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.**

Context of the economic model

Crowdsourced mesh networks built, maintained and used by several participants. How to collect funds from consumers and distribute them to providers?

- **Consumers** pay to the common funds account for using the network for Internet access or other services.
- **Providers** are paid (from the common funds account) for their contribution in building and maintaining the network infrastructure.

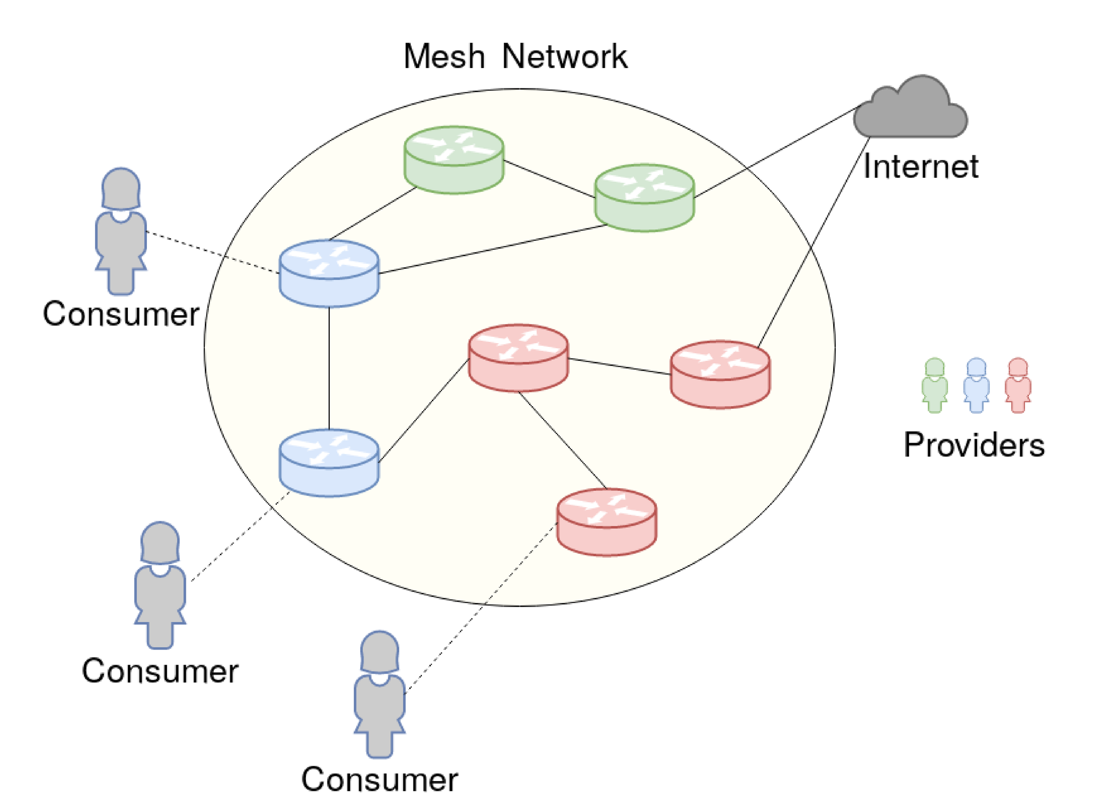

Figure 1: Example of a mesh network scenario where the infrastructure is owned by different providers

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 P owns too many devices D, we define a price limit p_{max} and the target number of devices (incentive), $I = \left\lceil \frac{3\#D}{2\#P} \right\rceil$, for which p stops to increase at p_{max}.
- To ensure prices cover minimum costs, we define p_{min} for a provider with only a single device.

The final price function for each provider is:

$$p_i = \begin{cases} \left\lfloor p_{min} + \frac{p_{max}-p_{min}}{I-1} \times (D_i - 1) \right\rfloor; \text{ if } D_i \le I \\ p_{max}; \text{ otherwise} \end{cases}$$

