Blockchain for Industrial Engineers: Decentralized Application Development

บล็อกเชนสำหรับวิศวกรอุตสาหการ: การพัฒนาแอปพลิเคชันแบบกระจายศูนย์

Short history - Bitcoin

- October 31, 2008
  - "White paper" by *Satoshi Nakamoto*
  - Describing a system to allow peer to peer payments without a financial intermediary (like a bank)
- January 3, 2009
  - The bitcoin network came into existence with Satoshi Nakamoto mining the genesis block of bitcoin (block number 0), which had a reward of 50 bitcoins

Shortcoming

Bitcoin can only be used for sending money.

> Can we use bitcoin technology to transfer other types of exchanges?

Short history - Ethereum

- December 2013
  - "White paper" by *Vitalik Buterin*
  - Discussing need for more programmatic control over transactions
  - Introducing the idea of *Smart Contracts* as an entity that can send and receive currency, beyond just humans
- July 2015
  - Birth of Ethereum network

Shortcoming

- Scalability
  - Bitcoin (Layer 1): 7 tps
  - Ethereum (1.0): 30 tps
  - Visa 24,000 tps
- Interoperability
  - Moving token between differnet networks.
- Governance system
  - Bitcoin Foundation and Ethereum Foundation are centralized organization.

Source

3rd-Generation blockchain

Source

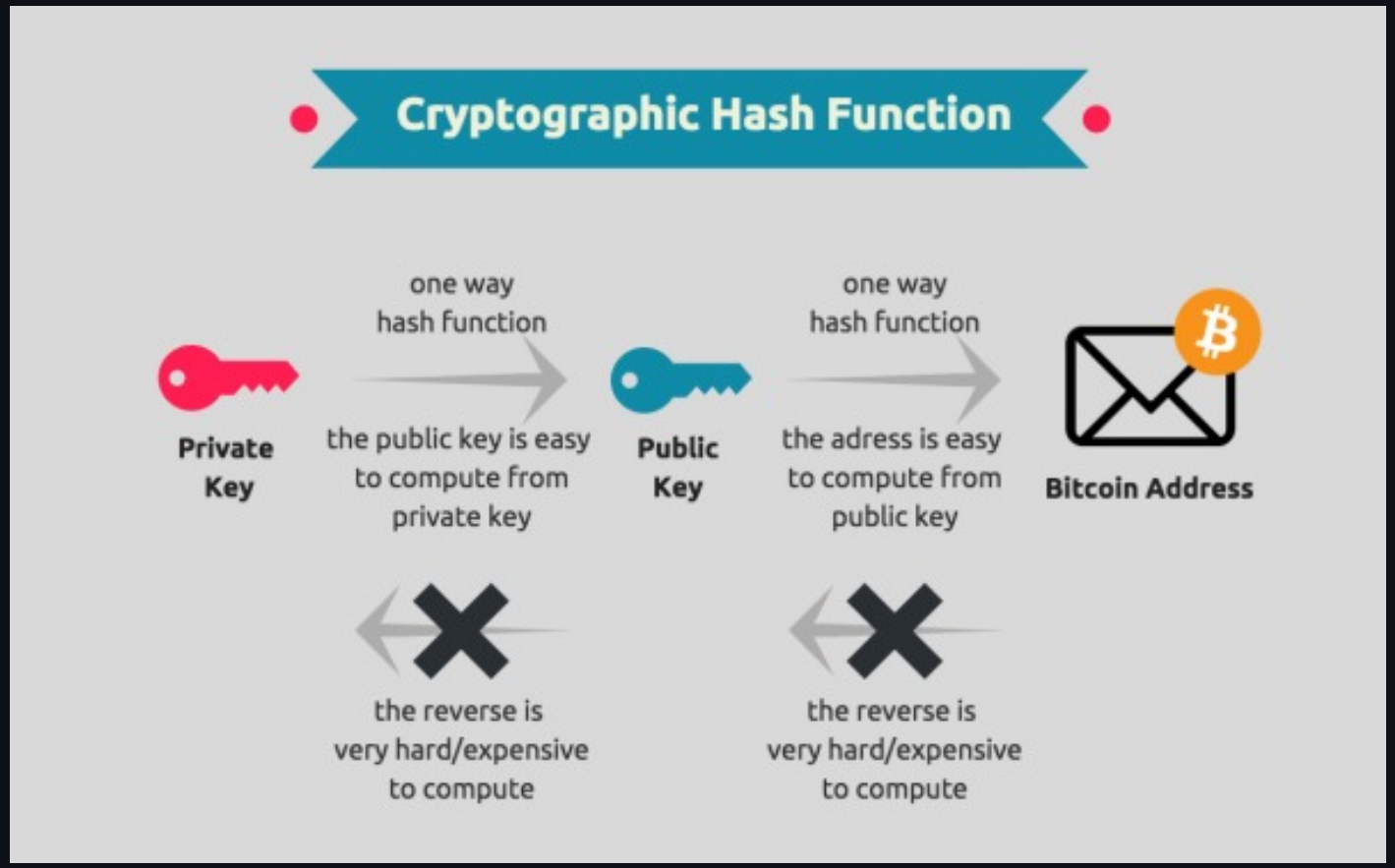
Getting to know blockchain

- Blockchain demo
- Public and private keys
- Block explorer

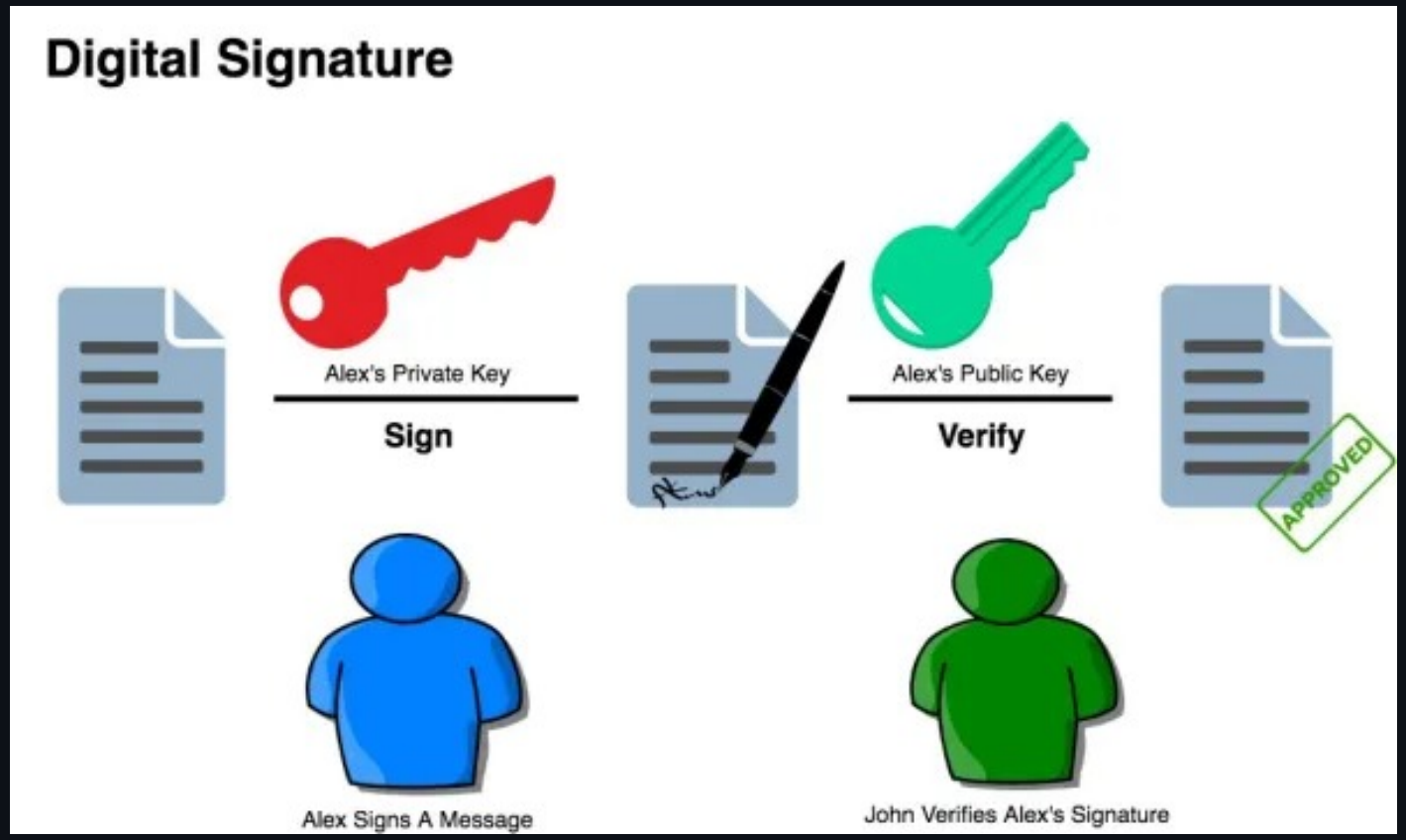
Other cool demos

- Blockchain demo
