



# What is the status of ePBS

And its future iterations

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Section 1

# Tech Debt





# An Ethereum block

## Consensus Layer



Administration	
slot	block number
proposer_index	proposing validator
parent_root	hash of the previous block
state_root	BeaconState Merkle root
randao_reveal	verifiably random data
graffiti	superfluous, for humans
signature	proposing validator's signature

Consensus	
deposit_root	validator deposit Merkle Tree
deposit_count	num of beacon chain deposits
ATT	ATT
deposits	proposer_slashings
voluntary_exits	attester_slashings
sync_committee_bits	participation in sync committee
sync_committee_signature	sync committee signature

Execution	
block_hash	hash of the (execution) block
Header	Transactions

## Execution Layer

### Execution

#### Header

#### Transactions

### Header

parentHash	hash of the previous block
timestamp	time of block creation
hash	hash of the current block
miner	successful miner
number	index, blockchain length
size	data in block (bytes)
difficulty	difficulty used for block
totalDifficulty	cumulative difficulty
nonce	extra data used for hash
prev_randao	previous block randao
baseFeePerGas	min cost of gas, burned
gasUsed	gas available to block
gasLimit	gas used by block
stateRoot	EVM state Merkle tree
transactionsRoot	block txns Merkle tree
receiptsRoot	txns receipt Merkle tree
logsBloom	probabilistic block search
extraData	superfluous, for humans

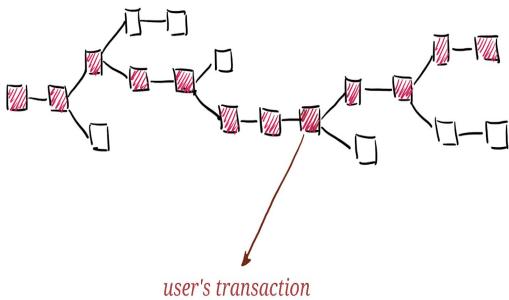
### Transactions

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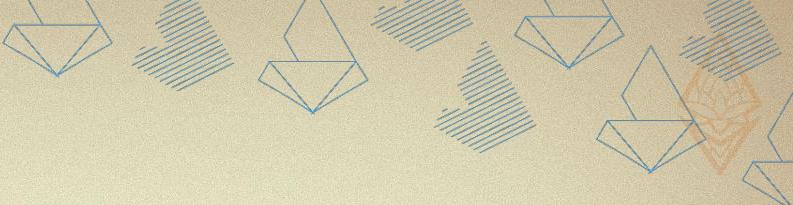


# Consensus



- Execution consensus:
  - Are the transactions valid?
  - What is the state of the Ethereum VM after executing them?
  - What is the gas price next block?
- Consensus consensus:
  - Are the attestations valid?
  - Reward/penalize validators
  - What is the current head of the chain?

# Ethereum Slot



past

future





# Current Ethereum Slot

- 2 seconds for payload validation.
- 4 seconds for attestation propagation (aggregation).
- 4 seconds for aggregation propagation (compute head).
- **Can we make validation longer?**  
No: timing games minimize validation inherently, proposers delay broadcast as much as possible. **There are constructions with changes to the EL consensus**
- **Bad utilization of CPU time**  
CPU is used only in the 2 seconds of validation and in the last milliseconds for head computing.



# Block – Payload separation, why?

- **Different validations**, with different deadlines and resources.
- **Separation of duties** between different set of entities, eg. the roles of *attesters, proposers, builders, IL constructors, IL attesters, etc.* can be carried by different entities
- **Different P2P networks** and peers, topologies adapted to propagation of the right channels.
- Better Devex. Testing, tooling, hard-fork programming,





Section 2

## Minimal Design

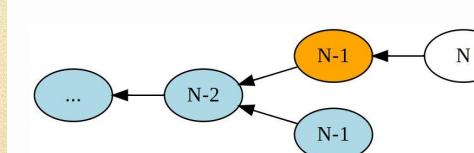


# Desiderata

- Separate validation of consensus and execution (including data availability and inclusion list satisfaction).
- Separate propagation of consensus blocks, blobs and execution payload.
- The consensus block cannot sign over the payload without risking free data availability.
- The payload and the consensus block both need to be signed.

