CSE446: Blockchain & Cryptocurrencies

Lecture – 11: Other Consensus Algorithms

Agenda

- PoW Limitations
- Other consensus algorithms
  - Proof of Stake (PoS)
  - Delegated Proof of Stake (DPoS)

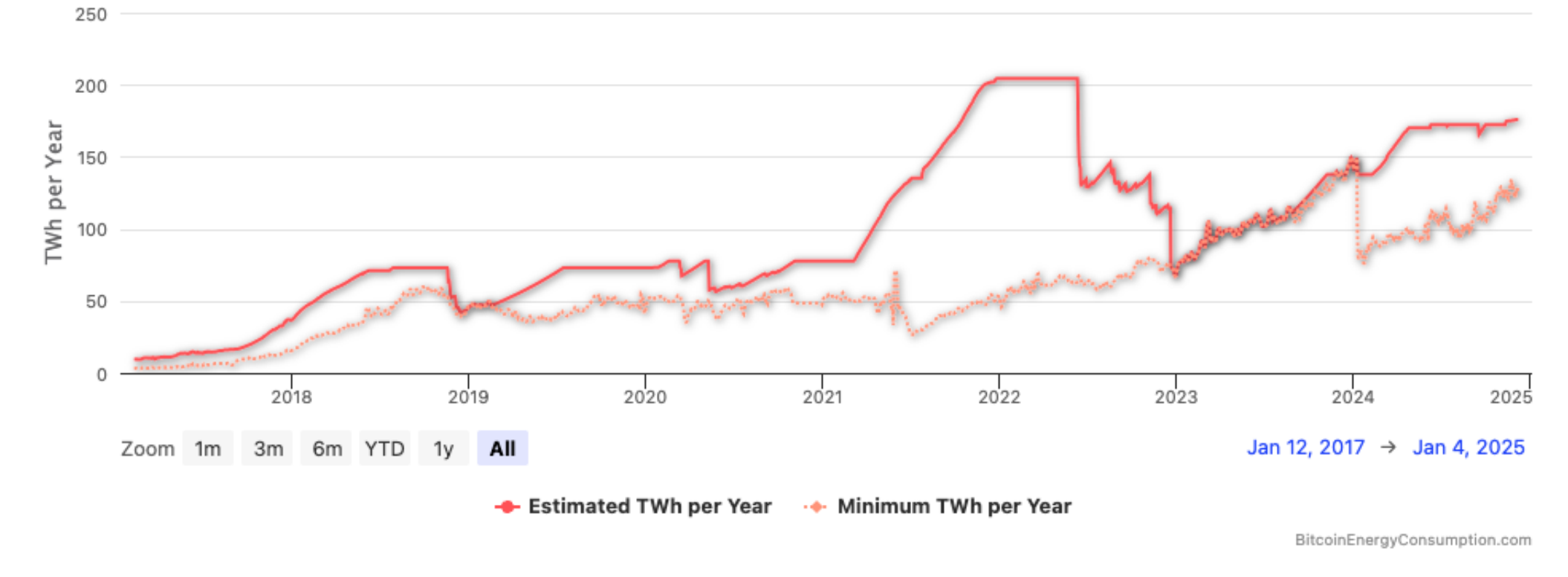
PoW Limitations

- There are a few major limitations of PoW
  - Energy consumption
  - Absence of penalty
  - Delay in block finality (confirmation)

PoW Limitations: energy consumption

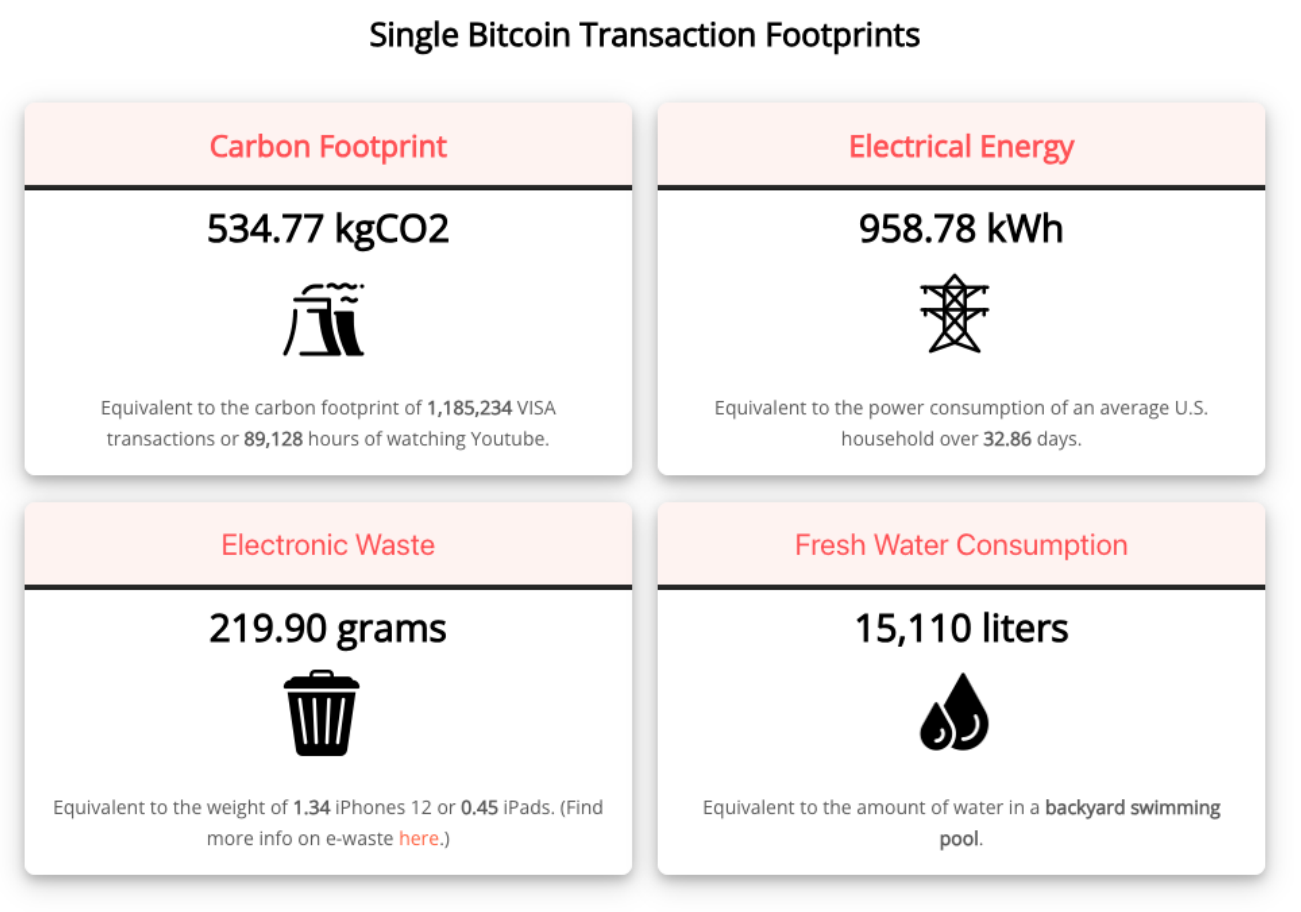
- Each PoW algorithm needs to consume electricity to compute the hash
- As the difficulty of the network starts to increase, so does the energy consumption
- The amount of consumed energy is quite significant when calculated over the whole network consisting of ASIC/GPU mining rigs all around the world

