Increase the MAX_EFFECTIVE_BALANCE

mike neuder – ethereum foundation

kiln rendez-vous – july 19, 2023

Outline

- Preliminaries
  - `MAX_EFFECTIVE_BALANCE`
  - `validator.effective_balance`
  - Partial withdrawals sweep
  - EIP-7002
  - Historical context
- Proposal
- Rationale
  - Validator set size
  - APYs & CL/EL rewards
  - Network stability
  - Single-slot finality, ePBS, mev-burn
  - Make solo-staking better
- Key takeaways

Preliminaries

MAX_EFFECTIVE_BALANCE (abbr. MaxEB)

Gwei values

Name	Value
`MIN_DEPOSIT_AMOUNT`	`Gwei(2**0 * 10**9)` (= 1,000,000,000)
`MAX_EFFECTIVE_BALANCE`	`Gwei(2**5 * 10**9)` (= 32,000,000,000)
`EFFECTIVE_BALANCE_INCREMENT`	`Gwei(2**0 * 10**9)` (= 1,000,000,000)

- Sets an upper bound on the "effective balance" of a single validator
- Currently, the minimum balance to become a validator *is the same as* the MaxEB (32 ETH)

https://github.com/ethereum/consensus-specs/blob/dev/specs/phase0/beacon-chain.md

Preliminaries

validator.effective_balance

```
class Validator(Container):
    pubkey: BLSPubkey
    withdrawal_credentials: Bytes32  # Commitment to pubkey for withdrawals
    effective_balance: Gwei  # Balance at stake
    slashed: boolean
```

- Represents the consensus layer view of the validator stake
- Incremented by whole values of ETH
- Can go *below* 32 ETH (until the ejection balance of 16 ETH), but never *above* 32 ETH

https://github.com/ethereum/consensus-specs/blob/dev/specs/phase0/beacon-chain.md

Preliminaries

Partial withdrawals sweep

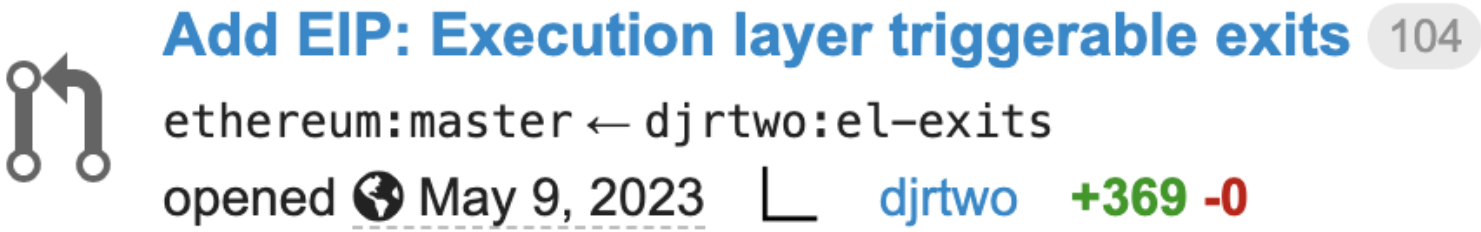
```
elif is_partially_withdrawable_validator(validator, balance):
    withdrawals.append(Withdrawal(
        index=withdrawal_index,
        validator_index=validator_index,
        address=ExecutionAddress(validator.withdrawal_credentials[12:]),
        amount=balance - MAX_EFFECTIVE_BALANCE,
    ))
```

- Removes any excess balance from the validator automatically
- Sends the rewards to a "withdrawal credential", which is an Ethereum address (EOA or contract)
- It takes about 6 days for the sweep to finish one round (0.015 ETH for most of these withdrawals)

https://github.com/ethereum/consensus-specs/blob/dev/specs/phase0/beacon-chain.md

