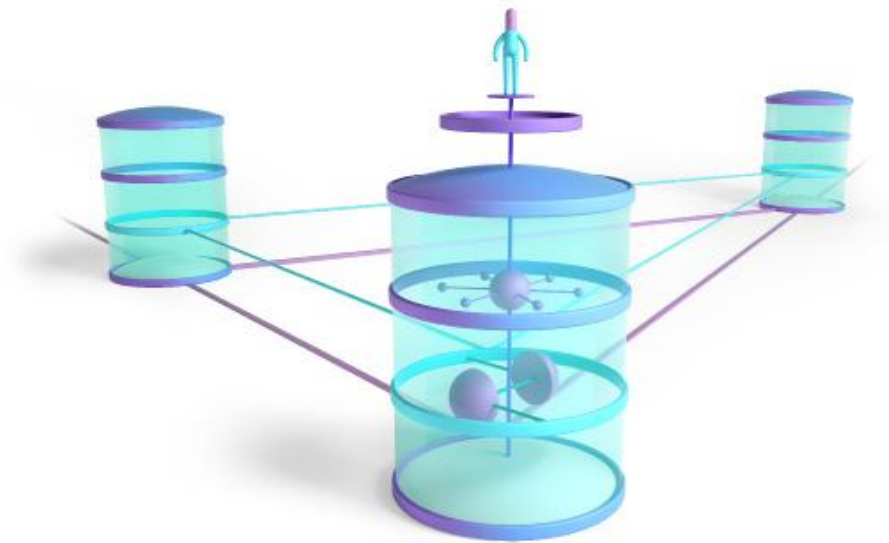


LTO Network

Token Economy

Version 1 - September 2018



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Introduction

We think it's essential to always ask ourselves why we do things: to understand why any particular solution was built in a certain way and why it was built in the first place. Therefore we explain in our documentation why our product is constructed the way it was constructed and why we ended up using blockchain technology as a backbone of our product.

In this paper, we would like to take one step further and zoom into one aspect of modern blockchain solutions: their token economies. Here again, we ask ourselves why token economies are designed in their particular ways and why they exist in the first place.

Every time you introduce a new token, you end up constructing a new miniature monetary system. In this system the functionality of the technology is inherently linked to the value of the token and its use, since the token value is correlated to the security of the network. This is especially the case in Proof of Stake ("PoS")-based systems. Having worked with blockchain projects for a long time, we find "tokenomics" to be one of the most overlooked design steps in many projects we came across. More often than not a token structure seems to be attached to a project for simple fundraising purposes, almost like an afterthought.

This paper seeks to explain our approach to creating a healthy blockchain project with a natural interaction between the token economy and the operation of the solution itself. We will walk you through the journey we took from developing a business solution to the construction of a whole new token economy. Along the way we will cover our token's functionality and reward mechanisms. This way, we hope to show how value can be created and captured on the LTO Network.

II. Product design evolution

Early product design

LTO Network's story commences in 2014. What started out as a document engine MVP gradually evolved into a workflow engine. As time went on, our clients got bigger and processes more encompassing. Being facilitators in the processes, we became the trusted third party for the users of our system. Organizations could be severely impacted if the data we stored were to be manipulated. We realized that we couldn't rely on trust alone. Adding layers of bureaucracy would help, but it would kill efficiency. Then along came blockchain technology, which offered the potential of solving all these problems at once without compromising productivity.

Recognizing its potential, we still had homework to do before we could begin applying this new technology to our existing business solution. We started consulting clients in different industries, such as supply chain, insurance and healthcare and asked them what they expected of blockchain technology and which processes could be digitized and put on blockchain. There were also legal and compliance developments to take into consideration, such as the data protection law GDPR in the EEA area and new privacy protection laws in the U.S. since July 2018.

Our efforts led to the design of a distributed business process management engine with ad-hoc private blockchains following the Finite State Machine logic. We needed to anchor our system on a public ledger in order to improve data integrity and security. But when we continued experimenting with different public ledgers, problems started to arise.

Issues with early product design

Most public chains we looked at fell short from a technical perspective: slow, expensive and not tailored to anchoring events on a blockchain. We set up the token functionality in the form of tokenized licenses. This was similar to Microsoft software, except in our case the miniature blockchain toolkit was available as a free download. Secure access to the blockchain, however, could only be gained if you could prove you had a license. A certain predefined number of tokens locked in your wallet would represent such a license.

