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COMPARISON OF MAJOR BLOCKCHAIN CONSENSUS MODELS

PROOF OF WORK VS PROOF OF STAKE

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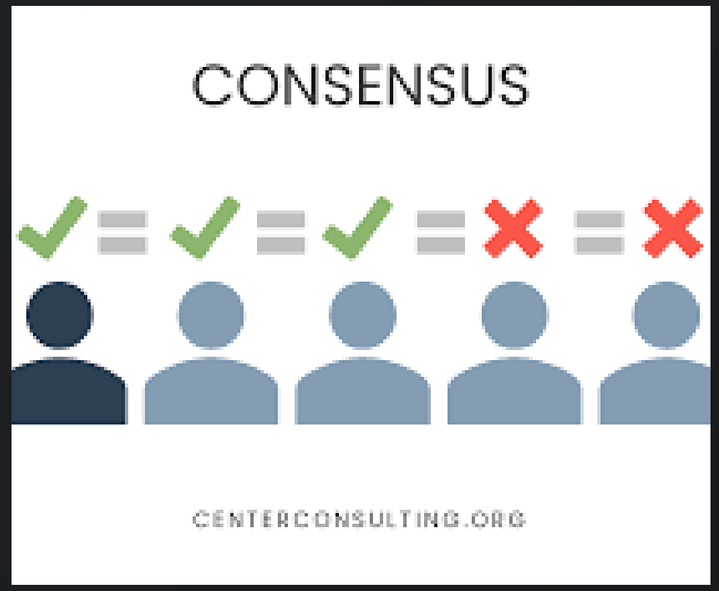
CONSENSUS IS A MECHANISM THAT ALLOWS DISTRIBUTED NODES IN A BLOCKCHAIN NETWORK TO AGREE ON A SINGLE VALID STATE OF THE LEDGER.



WHAT IS CONSENSUS?

It ensures:

- security
- consistency
- resistance to attacks
- trust without a central authority

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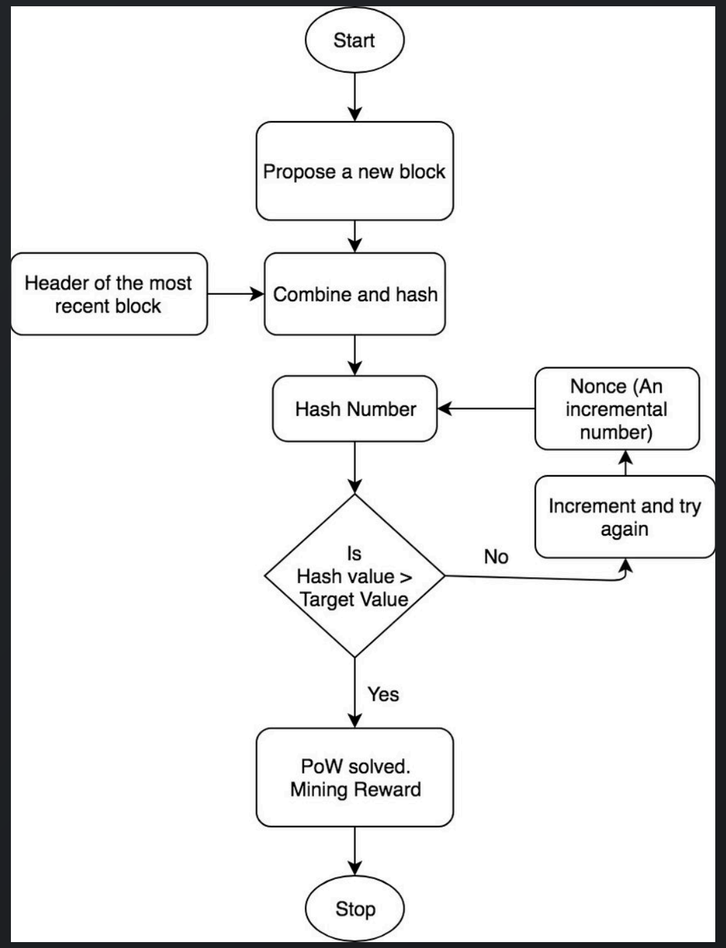
POW ARCHITECTURE



PROOF OF WORK ARCHITECTURE

In Proof of Work:

- transactions are broadcast to the mempool
- miners collect transactions into blocks
- miners compete by solving cryptographic hash puzzles
- the first miner to solve the puzzle adds the block to the chain

The chain with the most accumulated work is considered valid.