Preliminaries

EIP-7002



- Allows validators to trigger exits from their withdrawal credential rather than their validator signing key (a BLS key-pair used for consensus layer signings)
- *safety* – (if you lose your validating keys, you can still withdraw)
- *convenience* – programmability of the exits

https://ethereum-magicians.org/t/eip-7002-execution-layer-triggerable-exits/14195

Misc

Name	Value
`MAX_COMMITTEES_PER_SLOT`	`uint64(2**6)` (= 64)
`TARGET_COMMITTEE_SIZE`	`uint64(2**7)` (= 128)
`MAX_VALIDATORS_PER_COMMITTEE`	`uint64(2**11)` (= 2,048)

- Attesting committee for a slot was broken down into sub-committees (called just `committee` in the spec) for the sharding design
- Each committee needed to be majority honest for the security of that shard (meaning having large validator balances would be difficult)
- With Danksharding, we now just use committees to aggregate attestations, so we only need one honest aggregator

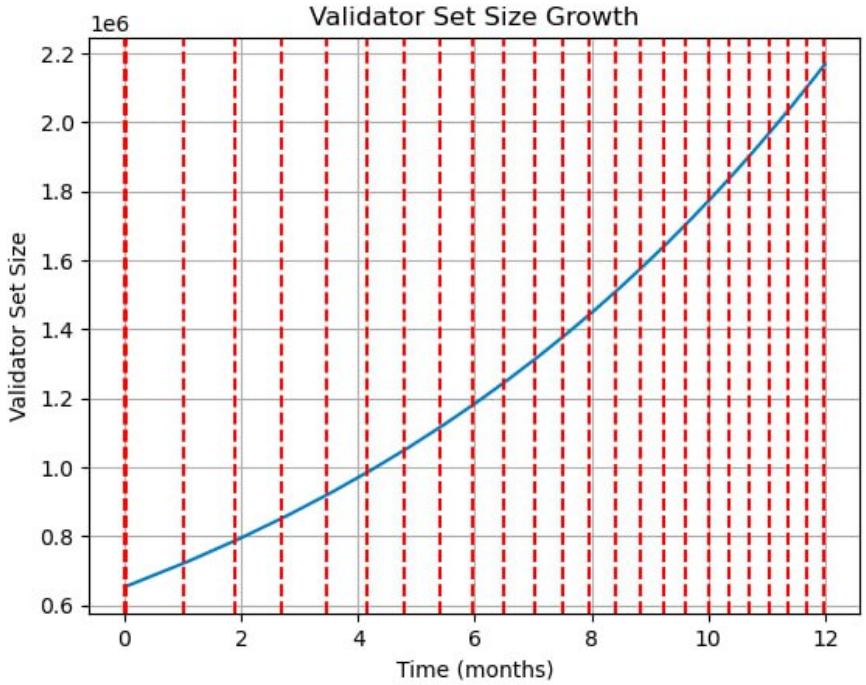
https://ethereum-magicians.org/t/eip-7002-execution-layer-triggerable-exits/14195

Proposal

- Increase the `MaxEB` from 32 ETH to 2048 ETH
- Allow for arbitrary execution layer partial withdrawals

