Evaluation of the level of decentralization in the ethereum crypto project

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GitHub Metrics

Number of contributors :
A high number of contributors generally indicates a decentralized development process. Ethereum is currently leading the race with the highest number of total developers, at 5,758. It also has a very good compound annual growth of monthly contributors since 2018 and around 2000 monthly contributors. A total of1106 Ethereum community members have contributed so far.

Number of pull requests :
Frequent pull requests suggest a very active and decentralized development community. There are 8973 pull requests.

Operational Metrics

Asset Distribution :
A more equitable initial allocation of assets at launch usually indicates a more decentralized network.
The Ethereum network started off with a supply of 72 million Ether (ETH). Eighty-three percent of that (60 million) was distributed to people who had purchased ETH in a crowd sale that was conducted in July and August of 2014. Since then, 49.1 million ETH has been newly issued and distributed through the process of proof-of-work mining. According to on-chain data provider Nansen, 10.3 million ETH (41.7% of the premine supply) has been sent to exchanges since network genesis. Conversely, only 1.6 million ETH (~2.3% of the premine supply) ETH has been held unmoved over the same period.

Profit Mechanism :
The way profits are distributed among stakeholders can also be an indicator of decentralization. Since the recent merge, Ethereum has moved to a complete PoS mechanism. We can link the concept with the transaction validation: Who can validate transactions or create blocks in the blockchain. If it's only a selected group of validators, then the system is less decentralized.
The transaction validation of Ethereum involves the process of approving transactions, creating new blocks, and maintaining the general functionality of the blockchain. With the Ethereum network's upgrade to version 2.0 in September 2022, it switched from the proof-of-work (PoW) consensus mechanism to a proof-of-stake (PoS) consensus algorithm. Here's a detailed explanation of the transaction validation process in Ethereum under the PoS mechanism:

- Proof of Stake (PoS): Ethereum's new consensus mechanism replaces the energy-intensive mining of PoW with staking. This makes the network more scalable and secure by using staked ETH.
- Staking Process: In PoS, staking replaces mining. Users or validators must store 32 ETH on the blockchain to become validators or stakers. Ethereum staking pools also exist, allowing individuals to collaborate to obtain the minimum score of 32 ETH required to become a validator. Some decentralized platforms like Lido DAO provide ways for liquidity with liquid staking options.
- Transaction Validation: The task of transaction validation in PoS is similar to mining in PoW. Validators are responsible for approving transactions, creating new blocks, and maintaining the blockchain's general functionality. This task is randomly distributed to validators, who receive a yield in ETH for locking up their ETH. This yield can be recovered if a validator needs to validate a block after the assignment.
- Earnings and Rewards: The payout for ETH staking and validation can vary based on the number of validators actively participating at any given time. Stakeholders can make between 5% and 20% per year, although this percentage may fluctuate with market conditions.
- Enhanced Scalability and Cost Effectiveness: The switch to PoS has addressed issues like scalability and high transaction costs that were prominent in the previous PoW system. After the upgrade, Ethereum now consumes less electricity, is more scalable, and has relatively less transaction costs.

Blockchain Metrics

Cost of 51% Attack :
The higher the cost to execute a 51% attack, the more secure and decentralized the network is. The cost of such an attack is influenced by multiple factors, including the current hash rate and market dynamics for hash power
With the data available during this year, in 2020 , it would cost around $560,000 USD to carry out a successful 51% attack on Ethereum.

Number of Nodes :
A higher number of nodes usually suggests a more decentralized network.
Although decentralization is a little more difficult to analyze, as many validators are run by the same entities, reports show that they are spread across at least 11,400 physical nodes in 80 countries. Also it is important to note that Ethereum Hits 500,000 Validator Milestone.

On-chain vs. Off-chain Governance :
Ethereum uses off-chain governance where any protocol change decisions happen through an informal process of social discussion. Observing the level of participation and diversity in this process could serve as a metric.

Number of Improvement Proposals :
The number of EIPs (Ethereum Improvement Proposals) and the diversity of their authors can indicate a broad community engagement in protocol development.We can see it all here : https://eips.ethereum.org/all
There are thousands of them.

Decentralization of Layer-2 Solutions :
The number and diversity of Layer-2 solutions built on Ethereum are a good indication of the decentralization at the application layer.

- The Nature of Layer-2 Solutions: Layer-2 solutions are secondary networks designed to address some key limitations in traditional Layer-1 blockchains like Ethereum, focusing mainly on improving scalability, transaction speed, and cost.
- The Approach to Scaling in Ethereum: Ethereum has adopted Layer-2 rollups as the primary scaling technique, supported by a cheaper form of data attached to Ethereum blocks that are designed to make rollups more cost-effective for users. The community has favored rollup-centric scaling over sharding.
- The Variety of Layer-2 Solutions on Ethereum: The Ethereum Layer-2 ecosystem is highly active, constituting the most vibrant Layer-2 space. Some known Ethereum Layer-2 chains include Polygon, Optimism, and Arbitrum.
- List of Top 10 Upcoming Layer-2 Projects: The top 10 Layer-2 protocols that are being closely watched in 2023 include Polygon, Arbitrum, Optimism, zkSync Era, Gnosis, Mantle Network, Scroll, Linea, Loopring, and ImmutableX.
- Benefits of Layer-2 Solutions: Ethereum's Layer-2 solutions offer various benefits like faster transactions and the ability to handle increased transaction volumes. They function as off-chain frameworks, akin to alternate pathways that clear traffic, making transactions faster and cheaper.
- Real-world Example: An example of Layer-2 in action is Polygon, which enhances Ethereum's scalability by offloading transactions onto its sidechains, solving the issues related to scalability, transaction speed, and cost.

