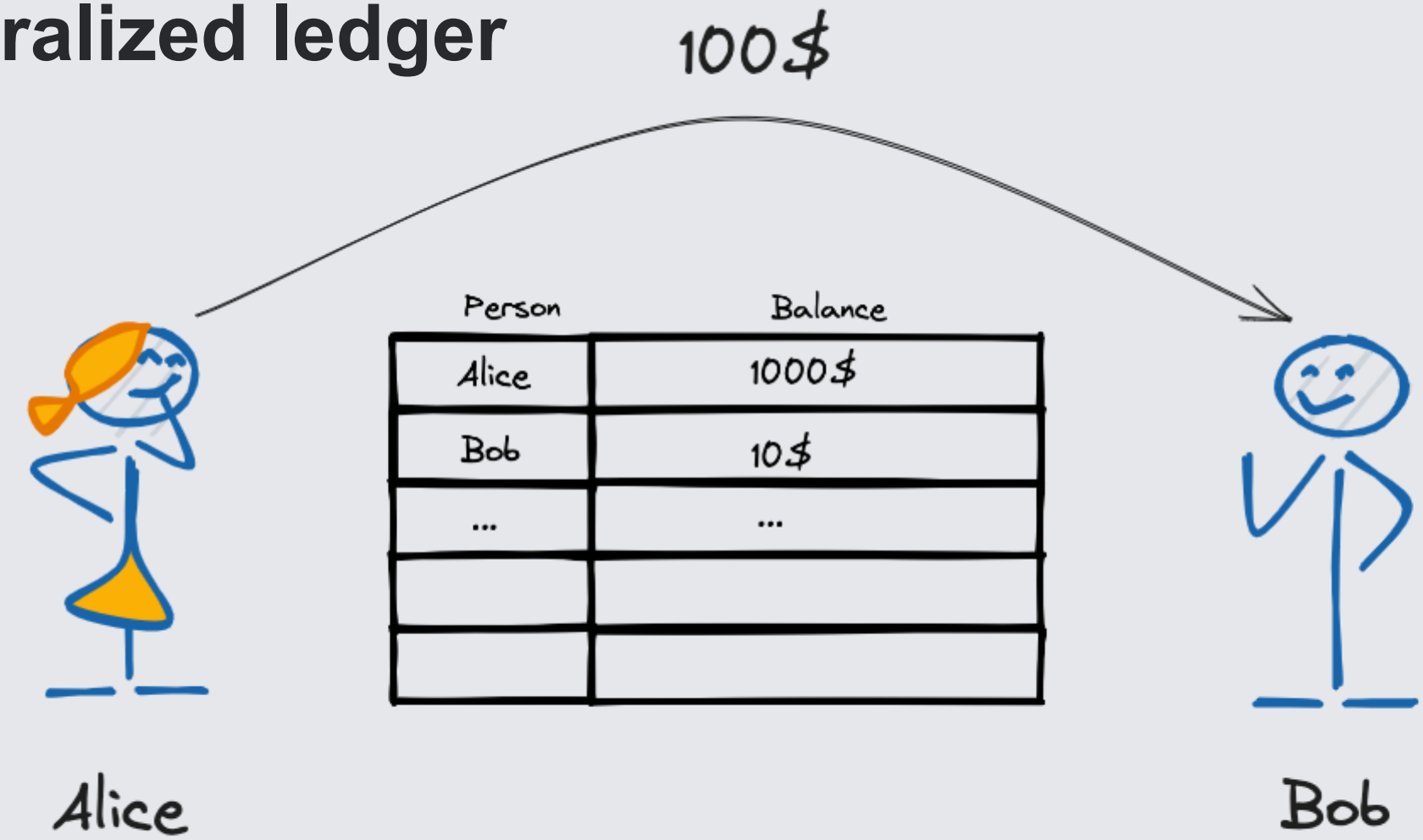


What is a blockchain?

Why is a blockchain?

