Factoring economic biases out of tokenomics

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***Abstract*—Blockchain technology has enabled decentralized applications and peer-to-peer networks to be sustained by an incentive system based on tokens. At the same time, reputation is a paramount component for any limited-trust or no-trust system. However, in many systems, e.g., proof-of-stake-based systems, tokens are a proxy for reputation, therefore there might be confusion between wealth and reputation. In this paper, we focus on the social layer of dApps and present a two-token system that allows a clear-cut separation between wealth and reputation and fits the case of DAOs where user contribution is essential to maintain and sustain the platform, such as social apps where users are asked to vote about newcomers' acceptance or to moderate and filter the content proposed by others. The paper delves into the implementation of such tokenomics, describes how the standard ERC-20 token can be adjusted to become a trustworthy reputation meter, and how the model can be optimized to reduce transaction fees. The value of the proposed work lies in moving away from a wealth-affected reputation in favor of a contribution-based one. Using such a system, dApps can reward users more fairly.**

Keywords*—*blockchain, decentralized applications, tokenomics, token, reputation

I. INTRODUCTION

Reward mechanisms have always been a key feature in p2p networks, as they motivate nodes to participate and maintain the stability of the network. The arrival of blockchain technology has enabled the creation of a new generation of incentive systems, based on token incentives and completely free from a central authority. Blockchains themselves are the first examples of such new systems since consensus mechanisms, i.e. the engines of decentralized networks, are based on token-incentive. As an example, Bitcoin and Ethereum motivate nodes in mining or validating new blocks with a consistent token based economic reward.

With regard to the network layer, an incentive schema is often implemented to motivate nodes in sharing bandwidth and storage within the network [1], as in the case of Swarm [2] or Filecoin [3]. The underlying rationale for this concept is that nodes are selfish agents but can be cooperative if an incentive system manages to align the personal interest with the community's one.

Blockchain technology has also generated innovation at the application level seeing as how it has enabled the introduction of a new approach, known as Social Finance (or SocialFi), that makes users able to tokenize their social activities and profit from them [4]. Another noteworthy use case is TCR (Token-curated Registry) where users are in charge of maintaining a high-quality list of items about a certain topic and are rewarded according to their contributions [5]. Rewarding can be leveraged to steer user behavior toward specific goals, as studies underline an already established trend where users are always more motivated to invest time and real money to get a better experience or virtual rewards on online platforms, such as social networks or games [6] [7]. Such systems were already present in platforms like Yahoo! Answer, Stack Exchange, and Quora before the advent of blockchain technology. However, in centralized systems, users collect *social capital*, which is not directly convertible into an economic reward and its scope is limited inside the specific platform [8]. Instead, token-based incentives are directly spendable and they are not limited to a platform. For example, users can trade tokens for other tokens or fiat currencies using Decentralized Exchanges (DEX).

However, token-based incentives are still far from perfect, especially regarding the application layer. For example, several studies highlighted how the inconsistency of token value, which is generally highly influenced by market trends, conditions the user contribution. In other words, users are more active when the economic rewards are higher [9] [10] [11] [12]. Besides, another relevant issue is coin voting. Generally speaking, in DAOs (Decentralized Autonomous System), TCRs, and other mechanisms that involve decentralized community voting, a user's vote is weighted according to his/her wealth. In this way, a platform can efficiently be protected from Sybil attacks but, at the same time, voting power is likely to be condensed into a few wallets [13]. If this happens, the result is more akin to a plutarchy than it is to a democracy. The issue becomes even worse if we consider the fact that a user can buy tokens from external sources, e.g., other users or DEXs, and hence becomes the richest and most influential user without any significant involvement in the platform [14].

The research question we want to investigate is how we can factor economic biases out of reputation but still be able to provide attractive rewards to users. In this paper, we propose a hybrid system where reputation is a trustworthy measure of a user contribution while a token system rewards users according to their reputation. In this way, the reputation value is enhanced because it can offer tangible rewards while the incentive schema is not influenced by an economical factor but is strictly merit-based. The solution we propose is designed for DAOs or DeCMS (Decentralized Content Management System) where users are asked to participate in community activities like voting proposals or moderating the content. However, we think our proposal has a more general value as it can be used in

generic fully-decentralized applications to steer users into contributing both at the networking layer, as nodes, and at the application one, as consumers.
The paper is organized as follows: in section II we explore and compare existing solutions to underline the gap we aim at covering in this paper. Then, in section III we describe our proposed solution and give an insight into the actual implementation. Later, in section IV we analyze the proposed solution in a real-case scenario, in section V, we briefly discuss some potential scenarios and disclose some aspects we would like to delve into as future work.