- Coin demo

Keys

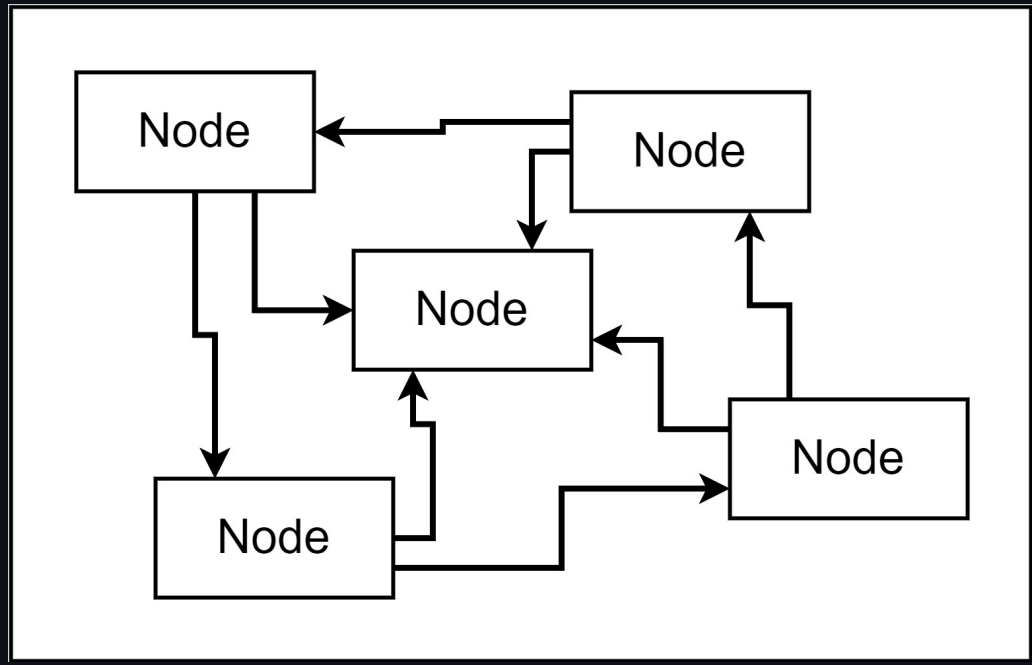

Cryptographic Hash Function
one way
hash function
Private
Key
the public key is easy
to compute from
private key
Public
Key
one way
hash function
the adress is easy
to compute from
public key
Bitcoin Address
the reverse is
very hard/expensive
to compute
the reverse is
very hard/expensive
to compute

Signature


Digital Signature
Alex's Private Key
Sign
Alex's Public Key
Verify
APPROVED
Alex Signs A Message
John Verifies Alex's Signature

Getting to know ethereum

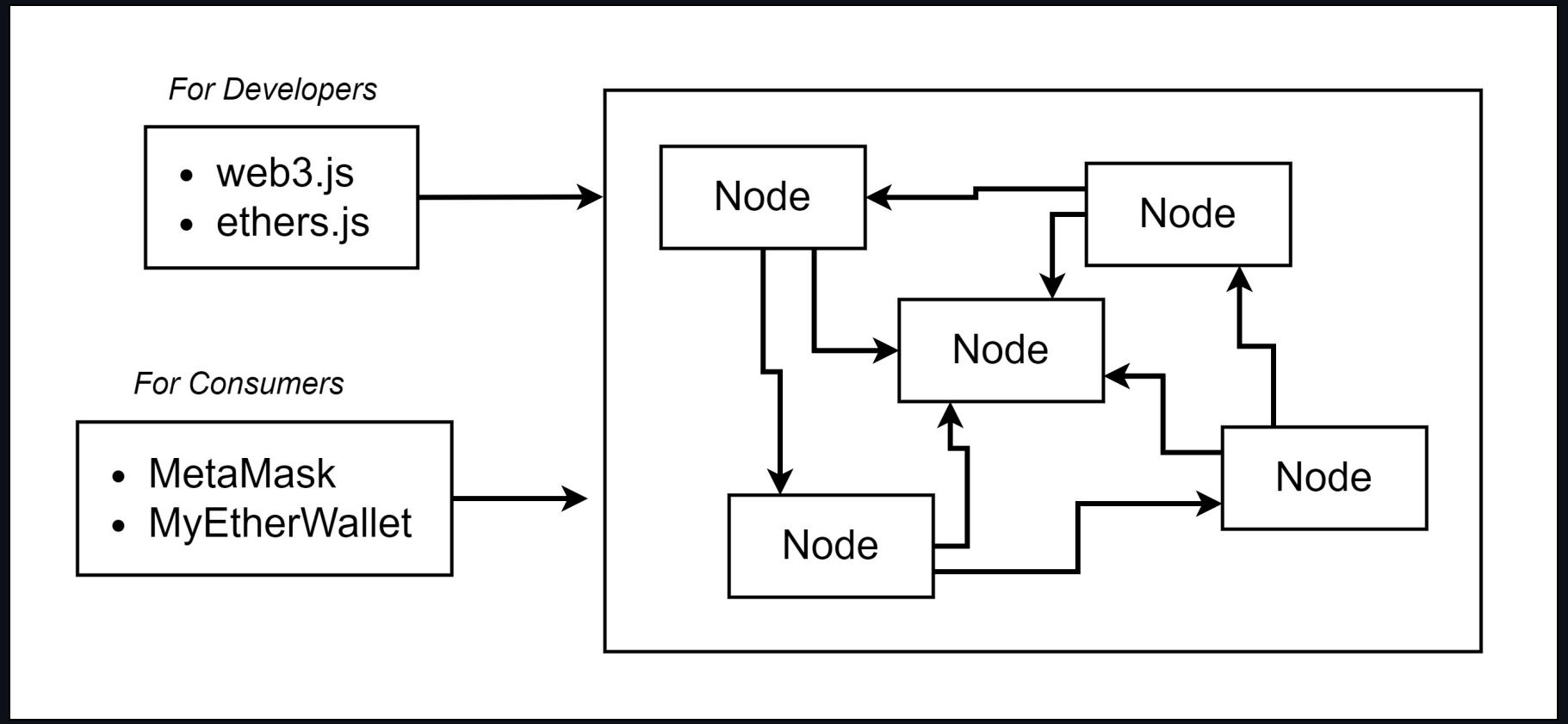
- Ethereum networks are used to transfer money and store data
- There are many different Ethereum networks.
- Networks are formed by one or more nodes.