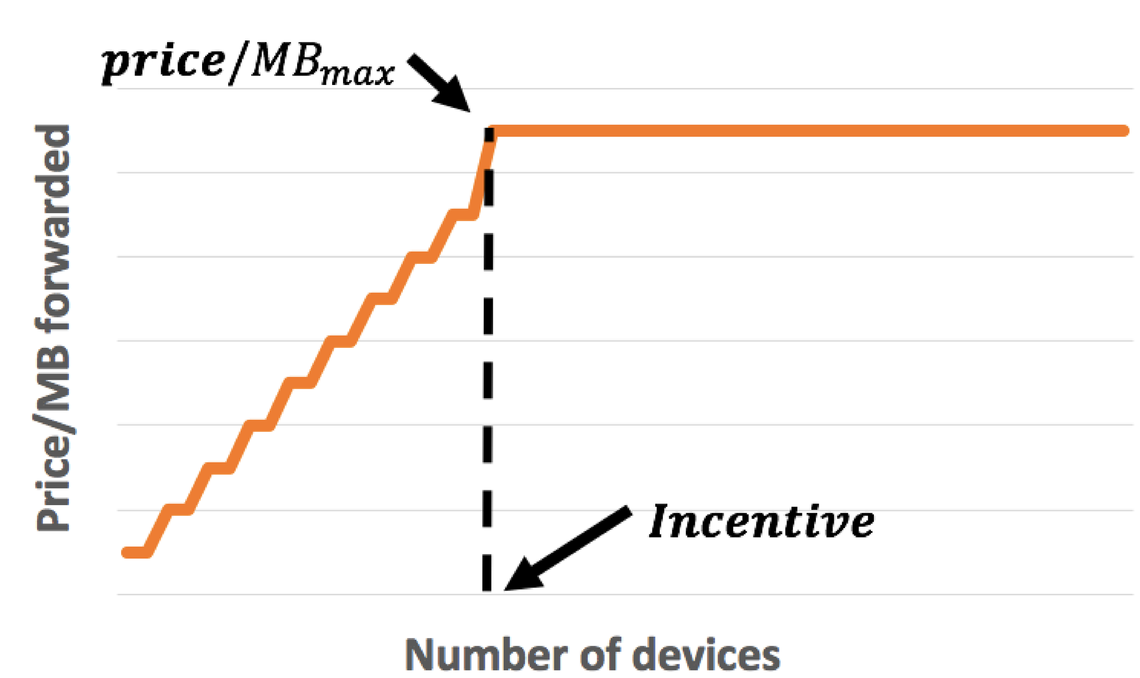

Figure 2: Price/MB (p_i) of a provider vs its number of devices

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 $min(\text{tx}, \text{rx})$.
- At each iteration, a provider decides to add a new device with probability pr_1 or pr_2 (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:

- Fair: our proposed model, $pr_1 = 0.7$, $pr_2 = 0.2$.
- Unbounded: *Fair* without p_{max}, $pr = 0.7$.
- Fixed-Price: constant price $\forall$ providers, $pr = 0.2$.

