



Beyond the Surface

The Hidden Benefits of Client Diversity

Daniel Lehrner

Besu Core Developer @ Consensys



Introduction

What is client diversity?

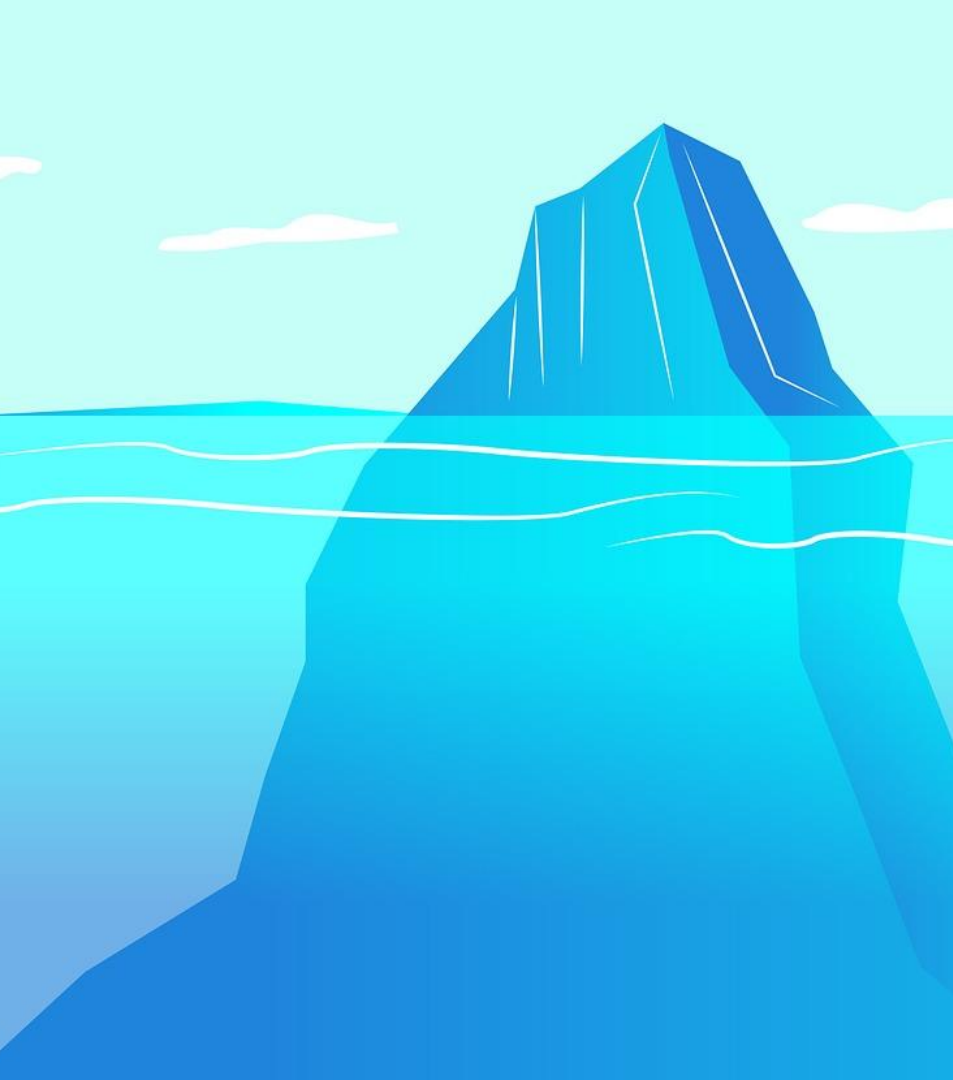
Client diversity

Execution Layer:

- Geth (Go)
- Nethermind (.NET)
- Besu (Java)
- Erigon (Go)
- Reth (Rust)
- EthereumJs (TypeScript)

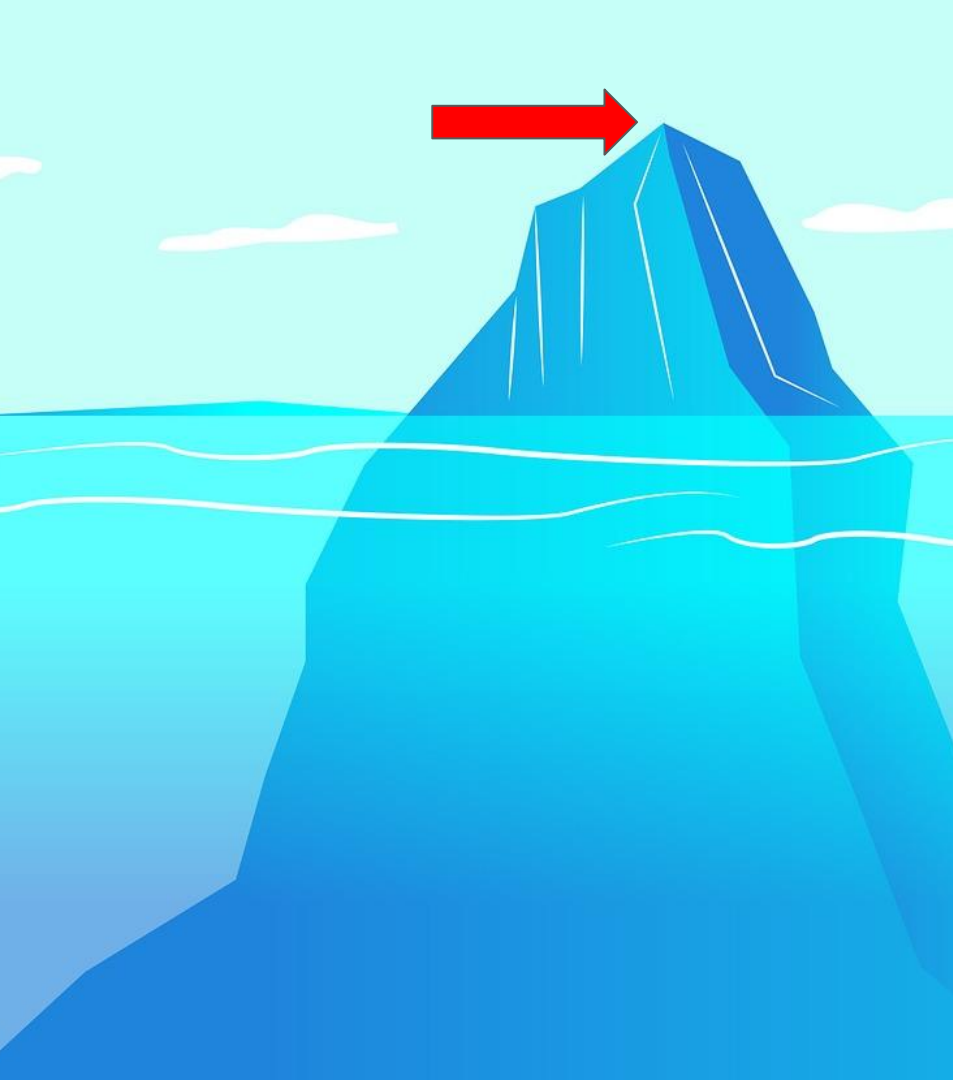
Consensus Layer:

