From Ethereum 1.0 to 2.0: Implications for the Blockchain-Based NFT Market

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Abstract: The Non-fungible Token (NFT), a pioneering embodiment of singularity within blockchain technology, has been increasingly recognized for its distinctive identity and exclusive attributes. Therefore, it is often used to protect intellectual property and gaming fields. Today, the issuance of NFTs is predominantly grounded on Ethereum's infrastructure. This study delves into a profound dissection of Ethereum 1.0's constraints, notably its inefficiency and disproportionate energy consumption. As we navigate the evolution of Ethereum from its 1.0 version to the more advanced 2.0, we spotlight the enhancements it offers - optimized performance, lessened energy consumption, and fortified security mechanisms - features reminiscent of a metamorphosis. We used an analytical approach to extract blocks from EthereumPoS and EthereumPoW for comparative analysis. Preliminary results indicated a pronounced reduction in transaction fees associated with Ethereum 2.0 - a promising leap towards increasing blockchain accessibility while maintaining its security integrity.

1 INTRODUCTION

In the vibrant arena of blockchain technology, branches such as Decentralized Finance (DeFi) and Non-Fungible Tokens (NFTs) (Wang, Q.- Kugler, L.) have charted groundbreaking paths. Foremost among these, the birth of the NFT market represents a game-changing application of blockchain technology. By offering an unprecedented approach to verifying digital ownership, NFTs bestow significant value upon innovative expressions ranging from artworks to game assets and musical compositions. However, the accelerated evolution of the NFT market has underscored a suite of critical challenges chiefly tied to Ethereum, the leading platform for NFT issuance, touching on aspects of performance, efficiency, and ecological footprint.

Ethereum (Chen, T., Chen, H.), while being the esteemed podium for the origination and deployment of NFTs, employs a consensus protocol hinged on the principles of Proof of Work (PoW) (Meneghetti, A., 2020) - an architecture that is not without its share of complexities and challenges. These encompass low operational efficiency, excessive energy expenditure, and the generation of electronic waste. These shortcomings cast shadows on the scalability, efficiency, and environmental-friendliness of the Ethereum network, posing a formidable barrier to the continued growth of the NFT marketplace.

Navigating this sea of complexities, the Ethereum team has set sail on a sequence of enhancements, collectively identified as Ethereum 2.0 (Cassez, F., 2022). The transformation of Ethereum's consensus protocol from the labyrinth of PoW to the streamlined Proof of Stake (PoS) (Saleh, F., 2021) is anticipated to significantly escalate network efficiency, reign in energy usage, and amplify network scalability via avant-garde sharding technology. This seismic shift not only holds the promise to redefine Ethereum's operational dynamics but also has the potential to carve deep imprints on the canvas of the NFT ecosystem.

The focus of this paper is to unravel the intricacies of the ripple effects Ethereum's metamorphosis from 1.0 to 2.0 could cast onto the blockchain-anchored NFT market. We adopt a trident strategy: initially, we shed light on the core issues of Ethereum 1.0 that are firmly rooted in the PoW algorithm; subsequently, we take a deep dive into the defining characteristics of Ethereum 2.0 and its potential ramifications on the NFT market; finally, employing a robust empirical approach, we gauge the aftershocks of Ethereum's shift from the PoW to the PoS paradigm on transactional tariffs.

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2 DRAWBACKS OF ETHEREUM 1.0'S POW ALGORITHM

Currently, the prevalent method of issuing Non-Fungible Tokens (NFTs) is based on Ethereum, and the consensus protocol of Ethereum prior to the Paris upgrade is Proof of Work (PoW). As depicted in **Figure 1**, the PoW algorithm belongs to the class of consensus protocols based on computational power, where the entity with the most computational power prevails. However, this characteristic imbues PoW with numerous shortcomings, which have become constraints on the popularization and development of NFTs (Saleh, F., 2022).

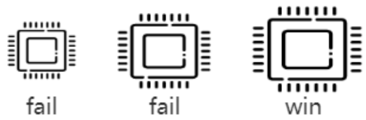


Figure 1: The computational power competition model in PoW.