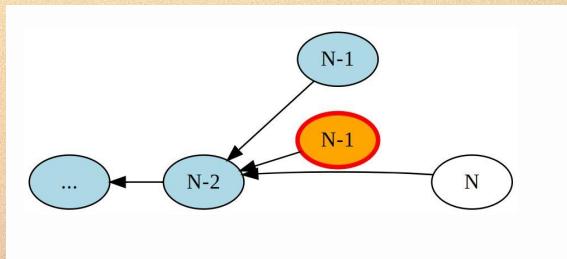


# Full, Empty, Skipped nodes



How to agree on presence/validity of the payload?

How to decide the head of the chain?



# Block processing changes

## Current Processing

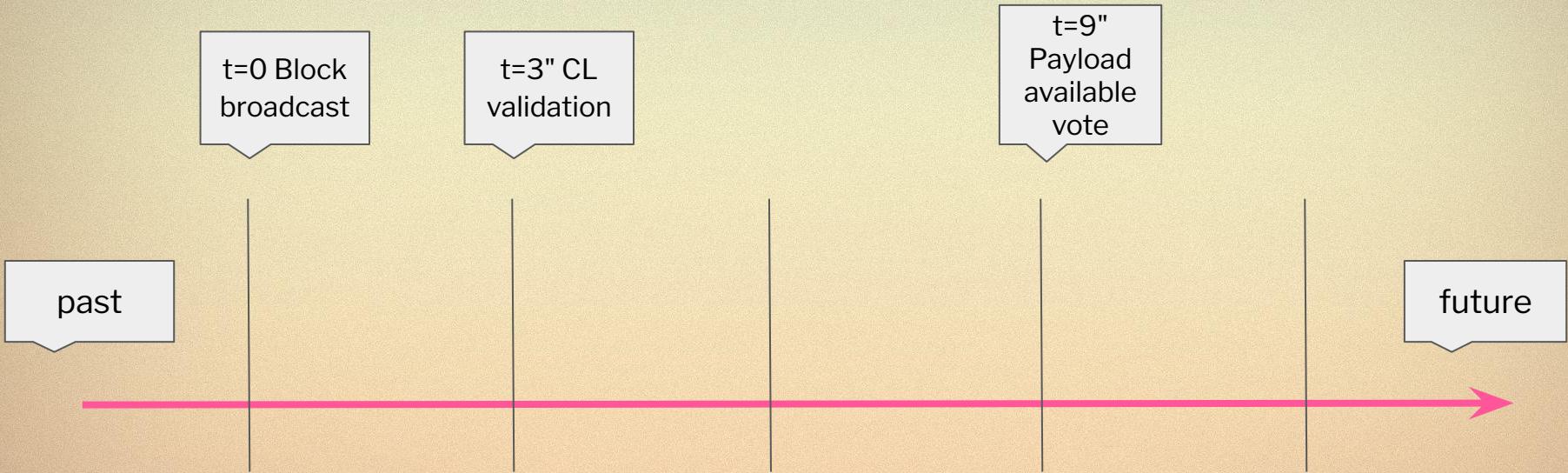
- Validate consensus
  - Process Attestations
  - Process Withdrawals
  - Process Deposit Requests
  - Reward validators
  - ...
- Validate Execution
- Validate Data availability
- Compute the new head of the chain
- Inform the execution layer of the new head of the chain.
- Attest

## ePBS Processing

- Validate consensus
  - Process Attestations
  - ~~Process Deduct Withdrawals~~
  - ~~Process Deposit Requests~~
  - Reward validators
  - ...
- Compute the new head of the chain
- Attest
- Validate Execution
- Validate Data availability
- Process Deposit Requests.
- Inform the execution layer of the new head of the chain.



# ePBS Slot





Section 3

## Auctions



# Auction mechanisms

## Block auctions

The proposer chooses a builder. Includes a signed bid with a commitment to a **payload** in the consensus block. The builder broadcast the payload independently and later during the slot.

## JIT Slot auctions

The proposer chooses a builder. Includes a signed bid with a commitment to a **payment** in the consensus block. The builder broadcast the payload independently and later during the slot.

## Execution Tickets/Auctions

The protocol does the auction in advance (e.g. 32 slots before the slot in question). Builders buy *tickets* from the protocol to obtain rights to propose these future execution payloads.