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

***Fair* economic model**

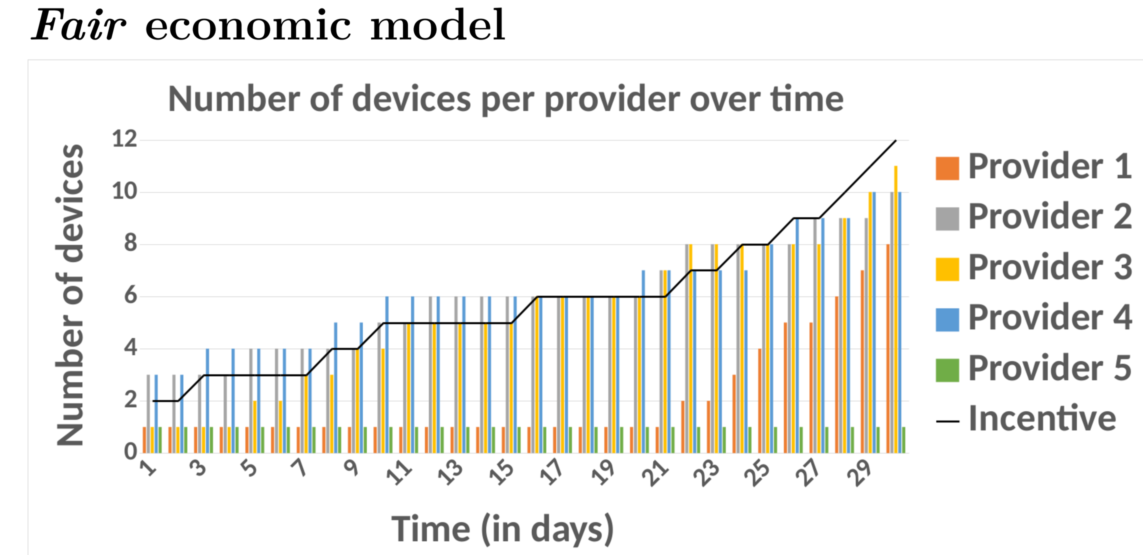

Figure 3: Ensures a fair and controlled growth of provider

Unbounded economic model

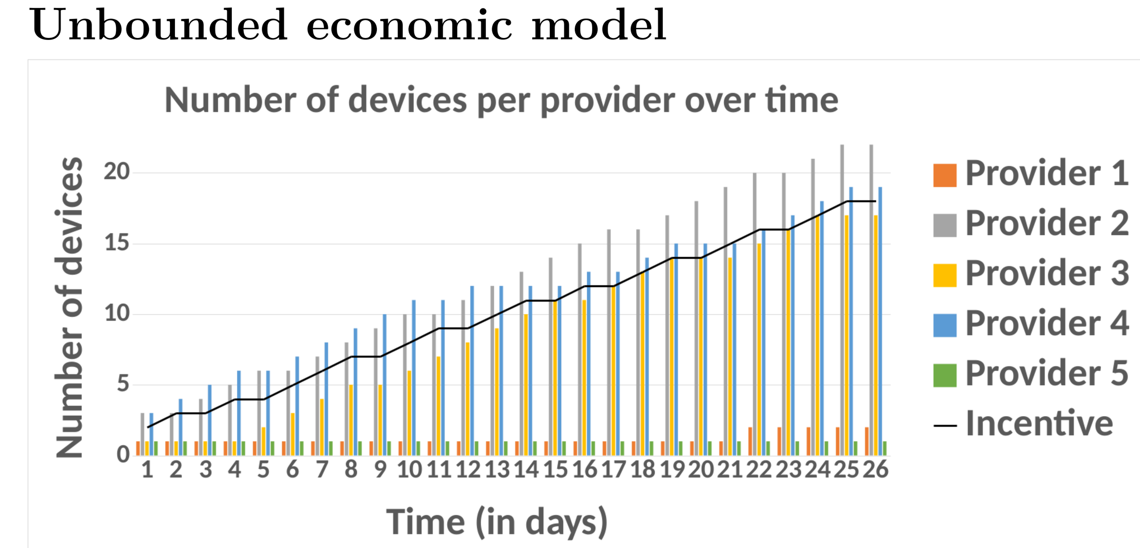

Figure 4: Increases the deviation between providers

Fixed-Price economic model

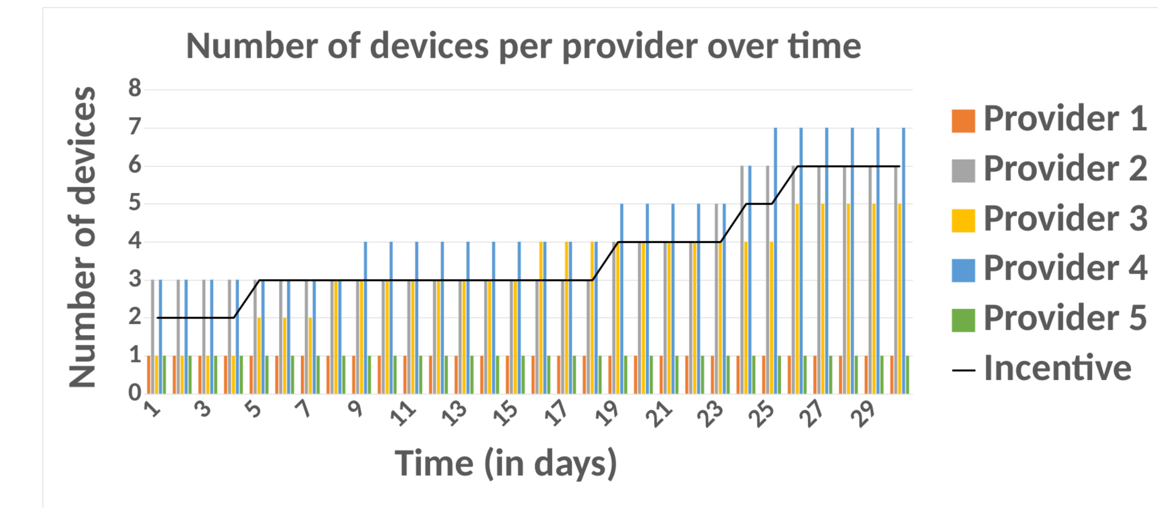

Figure 5: Makes providers grow slowly

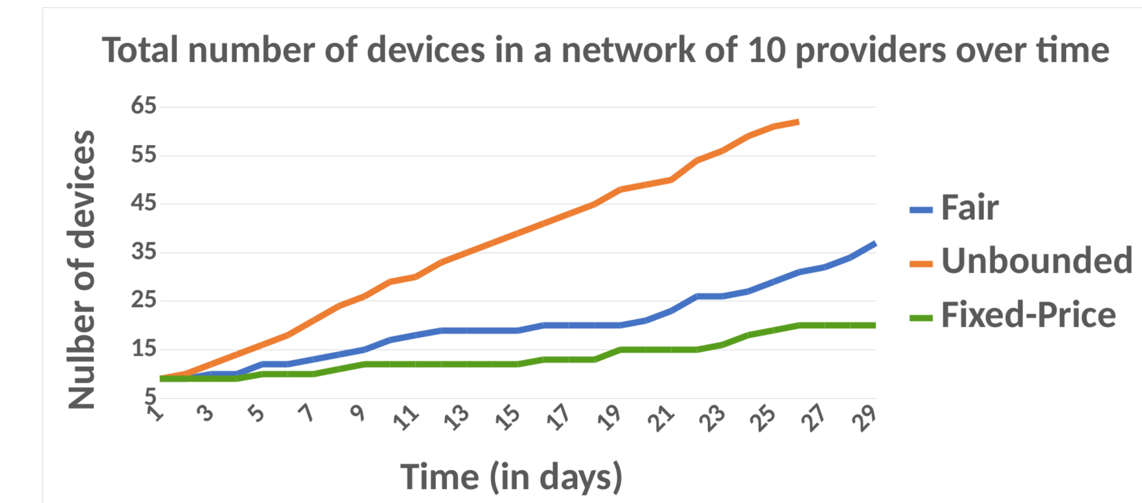