Although this setup was technically working, it was far from perfect. We had to rely on a specific public ledger to run the service, which in turn required continuous transaction fee payments. Furthermore, the token did not really capture the value of the solution because part of the network's functionality was dependent on public chains outside of our control. In fact, the token model seemed to exist solely for its own purpose, and not to serve the underlying system. Community incentives for ecosystem growth turned out to be very limited. We tried to experiment with discount token models, but we were not satisfied with the results.

Most token models we've come across seem to be attached to projects mainly for fundraising purposes. Economic incentives are usually not provided. We've learned that economic incentives ought to be the main priority when designing a token economy. The incentives should be tailored to serve the needs of the adoption strategy of the solution, and marked out as an integral part thereof. This is due to the fact that it takes a lot of courage for companies to introduce new technologies into their daily operations, especially as disruptive and novel as blockchain. Therefore, it is crucial to demonstrate to them the economic benefits of adoption and to foster experimentation. You can only really achieve this by offering economic incentives. Our first product design lacked in this respect, so we moved on to a new design. In this design, incentives form an essential part, not only of the LTO token economy, but of the LTO Network as whole. This makes our solution natural.

After accepting the fact that existing public ledgers were ill-suited for our intended purpose, we decided to build our own permissionless public ledger. This made life a lot easier, for two reasons:

(i) it allowed us to add new features to the public chain and configure it in a way that was inherent to the product and the adoption roadmap. Since the public ledger was built for anchoring, extra features like asset creation were not needed at all as they were only tampering with the primary use case.

(ii) this setup made it possible for us not only to experiment with token models, but to build a proper miniature monetary system which would be more efficient to use and to join as a company.

II. It's the economics, stupid!

The benefits of a Proof of Stake reward mechanism model

Modern Software-as-a-Service ("SaaS") solutions are generally offered on the basis of a multi-year contract, charging fixed fees regardless of use. There are of course exceptions to this, but the general idea is that you get tied down for a fixed amount of time, paying fees regardless of your actual use. The LTO Network takes a different approach. We make use of the network voluntary. We allow users to discontinue their use whenever they choose and to relieve them from their payment obligations during such time. Hence, we have managed to use token economics and incentivization to create an efficient and flexible user model for our network.

In order to achieve this, we decided to implement the PoS concept in our reward mechanism model, letting it control new entries by companies into the network. This was our "internal breakthrough". According to the PoS reward mechanism, the chance of a validator to be chosen is proportionate to the size of his stake relative to the total number of staked tokens. In case his stake amounts to 5% of the total of staked tokens, there is a 5% probability that he will be chosen to validate the block. This would, however, mean that a user would be awarded solely for holding tokens, and not necessarily for using

them. This is why we added the “Proof of Importance” concept, which rewards actual use of the tokens. We will explain this further in chapter IV.

This has led to the creation of a token model that essentially allows the network to charge users based on a predictable pricing model, because the setup of each user gives you statistics on how many transactions they conduct on the network during a certain period of time.

Each user knows the number of clients and partners they have, and they’ve gathered intelligence and statistics on the amount of transactions they do. This makes it easy to ascertain beforehand the number of transactions they would be running during a fixed period of time. Using this information allows a user to calculate the percentage of the network they would be using during this period of time. By acquiring the same percentage of the total staked tokens in the network, and staking them, a user can use the LTO Network solution **net zero without worrying about constant recurring fees and payments.**

Our model hinges on the characteristics of the users of the network. Hereafter we shall further elaborate on the different categories of users.

Type of users in the network

Within the LTO Network token economy, we can make a distinction between 4 types of token holders:

- **Integrator & Partners** – stakers in network, running nodes to validate transactions. They can act on their own behalf or on behalf of their clients;
- **Clients** – actors using the network and paying transaction fees, incidentally running nodes;
- **Passive stakers** – actors that will stake their coins (potentially through a lease) and run a node to validate transactions;
- **Non-active holders** - non-active participants in the network simply holding tokens

“Integrators & Partners” and “Clients” are both labelled as “Participants” in the network, and seen as the core actors within the LTO Network economy. As they are users of the network, they have a direct incentive to care for its stability and functionality. Therefore, we aim for a token distribution in the maturity phase of about ~80% held by Participants (see fig. 1).