## MEV Burn

The protocol collects part of the value of the auction, either by being the auctioneer or by burning some of the value in the proposer auction.



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## No Auction

Enforce that the proposer and the builder are the same entity. Likely relies on clients maintaining Mev-Boost support.



# New constraints

## Proposer Safety

An honest proposer that submits its block timely, is guaranteed to receive the value of the committed bid regardless of the builder's actions.

## Builder Reveal safety

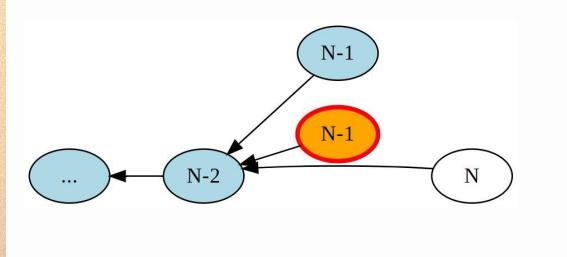
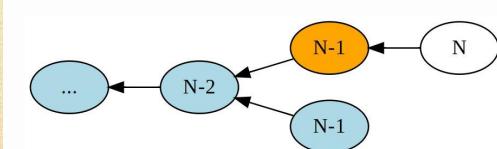
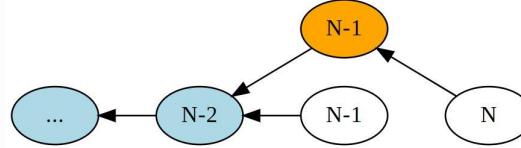
A timely revealed payload is guaranteed to be the head of the chain regardless of the current and next proposer's actions.

## Builder Withholding Safety

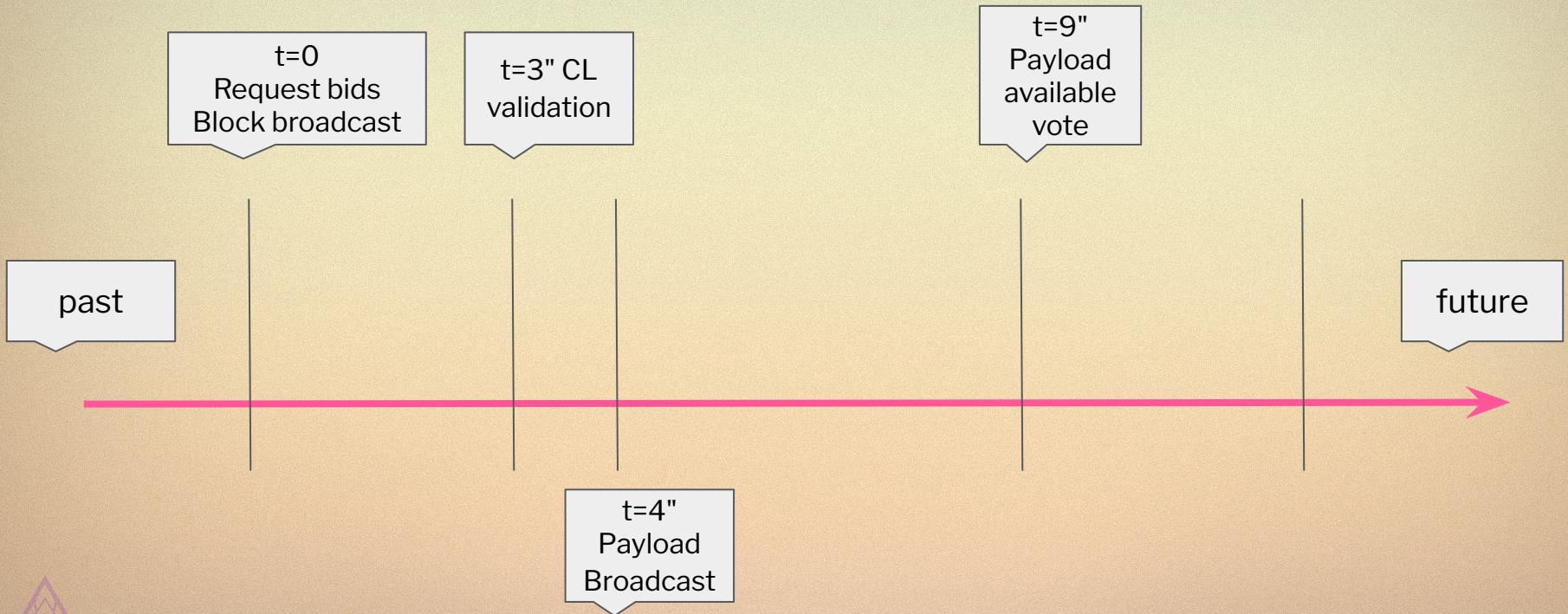
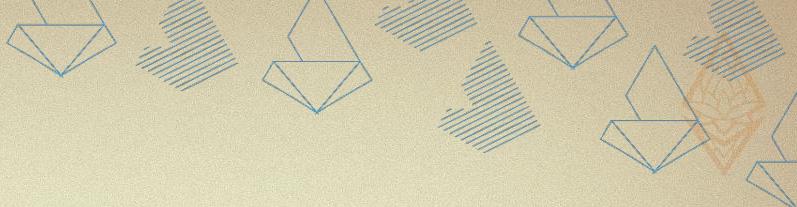
If the block revealed by the proposer has not obtained enough attestations so as to guarantee being canonical regardless of the next proposer's actions, the builder may withhold its payload without consequences (i.e. without paying the bid's value).