Getting to know ethereum

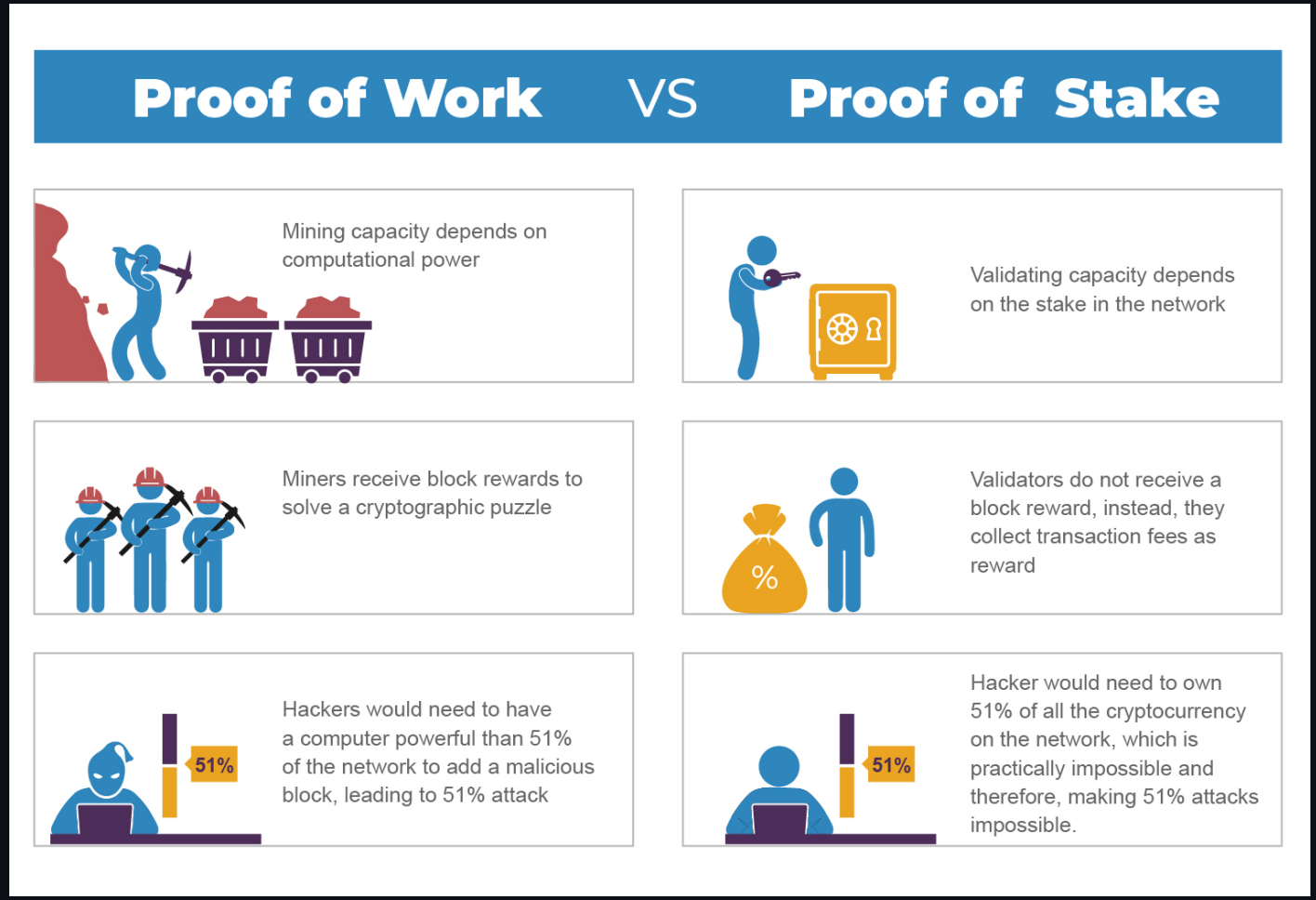
- Each node is a machine running an ethereum client.
  - Anyone can run a node.
- Each node can contain a full copy of the blockchain.
  - Stores the record of every transaction that has ever taken place.