PoW Limitations: energy consumption



https://digiconomist.net/bitcoin-energy-consumption

PoW Limitations: energy consumption



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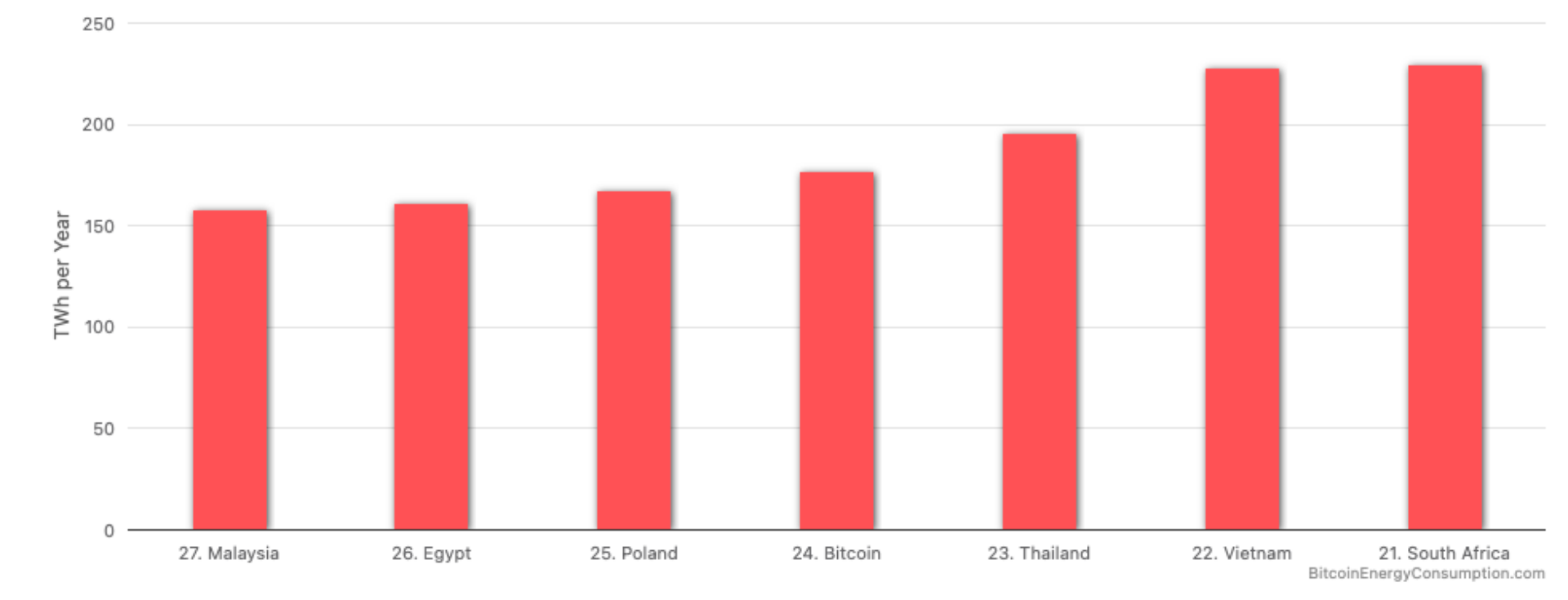
PoW Limitations: energy consumption by country



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PoW Limitations: absence of penalty

- PoW algorithms are altruistic in nature in the sense that they reward behaving miners
  - However, they do not penalise a misbehaving miner
- One example is that a miner can collude with a group of miners (a phenomenon known as selfish mining) to increase its profitability in an illegitimate way

PoW Limitations: absence of penalty

- In addition, a miner can engage in Denial-of-Service attacks by just not forwarding any transaction or block within the network
- Furthermore, such malicious miners can join forces to engage in the spawn-camping attack
  - Launching DoS attacks simultaneously over and over again to render the blockchain network useless
- A penalty mechanism would disincentivise any miner to engage in any type of malicious misbehaviour