# Full, Empty, Skipped nodes



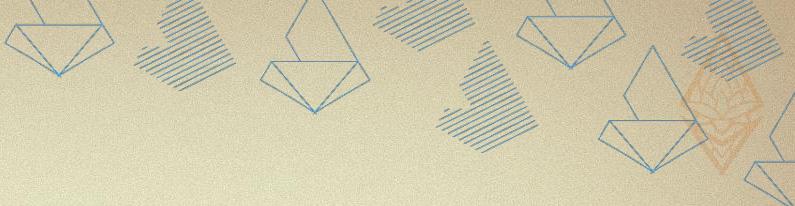
# ePBS Slot





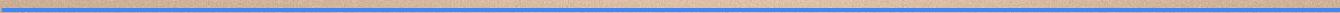
# Implementation status

- Prysm has a working minimal prototype
- Teku and Nimbus with implementations close to interop
- Lodestar and Lighthouse initiated implementations



# Thank you!

[potuz@prysmaticlabs.com](mailto:potuz@prysmaticlabs.com)



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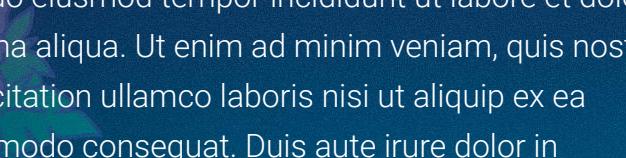
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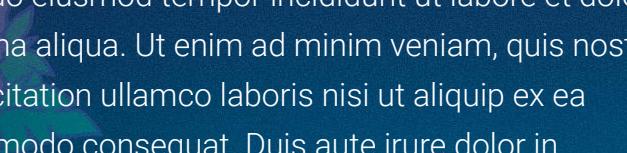
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## Event 3



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“Number rules the universe.”  
— Pythagoras