- A system for coordinating between many parties when no single trusted party exists.
- If trusted party exists ⇒ No need for blockchain
- Often used in financial systems

Decentralized ledger



Decentralized ledger

Alice

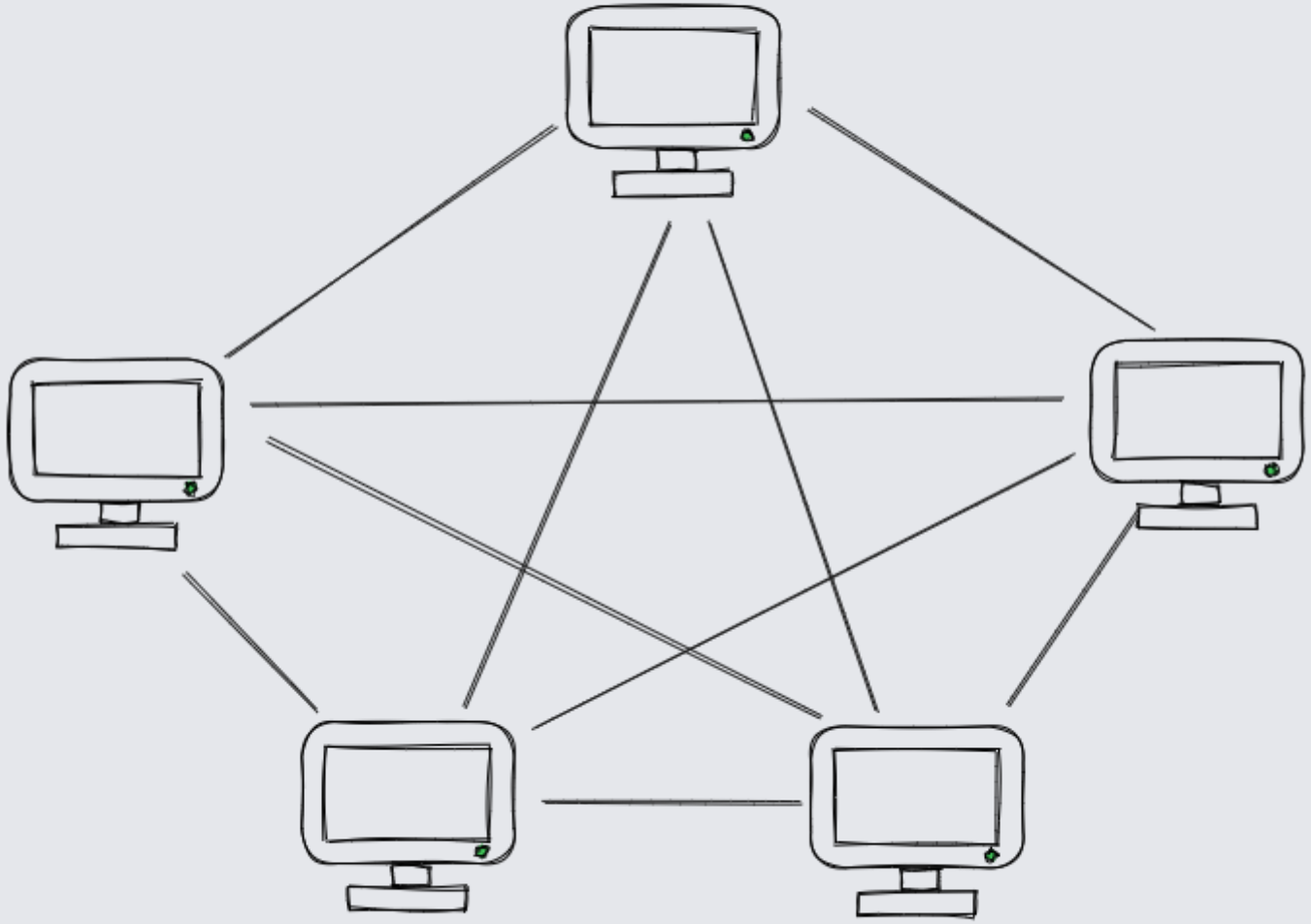
Person	Balance
Alice	900$
Bob	110$
...	...