Figure 1: Targeted token distribution in maturity phase

Of the 4 categories of actors in the network, the non-active holders are least likely to use the network. They do not generate transactions, nor do they stake their tokens to validate transactions. “Integrators & Partners”, “Clients” and “Passive stakers” can be categorized as “Active Users”, and plotted in a matrix according to the percentage of their overall stake within the network (fig. 2).

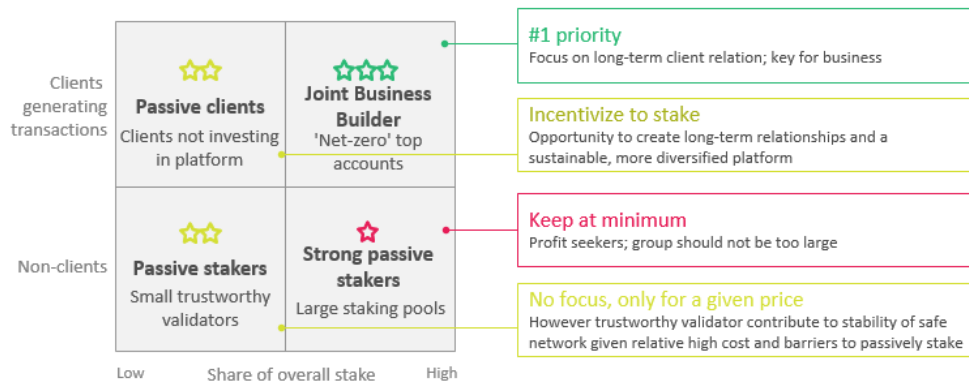


Figure 2: Actors and stakeholders in the LegalThings landscape

The 4 users of the network can be described as follows:

- **Strong passive stakers** have a large percentage of overall stake in the platform, yet do not generate transactions. They run a node to validate transactions, and in turn receive transaction rewards.
- **Passive stakers** are smaller (individual) actors holding tokens with the aim to sell for a higher price in the future, staking their smaller percentages to support the network.
- **Passive clients** run transactions and use the platform for its services without actually having a stake in the network. Note that if transaction fees become relatively large, these clients will incur significant running costs for using the platform.
- **Joint Business Builders** are clients that are actively participating and having a stake in the network.

We envisage an equilibrium phase that can be reached by stimulating early adoption, participation and active staking in the network. We designed our token economy in a way that stimulates this behaviour, helping us to reach the equilibrium quickly. Joint Business Builders will benefit from our reward mechanism the most, which makes sense as they contribute to the implicit value of the platform, ensuring a sustainable but gradual use of the network and creating value in the medium-to-long term.

IV. Reward Mechanism: from LPoS to LPoI

As the technical paper outlines, the existing PoS based approaches lead to centralization and an abundance of strong passive stakers. Establishing a maximum staking limit for nodes will simply lead to a form of a sybil attack: there would be more nodes, but they'd still have one controller. Thus we wanted to avoid that and actually push forward better incentives for Joint Business Builders and economically discourage strong passive stakers as they add no value to the network.

We combined WAVES’s Leased Proof of Stake (“LPoS”) concept with NEM’s idea of Proof of Importance (“PoI”), and implemented something we call Leased Proof of Importance (“LPoI”) in to our reward mechanism. The ‘leased’ part allows small token holders and those who hold tokens - but do not want to run a node - to still receive rewards for supporting the network. The ‘Importance’ factor ensures that active network members are rewarded more than passive stakers. You can read more about the differences of DPoS/PoS/LPoS [here](#).

From a company’s perspective, this makes sure that they can run the product without actually having to buy or own tokens. They can simply spin off a node and attract token holders who want to lease their tokens, improving the model from passive stakers into useful network participants.

Aiming to incentivize staking according to the percentage of transactions, we skewed the probability of validation towards those token holders that actually use the network by contributing transactions (see fig. 3). The impact of contribution on probability of validation becomes clear in the following example:

- If a user stakes 10% of the total number of tokens staked on the network, and contributes 10% of the total transactions, his chances of validation will be higher than 10%
- If a user stakes 10% of the total token supply, but does not contribute any transactions, his chances of validation will be lower than 5%