Interacting with Ethereum network



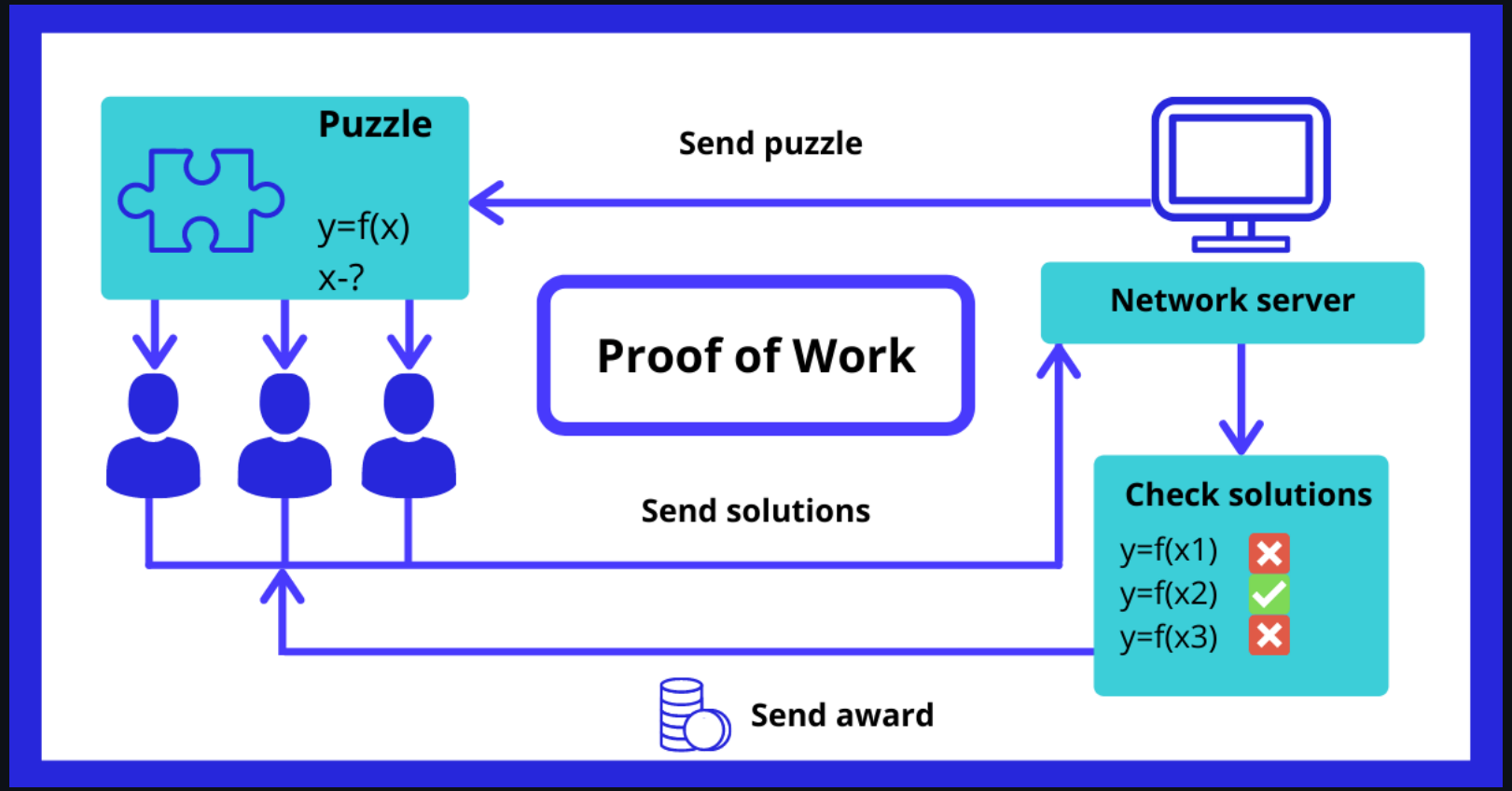
MetaMask uses Infura node.

Proof of work vs proof of stake


Proof of Work VS Proof of Stake
Mining capacity depends on computational power
Validating capacity depends on the stake in the network
Miners receive block rewards to solve a cryptographic puzzle
%
Validators do not receive a block reward, instead, they collect transaction fees as reward
51%
Hackers would need to have a computer powerful than 51% of the network to add a malicious block, leading to 51% attack
51%
Hacker would need to own 51% of all the cryptocurrency on the network, which is practically impossible and therefore, making 51% attacks impossible.