PoW Limitations: delay in finality

- Finality is the assurance or guarantee that crypto-currency transactions cannot be altered, reversed, or cancelled after they are completed
- Finality is used to measure the amount of time one has to wait for a reasonable guarantee for a transaction to be confirmed (included in a block)
- In blockchain technology, transactions are termed immutable due to its finality nature
- The latency level of a blockchain will ultimately affect the chain's finality rate

https://academy.binance.com/en/glossary/finality

PoW Limitations: delay in finality

- Finality is an essential feature for ventures accepting cryptocurrencies because
  - waiting endlessly on a blockchain network can have a high adverse effect for businesses or enterprises that accept crypto as a means of payment
- When creating a payment system, to be effective, it is crucial to have low latency
- If you were to have to wait for 10 minutes every time you wished to purchase anything, it would quickly become very inconvenient to go shopping
- However, most PoW-based blockchain protocols only show a probabilistic transaction finality
  - meaning that transactions are not automatically or instantly final but become "more and more final" over time (as more blocks are confirmed)
  - For Bitcoin, it is estimated that one has to wait 6 blocks, around 1 hour, before we can say that a transaction is final with a reasonable guarantee

https://academy.binance.com/en/glossary/finality

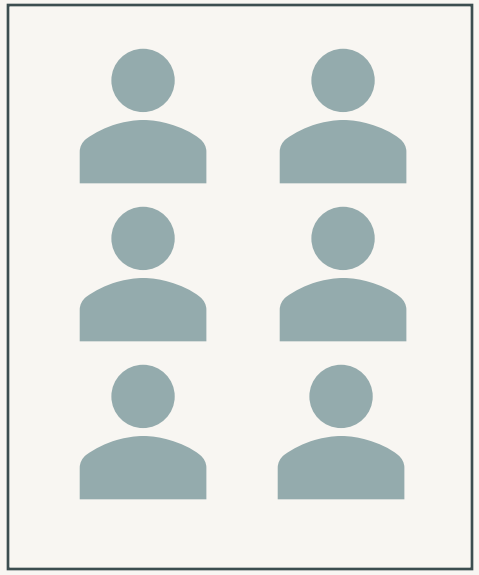
Proof of Stake (PoS)

- In PoS, the nodes who would like to participate in the block creation process must prove that they own a certain number of coins at first
- Besides, they must lock a certain amount of its currencies, called stake, into an escrow account in order to participate in the block creation process
- The stake acts as a guarantee that it will behave as per the protocol rules
- The node that escrows its stake in this manner is known as the stakeholder, staker, validator, leader, forger, or minter in PoS terminology
- The minter can lose the stake, in case it misbehaves

Proof of Stake

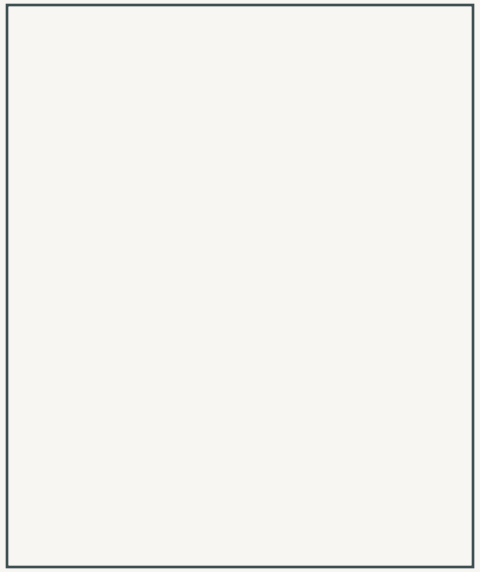
- In essence, when a stakeholder escrows its stake, it implicitly becomes a member of an exclusive group
- Only a member of this exclusive group can participate in the block creation process
- How much block a minter can generate depends on their size of stakes
- The stakeholder who produces blocks are rewarded in one of the two different ways
  - Either it can collect the transaction fees within the block, or
  - It is provided a certain amount of currencies that act as a type of interest against their stake