Bob

Requirements for the system

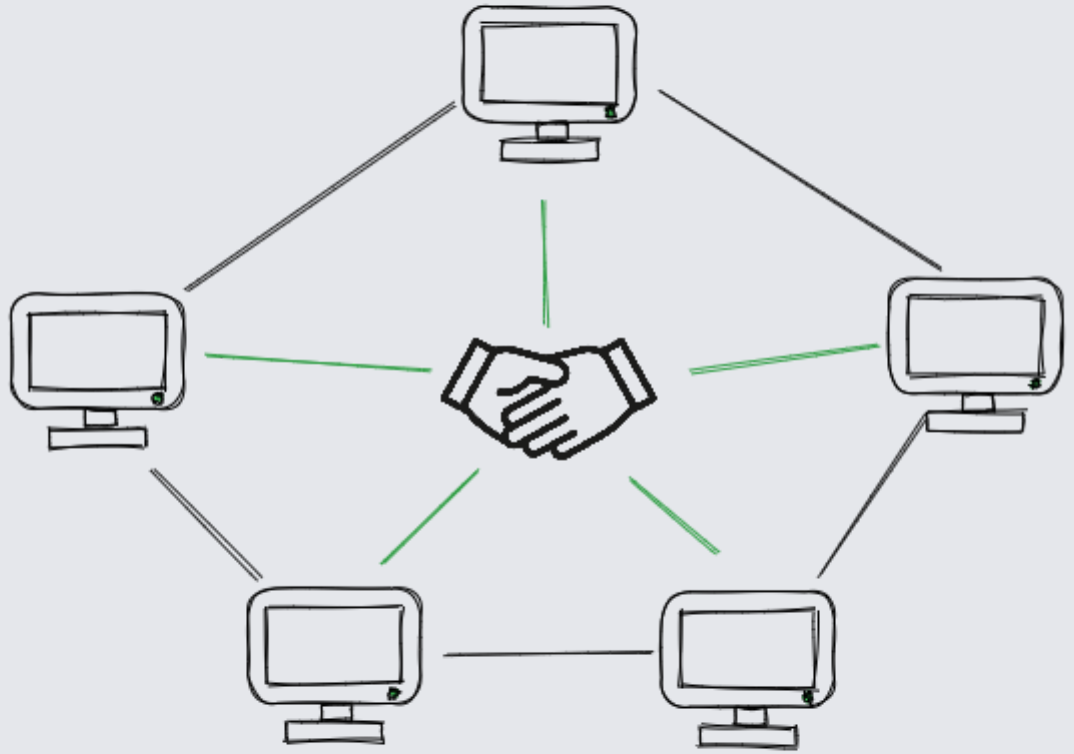
- Broadcast signed messages (transactions).
- Performs state transitions.
- Doesn't allow overspending.
- Decentralized.

Peer-to-Peer (P2P) network



Consensus mechanism

- The term refers to the mechanics, that allow a network of nodes to agree on the state of a blockchain.