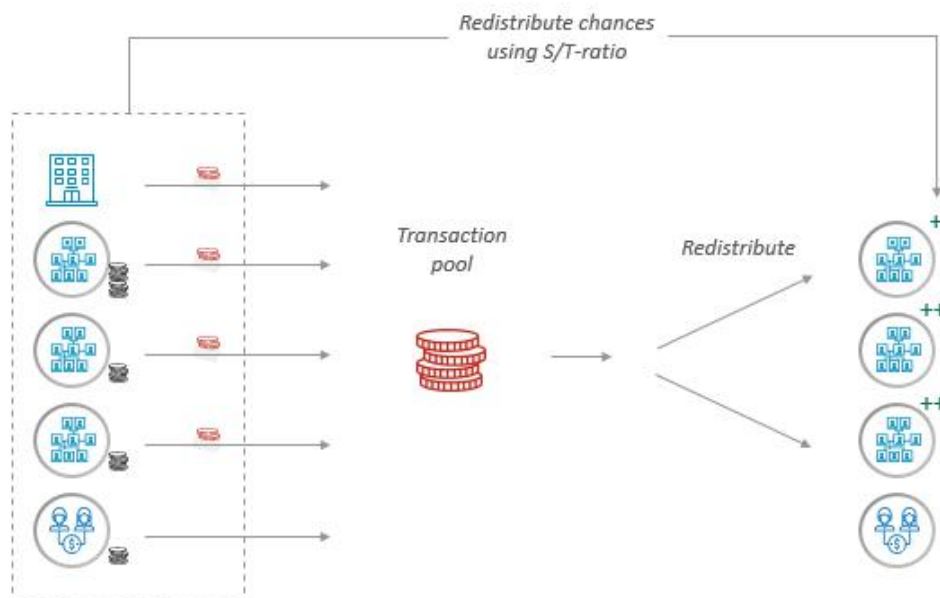


Figure 3: Conceptual example LPoI consensus algorithm. Black-coloured coins represent the staking amount by a party, and red-coloured coins represent the number of transactions

To determine the balance of staking versus transactions, their ratio (“S/T-Ratio”) will be established in the following manner:

$$ST \text{ ratio} = \frac{\text{Staked tokens as \% of total}}{\text{Contributed transactions as \% of total}}$$

Raffle factor

The S/T-ratio will be related to a 'Raffle-factor'. The Raffle factor is a mathematical formula that influences the chance that a node will be chosen to validate. The Raffle factor will be calculated using the formula below, and will have a minimum of 1.0, and maximum of 1.5. This maximum is chosen as half way between the minimum and the absolute maximum due to importance inflation.

The more balanced the S/T-ratio (~closer to 1.0), the higher the Raffle factor, with a maximum of 1.5. If the S/T-ratio is unbalanced (a node does not contribute any transactions), the associated Raffle-factor will be 1.0. Because of the large standard deviation of the bell-curve, robustness and predictability for active clients is ensured when the net-zero effect is reached. Potential changes in the transaction base will have a relative low effect on the net-zero position. See fig. 4 below for a graphic representation of the Raffle factor.