2.1 Low Efficiency

$$BlockHash = Hash(otherheader + None) \ll D \quad (1)$$

The PoW consensus protocol necessitates significant node participation in competition computing. **Equation (1)** describes the mathematical logic of PoW mining. D is the target difficulty value. All miners attempt to find the suitable nonce to obtain a BlockHash close to D. With potential benefits, more participants and computing power get involved in the mining process, but only one node can gain the right to package the block. The calculation results of other nodes are wasted. This leads to low efficiency in the blockchain system, extended transactions confirmation time, and lower throughput (Chen, Y., 2022).

2.2 Excessive Energy Consumption and Carbon Emissions

As the computational power required for mining grows, the energy consumption of Bitcoin and Ethereum exhibits a consistent upward trend each year (Gallersdörfer, U., 2020). This has raised concerns about the escalating electricity usage and its associated environmental consequences. The mining process serves only one purpose preserve choosing who ought to be rewarded. Therefore, mining is regarded as a severe waste of resources. **Figure 2** shows the annual electricity consumption of Ethereum from 2014 to 2022.

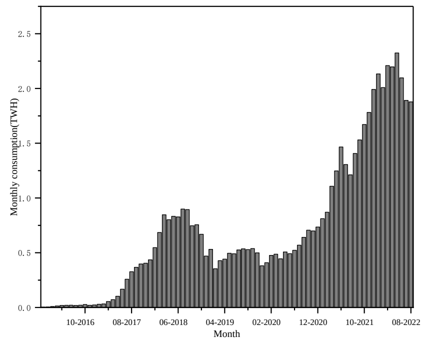


Figure 2: Ethereum's electricity consumption from 2014 to 2022.

2.3 Generation of Electronic Waste

Electronic waste refers to outdated mining machines. The lifecycle of a mining machine is typically two to three years. Although they can continue to work after two to three years, the likelihood of "mining" becomes meager. With the mining difficulty coefficient increasing, mining with old equipment is no longer feasible, as the cost of electricity cannot offset the mining output. If the mining electricity consumption C exceeds the mining revenue R, the miners will discard the equipment. These mining machines explicitly designed for PoW are discarded and become electronic waste. Electronic waste in cryptocurrency mining has become a grave concern overseas (Jana, R. K., 2022).

3 ETHEREUM UPGRADES

Ethereum 2.0 signifies the enriched edition of the Ethereum blockchain, aiming to amplify network speed, performance, and scalability. The enhancement, progressing through three stages, was initiated with the Beacon Chain, which has been operating for two years. The second stage, The Merge, concluded on September 15, 2022, while the final stage, Sharding, is predicted to conclude between 2023 and 2024.

Ethereum 2.0 (London upgrade, August 5, 2021) enacted the EIP-1559 reform proposal, changing transaction fees computation and allocation method. Transaction fees are made up of two parts: the Base Fee and the Priority Fee. The former gets burnt, while the latter is awarded to miners as an additional charge determined by users. This design tries to reduce transaction cost volatility, improving predictability and usability for users.

$$S_i = \text{ETH\_amount}_i * Coins\_age_i \quad (2)$$

The Merge (ethereum.org), called the "Paris upgrade," denoted a significant network update executed on September 15, 2022. This event held great importance as Ethereum transitioned from PoW to PoS. According to **Formula (2)**, in the PoS protocol, the quantity and duration of staked coins are factors in obtaining the right to mine. As shown in **Figure 3**, the one who holds more ETH and holds it for a longer time will win. The PoS algorithm brings several benefits, including reducing energy consumption and the cost of running the network. In addition, it also enhances network security and decentralization.

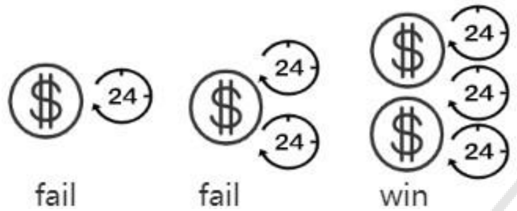


Figure 3: The stake-based consensus model in the PoS.