Consensus types

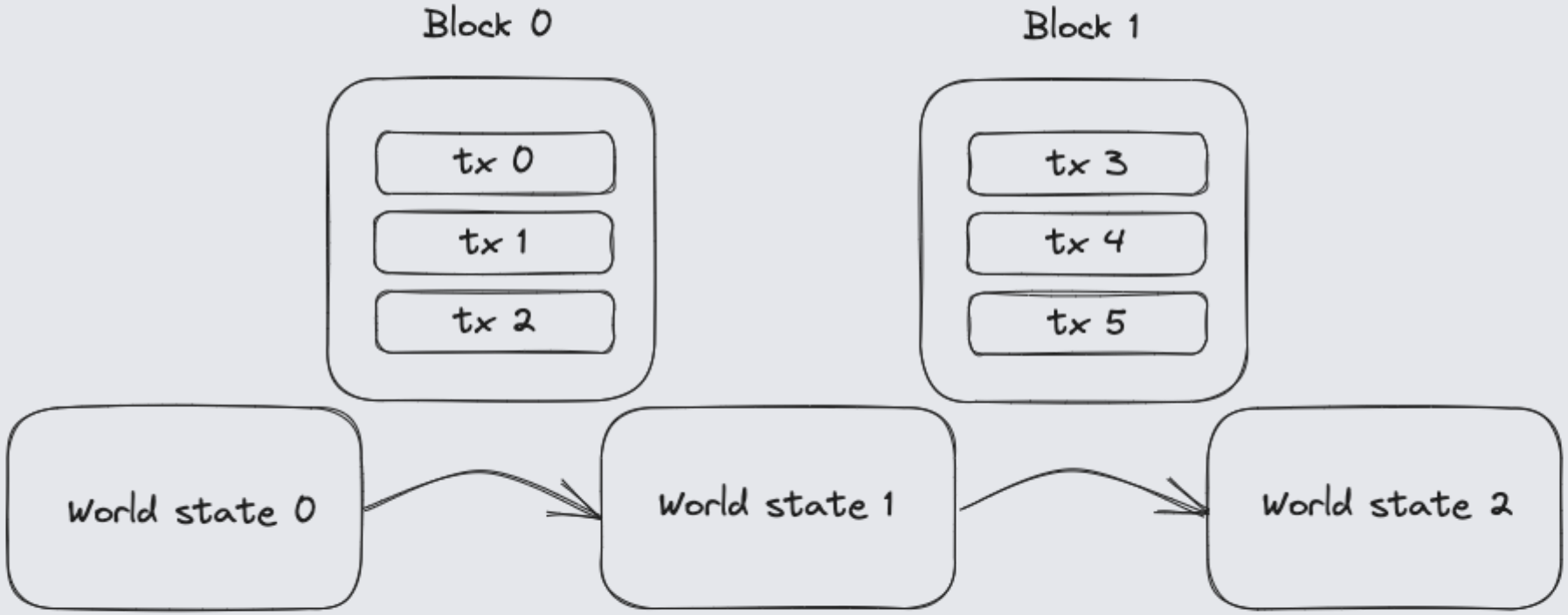
Proof of Work (PoW)

- Block creators are called miners.
- Miners run software that solves complex mathematical problems to validate and add new transactions.
- Mining consumes significant electrical power.

Proof of Stake (PoS)