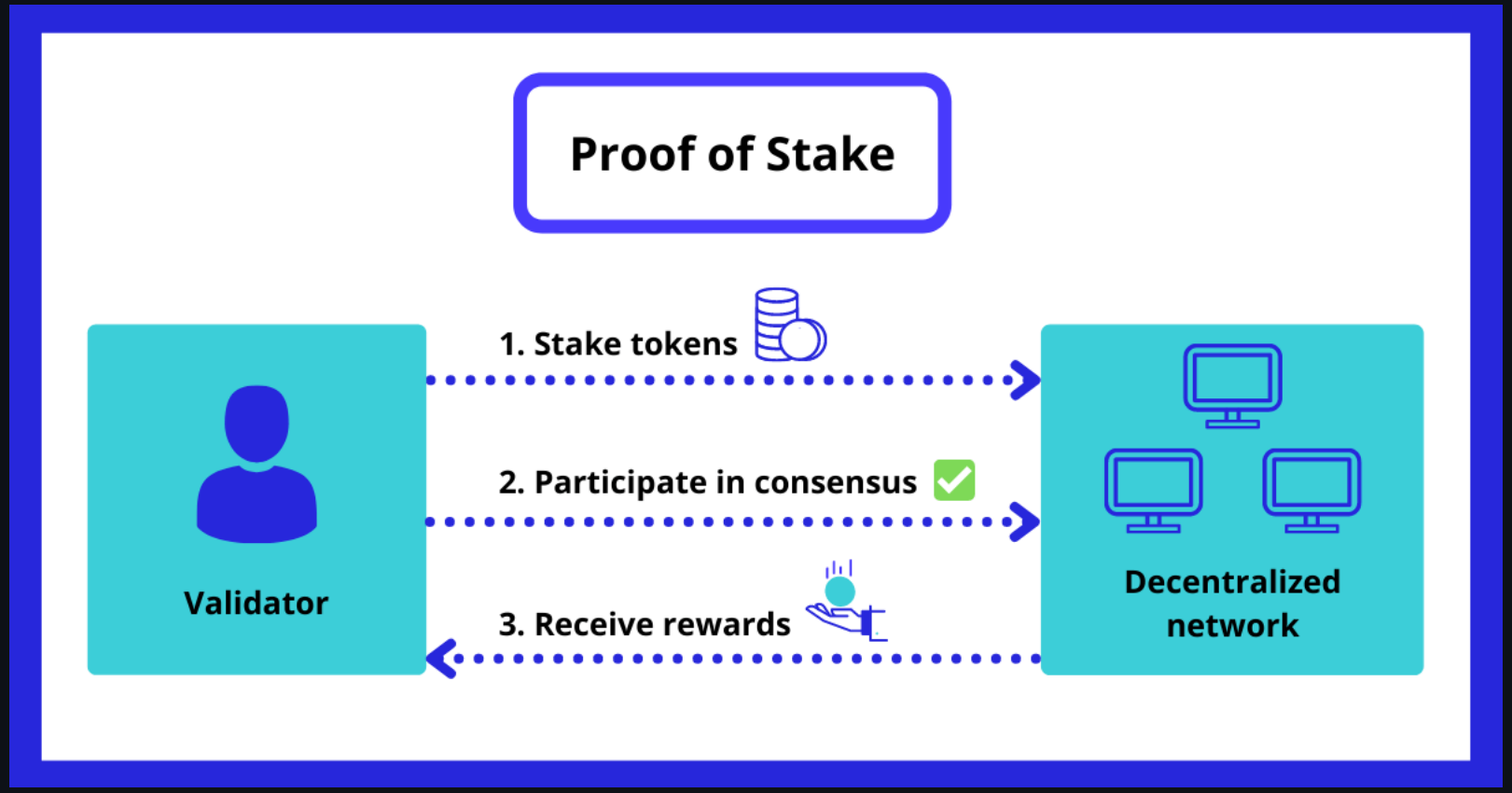
Source

Proof of work



Source

Proof of stake

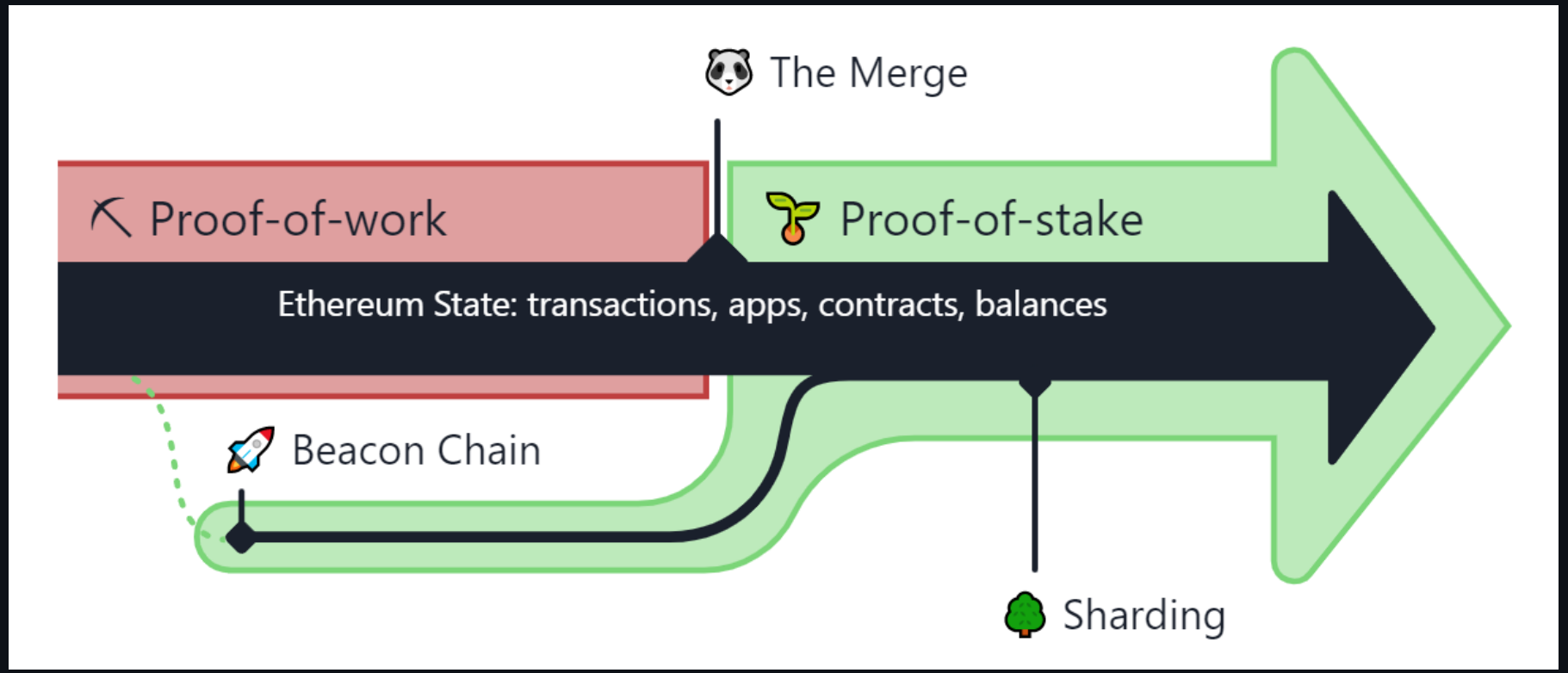


Source

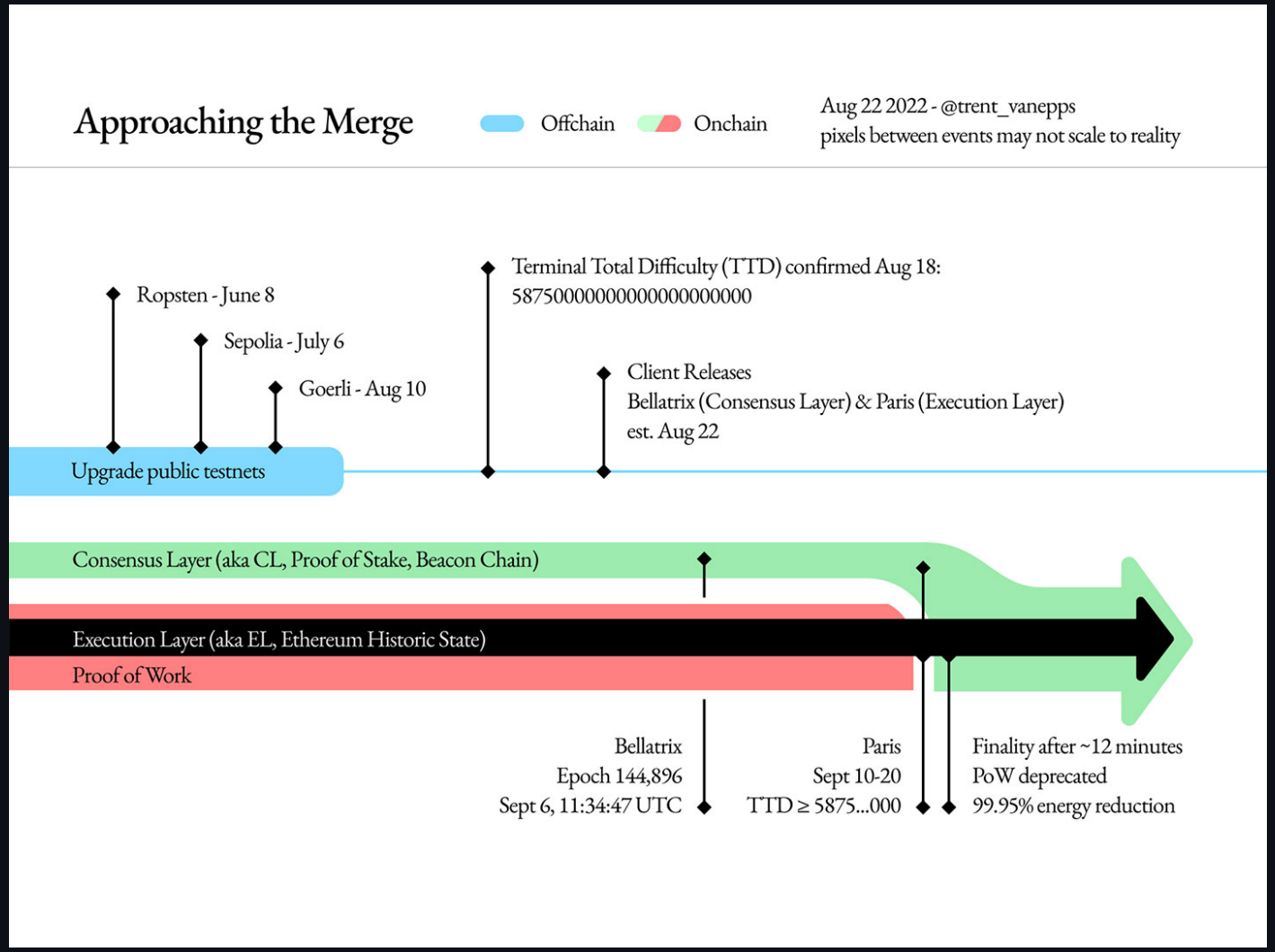
Proof of Work	Proof of Stake
Participating nodes are called miners	Participating nodes are called validators or forgers
Mining capacity depends on computational power	Validating capacity depends on the stake in the network
Mining produces new coins	No new coins are formed
Miners receive block rewards	Validators receive transaction fees
Massive energy consumption	Low to moderate energy consumption
Significantly prone to 51% attacks	51% attacks are virtually impossible

Ethereum merge

- The upgrade from the original proof-of-work mechanism to proof-of-stake was called The Merge.
- The Merge refers to the original Ethereum Mainnet merging with a separate proof-of-stake blockchain called the Beacon Chain, now existing as one chain.
- The Merge reduced Ethereum's energy consumption by ~99.95%.


The Merge
Proof-of-work
Proof-of-stake