Diversity of Developer Tools :
The variety and quantity of developer tools indicate a vibrant and decentralized developer ecosystem. Everything we need to know is here : https://ethereum.org/fil/developers/
The information provided details a variety of developer tools within the Ethereum ecosystem. Here is an overview: Smart Contract Developer Tools: there are ten categories of tools essential for smart contract developers, like for example :

- Smart Contract Languages
- Deployment & Testing Frameworks
- Wallets
- Block Explorers
- Layer 1 Connections
- Front End Tools
- Help & Support Tools
- Security Analysis Tools
- Monitoring & Maintenance Tools

Ethereum Dapps and Tools: Alchemy provides a list of 1474 decentralized applications (Dapps) and developer tools available in the Ethereum ecosystem as of 2023.
Projects and Tokens: While not exclusively focused on developer tools, the Ethereum ecosystem is also home to important projects, tokens, and applications that contribute to various industries such as finance, gaming, DeFi, NFTs, ...
ConsenSys Ethereum Developer Tools List: On GitHub, ConsenSys has compiled a guide to available tools and platforms for Ethereum development. This includes:

- Developing Smart Contracts
- Smart Contract Languages
- Frameworks
- IDEs
- Other Tools
- Test Blockchain Networks
- Frontend & Backend Ethereum APIs
- Ethereum ABI tools
- Patterns & Best Practices
- Infrastructure (Clients, Storage, Messaging, Distribution)
- Testing Tools
- Security Tools
- Monitoring & Other Miscellaneous Tools
- Smart Contract Standards & Libraries
- Developer Guides for 2nd Layer Infrastructure including Scalability, Payment/State Channels, Plasma, Side-Chains, Privacy/Confidentiality, ZK-SNARKs, ZK-STARKs, and Prebuilt UI Components.

Integration with Other Tools: Ethereum ecosystem tools such as Truffle are also mentioned for compatibility with various front-end frameworks like React and Angular, and other client libraries like Ganache.

Token Distribution :
This reflects how tokens are distributed among users. A higher concentration of tokens among a small group of users indicates less decentralization.
The token distribution within Ethereum, can be characterized by the following :

- Circulating / Max Supply: The circulating supply of Ethereum's native cryptocurrency, Ether (ETH), is 122 million tokens, with no maximum supply limit defined at the time of the data.
- Staking: Ethereum's transition to a proof-of-stake (POS) consensus mechanism has led to staking features within the network. Out of the overall supply, 13% of Ethereum's tokens are staked. The staked token distribution across validators is specified, with 57% from major platforms like Lido, Coinbase, Kraken, and Binance.
- Emission Structure: The emission structure of Ethereum is described as "Expanding & Contracting," influenced by the Ethereum Improvement Proposal (EIP-1559). This proposal made changes to the transaction fee market, including the burning of a portion of transaction fees, altering the dynamics of the Ether supply.
- Ownership by Founders: 17% of the tokens were initially held by the founders of Ethereum.
- Validator Staking APR: The annual percentage rate for validator staking in Ethereum is 4.37%.
- Global Ownership: More than a hundred million people own Ether, with higher ownership reported in emerging and frontier markets. Most Ether owners are under the age of 45, and a significant proportion use Ether as an instrument of speculation.
- Tokens Destroyed: Since the implementation of EIP-1559, more than 2.7 million ETH have been permanently destroyed, contributing to the altering dynamics of the token supply.
- Total Supply Stats: As of 2023, there are over 121 million ETH tokens in existence.

Network Value :
Also known as Total Value Locked (TVL). It is the overall value of cryptocurrency assets that users deposit in a DeFi protocol’s smart contract. A higher TVL could imply more decentralization as it suggests more users are interacting with the protocol. We could not find enough information to assess it.

Geographic Distribution :
Decentralization also refers to the global distribution of nodes, developers, and users.

- Age Distribution: A majority of ether owners are under the age of 45, which might provide some insights into the socio-demographic distribution of ownership.
- Global Ownership: Over a hundred million people own ether, and ownership is growing rapidly.
- Decentralization in Validator Technology: The Ethereum network depends on 606,947 validators, and the distributed validator technology (DVT) allows for the geographical distribution of machines, which means the nodes can be located in various parts of the world. Refer to the nodes paragraph for more details.
- Emerging and Frontier Markets: The ownership of ether is reported to be consistently higher in emerging and frontier markets compared to Western countries.

Open source code :
The Ethereum project's source code is open-source. Several repositories related to the Ethereum project can be found on GitHub, and they are publicly available. This includes various implementations of the Ethereum protocol, the Solidity programming language, Ethereum Improvement Proposals (EIPs), and other associated tools and libraries.

Conclusion

In short, there are many metrics, factors, parameters, both qualitative and quantitative, that can be used to measure the level of decentralization of a crypto project. We've tried to make this list as comprehensive as possible, although there are undoubtedly many other parameters and metrics to be analyzed to make this report as accurate as possible. From the data we've been able to collect and analyze, we can say that the ethereum project is a very well decentralized multi-layer solution. It should also be noted that academics are in the process of establishing standardized protocols and tools for measuring the level of decentralization of a crypto project.