II. STATE OF THE ART

Since blockchain technology enables a transparent rewarding phase, it has been widely adopted in OSNs (Online Social Network) where rewards are considered a key factor to give value to content and reward the creators [15] [16]. In this section, we will describe several significant examples.

A. Reddit Community Points

As the first example, we may cite Reddit Community Points (RPC). Reddit is one of the most popular Online Social Media (OSM). Its users, also known as *Redditors*, can aggregate into topic-specific communities, namely *subreddits*, where they can discuss and share opinions. Despite the centralized architecture of the platform, Reddit introduced blockchain tokens owned and controlled by the communities themselves. For example, the subreddit about Ethereum has its own implementation of RPC, called DONUTS. RPCs can be spent to buy aesthetic perks, advertising spots, and tipping other users for content creation; furthermore, DONUTS ownership increases a user's vote weight in community polls. There are two ways to earn RPCs: interacting in the subreddit and buying from popular decentralized exchanges like Uniswap or Honeyswap. As a result, the token cannot be considered a trustworthy measure of user involvement in the platform. This claim has been confirmed in [15], where it emerges that users are more likely to sell DONUTS on DEX instead of using them to redeem perks or advertising spots.

B. Steemit

As a further example, we have Steemit [17]. It is a blockchain-based OSN with a complex tokenomics to manage user rewards. It is made of three different tokens:

- STEEM: a liquid cryptocurrency to enable payments between users.
- STEEM Power (SP): tokenization of voting power. A user can earn SP by staking STEEM. SPs are not transferable but can be converted again into STEEM in a 13-week-long process.
- Steem Blockchain Dollar (SBD): a token pegged to the value of the US dollar to provide stability.

Users can earn STEEM thanks to content creation and curation. The latter is based on a staked-based voting system. Indeed, a curator can choose how much voting power is put behind a vote. Obviously, the reward will be proportional to the weight [8]. In such a system, the richest users, namely *whales*, are highly influential. As a result, the original idea has undergone a significant alteration, resulting in a system where often users ask to be paid for voting a certain content or they use bots to automate the curation process and hence earn tokens in an almost passive way [15].

C. Yup

Yup [1] is a social consensus protocol. Its novelty is that it is not a standalone platform, like Steemit, but it is built to work on top of existing OSM. In other words, it is a feed aggregator. In this way, a user can join Yup and, at the same time, enjoy the content he/she likes on whatever platform. The content curation works as follows: a user can like or dislike, even multiple times, every kind of online content. Content must be popular to be ible to be rewarded, i.e. other users have to agree. After the content is rated, the reward is split 50% to the creator and the remaining 50% to the curators. Curators' rewards are again split according to users' influence. The latter is based on a user's token holdings and previous rewards received. To summarize, Yup proposes a staking-based content curation that has the same inherent problems we have described with regard to Steemit.

D. MeritRank

As the last example, we may cite MeritRank [18]. The authors propose a merit-based and Sybil-resistant reward system to motivate user contribution in DAOs. MeritRank is based on feedback aggregation, i.e a peer's reputation is computed on the feedback other nodes provide about him. The proposed model is interesting because it moves away from a staking-based mechanism. However, we argue that feedback aggregation may not be the best fit for DAOs. Indeed, DAOs have a users-to-community model where members are usually asked to vote about new proposals. As a result, user-to-user relationships may be sporadic. Feedback aggregation is a better fit in a scenario like an OSN or a p2p network where users are *prosumers*, i.e. they are producers and consumers, depending on circumstances. Considering these facts, in section III we propose a model that does not adopt feedback aggregation.

E. Other solutions

Other similar solutions are described in the scientific literature. For example, Cai et al. [19] propose an oracle protocol to reward only honest reporting, avoiding in this way the phenomenons like lazy voting or bandwagon effect where users only aim at agreeing with the majority to be awarded. PaySense [20] describes a system where Bitcoin is meant to be a measure of reputation and a reward, simultaneously. We can find other use cases such as content-sharing [21] [22] [23] [24], and educational

[1] https://yup.io/

platforms [25], supply chains [26], and recommender systems [27]. Table I summarizes the main solutions.

III. Our Proposal: Design and Implementation

From the literature review, it emerges how creating a single ERC-20 token is a fast and efficient solution to set up a tokenomics. Nevertheless, it is also a limiting model if we aim at building a merit-based platform. A major contradiction is generated when a token is simultaneously signaling user contribution and compensating users because it allows buying and selling reputation. As a result, we have designed a two-token system to separate user contribution from its economic value.