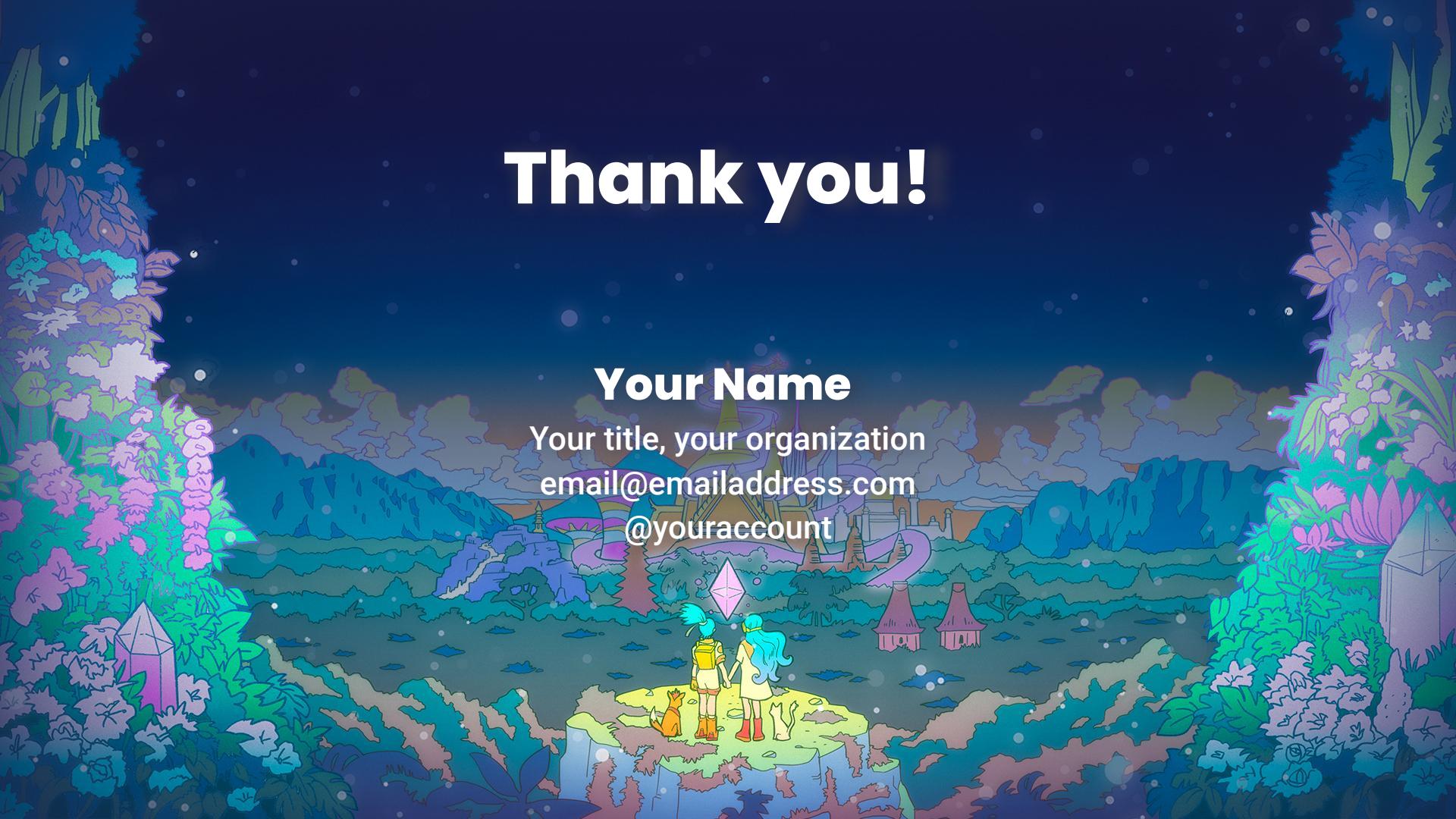
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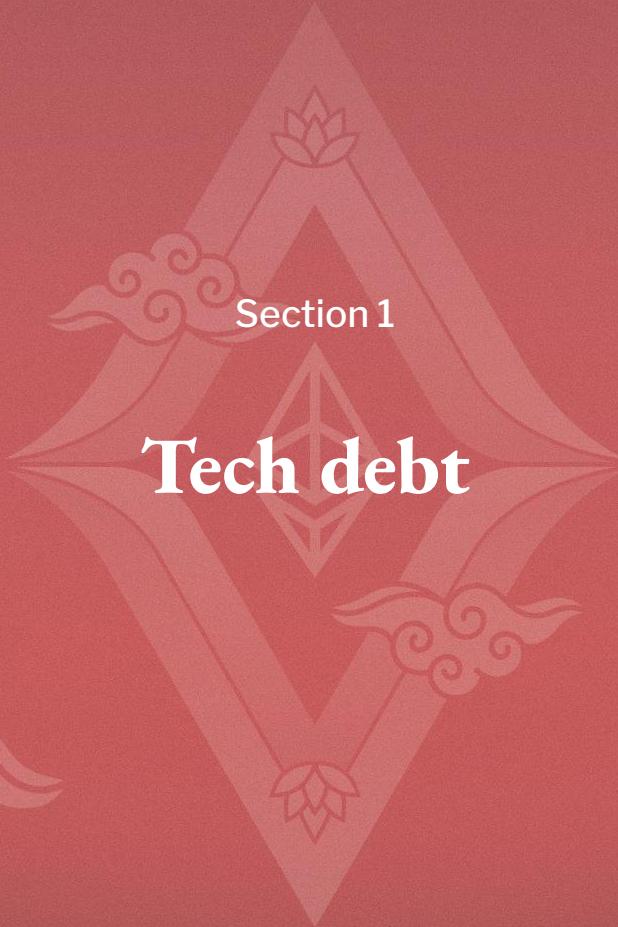
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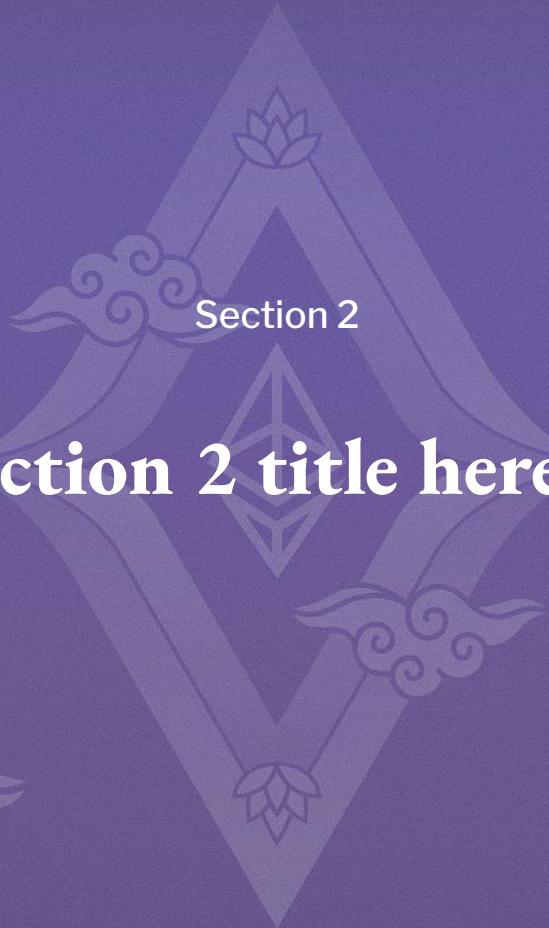
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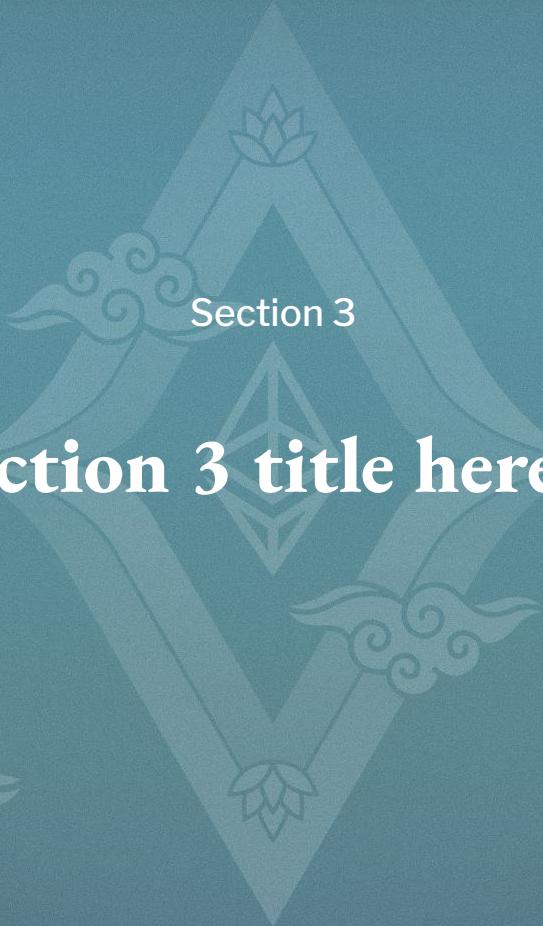