$$Raffle\ factor = 1 + (0.5 * e^{-\frac{(STratio-1)^2}{2}})$$

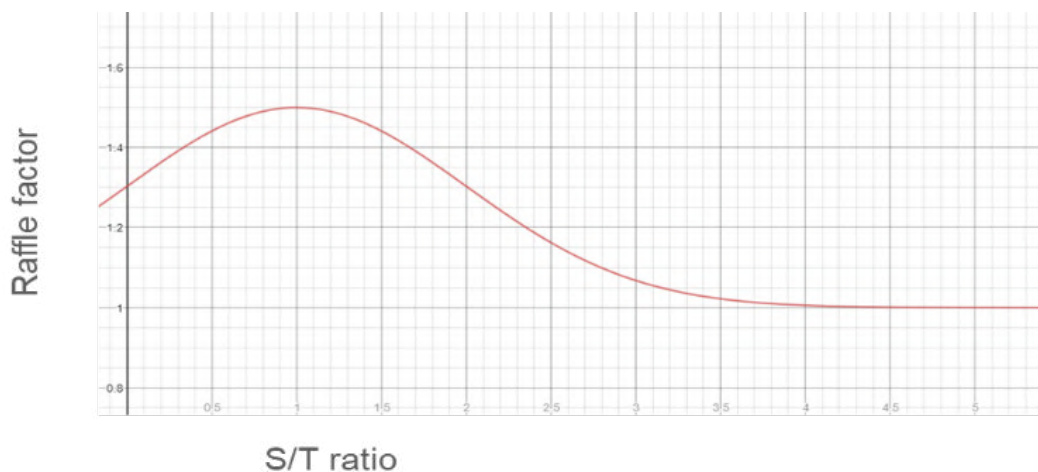


Figure 4: Graphic representation of Raffle factor as function of the S/T ratio

User	Balance	%	Transaction volume	%	S/T ratio	Raffle factor	Effective balance	P(forge)	Expected payout	Return on stake	Net profit
1 - Passive client	0	0%	350	35%	0	1.30	0	0%	0	n/a	-350
2 - Disproportionally large stake	8000	40%	200	20%	2	1.30	10426	39%	391	4,9%	191
3 - Client with balanced stake	4500	23%	250	25%	0.9	1.50	6739	25%	253	5,6%	3
4 - Client with balanced stake	4000	20%	200	20%	1.0	1.50	6000	23%	225	5,6%	25
5 - Passive staker	3500	18%	0	0%	n/a	1.00	3500	13%	131	3,8%	131
	20000		1000				26665	100%	1000		

Table 1: An example of the reward allocation over x period of time

As shown in Table 1, user 2 and 3 have the most balanced stake and transaction. Their S/T-ratio is close to 1, which gives them a high Raffle factor (1.5). Therefore, the system allocates to them a relatively higher effective balance than it does to users 1,2 and 5. The effective balance is used in the [Fair Proof of Stake algorithm](#), which determines the chance to forge a block; $P(\text{forge})$.

Because of the higher Raffle-factor, users 3 and 4 see an increase of their chances of being validator; from 23% and 20% to 25% and 23% respectively. On the contrary, user 5, who is a passive staker and does not contribute any transactions, sees a decrease in their chances of becoming a validator; from 18% to 13%.

Based on the number of straws, one can calculate an expected payout. This shows that despite having to pay transaction fees, user 2, 3 and 4 generate a profit because of their staking rewards. The return on staking is highest for user 3 and 4, as they have a well-balanced S/T-ratio.

Importance inflation

Constructing this system, we had to be mindful of the possibilities of gaming it. One possible way of doing this is through spam transactions. We can calculate the profit/loss from spam transactions as formula of the maximum raffle factor;

- Raffle factor; r
- Percentage of staked tokens; S
- Cost of a transaction; c
- Total transactions on network; Γ
- Spam transactions: τ
- Rewards: p
- Profit/loss from spam: $\Delta p = p_{r=r_{max}} - p_{r=1}$

$$p = (r \cdot S \cdot \Gamma \cdot c) - (\tau \cdot c)$$

$$\text{with } r = 1, \tau = 0 \Rightarrow p = S \cdot \Gamma \cdot c$$

$$\text{with } r = r_{max}, \tau = S \cdot \Gamma \Rightarrow p = (r_{max} \cdot S \cdot \Gamma \cdot c) - (S \cdot \Gamma \cdot c) = (r_{max} - 1) \cdot S \cdot \Gamma \cdot c$$

This gives

$$\begin{aligned} \Delta p &= ((r_{max} - 1) \cdot S \cdot \Gamma \cdot c) - (S \cdot \Gamma \cdot c) \\ &= ((r_{max} - 2) \cdot S \cdot \Gamma \cdot c) \end{aligned}$$

Given $s > 0, \Gamma > 0, c > 0$

$$\Delta p < 0 \Rightarrow (r_{max} - 2) < 0 \Rightarrow r_{max} < 2$$

This proves that it's impossible to gain directly from spam transactions, with a maximum raffle factor of less than two. A raffle factor close to 2 would make spam transactions nearly free. Increasing the importance on the network for little to no costs is undesirable, as it could aid an attacker trying to undermine the network with a 51% attack. The maximum raffle factor of 1.5 ensures high costs of inflating importance.

Summary Blocks

In order to solve the problems of blockchain’s growth in respect of data storage capacity, we are introducing an additional block type; summary blocks. These blocks are generated approximately once a day. The reasoning and details are thoroughly explained in the Technical Paper.

In order to incentivize participating in creating summary blocks, only 97% of the transaction fees are eligible for forging key blocks. The remaining 3% of the transaction fees is reserved for forging summary blocks.

V. Resulting user dynamics

As a consequence of the relatively large reward for Joint Business Builders (clients which have a balanced stake and transaction ratio), clients are expected to buy a stake in the platform sizeable enough that they obtain a ‘net positive’ position. This way, there are no marginal costs of doing a transaction, which stimulates adoption of the platform.

The expected dynamic is shown in Fig. 5.