A. Reputation Points

The first token, called *Reputation Points* is based on ERC-20 standard but with a relevant difference: it is non-transferable. In this way, users cannot trade reputation with each other and hence the token can be considered a trustworthy measure of a user contribution. In detail, the ERC-20 contract has a function *beforeTokenTransfer*. It is a hook that is called before any transfer of tokens. As a result, if the condition in the *require* clause is not satisfied, the transfer is blocked. Since we still want the contract to be able of minting and burning tokens, we have written the *require* clause such that it prevents every operation aside from the ones performed from or to the address 0x0, which identifies the contract itself. Any transfer that is not performed from or to the contract address is blocked. In this way, we have created a non-transferable token.
Thinking about a DAO use case, users can earn RPs by:

- creating a proposal.
- voting on a proposal.
- reporting an inappropriate item.
- moderating or filtering content.
- reporting a user who is not acting properly.

In other words, users are rewarded when they are involved in community activities. On the contrary, a user who is negligent with respect to his/her duties has to be punished. As a result, RPs are burned from a wallet when:

- a user doesn't vote.
- a user spams reports or produces a fake report.

The precise amount of RPs minted or burned is strictly related to the use case. Precise tuning is required to be in line with the platform requirements. For example, if a platform requires strict guidelines about the allowed content, it is possible to strengthen the punishment for off-topic posting to reinforce the community rules.

B. Community Token

As the second token, we have the Community Token (CT). It is a standard ERC-20 token and it is spendable to get rewards. The reward system has to be defined according to a use case but generally speaking, we can think of a Reddit-like system where users can buy aesthetic perks and advertising spots. CTs are also meant to be traded outside the platform or sent to other users as tips. The latter functionality could be useful in an OSN to make the creator-consumer relationship profitable for the creator. It is important to notice that CTs are generated from RPs. In this way, we give an intrinsic value also to RPs. Indeed, we have a sort of feedback loop because users are interested in rewards but the only way to redeem them is to earn RPs. Finally, users are motivated to complete activities that earn RPs.

C. Distribution mechanism

The distribution mechanism is responsible for generating CTs from RPs. It is managed by a smart contract, namely *Rewarder*. This design choice adds overhead but it allows to clearly separate the business logic from the token contracts and hence, it increases the upgradability and fault-tolerance of the whole system. We have identified two different ways to mint Community Tokens.

1) Staking-based lazy evaluation: a user stakes RPs on his/her wallet. Every time he/she earns new RPs, interests are computed according to the following formula:

$$CT = RP * r * t$$

where r is the interest rate and t is the period. Then, the amount of CTs is saved on a local mapping in the *Rewarder* contract. Whenever a user wants to redeem his/her CTs, he/she has to trigger the *Redeem* function and the equivalent amount of CTs will be transferred to his/her wallet. Making the conversion an on-the-fly process optimizes transaction costs because it reduces the number of transactions.

2) Airdrop: it is a periodic distribution. For each user, the amount of CTs he/she will receive is computed according to an allocation policy where the higher the reputation, the more CTs are minted. To optimize the process, it is preferable to select a large period. On top of that, it is important to notice that the function to start the airdrop has to be manually triggered by a user since scheduling a function is not built-in in the Ethereum ecosystem. During the implementation, we have faced another issue: ERC-20 contract associates users to their wallet balances thanks to a mapping. However, in Solidity mappings are not iterable and do not have a *length* property like arrays. As a result, it is not possible to know how many users are holding a certain token. To overcome this issue without changing the standard implementation, we have introduced a subscription mechanism in the *Rewarder* contract. In other words, before being eligible for an airdrop, each user has to register his/her address by calling *subscribeToAirdrop*, which will proceed to add the sender address to an array. When distributing the CTs, the *Rewarder* will iterate over that array. During the testing phase, we have taken into consideration also an alternative implementation, called *Aidrop&Redeem*. The difference is that during the airdrop process, this approach saves the CTs on a local mapping