Proof of Stake



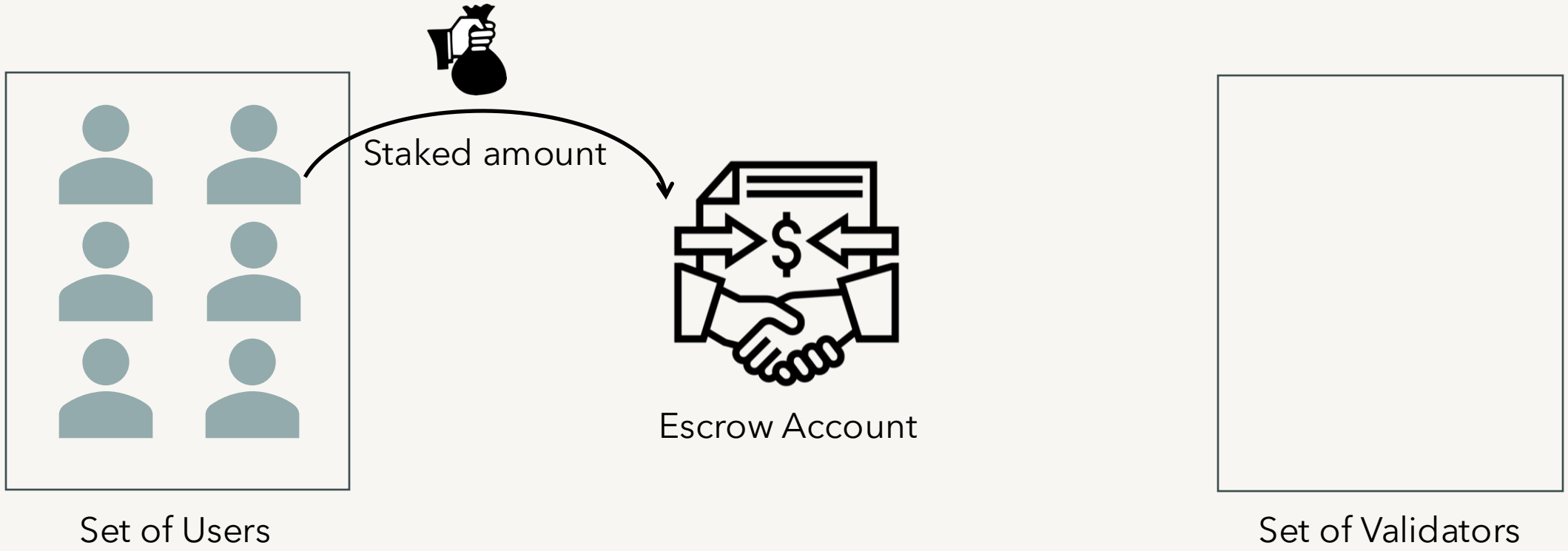
Set of Users

Escrow Account



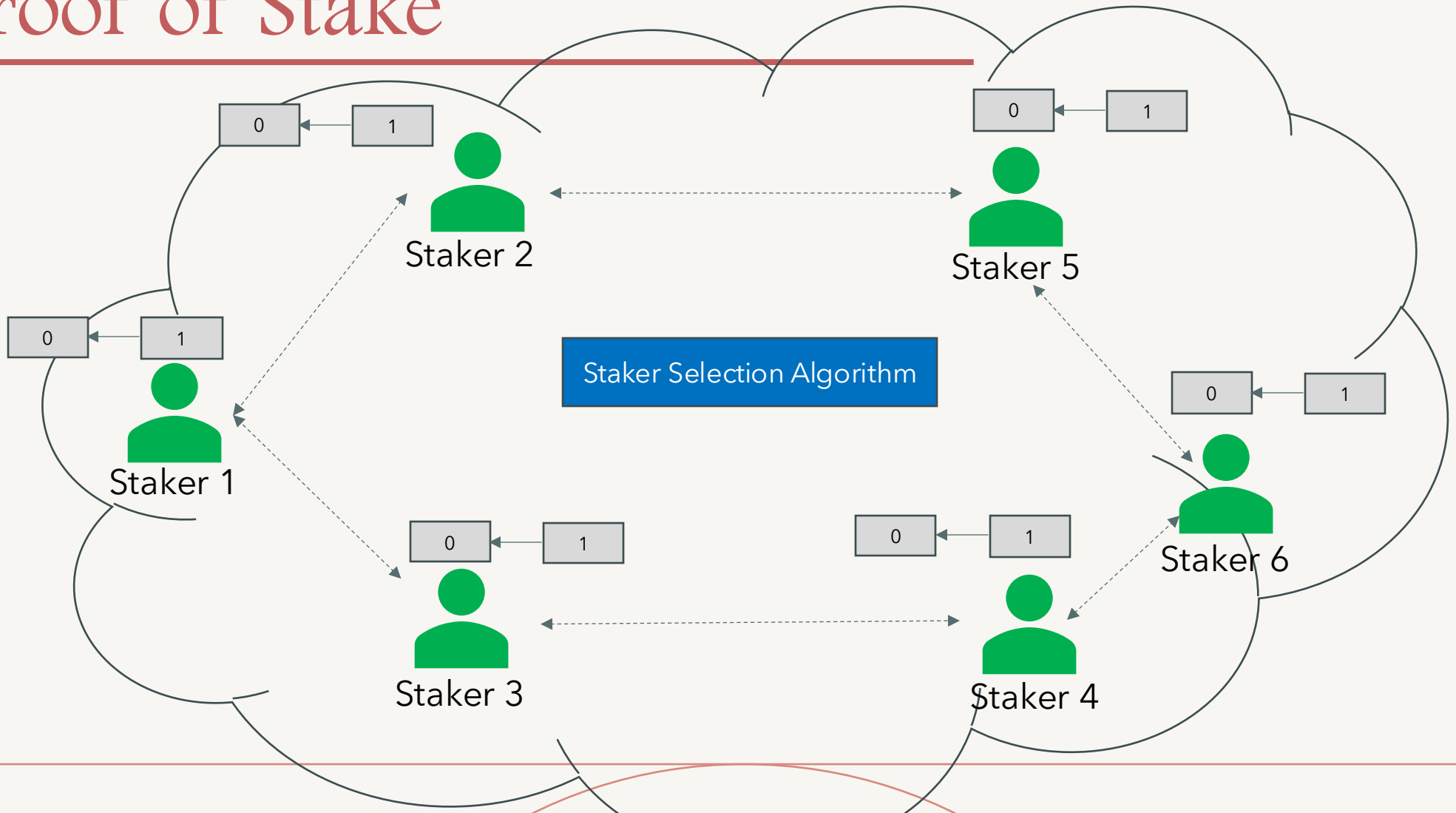
Set of Validators

Proof of Stake



Proof of Stake

Proof of Stake



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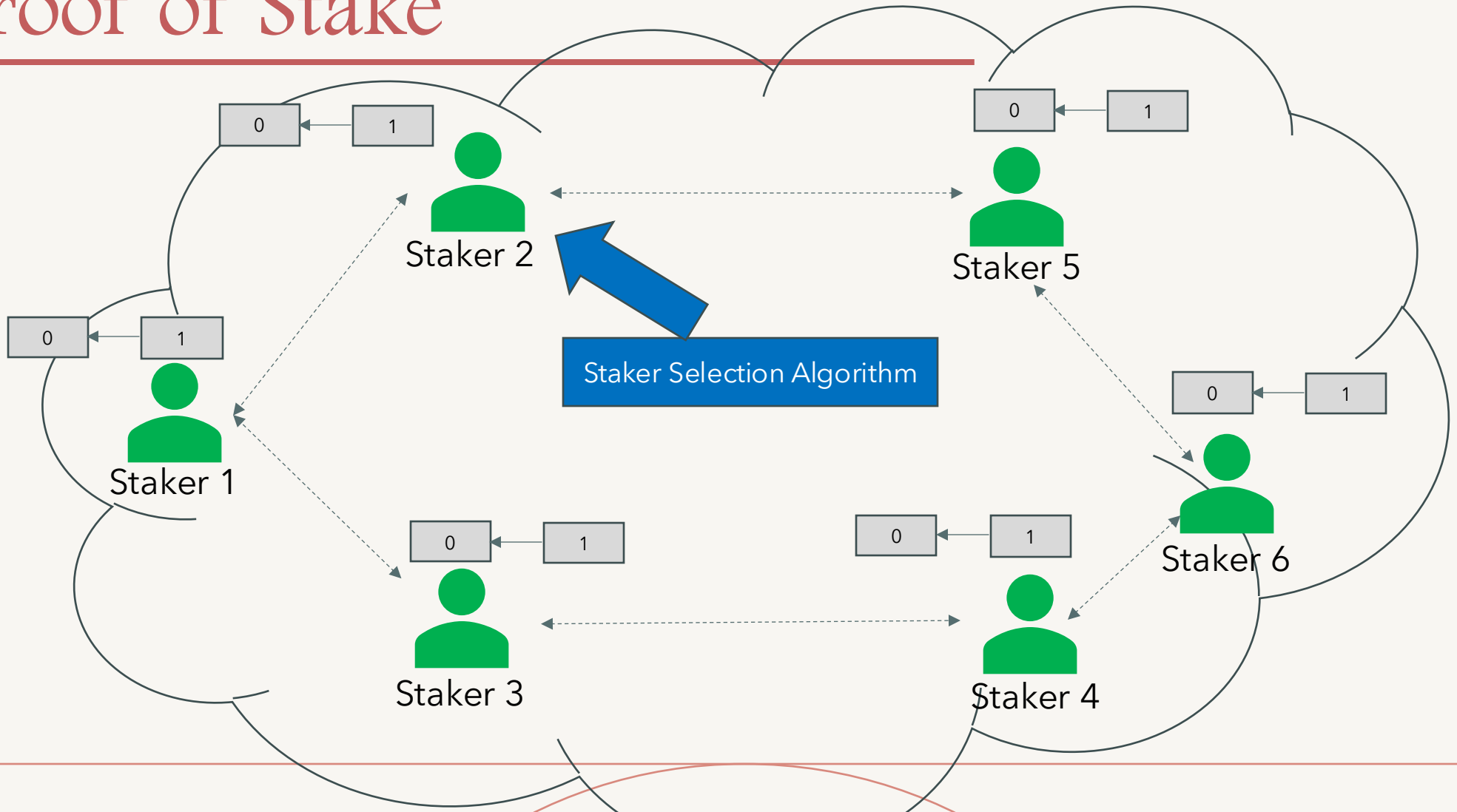