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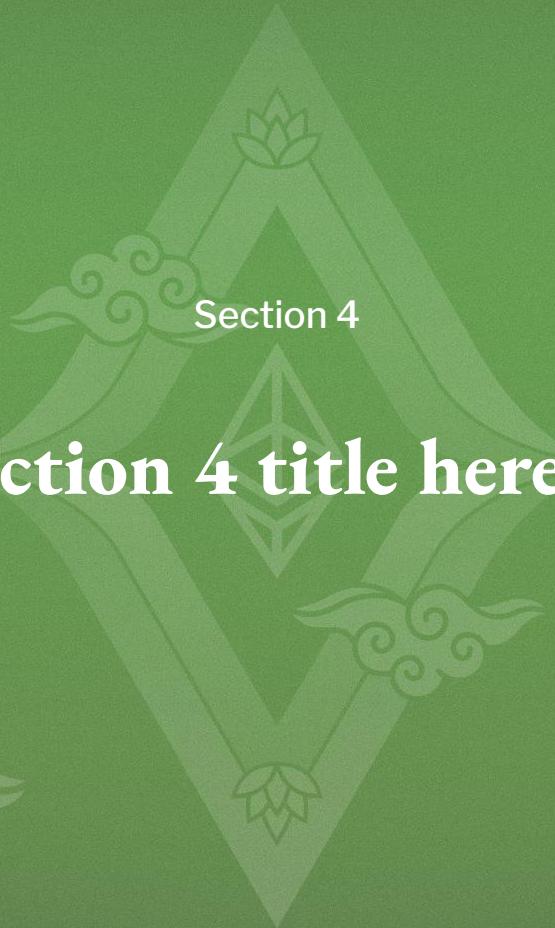
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“Number rules the universe.”