- Passive clients move towards Joint Business builders as they are incentivized to stake a similar percentage of tokens as their percentage of transactions: this decreases their marginal costs of using the platform;
- Passive clients buy their tokens from (strong) passive stakers as the returns for passive stakers are relatively low;
- When the number of active clients on the platform increases, the pool of passive stakers gets depleted

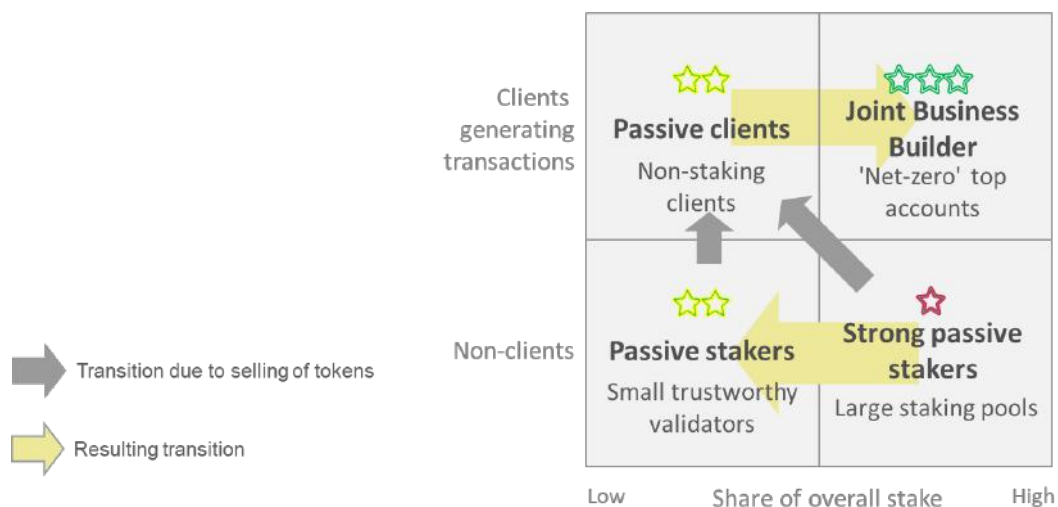


Figure 5: Stakeholder dynamics during market development

Platform adoption and dynamics over time

These dynamics in the LTO Network economy will occur over time and in four distinct stages; Development, Growth, Shake-out and Maturity. The speed of the market development depends heavily on token price movement, transaction price and adoption rate in the early stages. We estimate to reach the market maturity phase within 3-5 years. The four phases are described in fig. 6 below.