Rationale

Validator set size

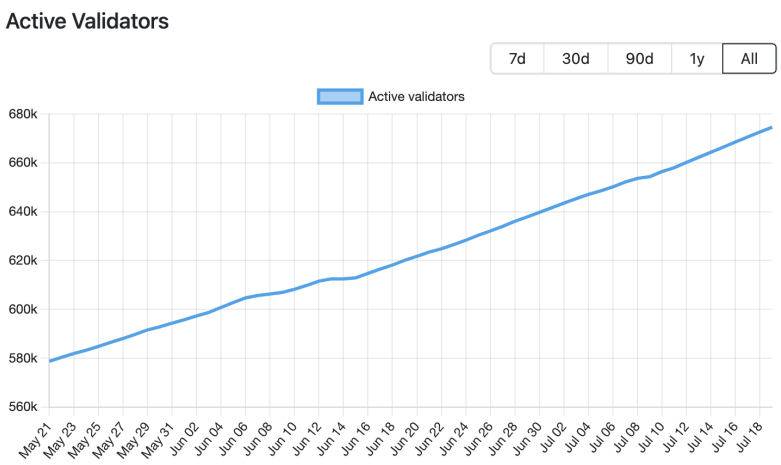


- If the activation queue remains full, the validator set grows exponentially

https://notes.ethereum.org/@mikeneuder/eip-7251-faq

Rationale

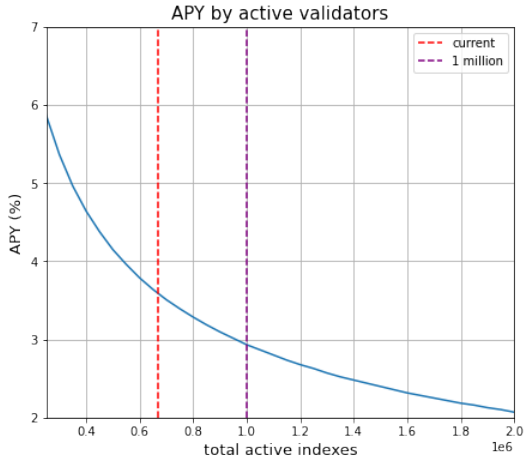
Validator set size