Ethereum State: transactions, apps, contracts, balances
Beacon Chain
Sharding

Source


Approaching the Merge
Offchain
Onchain
Aug 22 2022 - @trent_vanepps
pixels between events may not scale to reality
Ropsten - June 8
Sepolia - July 6
Goerli - Aug 10
Upgrade public testnets
Terminal Total Difficulty (TTD) confirmed Aug 18:
58750000000000000000
Client Releases
Bellatrix (Consensus Layer) & Paris (Execution Layer)
est. Aug 22
Consensus Layer (aka CL, Proof of Stake, Beacon Chain)
Execution Layer (aka EL, Ethereum Historic State)
Proof of Work
Bellatrix
Epoch 144,896
Sept 6, 11:34:47 UTC
Paris
Sept 10-20
TTD ≥ 5875...000
Finality after ~12 minutes
PoW deprecated
99.95% energy reduction

Source

Account

- **Externally-owned account (EOA)** – controlled by anyone with the private keys
- **Contract account** – a smart contract deployed to the network, controlled by code.

Transaction

- An Ethereum transaction refers to an action initiated by an externally-owned account
  - In other words an account managed by a human, not a contract.
- For example, if Bob sends Alice 1 ETH, Bob's account must be debited and Alice's must be credited. This state-changing action takes place within a transaction.

Let's look at a contract

- Send somebody some ETH.
  - If you want, you can send it to me 😍. 0x6269f27234747F4ac12A6d5E88c75e021da290CF
- Transaction example

How long do we have to wait?

- Block time
- Details

Gas

> Gas fees help keep the Ethereum network secure. By requiring a fee for every computation executed on the network, we prevent bad actors from spamming the network.

Gas

- Gas refers to the unit that measures the amount of computational effort required to execute specific operations on the Ethereum network.
- Gas fees are paid in ether `ETH`.
- Unit of gas is `gwei`.
  - 1 `gwei` = 0.000000001 `ETH` (10^-9 `ETH`).
- Gas limit
  - Maximum amount of gas you are willing to consume on a transaction.
  - A standard ETH transfer requires a gas limit of 21,000 `gwei`.

Gas information

- https://etherscan.io/gastracker
- https://ethgasstation.info/