- Prysm (Go)
- Lighthouse (Rust)
- Teku (Java)
- Nimbus (Nim)
- Lodestar (TypeScript)
- Grandine (Rust)



**Many benefits of
client diversity**





Stability





r/ethereum · 8 yr. ago

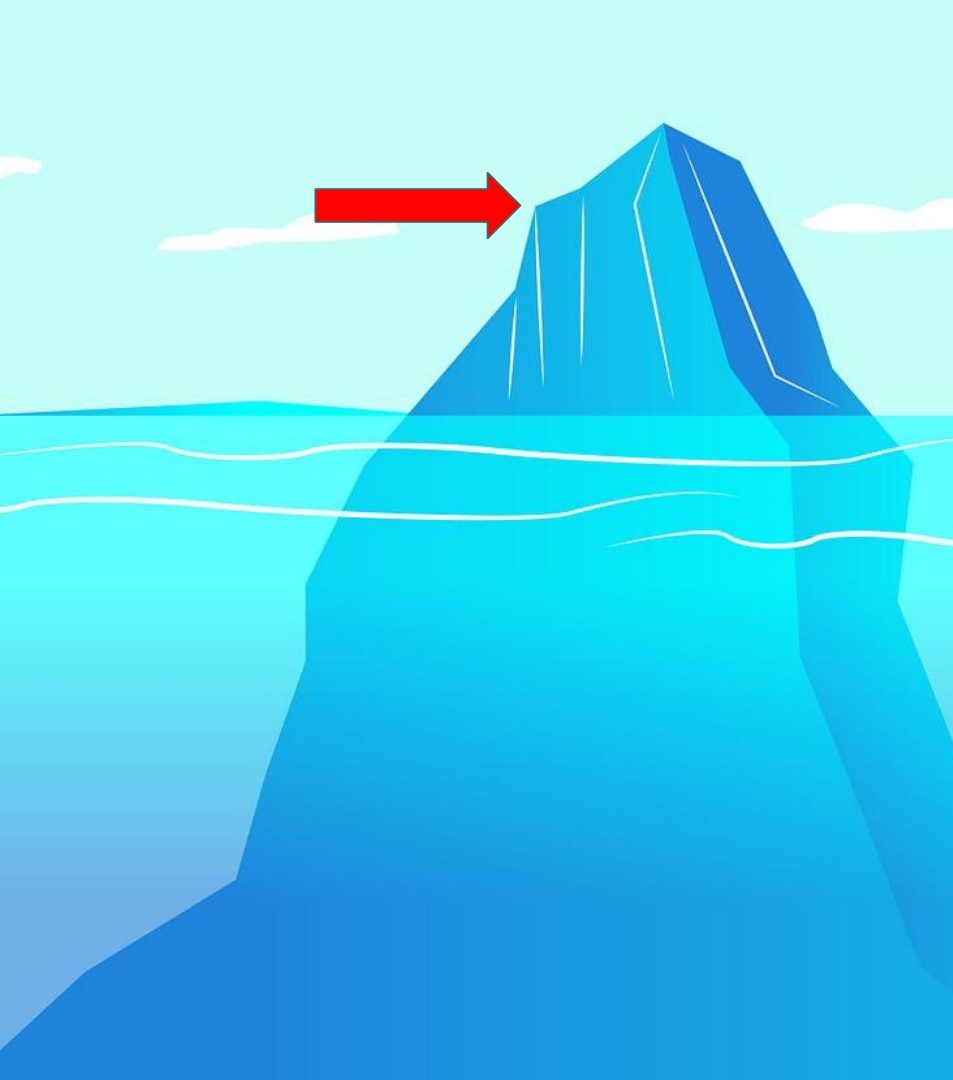
vbuterin



Consensus flaw in geth; we have identified the problem and are now in the process of testing a fix for a release.

Essentially, geth's journal was failing to revert account deletions when a transaction that deleted empty accounts went OOG. [This transaction](#) triggered it.

EDIT: new geth released <https://blog.ethereum.org/2016/11/25/security-alert-11242016-consensus-bug-geth-v1-4-19-v1-5-2/> download direct here <https://github.com/ethereum/go-ethereum/releases/tag/v1.5.3>



**Correctness &
error detection**





Author

Topic: Strange block 74638 (Read 44518 times)

jgarzik (OP)

Legendary



Activity: 1596

Merit: 1100



Strange block 74638

August 15, 2010, 06:08:49 PM

Merited by EFS (10), fillppone (9), hugeblack (6), LoyceV (4), DdmrDdmr (2), vapourminer (1), Financisto (1), kopipe (1)