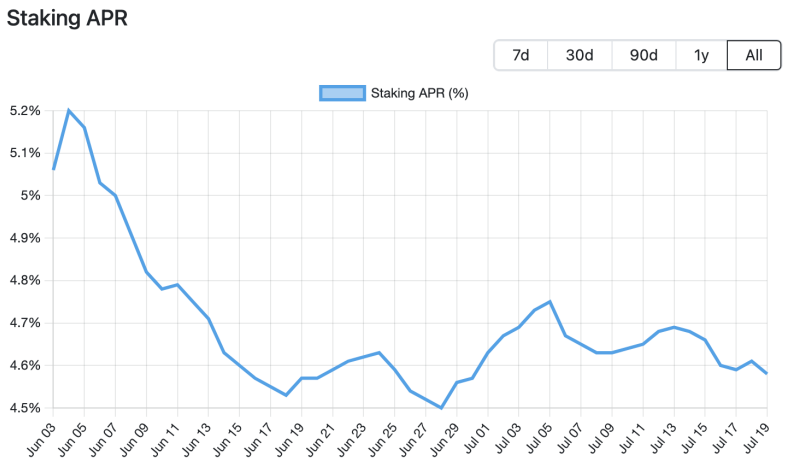


https://www.validatorqueue.com/

Rationale

APYs & CL and EL rewards



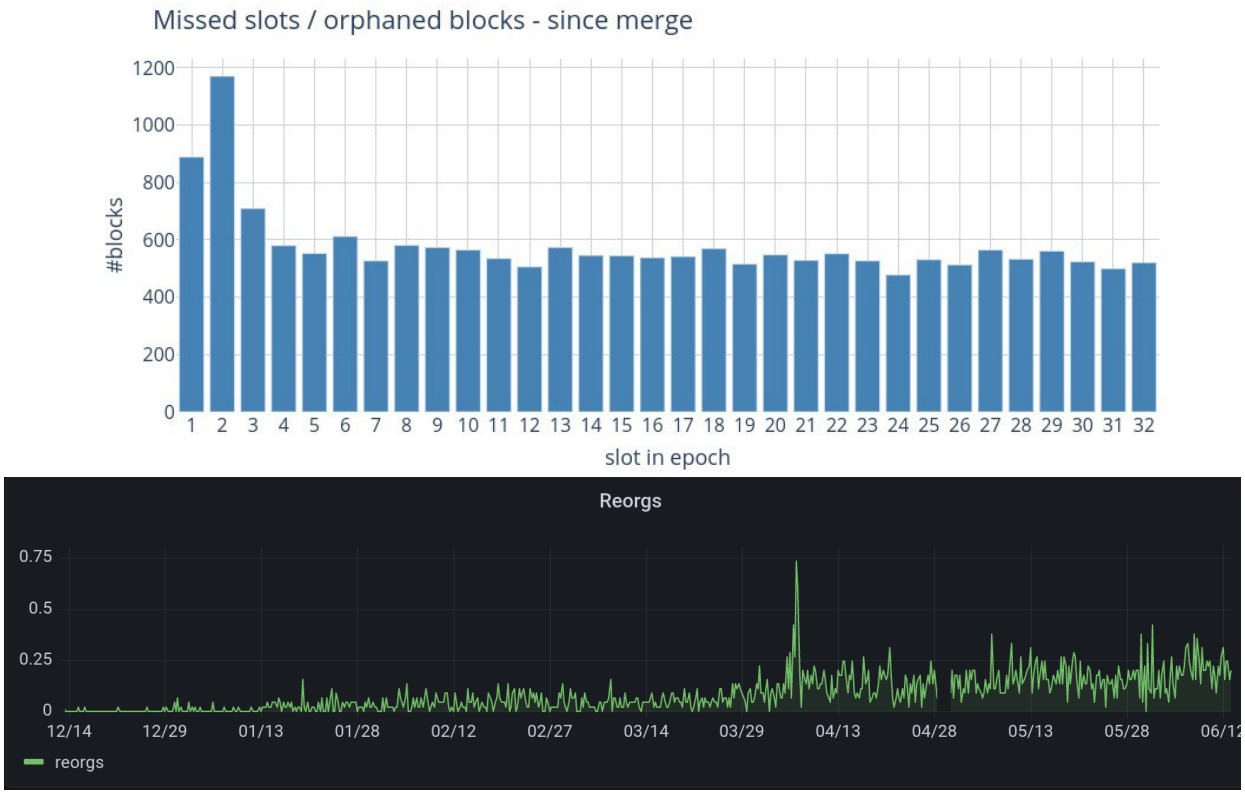


- It seems like it is *too profitable* to be a validator
- `mev-boost` facilitates earning MEV rewards on the EL