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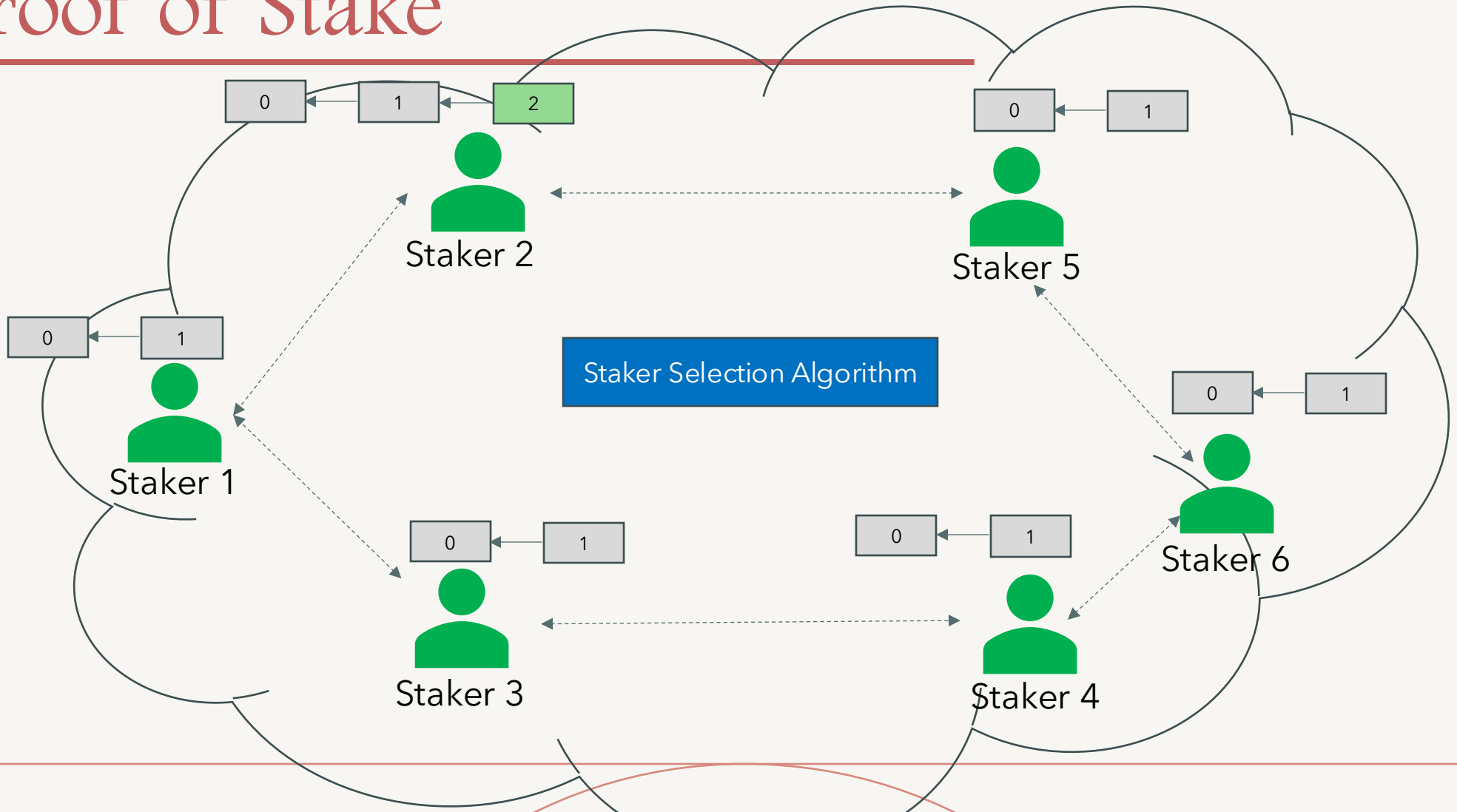