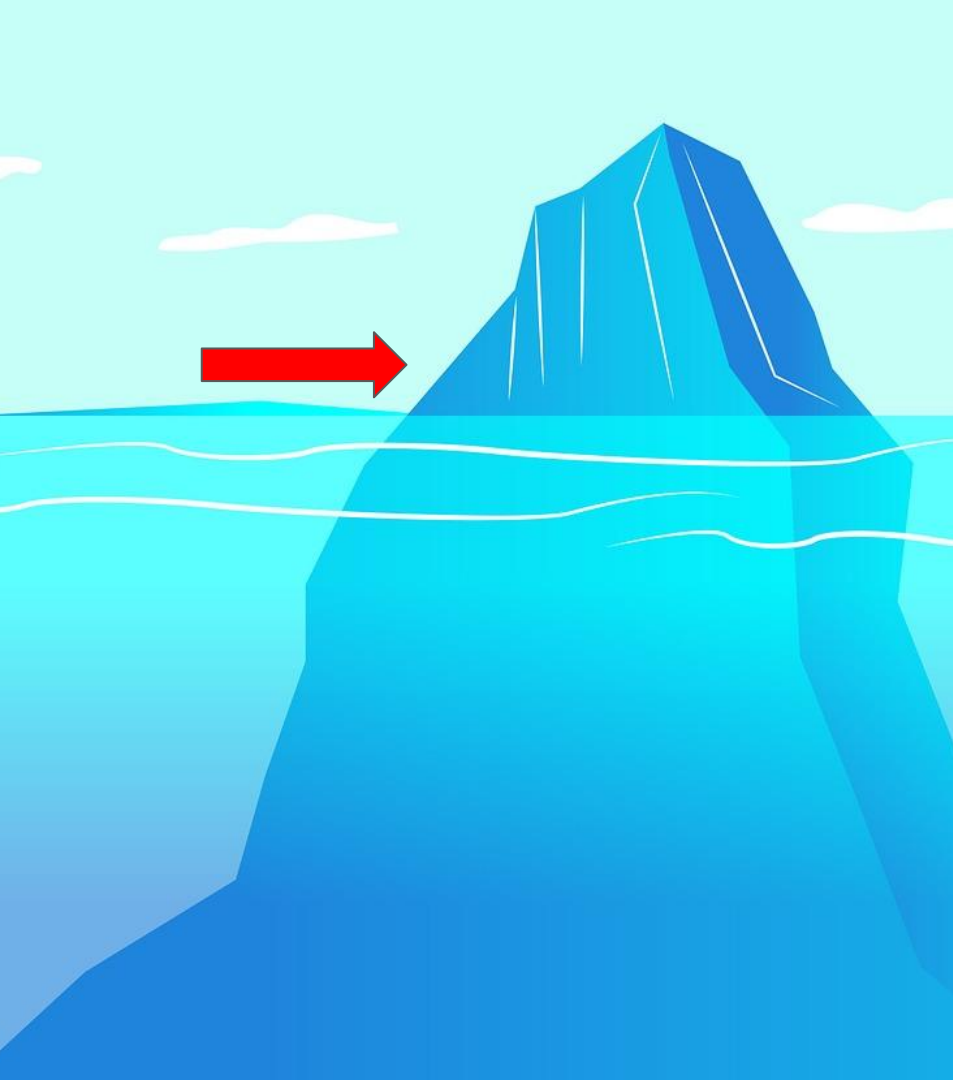
#1

The "value out" in this block #74638 is quite strange:

Code:

```
{
  "hash" : "000000000790ab3f22ec756ad43b6ab569abf0bddeb97c67a6f7b1470a7ec1c",
  "ver" : 1,
  "prev_block" : "000000000606865e679308edf079991764d88e8122ca9250aef5386962b6e84",
  "mrkl_root" : "618eba14419e13c8d08d38c346da7cd1c7c66fd8831421056ae56d8d80b6ec5e",
  "time" : 1281891957,
  "bits" : 469794830,
  "nonce" : 28192719,
  "n_tx" : 2,
  "tx" : [
    {
      "hash" : "012cd8f8910355da9dd214627a31acfeb61ac66e13560255bfd87d3e9c50e1ca",
      "ver" : 1,
      "vin_sz" : 1,
      "vout_sz" : 1,
      "lock_time" : 0,
      "in" : [
```

92233720368.54277039 BTC? Is that UINT64_MAX, I wonder?



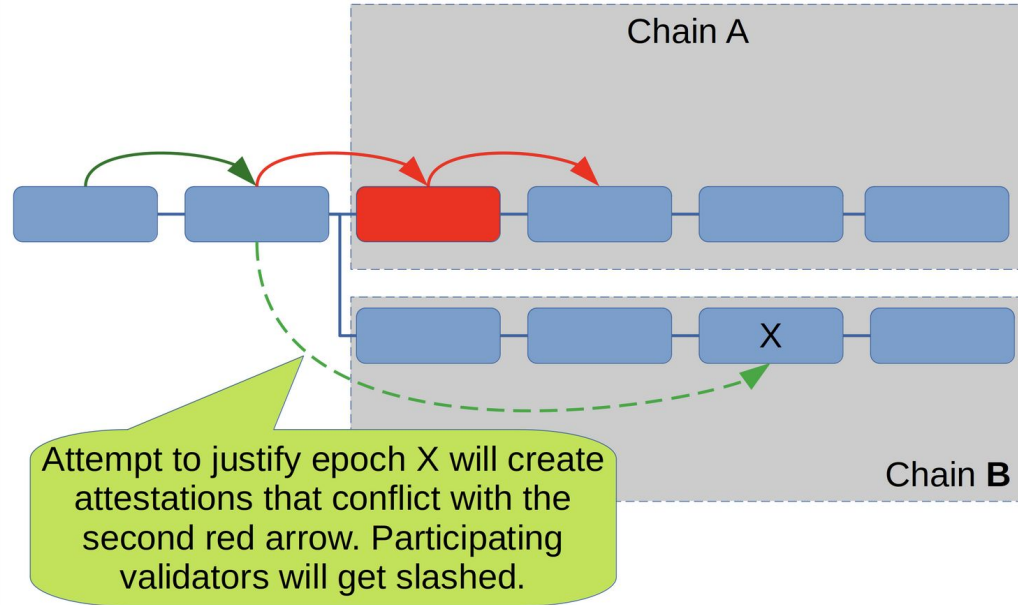
**Avoiding
catastrophic
errors**



Ethereum Merge: Run the majority client at your own peril!