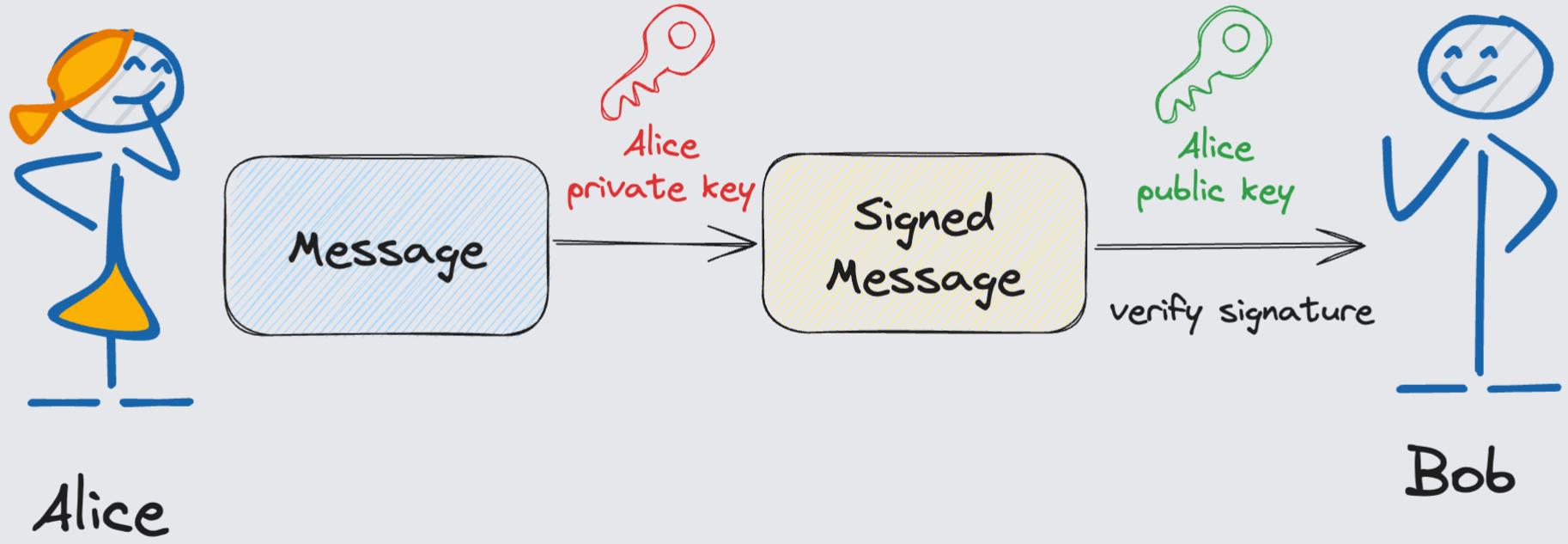
- Block creators are called validators.
- Validators lock up a certain amount of cryptocurrency as collateral to validate and produce new blocks.
- Malicious validators will be losing their staked assets if they attempt to validate fraudulent transactions.

