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SUMMARY REPORT & KEY TAKEAWAYS

EEA Workshop on Sustainability and Resource Efficiency in Public and Private Ethereum Networks

Overview

The EEA Workshop on Sustainability and Resource Efficiency in Public and Private Ethereum Networks, held Thursday, Dec. 16, 2021, brought EEA leaders together to discuss recent improvements on energy consumption within the Ethereum Network and explore additional areas where gains can be made. This report provides a summary of the workshop discussion and key takeaways. Learn more about how to get involved in the EEA on our membership page.

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Workshop Summary: The primary goals of the workshop were to:

1) Gain a solid understanding of the current state of resource usage in the Ethereum Mainnet and related networks, and

2) Explore areas where future gains can be made. While it was a short exercise, the workshop allowed attendees to learn and participate in building a collective understanding of a more sustainable technological future for the Ethereum community.

Opening Interview with Carl Beekhuizen on Ethereum's Move to Proof of Stake

The EEA Workshop on Sustainability and Resource Efficiency in Public and Private Ethereum Networks opened with remarks from Carl Beekhuizen, a researcher at the Ethereum Foundation and the author of a research forecast on the energy consumption of Eth2. EEA Board Member Yorke Rhodes III, Cofounder Blockchain @Microsoft and Director, Digital Transformation Blockchain, moderated the discussion.

Carl Beekhuizen:

> *The reason we see so much energy being consumed is because it is necessary for security. The security is provided by having the honest participants use more energy than the people who are dishonest or trying to attack the chain. And because you don't know how strong the attacker may be, you have to assume that they're really bad and you have to provide enough incentive to basically use lots of energy to secure the chain such that it's not feasible to even imagine what an attacker would have to do to attack these chains.*
>
> *So we see this incredible amount of energy usage on the scale of countries for Proof of Work (PoW) chains, which is horrendous. In my opinion, it's completely unacceptable for the gains we're providing as a technology in the long term. And so moving away from [Proof of Work] is a dramatic improvement. Proof of Stake (PoS) – amongst a myriad, other security and protocol improvements – brings about this change by no longer securing the network under this expenditure of energy.*

Carl Beekhuizen:

> *In the case of Ethereum 2.0 – or Ethereum Proof of Stake as we're calling it now – it is staked ETH [that secures the network]. Instead of having to have… the honest people spend more energy as in a Proof of Work context, now we have to make sure that there's more honest ETH locked up.*
>
> *Because of this change, we can dramatically re-architect the system where the energy is now no longer just being spent for the sake of spending energy and trying to outdo whatever bad attack you can see on the system. [Instead] it comes down to the only energy costs to make the chain progress [along with] sanity checking everything that's happening on-chain. Because of [this new Proof of Stake approach], we are looking at something like a thousand-fold improvement in energy consumption.*

Carl Beekhuizen:

> *Most of the efficiency gains that you ever get in a protocol translate into environmental gains. So when we design faster and cheaper protocols, this also makes things better for the environment. And so all these things that we care about from purely designing a better product leads to improvements from an environmental standpoint.*

View the complete interview here on the EEA's YouTube Channel. Beekhuizen's research report on Ethereum's energy usage improvement via Proof of Stake (~99.95%!!) can be found here. Read additional research in Rhodes' EEA blog, "Ethereum's Environmental Footprint: Breaking Down the Misconceptions."

Ideas on Additional Improvements in Energy and Resource Consumption

Following the interview, attendees broke into several groups to discuss areas of interest. These included:

1) Proof of Stake and Rollups,

2) Hardware Acceleration, Network Bandwidth Improvements, Language Improvements, and

3) Marketing and Communication on Energy Usage and Efficiency.

1. Proof of Stake and Rollups

The discussion that took place as part of this breakout was less about the actual technologies used within Proof of Stake consensus models and rollup networks and more toward recommendations for those looking to use Ethereum Virtual Model (EVM) based networks.

For sustainablity, the Proof of Work approaches that consume vast amounts of energy for hashing are undoubtedly not sustainable. One of the key proposals by the group was to adopt and popularize a message of "No more Proof of Work '' and instead emphasize the importance of using energy-efficient consensus models such as Proof of Stake and BFT. It was also recommended that attention be made to use Layer 2, sidechains, subnetworks, and other Ethereum-based scaling solutions that leverage the security framework of the Ethereum Mainnet so as to reduce the degree of redundancy of blockchain nodes and improve energy efficiency.

Another consideration of energy efficiency is to move heavy duty computation offchain with zero knowledge proofs (and zk-SNARKs in particular as recommended by participants). Zero Knowledge Proof (ZKP) separates validation of a problem into two parts – generation of proof and verification of proof. The generation of proof is computationally intensive, and hence can and should be performed offchain by a handful of nodes. On the other hand, the verification step is relatively efficient and can be carried out onchain by validator nodes and nets in the Layer 1 network.

2. Hardware Acceleration, Network Bandwidth Improvements, Language Improvements

- **Cloud-native technologies**, including Kubernetes, Docker, and other virtualization/containerization components, are well-known and widely adopted technologies that support scalable applications in dynamic environments.

  For example, containerization can be applied to dynamically allocate machine resources for dedicated blockchains in a multichain network. Virtualization technologies can divide nodes into subnodes to support multi-chain networks and/or sharded chains.

  These technologies allow engineers to positively and frequently affect hardware resource utilization. Better hardware utilization means fewer wasted cycles and greater efficiencies and/or greater network capacity.