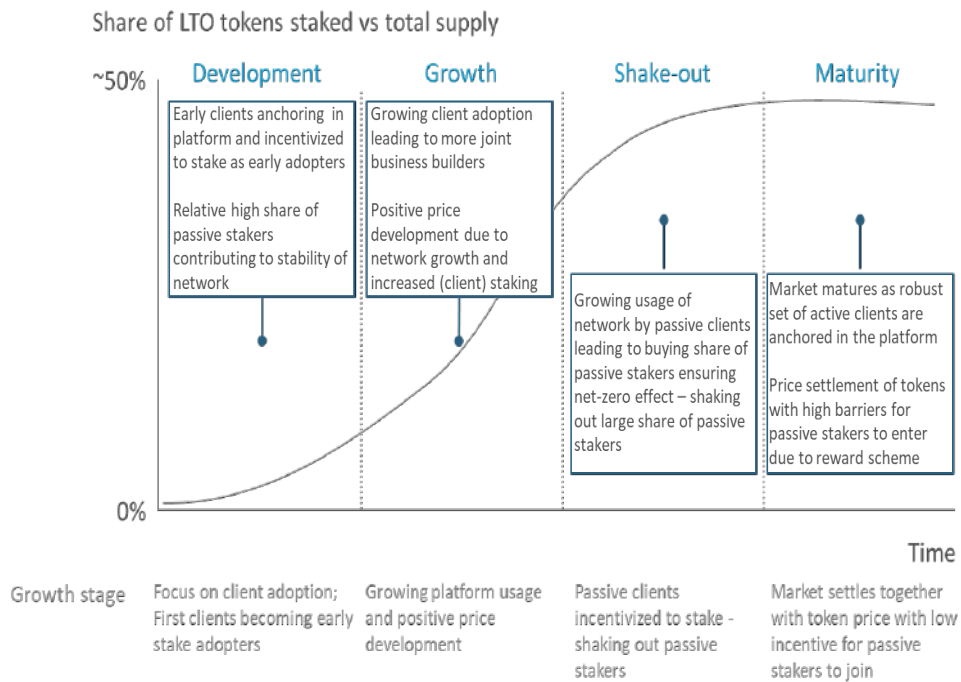
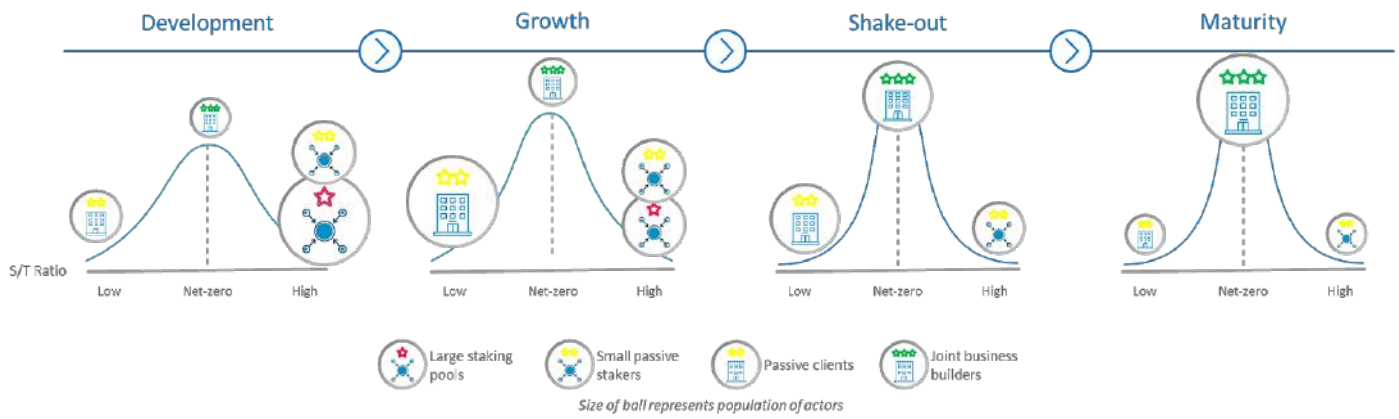


Figure 6: Platform development to market maturity

Going through the four phases, we expect to encounter a transition of types of users due to the nature of the reward mechanism(see fig. 7 below). In the Development phase, directly after the token sale, there will be a relatively high passive stake percentage. Early adopting clients are incentivized to move to the net-zero point quickly, as a relatively low investment in tokens will bring them a net-positive return on their transaction volume. In the Growth phase, increased platform adoption leads to an increase in (passive) clients.

Due to the nature of the solution, it's unlikely that clients will purchase tokens on a monthly basis. Instead, we expect them to either opt to take a stake in the network, reducing the running costs to zero, or to use the service through an integrator which benefits from owning a part of network. Passive clients will gradually buy their tokens from large passive stakers. Moving towards the Shake-out and Maturity phase, staking pools deplete as stakes are increasingly required by clients and integrators for running their nodes.



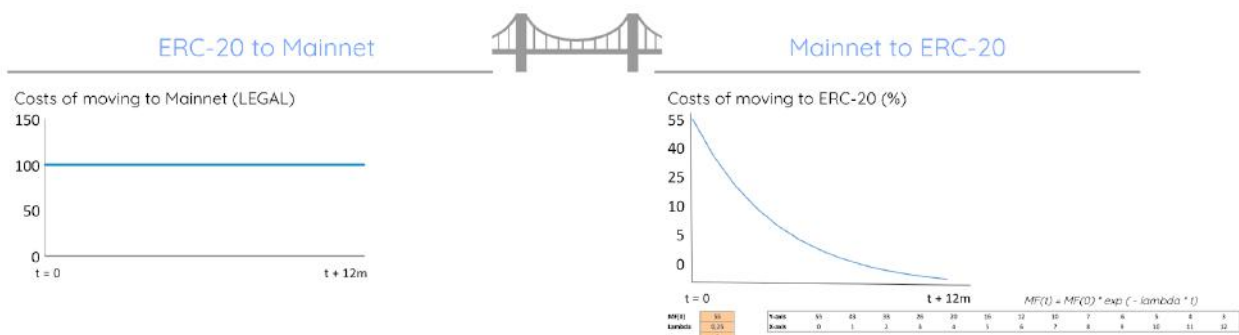
VI. Preventing speculation from ruining economic assumptions

Volatility is still a wrinkle that needs to be ironed out in this system, because we cannot allow speculation to tamper with the predictable pricing model. If a lot of people randomly stake and re-stake tokens without using the network, it impacts the economic setup of predicting the part of the network, and therefore the amount of tokens a company would need to run net zero. Therefore, before the system reaches at least an early maturity phase, we will be introducing a concept called “the Bridge” between the pools of Mainnet and ERC-20 tokens.