Chain of states



Cryptography background

Digital signature

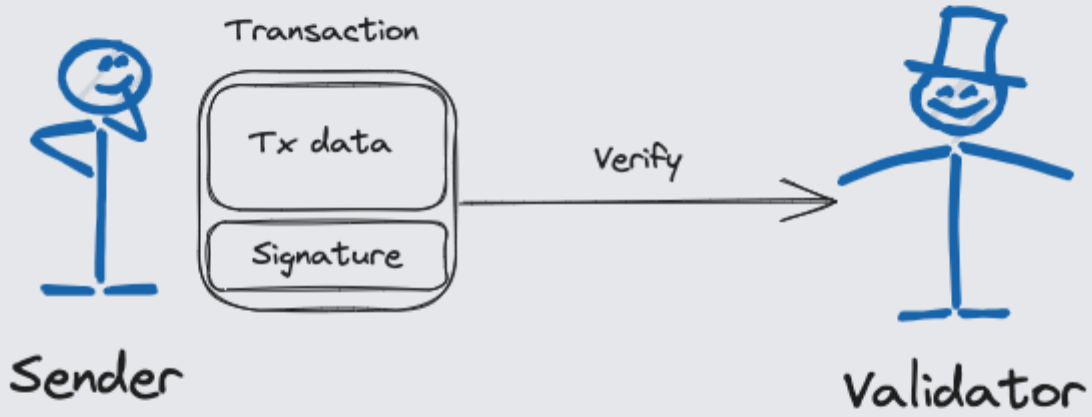


Digital signature: algorithms

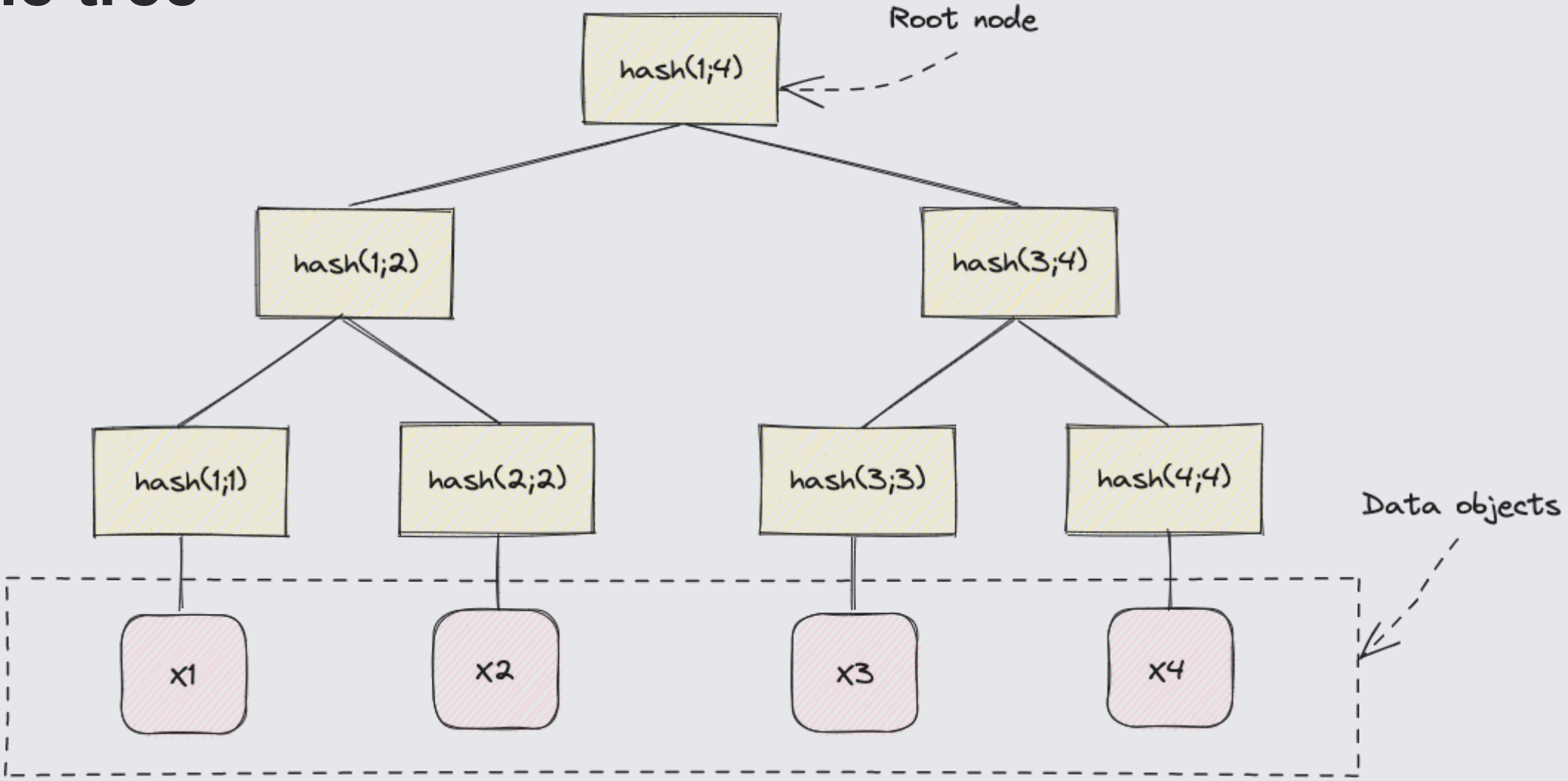
- `gen()` – generate a key pair `(public_key, private_key)`.
- `sign(data, private_key)` – signs data.
- `verify(signature, public_key)` – verifies signature or extract the data.

Signatures on blockchain

- Signing user transactions.
- Signing blocks (for validators).
- Other applications,
  such as voting mechanics.