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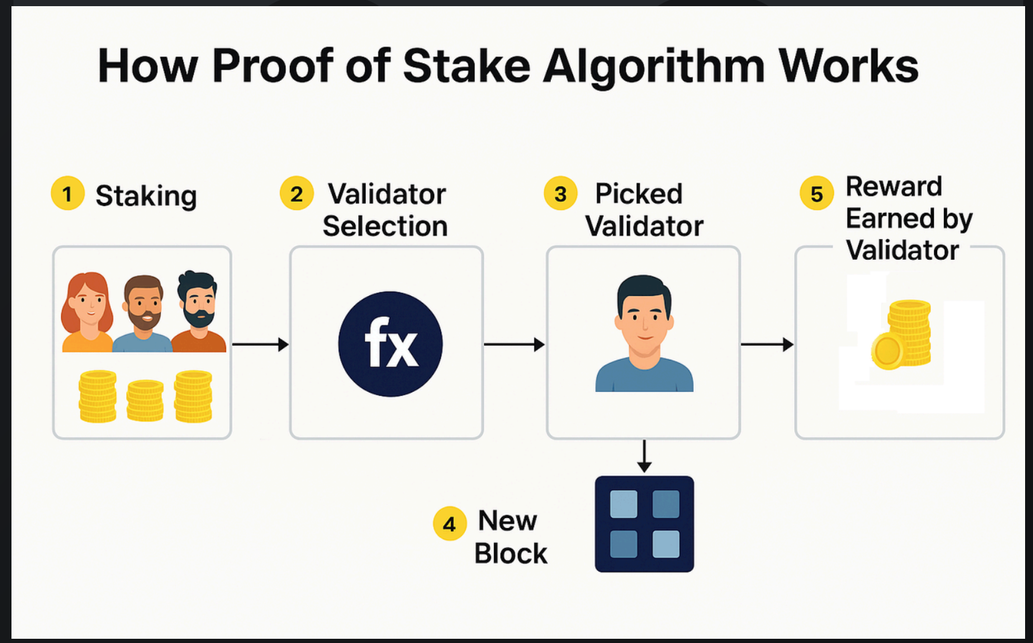
POS ARCHITECTURE

PROOF OF STAKE ARCHITECTURE

In Proof of Stake:

- validators lock funds as stake
- a validator is selected to propose a block
- other validators attest to the block
- blocks are finalized using voting-based finality mechanisms
- Ethereum PoS uses proposer–attester roles and finality checkpoints.



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THREAT MODEL

+ POW THREATS:

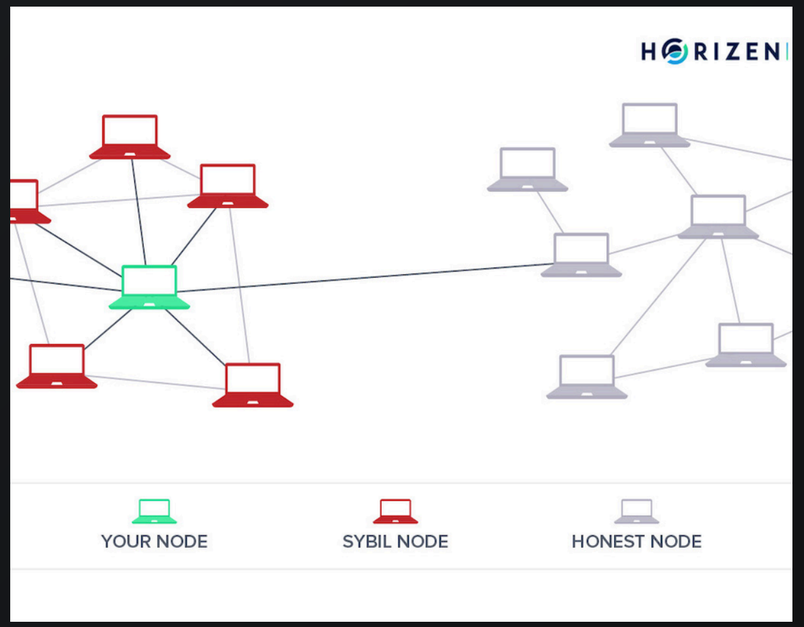
- 51% attack using majority hash power
- selfish mining
- mining pool centralization

+ POS THREATS:

- majority stake control
- validator collusion
- long-range attacks
- MEV-based manipulation

Proof of Work → Requires solving complex puzzles → very secure, but energy-heavy.

Proof of Stake → Based on ownership → efficient, faster.