TABLE I: General overview of incentive mechanisms

Protocol	**Distinct Features**	**Transferable Token**	**Influence on voting**	**Notes**
DTube [24]	Rewards creation and curation.	Yes	Yes	
Helios [23]	Rewards users according to contributions.	Yes	No	
HiDe [22]	Rewards creators and manage budget allocation.	Yes	Yes	
Innerlight [21]	Has financial bounties to push best responses.	Yes	No	There is no reputation mechanism.
MeritRank [18]	Is sybil-resistant and merit-based.	No	Yes	Feedback aggregation may not be a good fit for DAOs.
PaySense [20]	Uses Bitcoin as reward and reputation measure.	Yes	No	Reputation is easily tradeable because of Bitcoin.
Pranesh [26]	Rewards the supply chain parties.	Yes	No	There is no reputation mechanism.
RPC	Measures user contribution and interaction.	Yes	Yes	
Steemit [17]	Implements tokenization of user economic investment.	Yes	Yes	Direct connection between wealth and voting power.
YUP	Rewards content curation and moderation.	Yes	Yes	

instead of directly minting them. Users have to trigger a function to transfer CTs to their wallets. We wanted to explore if an "on-the-fly" computation could make the airdrop process lighter and hence optimize gas consumption.

IV. EXPERIMENTAL RESULTS

We have set up a local environment to test and compare the three implementations. We have relied on Ganache [2] to create a local and customizable blockchain instance. In detail, we customize the block time to 0.35 s and the gas price to 0.1 gwei, in order to simulate the Arbitrum blockchain and reproduce a real-world scenario. On top of that, Ganache is set to create 100 accounts to interact with smart contracts and test functionalities. The testing phase is managed by Mocha [3], a Javascript framework. We have run a unit test for each function involved in the example. For each execution, we registered the gas consumption and the execution time. In this regard, Table III shows the results obtained. The "user-specific" functions, like *addRPsToAccount* or *redeem* have been executed for each user, i.e. one hundred times. Instead, *airdrop* has been executed only once because it operates on multiple users simultaneously. In this way, we have obtained consistent data to make a comparison.

A. Use Case

Despite our solution being designed to work in general scenarios, we have selected a specific use case for testing. More in detail, we refer to an advertising platform with a voting-based registration mechanism. In other words, registered users have to vote about accepting or rejecting a newcomer every time a new user asks for a subscription. The platform displays user-generated content, so there is a need of moderating and filtering the content proposed by users. Since user participation is essential to make the portal work, we think it is a perfect example of how a well-designed reward system can steer user behavior.
We consider the following example:

1) A user asks for the subscription.
2) Registered users vote.
3) After the deadline is met, the *Rewarder* gives RPs to users who voted and it burns RPs from those who did not.
4) The *Rewarder* distributes CTs according to the policy. For example, Fig.1 shows *Airdrop* distribution process.

In the testing script, we set the interest rate equal to 0.07 and the airdrop period is equal to four weeks.

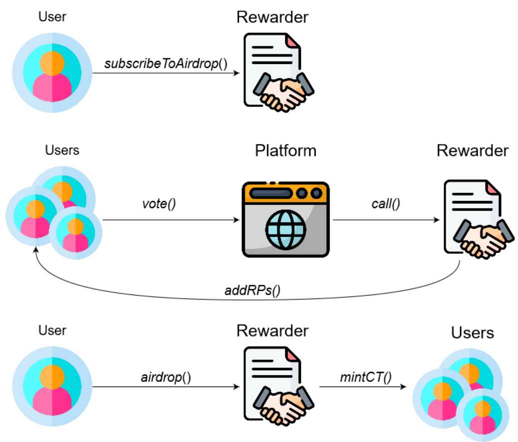

Fig. 1: Rewarding process following the airdrop implementation

B. Contract size

As we can see from Table II, the *Airdrop* implementation is lighter and hence it requires less gas to be deployed. It is worth noting that *Airdrop* has only an array, i.e. the users subscribed, while *staking-*

TABLE II: Deployment Costs

Implementation	**Gas Used**	**Bytecode**
Airdrop	590625	4784
Staking-based	638518	5228
Airdrop&Redeem	691868	5726

[2]https://trufflesuite.com/ganache/
[3]https://mochajs.org/

TABLE III: Analysis of costs and time required for each implementation to distribute RPs and CTs to 100 users

Implementation	**Transactions**	**Gas**	**Time [ms]**	**Cost per user**
Airdrop	*addRPsToAccount*	4170000	110000	75000 = 0.011 USD
	subscribeToAirdrop	4850000	107000	
	airdrop	3360000	5000	
Staking-based	*addRPsToAccount*	7480000	110000	130000 = 0.019 USD
	redeem	5850000	106000	
Airdrop&Redeem	*addRPsToAccount*	4180000	110000	145000 = 0.021 USD
	subscribeToAirdrop	4871000	105000	
	airdrop	3000000	2600	
	redeem	7300000	100000	

based lazy evaluation requires two mappings: one to store the amount of CTs accumulated and one to save the last computation of interests. On top of that, the redeeming process that mints new CTs requires a specific function and hence it increases the contract size. *Aidrop&Redeem* is the heaviest because it has both functions, the one for creating an airdrop and the one for redeeming CTs.