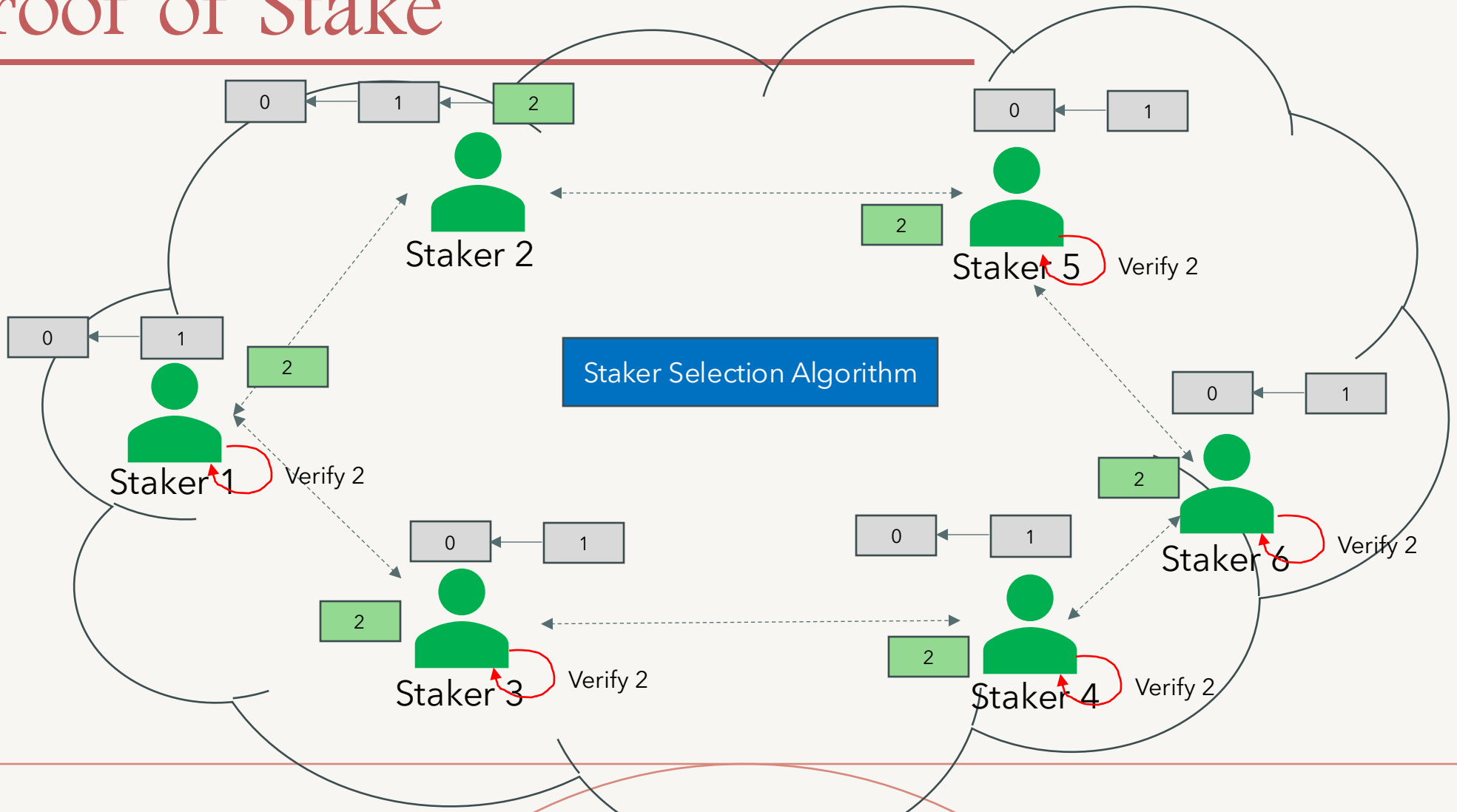
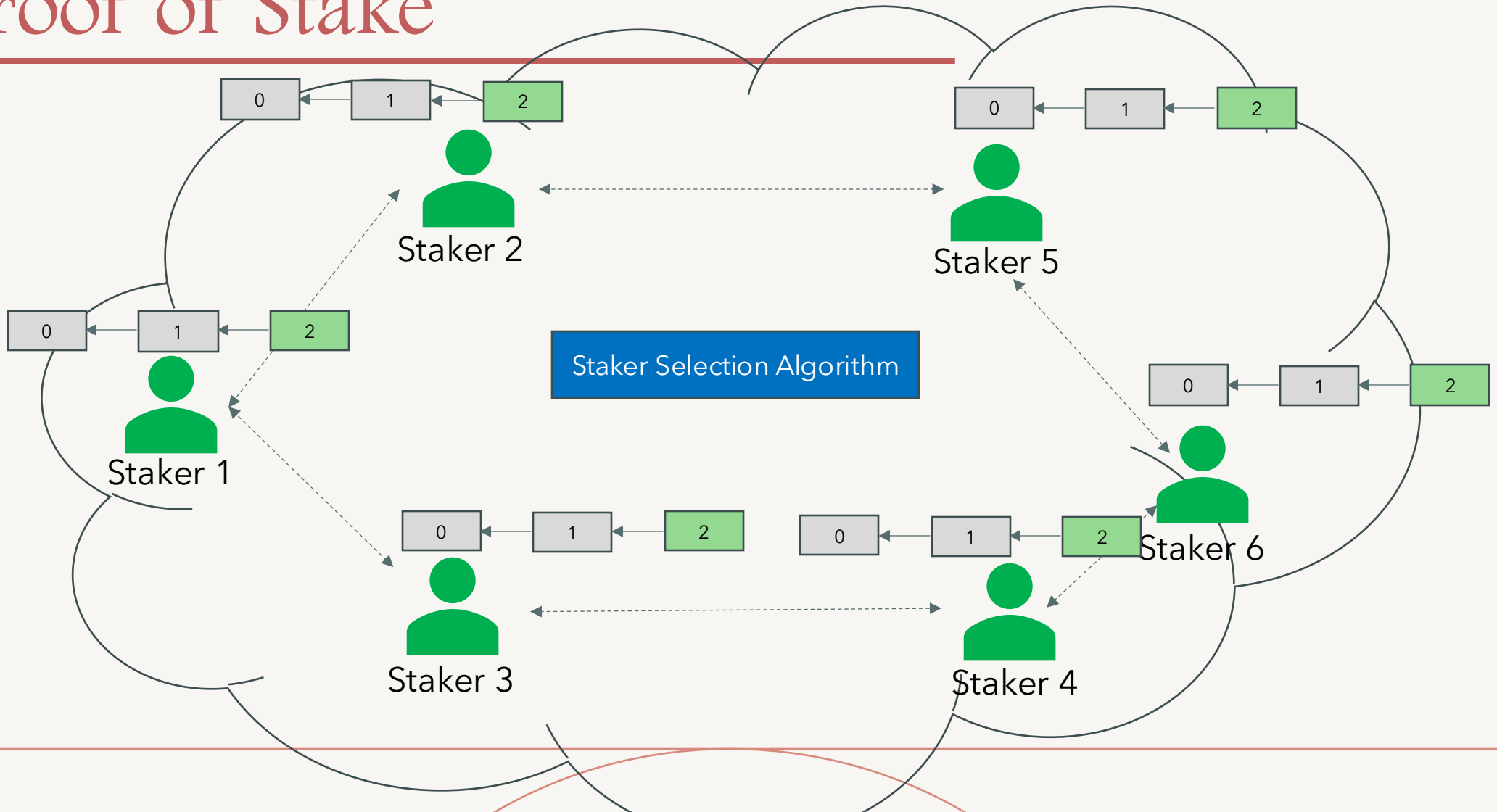