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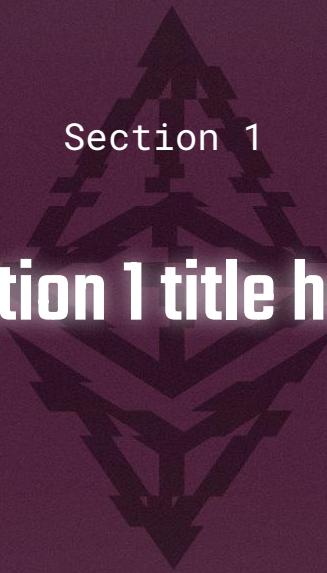


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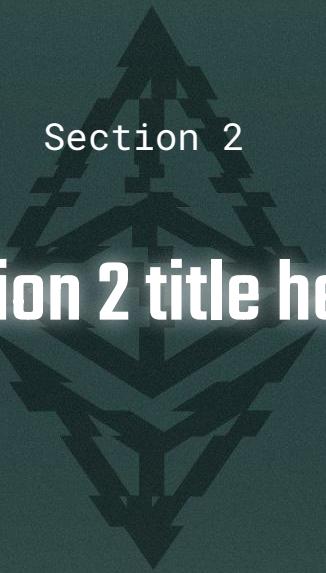
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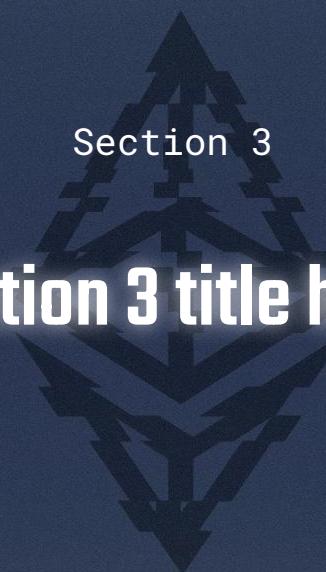
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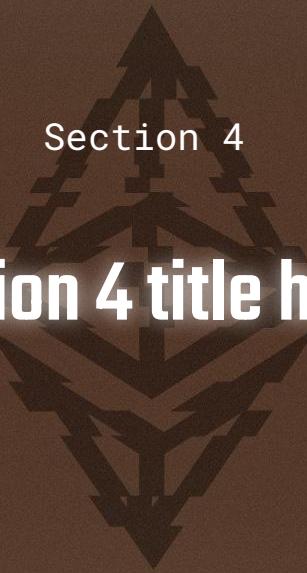


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