An Incentivization Scheme for a Fixed-Supply DLT with no Base Token Fees

Abstract—**This paper introduces a novel incentivization scheme tailored for a leaderless Directed Acyclic Graph-based Distributed Ledger Technology. The distinctive feature of the proposed scheme lies in enabling a no-fee environment with a fixed supply token, all while incorporating a robust anti-spam mechanism and a well-defined incentivization scheme.**

Index Terms—**Leaderless distributed ledgers, DAG-based ledgers, Dual-token economy, Feeless, Fixed-Supply**

I. Introduction

In the ever-evolving landscape of cryptocurrencies, the enduring success of these digital assets is intricately linked to their underlying tokenomics and incentive structures. A well-crafted tokenomics model serves as a cornerstone for long-term viability, shielding projects from short-term economic volatilities that may trigger detrimental consequences such as selling spirals and hyperinflationary scenarios—a phenomenon not exclusive to the realm of cryptocurrencies but also resonating in traditional monetary dynamics as observed in [1].

Existing tokenomics paradigms in the cryptocurrency market often foster centralized systems by rewarding validators through token fees and inflation, while penalizing users who finance these activities. However, this research introduces a paradigm shift by proposing a fundamentally distinct tokenomics model tailored for distributed ledger technologies (DLT) with fixed token supply, such as IOTA 2.0 [4]. We introduce the three additional pivotal characteristics of the proposed model, as follows:

a) Fixed-supply DLT: A tokenomics model aiming to prevent the extraction of value from token holders should refrain from funding rewards through inflation. Hence, to avoid wealth erosion caused by inflation, our scheme uses a fixed supply.

b) Frictionless access to the ledger: While paying fees may not significantly burden many users given the low frequency of their transaction issuance, certain applications developed using DLTs could be considered impractical due to this constraint, hindering the development of decentralized applications. Notably, most DLTs deem numerous applications unfeasible due to the barrier of high and constant fees, especially in scenarios requiring substantial throughput. Thus, a frictionless system is inherently feeless.

c) Integration of robust anti-spam mechanisms: Simply eliminating fees from a traditional protocol has consequences in the protocol's behavior. In many protocols, fees serve as the sole bottleneck between transaction issuance and their inclusion in blocks. Validators rely on fees as a practical and economically effective means of prioritization. Hence, fees can be regarded as integral components of the anti-spam mechanisms employed by numerous protocols. As a result, a feeless protocol necessitates an alternative anti-spam mechanism. Ideally, to extend this anti-spam functionality to smart contract execution in a seamless manner, it should be based on the consumption of a scarce resource.

As in any protocol, a basic prerequisite for the well-functioning of the economy is the presence of incentives for validators to correctly execute their services. Validators bear financial costs in operating validation nodes; hence, an effective incentivization scheme must ensure proportional profits for these actors. Thus, the objective of this paper is to propose an incentivization scheme that incorporates the aforementioned three features, while ensuring incentives for validators.

II. The system model

Before delving into the proposed tokenomics, it is essential to highlight some protocol characteristics that render it viable. Consider the conventional leader-based blockchain model, where a block issuer — be it a miner or a validator — takes on the responsibility of constructing a block, determining which transactions from a mempool will be included. This centralized selection process can introduce bias, influenced by transaction fees or other motivations.

In contrast, a leaderless approach empowers end-users to independently issue their own blocks [2]. While validators still play a pivotal role in validating and finalizing transactions, the structured nature of the DAG renders censorship or manipulation of transactions inherently challenging.

Since token holders can issue blocks containing their transactions, users do not need to pay validator fees for network access. However, as mentioned in the preceding section, the introduction of an anti-spam mechanism linked to a scarce resource becomes imperative to mitigate potential spamming attacks. In principle, any scarce resource can be employed to regulate network access. In this paper, we delve into the exploration of a resource generated through the possession of the network's base tokens, defining the users' right to access the ledger [3].

A. The anti-spam mechanism

To deal with spam attacks, we propose an anti-spam mechanism based on a dual token economy consisting of a *base token* and a secondary *access token* used to pay for access to the DLT. The access token is generated by each user proportionally to the their base token holdings. Additional access tokens can also be gained as a reward for services such as validation.

Users issue their own blocks and pay for them with access tokens according to how much *gas* the block consumes and the *gas price*. During periods of heightened congestion, the *gas price* increases, acting as a deterrent to excessive block creation. Conversely, in periods of low congestion, the *gas price* decreases, facilitating smoother and more cost-effective transaction processing. To prevent the undue accumulation of access tokens in the system, we introduce a global decay rate. This decay mechanism serves a dual purpose: firstly, it incentivizes the spending of access tokens, discouraging hoarding by diminishing the value of stored access tokens over time. Secondly, the decay rate ensures that the total supply of access tokens remains finite, even with a constant generation of access tokens over time from the base token. This dual functionality guarantees scarcity, fostering a stable price for both *gas* and the access token itself.

The system defined until now already respects two of the aforementioned desired features defined above: the frictionless access to the ledger, and the integration of a robust anti-spam mechanism.