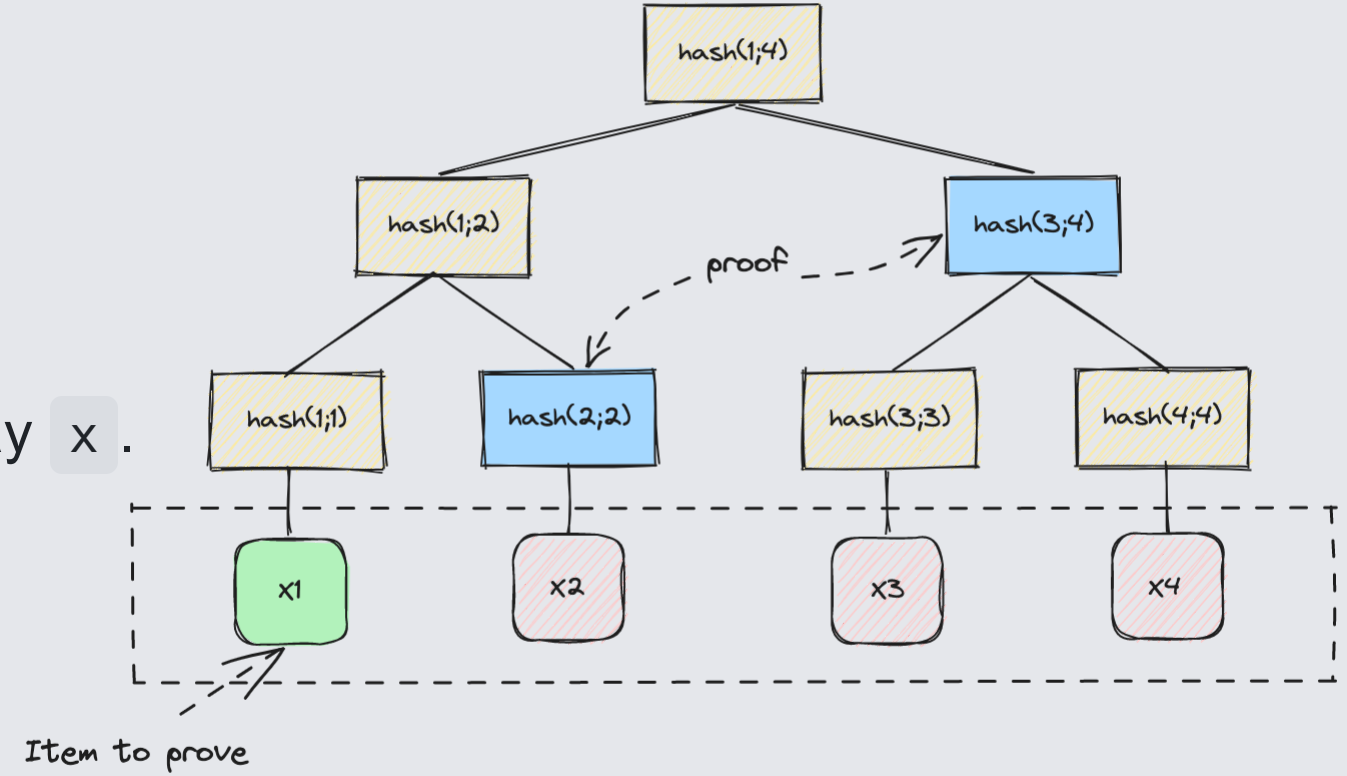
Merkle tree


Root node
hash(1;4)
hash(1;2)
hash(3;4)
hash(1;1)
hash(2;2)
hash(3;3)
hash(4;4)
Data objects
x1
x2
x3
x4

Merkle tree

Goal

- get a short representation to the array `x`.
- later prove that element i is `x[i]`.



Merkle tree on blockchain

- Each block contains only merkle root of transactions.
- Later we can prove that a transaction is on the blockchain.