Ethereum 2.0 (in the future) will have a new feature known as sharding technology, which divides the network into smaller segments that can operate simultaneously, thereby enhancing the system's efficiency and capacity to process more transactions concurrently. Moreover, sharding aids in reducing network congestion, transaction confirmation latency, and transaction fees.

4 IMPACT OF ETHEREUM UPGRADES ON THE NFT MARKET

The Ethereum upgrades, mainly the Paris upgrade, profoundly impact the NFT market. This impact can be evaluated from four perspectives:

4.1 Enhancing Performance and Scalability of NFTs

Currently, Ethereum, based on the PoW consensus protocol, can only support about 30 TPS [Kim, H., 2021]. This cannot meet the needs of the NFT market. Fortunately, Ethereum will adopt a new consensus protocol after the Paris upgrade, which is expected to significantly enhance network performance and scalability. According to the estimation of the Ethereum Foundation, the PoS consensus mechanism can help Ethereum's transaction processing speed reach hundreds or even tens of thousands per second. This performance improvement will enable the NFT market to accommodate more users and handle more transactions, thereby promoting innovation

4.2 Improving Security and Attack Resistance of NFTs

Because of the PoW consensus protocol, the NFT market is vulnerable to security threats such as 51% assaults, selfish mining, and double spending (Li, X., 2020). These attacks can negatively impact NFT ownership, authenticity, and scarcity. However, Ethernet's adoption of the PoS consensus protocol after the Paris upgrade strengthens network security and resistance to such attacks. Vitalik Buterin's analysis suggests that the PoS consensus protocol can resist over 67% of malicious validators (Buterin, V., 2020), whereas the PoW consensus protocol can only withstand over 50% of malicious miners. Moreover, the PoS consensus protocol introduces a penalty mechanism that penalizes validators who engage in malicious behavior or go offline by confiscating their staked tokens. This mechanism incentivizes validators to remain honest and active, ensuring the regular operation of the network.

4.3 Reducing Energy Consumption and Carbon Footprint of NFTs

Formula (3) shows the linear relationship between carbon emissions and electricity consumption. Considering the substantial power consumption necessitated by the PoW consensus protocol, resulting in significant energy waste and carbon emissions, the NFT market also encounters environmental and social responsibility concerns. Following the Paris upgrade, Ethereum will shift to the PoS consensus mechanism, substantially reducing energy consumption and carbon footprint. As per the estimations by the Ethereum Foundation, adopting the PoS consensus mechanism has the potential to decrease Ethereum's energy usage by 99.95%. This implies a decrease in annual energy consumption from approximately 50.6 TWh to around 2.62 GWh. This reduction is equivalent to decreasing the yearly electricity usage of a medium-sized country like Bulgaria to that of a tiny town like Harrisburg. Such a transition would facilitate the development of an environmentally friendly and sustainable NFT market.

$$Emissions = electricity\_consuption * carbon\_intensity \quad (3)$$

4.4 Lowering NFTs Minting Fees and Transaction Fees

In Ethereum 1.0, the minting and transaction costs for NFTs (often referred to as "Gas fees") tend to be exceedingly high, posing a significant barrier for artists and collectors. Exorbitant Gas fees make low-cost NFT creations impractical, constraining the development and popularization of the NFT market.

Ethereum 2.0, by changing the consensus mechanism and introducing sharding technology, dramatically enhances the network's throughput, thereby reducing the Gas cost for each transaction. Under the PoS protocol, validators no longer need to perform high-energy-consumption hash calculations to compete for packaging rights; instead, they are selected based on their token holdings and duration, considerably lowering transaction costs. This suggests that under Ethereum 2.0, the minting and transaction fees for NFTs will be significantly reduced, allowing more artists and collectors to participate in the NFT market, improving NFT liquidity and market activity, and propelling the development of the NFT market.

5 EMPIRICAL EVIDENCE

The transaction fees of Ethereum are the most significant confusion for NFT creators and traders. The minting and trading of NFTs must be stored on the blockchain, corresponding to an Ethereum transaction. This means that the transaction fees of Ethereum determine the minting cost and transaction cost of NFTs. We have collected data from operational blockchain systems to compare the transaction fees under the PoW and PoS consensus algorithms.