[1] <https://dankradfeist.de/ethereum/2022/03/24/run-the-majority-client-at-your-own-peril.html>

Now let's assume that the bug has been fixed and the validators that finalized the invalid epoch would like to rejoin the correct chain **B**. In order to be able to finalize the chain, a first step is to justify epoch X:



However, in order to participate in the justification of epoch X (which needs a supermajority link as indicated by the dashed green arrow), they would have to "jump over" the second red arrow – the one that finalized the invalid epoch. Voting for both of these links is a slashable offense.

This continues to be true for any later epoch. The only way it will get fixed is through the quadratic inactivity leak: As chain **B** grows, the locked out validators will leak their funds until chain **B** can be justified and finalized by the correctly working clients.

Execution Clients



Switch from Geth to a minority client!

Geth - 84.0%



Nethermind - 8.18%



Besu - 4.97%



Erigon - 1.69%



Unknown - 1.16%



Reth - 0.0%



Other - 0.0%



Data provided by execution-diversity.info — updated daily.

Data may not be 100% accurate. ([Read more](#))

Network coverage: 59.7%

Data source ([read more](#)):



Execution-Diversity.info



Ethernodes

Murphy's law

Besu Jan 6 Mainnet Event

Besu developer Matt Nelson shared details about an outage of roughly 70% of Besu Ethereum nodes on Ethereum in early January. A full postmortem about the event has been shared by the Besu team [on their blog](#). Nelson explained that the outage was due to a bug in Besu's Bonsai state storage format, specifically, how Bonsai encoded state changes. A hotfix to the Besu client has been rolled out and Nelson emphasized his appreciation for EL client diversity through the event on January 6. Because a diversity of other clients such as Geth, Nethermind, and Erigon, are being run by Ethereum node operators, the outage of Besu nodes did not materially impact network health or disrupt network activity.

Technology

Bug That Took Down 8% of Ethereum's Validators Sparks Worries About Even Bigger Outage

Shoutout



EthStaker

Execution Clients



Switch from Geth to a minority client!

Geth - 52%



Nethermind - 30%



Besu - 15%



Erigon - 2%



Reth - 1%



Other - 0%



Data provided by supermajority.info — updated manually.

Data may not be 100% accurate. ([Read more](#))

Based on 68.5% self-reported network coverage with the remaining assumed to be mostly Geth.

Data source ([read more](#)):











































Supermajority.info



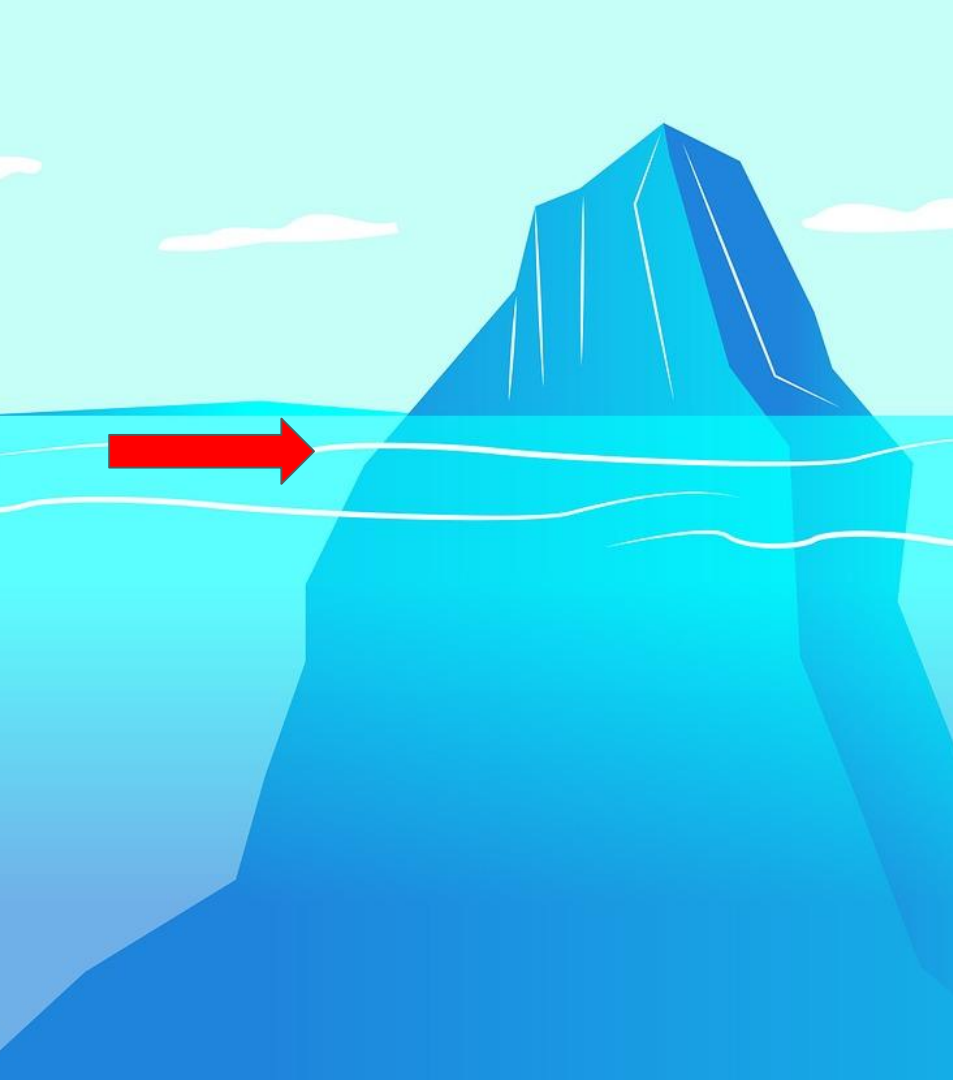
Ethernodes

The slide features a dark blue background with a subtle gradient. On the left and right sides, there are decorative borders made of stylized, light blue and white floral and leaf patterns. The text is centered in a bold, white, sans-serif font.