Figure 6: *Fair* incentive for providers to invest in the network

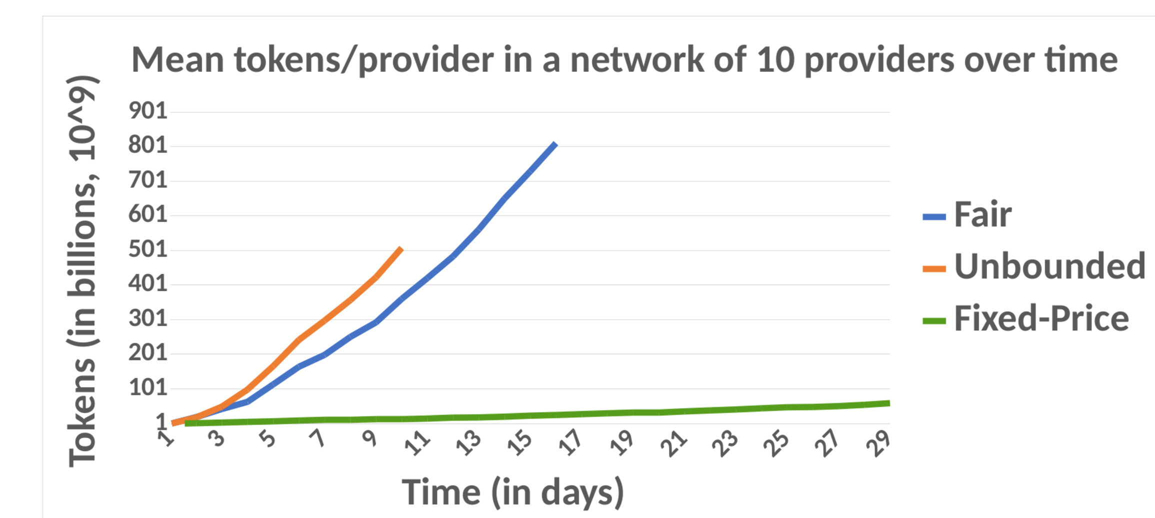

Figure 7: *Fair* model ensures that providers earn tokens

Conclusion

- Win-win situation ensured: the network grows and providers compensated for their investment.
- p_{max} is an incentive for growth, avoid centralization with a few large providers controlling supply.

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.