- **BLS signatures and fingerprinting transactions**, when combined with Byzantine Fault Tolerance (BFT) optimizations such as Asynchronous Binary Byzantine Agreement (ABBA) or sBFT protocols, can have a positive impact on network bandwidth usage. These technologies do this by reducing the network overhead for information contained in each committed block or information shared across the network during the pre-commit phase of consensus.

BLS Signatures

BLS signatures can improve throughput by using only a threshold of signatures or aggregating signatures into a new digital signature and then allowing for verification by using a single public key. Each digital signature on Ethereum is 65 bytes and so this aggregation saves tremendous space without sacrificing security. In a similar way, only requiring a threshold of signatures reduces the number of messages required by a receiver or verifier. With all these nice features, BLS still provides security comparable to 2048-bit RSA signatures but is just 33 bytes long. The only challenge to using a threshold cryptosystem such as BLS is coordinating a distributed key generation (DKG) process, where a set of independent servers jointly generates a pair of public and private keys without ever storing the secret key in any single server and assuming presence of a malicious party.

Fingerprinting Transactions

In many consensus models, nodes in the mining set and/or the validator set submit block proposals to other nodes in the network. Sharing block proposals across a large network can be expensive as much of the same transaction data is transmitted by each node. The use of fingerprints – or hashed or otherwise compressed representations of transactions – can reduce the amount of data transmitted for each block proposal.

This approach can be useful as pending queues are approximately equal, with differences occurring primarily because of propagation delays and other network transmission issues. Instead of receiving full transactions, nodes can receive a block proposal containing transaction fingerprints. They can check them against the transactions in their pending queues and reconstruct the block proposals from the fingerprints. Any transactions that are not present can be requested from the sender. With this approach, block proposals become more lightweight, faster to transmit, and far more efficient.

Key Takeaways on Energy Usage and Efficiency in Ethereum

Sustainability and resource efficiency on Ethereum, and in particular public Ethereum, is an important topic with a potentially major impact on Ethereum adoption as it greatly influences public opinion. Concerns about energy consumption of blockchains have been around since the early days of crypto but have mostly been associated with Bitcoin. But the recent surge in interest in and awareness of Ethereum on the back of the DeFi summer and current NFT boom has had the effect of raising awareness of Ethereum's energy usage and carbon footprint as well. Today it is fair to say that Ethereum is considered by many to be on par with Bitcoin with repect to energy waste. And the numbers are concerning.

As for addressing this topic with others, there are a number of approaches that can be taken to acknowledge the nature of the situation and the current and future efforts to improve upon it.

Several of these approaches include:

- **Acknowledging the Problem** – It is important to stress that the Ethereum community is neither ignorant of the issue nor dismissive of its importance. Quite the contrary, the community has long been aware of this issue and is clear on the need to fix it. Serious discussion of alternatives to proof of work, and in particular proof-of-stake, date back to the early days of the network.

- **Explaining the Complexities** – People need also to understand that, while the community has long been concerned about sustainability of the Ethereum blockchain, actually building a less-energy consuming network without compromising on security or decentralization is a difficult task. An analogy might be trying to replace the engines of an airliner while in flight. This complexity is why the merge to Eth 2.0 has not happened as of yet. Another concern with moving from Proof of Work to Proof of Stake involves taking steps so as not to compromise the security of the network.

  Toward this end, it is beneficial to explain the connection between the “expense” of proof of work and the security of a public network. Proof of work is in use because it does, indeed, work, and it does so under extremely adversarial conditions. Despite the billions of dollars of value they hold, neither the Bitcoin nor Ethereum blockchains have ever been compromised in a significant way. Not enough was known about proof-of-stake in 2014 or 2015 to make it a viable, secure-enough option under such conditions. Fundamental advances in cryptography and consensus protocol design were needed to make Proof of Stake viable for Ethereum, and these took time.

  Through the work of those working on the Ethereum core and others in the community, this state of inertia has changed. Soon, Ethereum will move to a Proof of Stake consensus model, dropping the energy consumption per transaction by a significant factor. Some say it will be 1/10,000th of what it is today.

- **Putting Things in Perspective** – While we can never deny the problem, it can help to put it in perspective. All computation consumes energy. The traditional financial system, the major Internet platforms, all our telecommunications: everywhere there is computing, energy is consumed. We never want to try to downplay the seriousness of the problem or deflect attention elsewhere. However, putting the energy consumption of Ethereum in context with other traditional computational efforts reduces attempts to isolate Ethereum and other forward-thinking blockchain networks as outliers or targets of specific remedies or restrictions.

- **Showing the Solutions** – Perhaps the most important talking point for Ethereum is the fact that the community has responded and is moving the network to a new, far more sustainable variant of the technology. Explaining both what Proof of Stake models are and more importantly why they consume far less energy than Proof of Work will address the proverbial gorilla in the room. Getting proof of stake right has proven to be a great challenge and the community has been prudent to move slowly with it. While sustainability is important, security and the viability of the platform, and the billions of dollars of value entrusted to it, is paramount.

  Along with PoS, we should talk about the other efforts to add scalability (and hence reduce computational requirements and with them energy requirements). Examples include rollups, virtualization, improved cryptography, hardware acceleration, and many of the other solutions outlined above.

About the EEA

The Enterprise Ethereum Alliance (EEA) enables organizations to adopt and use Ethereum technology in their daily business operations. The EEA and its EEA Community Projects hub for open source-based standards development empowers the Ethereum ecosystem to develop new business opportunities, drive industry adoption, and learn and collaborate. For additional information about joining the EEA, please reach out to membership@entethalliance.org or visit https://entethalliance.org/join.

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