Client diversity is a choice

Client	Get Started	Audience	Wallet Security	Network Security	Backups	Setup Time	Disk Space	Maturity	Multi-user	Available for
Airbitz	Download	Everyone	Encrypted, on-device. Server backup	Partial	Automatic	Instant	20 MB	Oct 2014	Multi-wallet	 
Armory	Download	Power users	Encrypted, on-device	Addon	One-time	Hours	150+ GB	Jul 2011	Multi-wallet	  
Bitcoin Core	Download	End-users	Encrypted, on-device	Full	Manual	Hours	120+ GB	May 2011	No	  
Bitcoin Knots	Download	End-users	Encrypted, on-device	Full	Manual	Hours	5 GB	Dec 2011	Multi-wallet	  
bitcoind	Download	Programmers	Encrypted, on-device	Full	Manual	Hours	120+ GB	Aug 2009	No	 
Bitcoin Explorer	Download	Power Users	Ephemeral, Multisig Optional	Full w/local node	BIP39	Instant	3 MB	May 2011	Multi-wallet	  
Bitcoin Wallet	Google Play BlackBerry World	End-users	Isolated, on-device	Partial	Manual	Instant	15 MB	Mar 2011	on JB tablets	 
Blocktrail	Download	Everyone	Encrypted, on-device, Multisig, HD, Backup server	Remote	One-time	Instant	7.5 MB	Sep 2015	No	 
Electrum	Download	Power users	Encrypted, on-device	Minimal	Memorized	Minutes	5 MB	Nov 2011	No	  
Gocoin	Build It Yourself	Power users	Designated offline PC	Full	Memorized	Hours	120+GB	May 2013	Multi-wallet	   
GreenAddress	Web ChromeApp Google Play	Everyone	Encrypted, on-device	Remote	Memorized/Manual	Instant	None	Apr 2013	Yes	   
MultiBit	Download	End-users	Encrypted, on-device	Partial	Automatic (local)	Seconds	50 MB	Jul 2011	Multi-wallet	  
Mycelium	Download Google Play	Everyone	Isolated, on-device	Partial	Manual, encrypted	Instant	10 MB	Sep 2013	No	 
My Wallet	Web-based	Everyone	Encrypted, on-server	Remote	Automatic	Minutes	None	Dec 2011	Yes	   

98.36% of nodes are running Bitcoin Core



**Specification
easily accessible**



Specifications

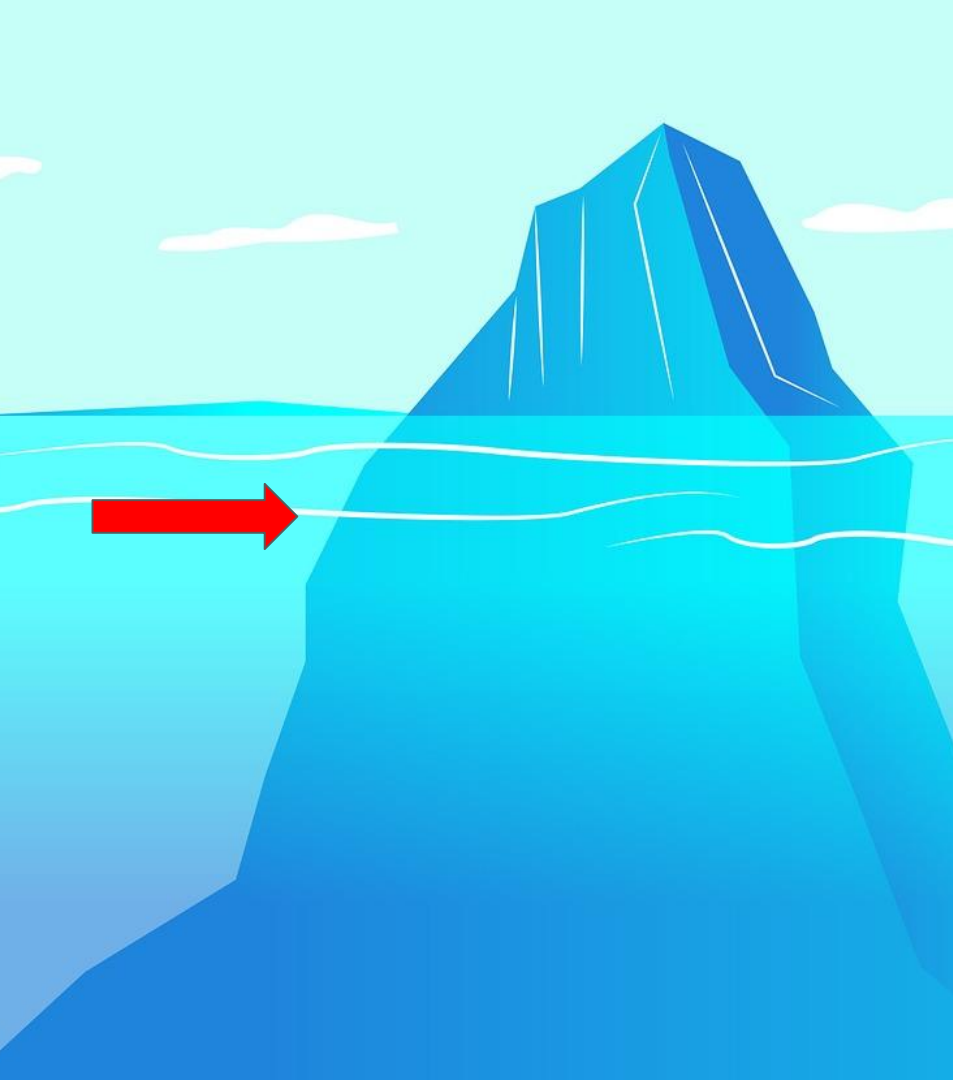


Ethereum Magicians

Ethereum Improvement proposals (EIPs)