https://notes.ethereum.org/@mikeneuder/eip-7251-faq

Rationale

Network stability

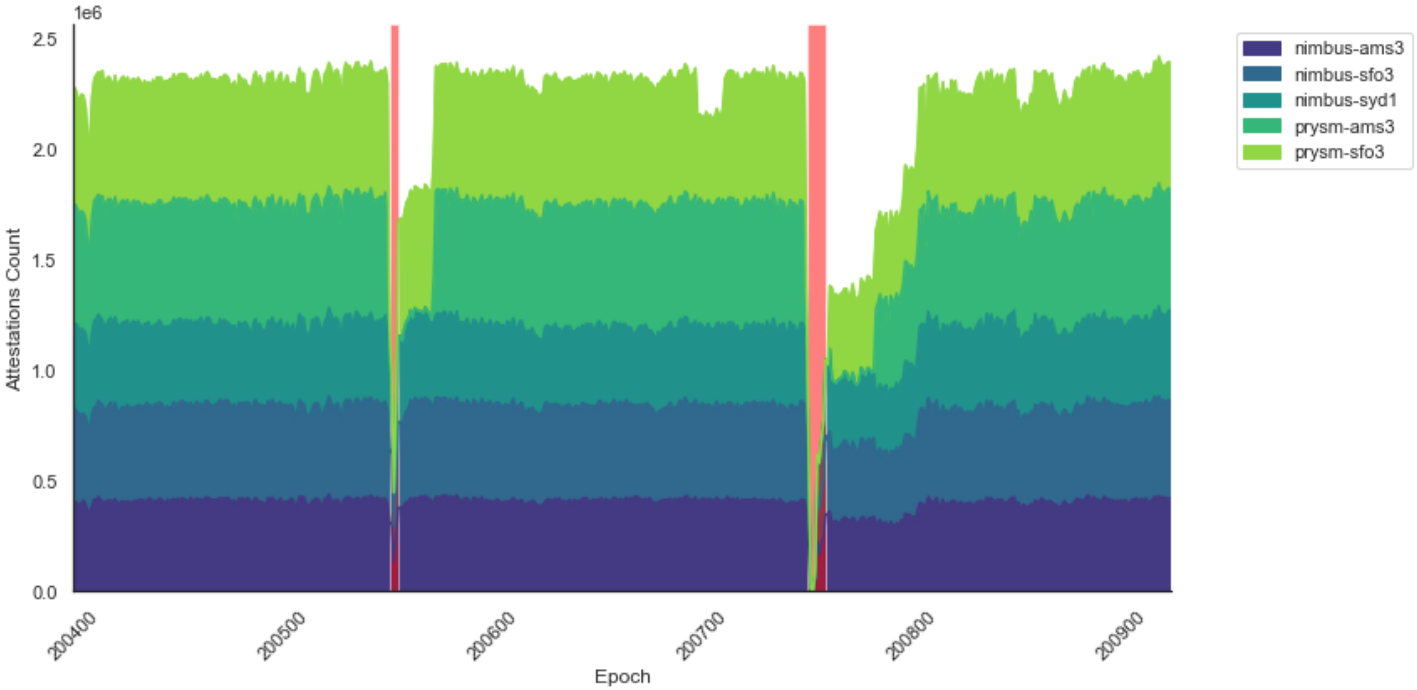


- Reorgs happen more frequently
- Epoch processing is especially unstable

https://twitter.com/jcksie/status/1668559049040748545

Rationale

Network stability



- Non-finality event on May 11-12 partially attributable to processing so many activations
- Large validator set means: large beacon state, long signature aggregations, and more p2p networking overhead

---

https://ethresear.ch/t/cascading-network-effects-on-ethereums-finality/15871

Rationale

Single-slot finality

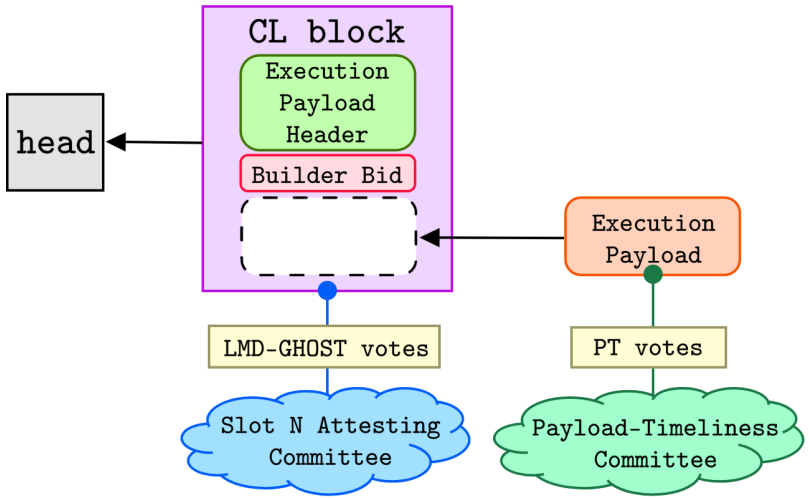
Bad news: hybrid consensus mechanisms actually have many unavoidable problems

- Current consensus mechanism has issues around UX, safety, and protocol complexity
- How do we do SSF?
  - Rotating validator set
  - Validator set capping (how do you choose)
  - Change validator economics directly (negative issuance?!)
- All of these changes modify core elements of the protocol

https://notes.ethereum.org/@vbuterin/single_slot_finality

Rationale

ePBS & mev-burn



- ePBS designs change consensus rules, add some complexity
- ePBS directly enables mev-burn, which is potentially a better way to address the validator economics