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MATHEMATICAL ASSUMPTIONS

HOW THE NETWORK DECIDES WHAT'S TRUE

PoW assumes:

- honest majority of computational power
- cryptographic hash functions are secure
- block creation is probabilistic

PoS assumes:

- honest majority of staked capital
- digital signatures are secure
- network eventually reaches synchrony

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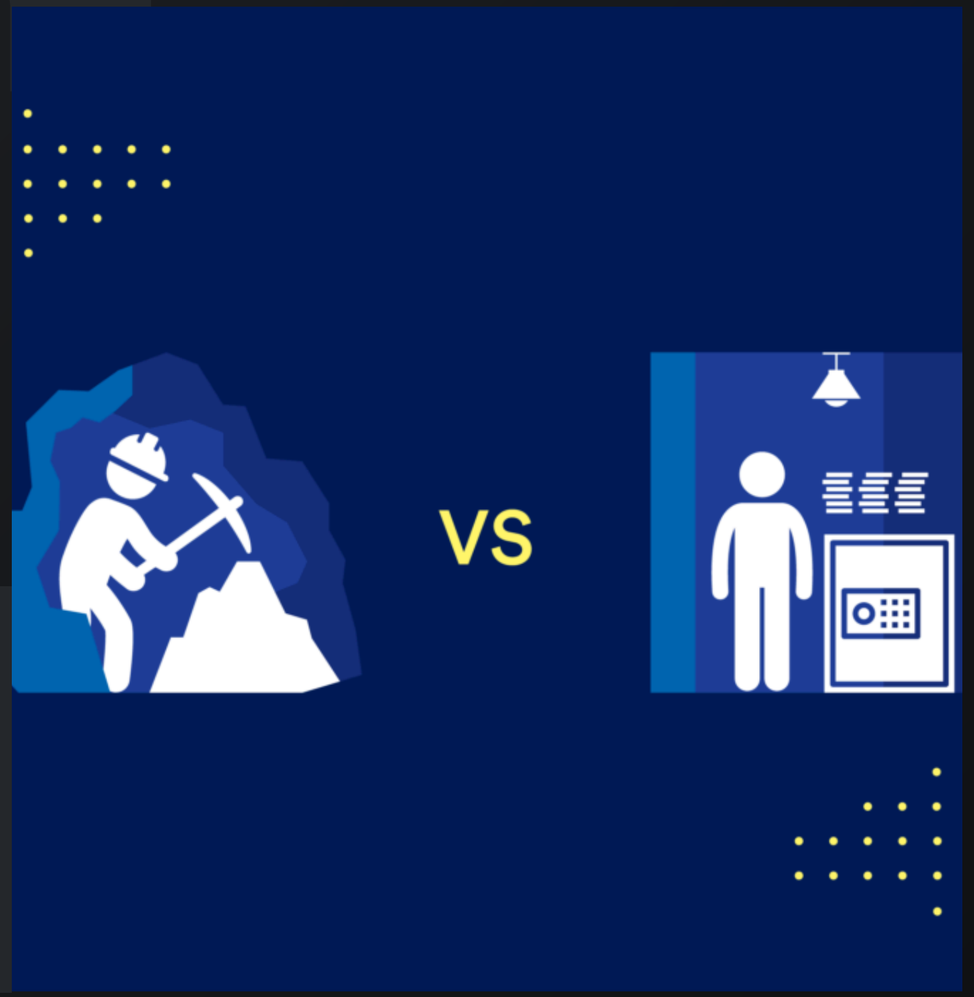
ECONOMIC ASSUMPTIONS

PoS security relies on:

- capital at risk (stake)
- slashing penalties for misbehavior
- economic disincentives for attacks

PoW security relies on:

- high energy and hardware costs
- continuous operational expenses



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REAL-WORLD ATTACKS

PoW examples:

- 51% attacks on small PoW blockchains
- mining pool concentration risks

PoS examples:

- validator centralization
- MEV attacks (transaction reordering)
- slashing incidents due to misconfiguration

Each model achieves consensus through different security and incentive structures.

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CRITICAL COMPARISON OF POW AND POS

+ Proof of Work

- Security is based on computational power and energy expenditure
- Resistant to some economic attacks but vulnerable to mining centralization
- Provides probabilistic finality, allowing temporary chain reorganizations

+ Proof of Stake

- Security is based on economic stake and validator incentives
- Reduces energy consumption significantly
- Provides faster finality through validator voting and slashing mechanisms

CRITICAL EVALUATION

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CONCLUSION

- Proof of Work and Proof of Stake represent two fundamentally different approaches to achieving consensus in blockchain networks.
- Proof of Work secures the network through computational effort and energy expenditure, while Proof of Stake relies on economic incentives, validator participation, and penalty mechanisms.
- Both models involve trade-offs between security, decentralization, efficiency, and scalability.
- The choice of a consensus mechanism depends on the specific goals and constraints of the blockchain system.

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