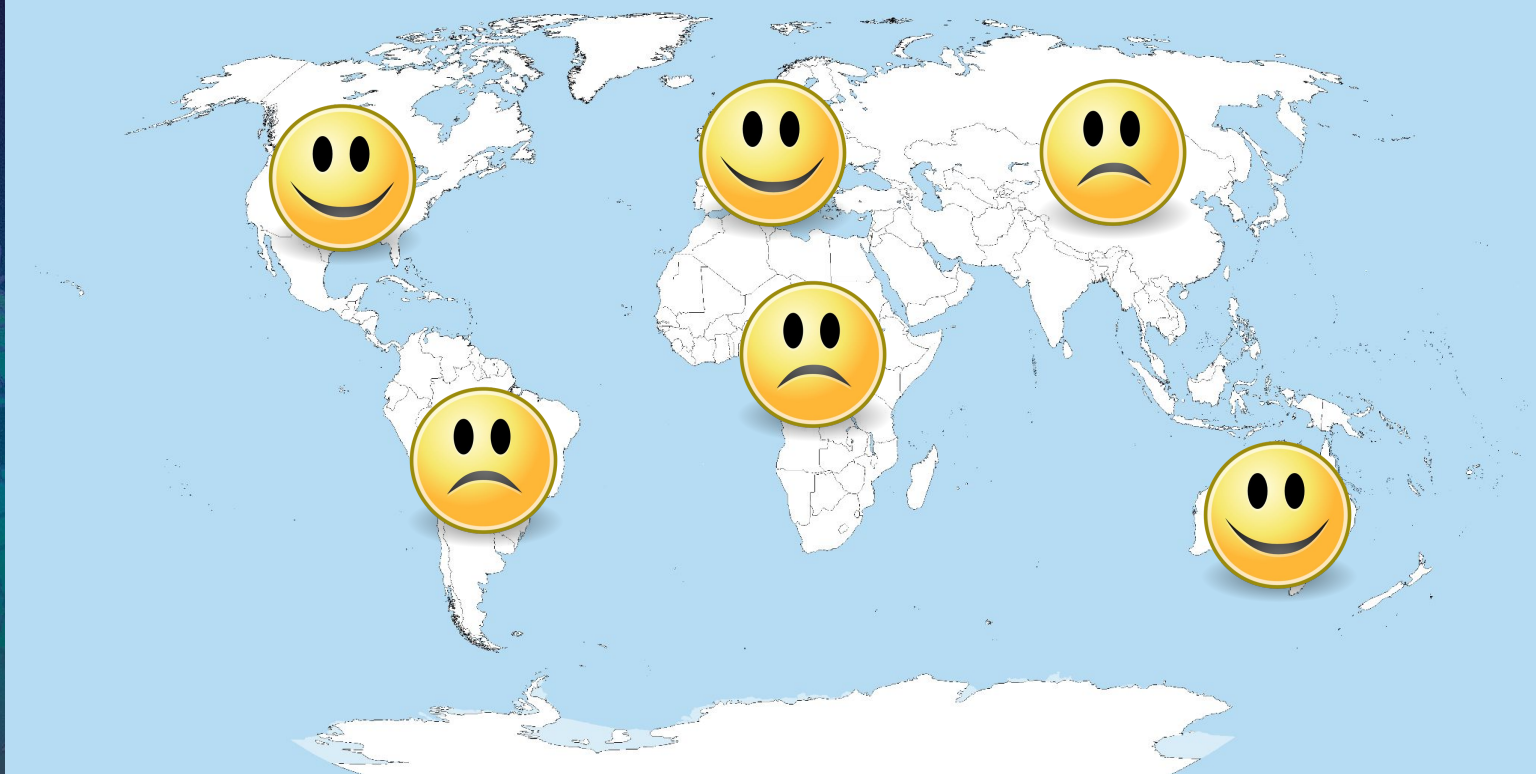
Ethereum Execution Spec Tests

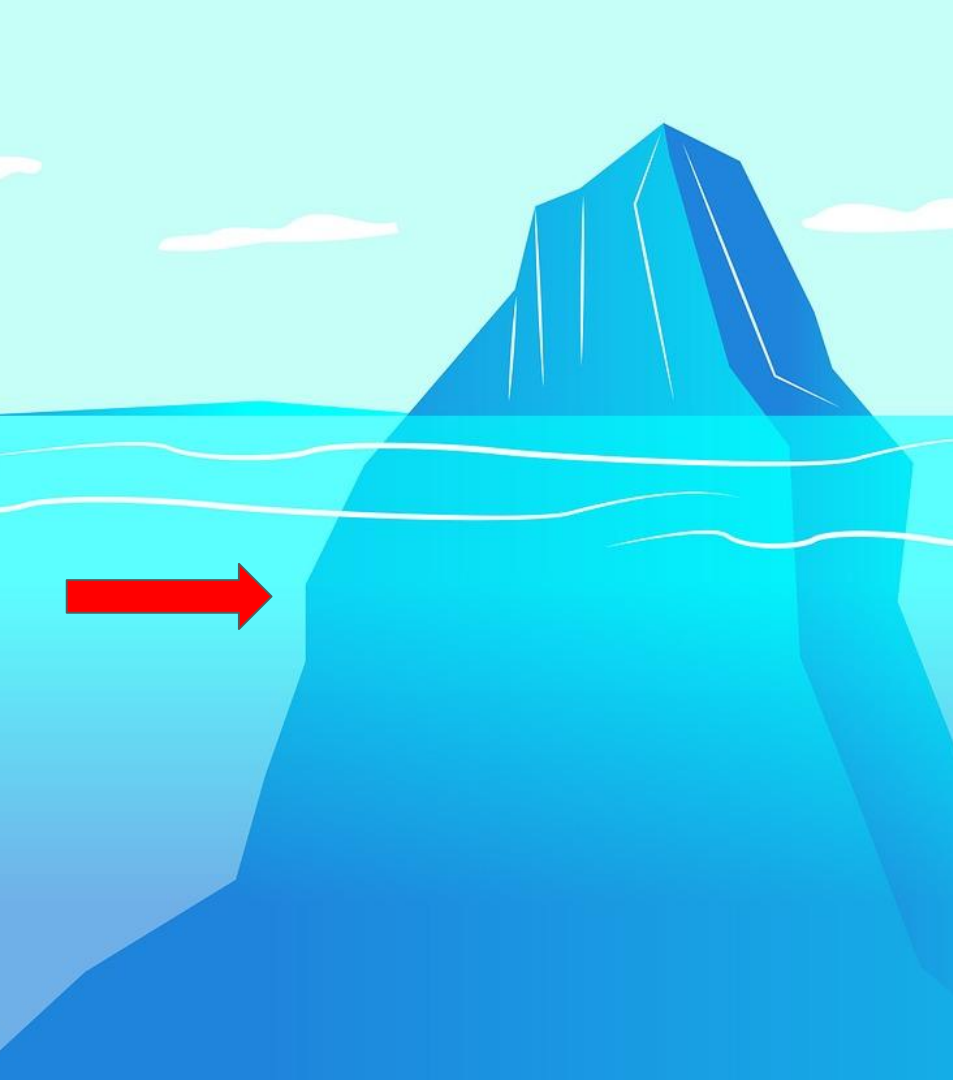


Less blind spots



Core devs locations





Improvements & experiments




Examples of minority client contributions

- Nethermind: Performance work (1 GGas)
- Besu: parallel transaction processing
- Erigon: archive node for home stakers
- Reth: Execution Extensions (ExEx)

EOF is driven by the minority clients



Péter Szilágyi (karalabe.eth) 

@peter_szilagyi

...

Oh hey, someone told us having Reth's ExEx support in Geth would be useful. Figured how hard can it be :D

4 hours later, my Geth ExEx prototype landed 🙈 github.com/ethereum/go-et...

Minimal example is 21 lines of Go code and it even auto-generates Geth CLI flags for you! [#Ethereum](#)

