Blockchain-Enabled Participatory Incentives for Crowdsourced Mesh Networks

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Introduction

There is need for a system which coordinates flow of economic value in mesh networks that is:
- Transparent: shared across participants,
- Automated: avoid cost, delays, errors of manual accounting,
- Decentralized: diverse participants,
- Secure: calculations and money transfers are safe, automated, irreversible.

MeshDApp, a value transfer platform for mesh networks that uses a local Ethereum Proof-of-Authority blockchain + Solidity smart contracts. We designed & implemented Fair, a new economic model for MeshDApp. The goal is to reach a win-win situation for the network and the users.

Economic Model

Each provider will be paid for the amount of forwarded MB with different price/MB.

- In fact, the main idea is the more devices a provider has, the higher its price/MB forwarded will be, up to a certain limit.
- The goal is to provide an incentive for providers to invest in the network by adding more devices to expand its coverage and improve its density and capacity.
- As it is not so good for the diversity of the network that one provider has, the higher its price/MB forwarded will be, up to a certain limit.
- To ensure prices cover minimum costs, we define a price limit for minimum costs, we define $p_{\text{min}}$ for a provider with only a single device.

The final price function for each provider is:

$$p_i = \begin{cases} p_{\text{min}} + \frac{D_i - 1}{D_{\text{max}}} \times (D_{\text{max}} - 1) & \text{if } D_i \leq I \\ p_{\text{max}} & \text{otherwise} \end{cases}$$

Assumptions

- We do not address the problem of collecting payments from consumers. For that we assume “infinite funds” in a common account.
- Forwarded MB in a device is $\min(tx,rx)$.
- At each iteration, a provider decides to add a new device with probability $p_{r1}$ or $p_{r2}$ (depending on the number of devices it has), given that it has the necessary tokens to buy.

Evaluation

Data: Forwarded MB from QMPSU mesh network, every hour during one month, for 62 devices.

Economic models tested:
- Fixed-Price: constant price $\forall$ providers, $p = 0.2$.
- Unbounded: $p_{\text{max}} = 0.7$.
- Fair: $p_{\text{max}} = 0.7$, $p_{r1} = 0.7$, $p_{r2} = 0.2$.

Initial state:
- Number of providers: 2, 5 or 10.
- Initial #devices per provider: 1 or 3, $pr = 0.5$.

Measured variables:
- Size of the network over time.
- Number of devices per provider over time.
- Number of tokens per provider over time.

Results

Win-win situation ensured: the network grows and providers compensated for their investment.

Future work

- Use a more realistic distribution for probabilities of adding a new device.
- Test the model in a real environment.
- Compare to alternative models, including auctions.

Conclusion

- Fixed-Price economic model
- Unbounded economic model
- Fair economic model
- Evaluation

Figure 1: Example of a mesh network scenario where the infrastructure is owned by different providers

Figure 2: Price/MB ($p_i$) of a provider vs its number of devices

Figure 3: Ensures a fair and controlled growth of provider

Figure 4: Increases the deviation between providers

Figure 5: Makes providers grow slowly

Figure 6: Fair incentive for providers to invest in the network

Figure 7: Fair model ensures that providers earn tokens