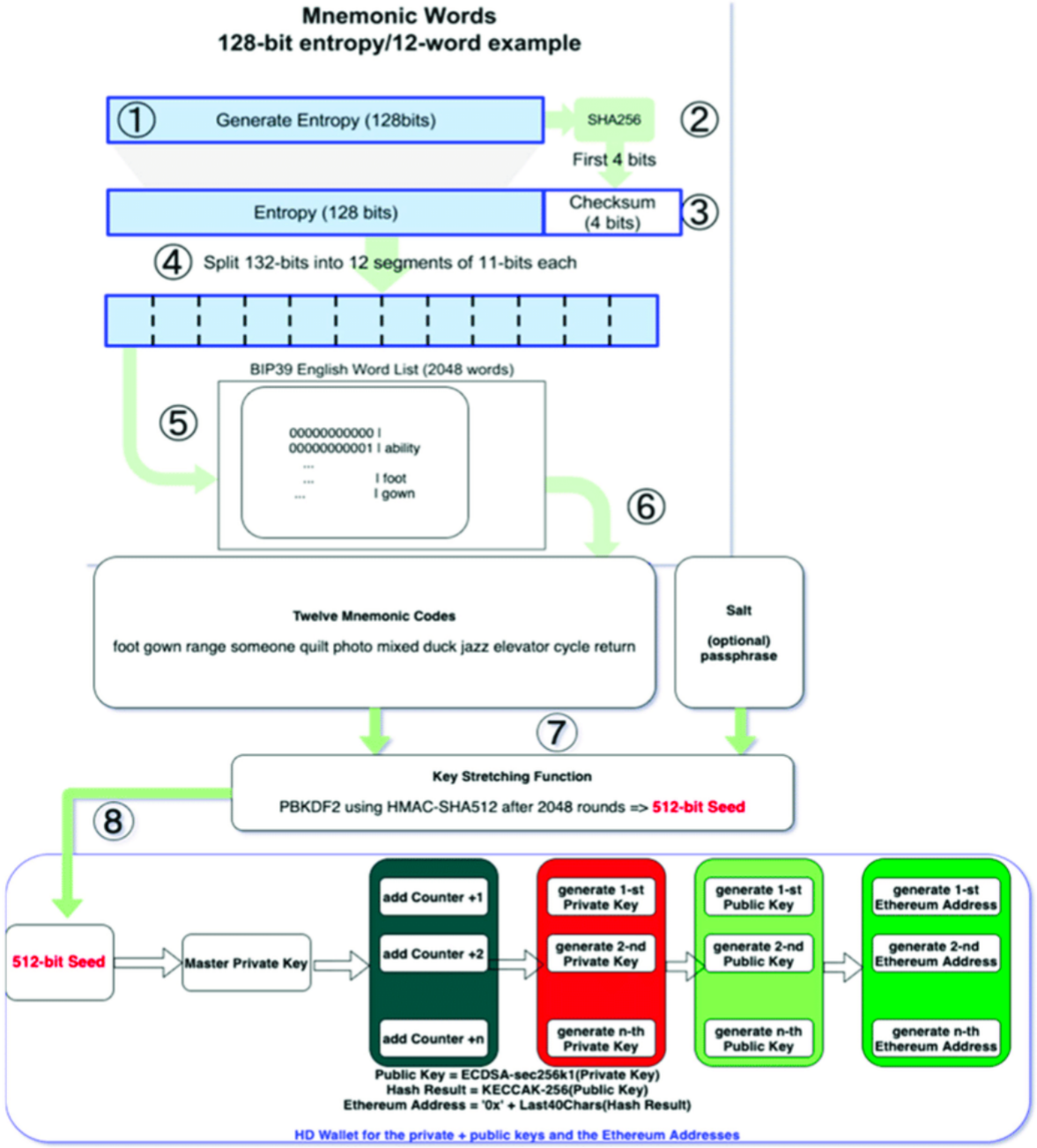
Crypto wallets

What wallets do

- Generate private and public key.
- Store private key.
- Sign and send transactions.
- Show balances.

Mnemonic phrase

A mnemonic phrase is superior for human compared to the handling of raw seed.



Types of wallets

- Cloud
  - Cloud holds private keys.
- Soft
  - Browser extension.
  - Mobile application.
  - Desktop app.
- Hardware
  - Ledger, Trezor, etc.
- Paper
  - Write secret key on paper.
- Brain
  - Memorize your secret key.

Hardware wallets

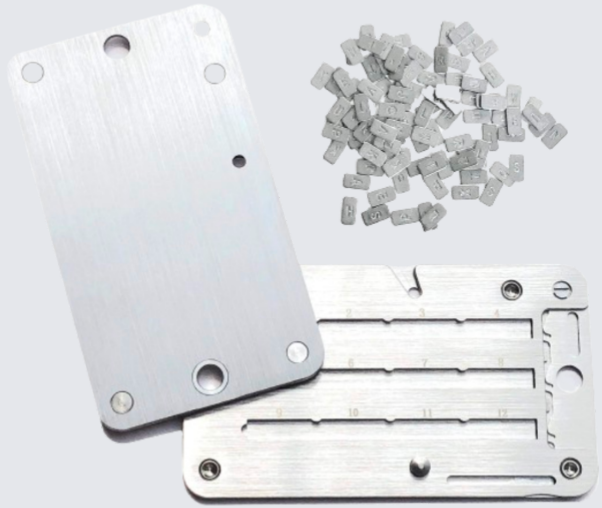
- Physical devices designed to securely store cryptocurrency private keys offline.
- Connect to a computer via USB and require physical confirmation for transactions.

Brain wallet

- Storing private key using a memorized phrase, that was self-generated.
- Have low entropy, vulnerable to brute-force.

Paper wallet

- Write private key on paper (or other physical item).
- Secure from digital attacks, but vulnerable to physical risks like damage, theft, or loss.



Let's create a hot wallet

- **Metamask** is the most popular one.