ethereum/go-ethereum

#30611 cmd, core, eth: add support for Reth style ExEx plugins



 6 comments  4 reviews  18 files  +819 -2 



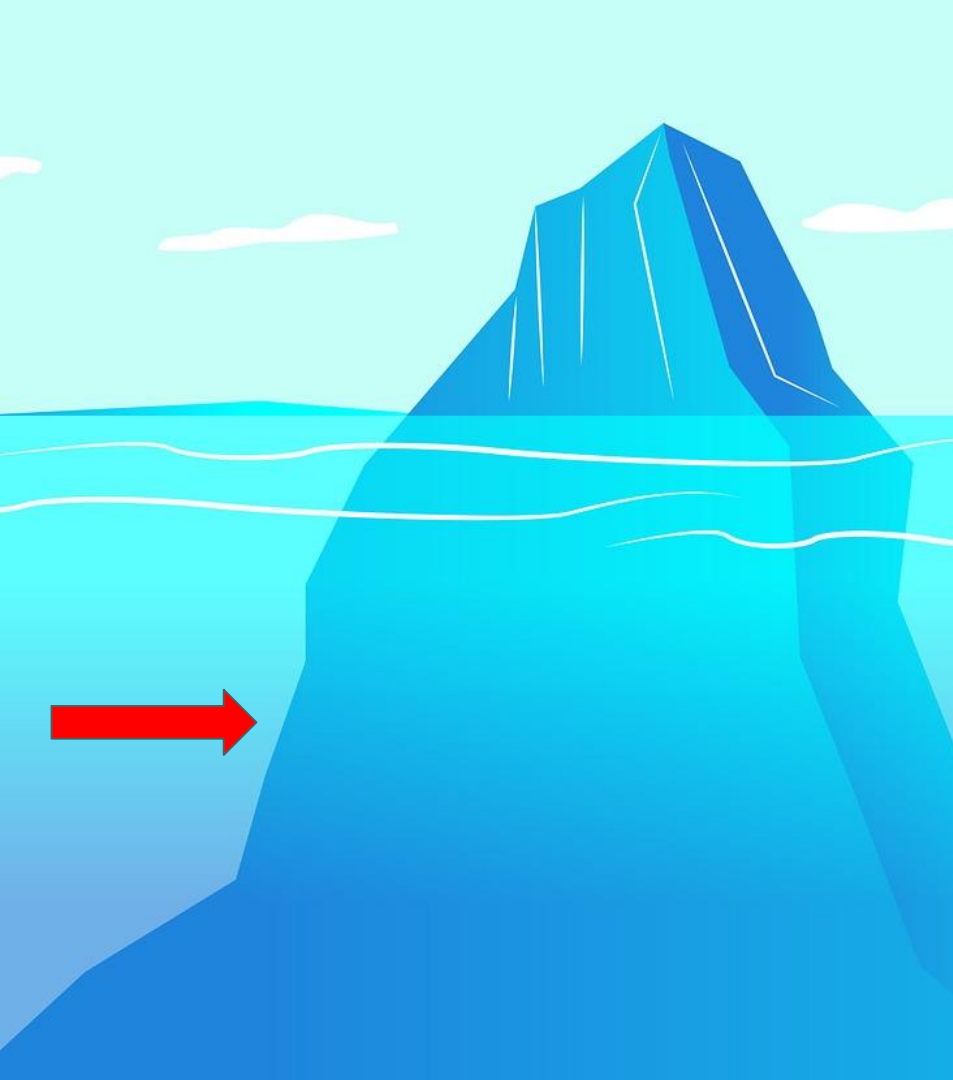
karalabe • October 16, 2024  9 commits



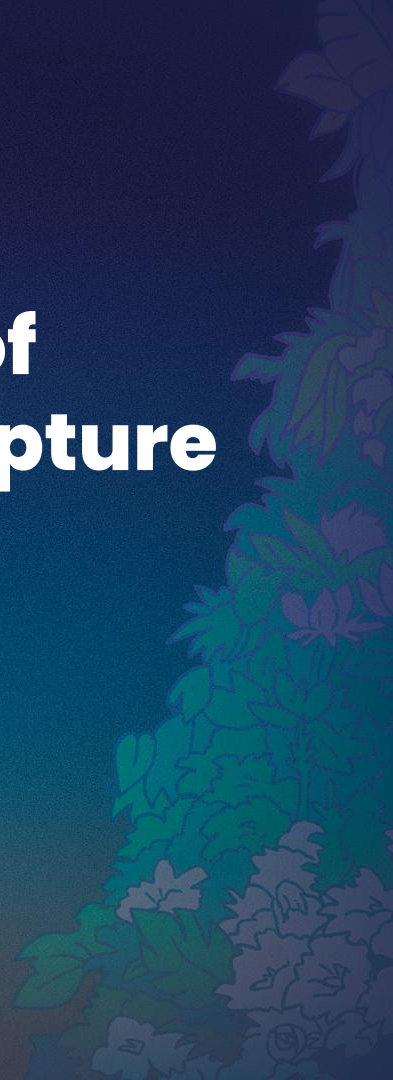
cmd, core, eth: add support for Reth style ExEx plugins by karalabe · Pull Request #3...

From github.com

6:45 PM · Oct 16, 2024 · **22.6K** Views

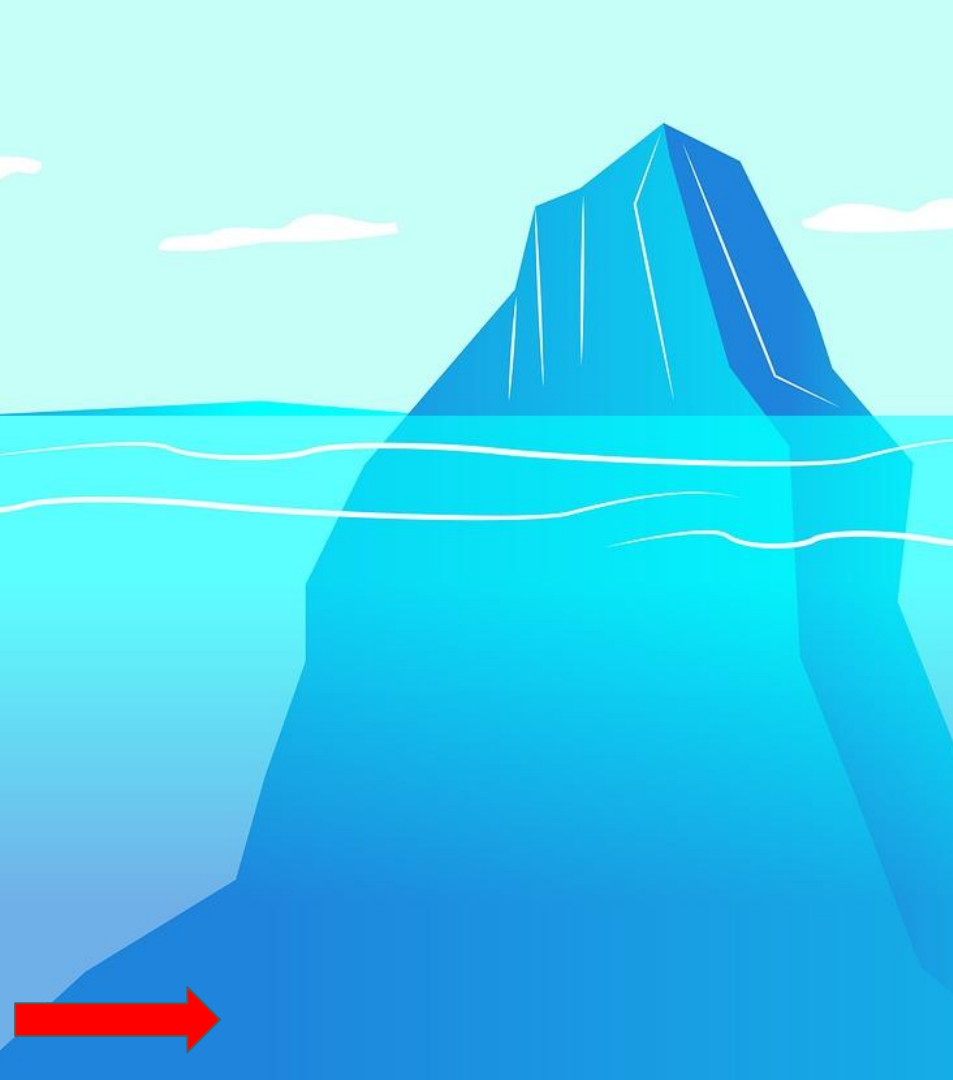


**Lower risk of
protocol capture
or failure**



Types of capture or failures

- One team can be pressured or infiltrated by a government
- One team can withhold updates
- One team can abandon the client



**Permissionless
contributions to
the protocol**



I want you to become a core dev



Client repositories

- <https://github.com/ethereum/go-ethereum>
- <https://github.com/NethermindEth/nethermind>
- <https://github.com/hyperledger/besu>
- <https://github.com/erigontech/erigon>
- <https://github.com/ethereumjs/ethereumjs-monorepo>
- <https://github.com/paradigmxyz/reth>
- <https://github.com/prysmaticlabs/prysm>
- <https://github.com/sigp/lighthouse>
- <https://github.com/Consensys/teku>
- <https://github.com/ChainSafe/lodestar>
- <https://github.com/status-im/nimbus-eth2>
- <https://github.com/grandinetech/grandline>

Keeping up with Core development

- <https://x.com/TimBeiko>
- https://x.com/christine_dkim
- ETH R&D: <https://discord.gg/PQBimg4yGv>
- ETH Magicians: <https://ethereum-magicians.org/>
- EIPS: <https://eips.ethereum.org/>
- ACD: <https://www.youtube.com/@EthereumProtocol/streams>
- Implementer calls: <https://www.youtube.com/@EthereumProtocol/videos>

Thank you!

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