Proof of Stake



Proof of Stake



PoS: Bootstrapping issue

- One of the major barriers in a PoS algorithm is how to generate the initial coins
- A fair distribution of coins among the stakeholders are essential to ensure a secure PoS algorithm
- This is known as the bootstrapping problem
- There are two ways to solve the bootstrap issue:
  - Pre-mining
  - PoW to PoS transition

PoS: Bootstrapping issue

- Pre-mining:
  - A set of coins are pre-mined, which are then sold before the launch of the system in an IPO (Initial Public Offering) or ICO (Initial Coin Offering)
- PoW-PoS transition
  - The system starts with a PoW system to fairly distribute the coins among the stakeholders
  - Then, it slowly transitions towards the PoS system
  - Ethereum took this approach

DPoS

- Delegated Proof of Stake (or DPoS in short) is a form of consensus algorithm in which reputation scores or other mechanisms are used to select the set of (delegated) validators
- Even though it has the name Proof of Stake associated with it, it is quite different from other PoS algorithms
- In DPoS, users of the network vote to select a group of delegates (or witnesses) who are responsible for creating blocks
- Delegates are the only entities who can propose new blocks

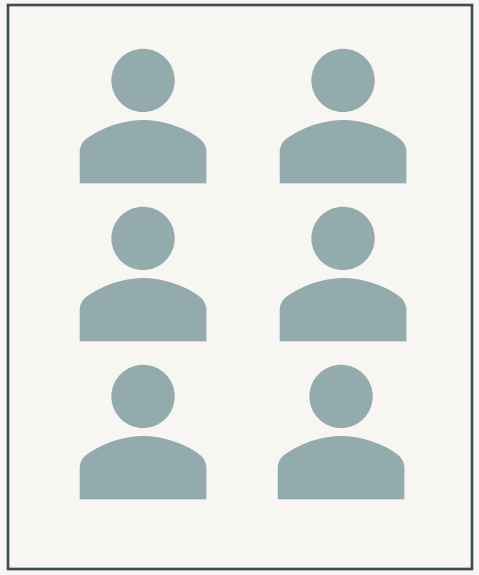
DPoS

- For each round, a leader is selected from the set of delegates who can propose a block
- How such a leader is chosen depends on the respective blockchain system
- The leader gets rewards for creating a new block, and is penalised and de-listed from the set of validators if it misbehaves

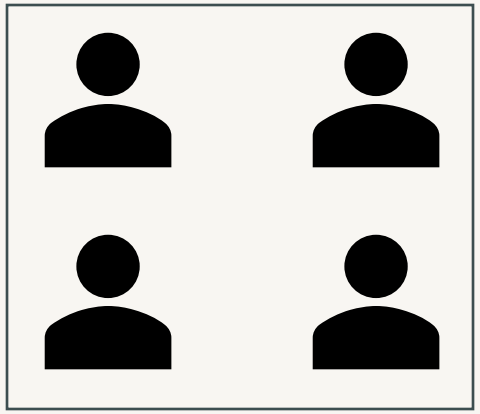
DPoS

- The delegates themselves compete with each other to get included in the validator list
- In such, each validator might offer different levels of incentives for the voters who vote for it
- For example, if a delegate is selected to propose a block, it might distribute a certain fraction of its reward among the users who have voted for the delegate
- Since the number of validators is small, the consensus finality (confirmation) can be fast