B. The incentive scheme

As previously mentioned, to imbue this model with all the desired features, an additional reward structure for validators must be introduced, all while avoiding exposure to inflation for users. In the proposed model, validators receive an extra reward in the form of access tokens rather than the base token. This distinguishing feature thereby completely eliminates the need for inflation on the base token to incentivize validators.

By rewarding validators with access tokens, they are granted a proportionally larger share of network throughput. This becomes particularly advantageous for validators seeking to develop decentralized applications atop the network, substantially reducing their operational costs. This establishes a natural incentive structure for entities wishing to build applications on the DLT.

While the scheme outlined in this paper is yet to undergo rigorous testing, it can be postulated that it exhibits promise, potentially embodying all the desired features outlined in Section I. To complete the present work, in the following section, we undertake a simplified analysis of the base token supply distribution of our system.

III. Base token supply distribution

The base token supply distribution in our proposed system differs significantly from traditional PoS systems. Next, we present a simplified discrete-time model of the token supply of validators and users in both types of systems. Note that we disregard any supply flow unrelated to the functioning of the protocol.

a) Traditional PoS Systems: The token supply in the hands of validators and token holders at epoch t is represented by $S_V(t)$ and $S_H(t)$, respectively. At each epoch, validators collectively receive $R(t)$ new tokens as rewards. The validator's token supply can, then, be expressed as:

$$S_V(t) = S_V(0) + \sum_{j=0}^{t-1} R(j) \tag{1}$$

Different protocols can exhibit a distinct allocation of rewards. Assuming an unbounded reward accumulation, the fraction of supply held by token holders $p_H(t)$ tends to zero as $t \to \infty$, given the unbounded total supply. Conversely, if rewards accumulation is bounded (and thus $\lim_{t\to\infty} R(t) = 0$), potential issues related to validator profitability and undesired mining strategies may arise [5]. Thus, a traditional PoS protocol can either be provably safe against such behaviors or have a token holders' share of supply tending to zero.

b) Our system: In our proposal, the distribution of tokens among actors remains constant. The access token supply distributed to users and validators until epoch t, denoted by $M_H(t)$ and $M_V(t)$, respectively, can be modeled as follows:

$$M_H(t+1) = M_H(t)d + I_H\gamma \tag{2}$$

$$M_V(t+1) = M_V(t)d + (1+k)I_V\gamma \tag{3}$$

where $1-d$ is the access token decay per epoch, γ is the access token generation per epoch and per base token, γk is the additional generation for validators, and I_H and I_V are the users' and validators' base token supply, respectively. Assuming that no generation occurred before epoch zero, the access token supply is given by:

$$M_H(t) = \frac{I_H\gamma(1-d^t)}{(1-d)} \tag{4}$$

$$M_V(t) = \frac{(1+k)I_V\gamma(1-d^t)}{(1-d)} \tag{5}$$

The share of access tokens distributed to holders, $p_H(t)$, is given by $p_H(t) = \frac{I_H}{I_H+(1+k)I_V}$. Thus, in contrast to traditional PoS systems, the presented tokenomics scheme avoids penalizing users with a diminishing share of the supply while still providing incentives to validators.

IV. Conclusion

While the presented model remains a simplification that overlooks various potential interactions among system actors, it depicts the inherent and qualitative distinctions in supply dynamics between traditional PoS systems and our fixed-supply proposal. The uniqueness arises from two main factors: first, rewards (in the form of access tokens) are also allocated to holders; second, rewards depend on the base token holdings of the actors involved.

Additionally, the system, besides being characterized by a no fees structure and fixed supply, also presents incentives compatibility [4]. Particularly noteworthy is its distinctive long-term behavior, as evidenced by the difference between the evolution of the share of supply of users, presenting an interesting facet for further exploration.

REFERENCES

[1] P. Cagan, “The monetary dynamics of hyperinflation,”, Studies in the Quantity Theory of Money, University of Chicago Press, 1956.

[2] S. Müller, A. Penzkofer, N. Polyanskii, J. Theis, W. Sanders and H. Moog, ”Tangle 2.0 Leaderless Nakamoto Consensus on the Heaviest DAG,” in IEEE Access, vol. 10, pp. 105807-105842, 2022, doi: 10.1109/ACCESS.2022.3211422.

[3] Camargo, D., Vigneri, L., Cullen, A. (2023). Managing Write Access Without Token Fees in Leaderless DAG-Based Ledgers. In: Machado, J.M., et al. Blockchain and Applications, 5th International Congress. BLOCKCHAIN 2023. Lecture Notes in Networks and Systems, vol 778. Springer.

[4] O. Saa, A. Cullen and L. Vigneri, ”IOTA 2.0 Incentives and Tokenomics Whitepaper,” unpublished.

[5] Miles Carlsten, Harry Kalodner, S. Matthew Weinberg, and Arvind Narayanan. 2016. On the Instability of Bitcoin Without the Block Reward. In Proceedings of the 2016 ACM SIGSAC Conference on Computer and Communications Security (CCS ’16). Association for Computing Machinery, New York, NY, USA, 154–167. https://doi.org/10.1145/2976749.2978408