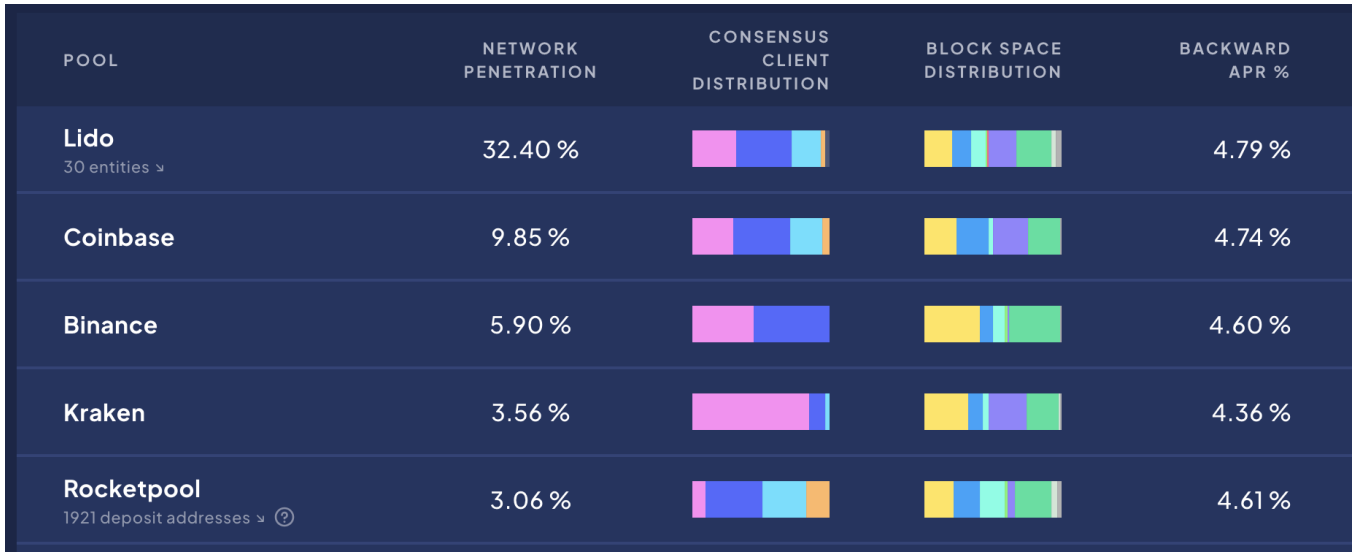
---

https://ethresear.ch/t/payload-timeliness-committee-ptc-an-epbs-design/16054

https://ethresear.ch/t/mev-burn-a-simple-design/15590

Rationale

Make solo-staking better



POOL	NETWORK PENETRATION	CONSENSUS CLIENT DISTRIBUTION	BLOCK SPACE DISTRIBUTION	BACKWARD APR %
Lido 30 entities ↘	32.40 %			4.79 %
Coinbase	9.85 %			4.74 %
Binance	5.90 %			4.60 %
Kraken	3.56 %			4.36 %
Rocketpool 1921 deposit addresses ↘ ⓘ	3.06 %			4.61 %

- Pools provide auto-compounding and flexible staking amounts
- This quickly overcomes the fixed-rate fee taken by the pool
- Solo-stakers should also have these benefits, without needing to join a pool

---

https://www.rated.network/?network=mainnet&view=pool&timeWindow=1d&page=1

https://blog.rated.network/blog/solo-stakers

Key takeaways

- Increasing the `MaxEB` is an easy tech-debt fix that slows the growth of the validator set
- A much better solution than directly changing the validator economics
- Added benefit of making solo-staking better
- Fits perfectly into the roadmap of SSF, ePBS, and mev-burn

Thanks!

https://notes.ethereum.org/@mikeneuder/eip-7251-faq