C. Transaction Costs

From the example described above, we consider only two functions: minting new RPs and minting new CTs. Indeed, the voting and registration mechanisms are the duties of the platform. Firstly, we have registered a significant difference between the first time a user receives RPs and further ones. For example, a first distribution requires 86582 instead of 74760 while using the *staking-based* implementation. The reason is that the first distribution includes the cost of initializing the data structures. To be clear, in Table III we have taken into consideration only successive releases. Secondly, Table III shows clearly that the *airdrop* mechanism is the most efficient. Indeed, by removing the interest computation we can halve the gas consumption required by *addRPsToAccount*. *Airdrop&Redeem* is the least sustainable model, we can notice that its alternative version of an airdrop is slightly cheaper but it loses all the convenience because of the cost of *redeem*. Finally, we have computed the gas each user has to spend to complete the process. In this regard, since the airdrop subscription is a one-time transaction we have not considered its cost for calculation. Later, we have converted the gas consumption into US Dollars to give the reader a better understanding. In detail, we have considered the gas price equal to 0.1 gwei and the ETH price equal to 1500 USD, as of the time of writing. The results are included in Table III.

D. Execution Times

Concerning the distribution of RPs, the execution times are similar. However, the airdrop mechanism is more efficient in distributing CTs. Also in terms of scalability, airdrop is a better solution. Indeed, it is a *for* cycle repeated every four weeks, while lazy evaluation is called every time a user earns new RPs. As a result, in use cases such as social networks, where the number of users is high and the interactions between users are even higher, lazy evaluation could be very inconvenient because of transaction costs and the time required. As a final note, *Airdrop&Redeem* halves the airdrop time by removing the minting process.

E. Discussion

Concerning performances, *Airdrop* is the most efficient and scalable among the different options. Indeed, if we consider the case in which a user is already subscribed to the airdrop, the cost of the whole process is almost equal to the cost of adding RPs in the *staking-based* implementation. As a result, the cost per user is halved and, even if the amount of money seems negligible, it is not when we think about a real-case scenario involving millions of users. From an economical point of view, the airdrop mechanism allows arbitrarily selecting the supply. In this way, the platform has control over the coin distribution. For example, it is possible to peg Community Token to a stable currency and hence ensure the tokenomics stability [28]. On top of that, the airdrop process can adopt several distribution policies, e.g. Pareto Distribution or the power law one, and hence it can adapt to different use cases and platforms' requirements. We claim a two-token system with airdrop distribution is a reasonable alternative to coin-based governance where users' wealth is too much influential on community decisions. Indeed, the reputation token we propose is merit-based and it could be easily implemented in a DAO voting mechanism. On a second note, a strength of this proposal is that both tokens are saved on a blockchain. Indeed, solutions like RPC describe a hybrid where information is saved on centralized platforms and then transferred to the blockchain through a minting process. Obviously, a fully-decentralized system like the one we propose is a better fit for decentralized apps. On top of that, it allows interoperability between different services or layers because the information saved on a blockchain is public. In this sense, our solution is similar to *Yup* because it can be implemented on different platforms.

V. CONCLUSION

In this paper, we described a two-token system to motivate users in community activities, e.g. moderating or voting, and reward them according to their contribution to the platform wellness. In comparison with existing systems, we introduce a non-transferable token to measure user contribution. The novelty lies in being able to fully separate economic wealth from actual social contributions, something that is not possible in many DAOs because of coin-based governance. To complete the system, we also added a spendable token to buy rewards, such as aesthetic perks or advertising spots. This token is distributed according to user reputation. In this way, the reward schema lends an intrinsic value to reputation and it generates a feedback loop that keeps users involved. Furthermore, we have studied the implementation by analyzing three different approaches according to deterministic metrics such as contract sizes, transaction costs, and execution time. From these results, we have understood that a monthly distribution, namely *Airdrop*, is an efficient and scalable method to mint and distribute tokens to users. Nonetheless, there still are some unresolved questions that need to be tackled in future works. For example, we could analyze different probability distributions to understand which is the best one for a specific use case. Furthermore, we could extend our analysis to other blockchains to understand which one is the best fit for implementing such a system. Finally, in a larger scope, it would be interesting to examine the consequences of the adoption of a platform capable of using Self-Sovereign Identity for user registration and authentication in terms of privacy and security.

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