Both pools serve different purposes:

- The Mainnet pool is intended for actual usage of the network: to stake or to pay for transactions and intended for the functionality as the utility token of the platform;
- The ERC-20 pool is intended mostly for liquidity and as a gateway for companies to join the network

The Bridge will manage the flow between the two pools. The aim of the Bridge is to ensure stable and gradual adoption of, and inflow in, Mainnet as the market matures. To that end, a Bridge Troll will be appointed to collect fees when transferring tokens from one pool to the other. **Bridge troll fees are burned**, making sure that the movement of large stakers during the Development phase of the network will not drastically impact the price.



Moving from the ERC-20 pool to the Mainnet pool, the Bridge Troll will collect a fixed fee of 100 LTO Network Tokens per transaction. This small barrier will not withhold actual users of the network (clients, integrators) from moving liquidity to Mainnet, but will act as a disincentive for speculators and small passive stakers to move towards Mainnet.

From Mainnet to ERC-20, the Bridge Troll will collect a fee according to a curve which corresponds to the development roadmap. As the platform reaches maturity and the market becomes more educated, there will no longer be a threat of negative influence from price volatility. Before that happens, the fee curve will de-incentivize random staking and not using the network. This ensures that the assumption of the predictable pricing model remains.

Would token price volatility prevent companies from joining?

We set the nominal anchoring transaction price at such a level that it leaves room for token price growth. Meaning that in case the token price were to go up, the setup would still ensure that companies would be incentivized to join the network as it would be cutting down operational costs and have competitive advantages over other solutions in the field.

Then there's the potential problem of a growing token price becoming a barrier for companies to enter. Like with any blockchain, you can set the fee to the amount you want to pay. The node that mines the block can choose to accept it or not. Therefore, the market will be able to find an equilibrium. Node facilitators will be inclined to lower the fees in such a case, otherwise it will prevent more people from joining the network, thus having a negative economic impact on the current participants of the network and those exact node facilitators.

VII. Value creation and capture

Most blockchain projects are creating permissionless public ledgers. Businesses, enterprises and governments are reluctant or even unable to utilise these, due to logistical and legal issues. These restrictions are an obstacle to adoption by the public sector, which is a giant market. According to different reports [like the one of McKinsey](#), public sector is by far the largest use case for blockchain adoption.

What has been happening with the blockchain technology thus far is that companies utilise private blockchains. So far the only use cases public chains see are either dApps (see the state of dAPPs: daily active users count is very low) or they do not go further than becoming an ICO money collecting platform.

Despite what the future holds for permissionless public chains, public sector will not be able to fully optimise them for their businesses purposes.

Let us walk you through what we see are the economic reasons and consequences of this.

Token vs tokenless

Private blockchains do not use tokens. Instead, the network value is represented in the authority of the selected group of companies. In other words, access to the network is exclusive, and is based on some criteria of the governing parties.

With the governing structure established and industry adoption reached, the authoritative parties have little to no economic incentive to redistribute power by adding new members. With the ability to accept or reject newcomers, such setups are likely to lead to cartels.

On public permissionless blockchains, especially in the case of PoS, the network has an economic value that is represented in the underlying tokens. If tokens are publicly available, anyone is able to join the network and become a validator.

Layered solution

Then what is different about LTO Network? The key here is that the product is the combination of the private and public layers. The private layer grants organizations all the tools necessary to apply the blockchain to their business. The public permissionless layer provides a decentralized method of protecting data integrity of the private layer.

The economic value is actually present in the underlying public chain, where the access and 'share' of the network are distributed globally and are represented in tokens. The result of such a setup is that adoption, brought to the network by the solution expressed in private ad-hoc chains, has direct implications on the token value based on the economic assumptions made earlier in this paper.

Company integrators are economically incentivized to become Joint Business Builders and acquire a part of the network for staking. The product, comprised of both private and public layers, creates and captures value: the private layer creates value from the business perspective and the public layer captures it from the economic perspective.



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