We collected blocks 17691772-17691873 from EthereumPoS and blocks 17491733-17491847 from EthereumPoW and conducted data analysis on 100 effective blocks from each. EthereumPoS represents the Ethereum main chain executing the PoS protocol after the Paris upgrade, while EthereumPoW represents the Ethereum fork chain executing the PoW protocol after the Paris upgrade.

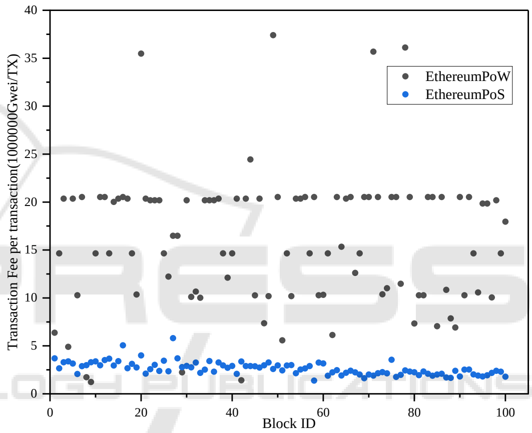
$$\text{transaction fee per transaction} = \frac{\text{Avg.GasPrice} * \text{GasUsed}}{\text{Txns}} \quad (4)$$

$$\text{transaction fee per byte size} = \frac{\text{Avg.GasPrice} * \text{GasUsed}}{\text{Block Size}} \quad (5)$$

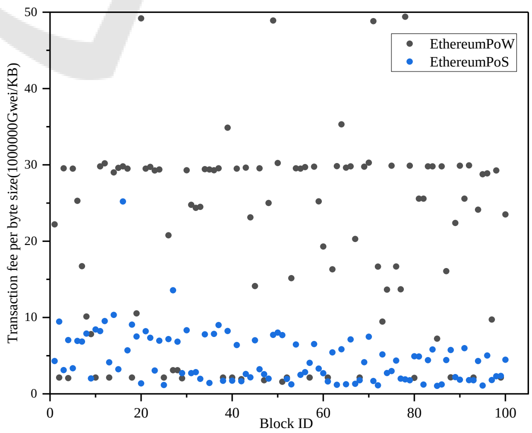
We collected Txns, Block Byte Size, Gas Used, and Average Gas Price from the blocks of EthereumPoS and EthereumPoW. Using **Formula (4)** and **Formula (5)**, we can calculate the transaction fee per transaction and the transaction fee per byte size.

Figure 4 reveals a significant drop in average transaction fees after Ethereum's consensus protocol transitioned from PoW to PoS, aligning with our expectations. It is imperative to recognize that within the context of the Ethereum blockchain network, ETH, Wei, and Gwei are essential units of measurement for the cryptocurrency Ethereum (ETH). Serving as the most granular unit, Wei represents the foundational measure, while Gwei, a more substantial denomination, is frequently employed to articulate gas prices, enhancing the clarity of transactions. The interconversion among ETH, Wei, and Gwei adheres to the following relationships:

$$1\,ETH = 10^{9}\,Gwei = 10^{18}\,Wei \quad (6)$$



(a) transaction fee per transaction



(b) transaction fee per byte size

Figure 4: Average transaction fees for EthereumPoS and EthereumPoW.

6 CONCLUSION

The upgrades to Ethereum 2.0 has profound implications for the NFT market. After the Paris upgrade, Ethereum transitioned from the PoW consensus protocol to the PoS consensus protocol, significantly enhancing the performance, security, scalability, and sustainability of the Ethereum network. Reducing energy consumption and carbon emissions and decreasing electronic waste will allow NFTs to regain moral commendation. We collected blockchain data and empirically demonstrated the significant effect of Ethereum's upgrades in reducing transaction fees. These changes will have a positive impact on the NFT market. The Upgrades of Ethereum 2.0 provide more space and possibilities for the NFT market, which will powerfully promote the further development and innovation of the NFT market.

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