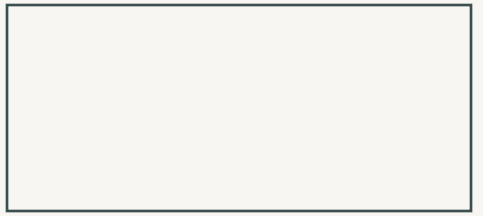
DPoS



Set of Users

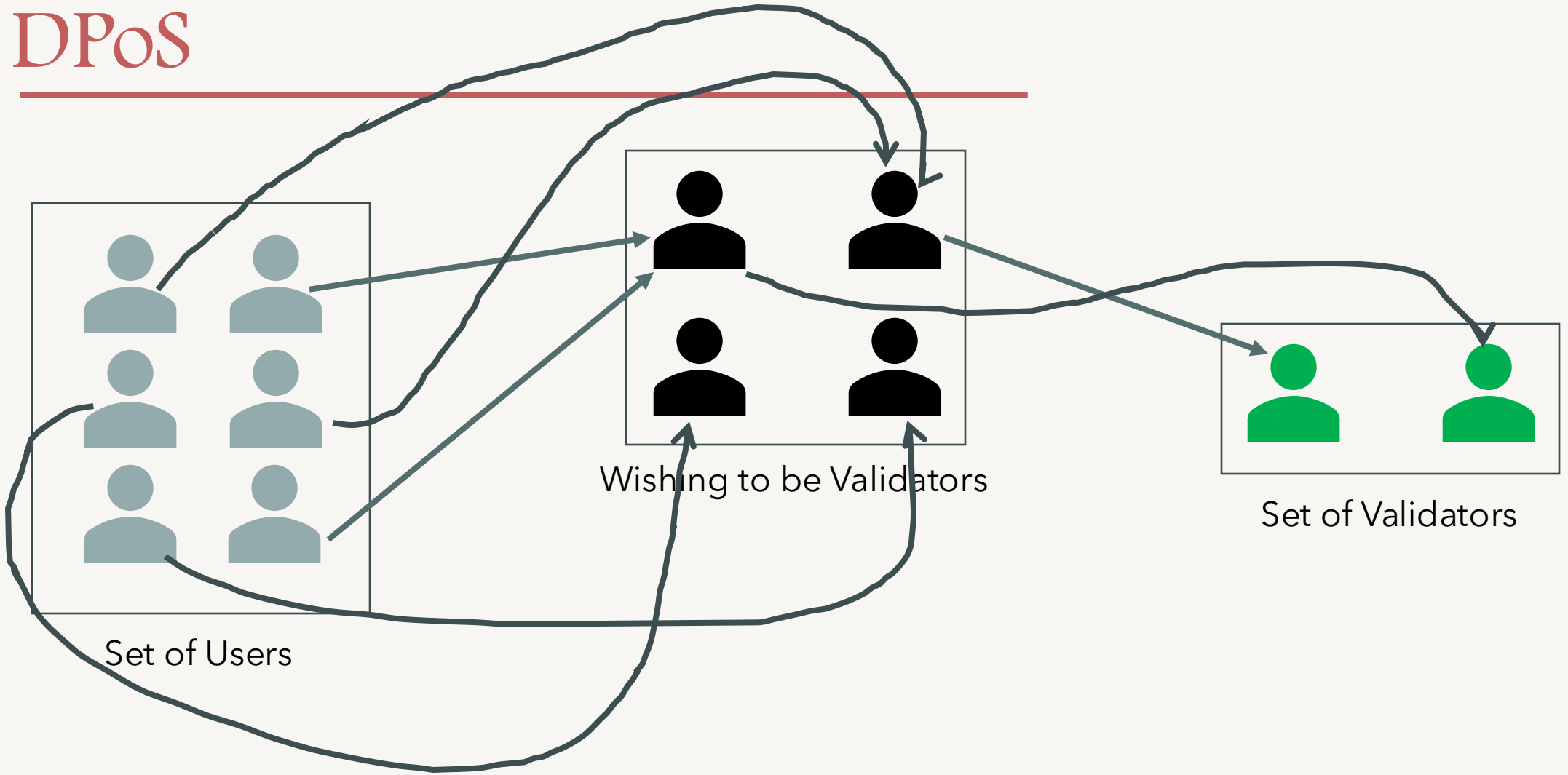


Wishing to be Validators



Set of Validators

DPoS



DPoS: EOS

- EOS is the first DPoS crypto-currency and smart-contract platform
- The DPoS consensus algorithm of EOS utilises 21 validators, also known as Block Producers (BPs)
- These 21 validators are selected with votes from EOS token (currency) holders
- The number of times a particular BP (block producer) is selected to produce a block is proportional to the total votes received from the token holders

DPoS: EOS

- Blocks in EOS are produced in rounds where each round consists of 21 blocks
- At the beginning of each round, 21 BPs are selected
- Next, each of them gets a chance to create a block in pseudo-random fashion within that particular round
- Once a BP produces a block, other BPs must validate the block and reach into a consensus
- A block is confirmed only when the (+2/3) majority of the BPs reach the consensus regarding the validity of the block
- Once this happens, the block and the associated transactions are regarded as confirmed or final, so no fork can happen

Finality: Bitcoin vs EOS

Blockchain	Consensus	Avg. time per block	Avg. time to finality
Bitcoin	PoW	10 minutes	60 minutes (6 confirmations)
EOS	DPoS	0.5 - 1 second	2-3 seconds (2-3 commitments)

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ANY QUESTIONS?