Simulating a Blockchain Network with SimBlock

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Abstract—Blockchain techniques are attracting growing interest due to their capability of immutable and anonymous recording without any centralized authority. One of the difficulties blockchain researchers are facing is a lack of ways to verify behaviors of large scale blockchain networks. In this demonstration, we present SimBlock, a blockchain network simulator. It simulates the peer-to-peer network of a public blockchain, e.g., Bitcoin, which consists of thousands of nodes, as well as parameters related to a blockchain and its network are flexibly configurable. SimBlock can also visualize nodes' behavior and block propagation. By giving some example studies, such as exploring better neighbor selection strategies and assessing the influence of relay networks, we show that SimBlock can facilitate blockchain network research.

Index Terms—Blockchain, Simulator, Peer-to-peer network

I. Introduction

Blockchain elicits increasing attention in recent years as one of the key technologies of cryptocurrencies. It has been giving rise to lots of research topics not only for security researchers but for **network researchers**.

However, blockchain "network" researchers have difficulty in research means; because of its P2P-based scalable architecture, researchers are faced with the following issues:

- In a large scale public blockchain network, it is hard to obtain information about the whole network, unless they provide most of the nodes by themselves. Even if they can obtain, ambitious experiments do not receive a welcome.
- In a small scale private blockchain network, they cannot observe actual behaviors in practical scale networks.

For that reason, it is hard to conduct experiments in practical large scale blockchain networks. This has also caused insufficient quantitative evaluation of emerging blockchain techniques, despite their giving rise to launch of various venture businesses.

To solve such problems, we developed a blockchain network simulator SimBlock [1]. In this demonstration, we present actual usage of SimBlock with some examples, such as exploring better neighbor selection strategy and assessing the influence of relay networks. By these, we show that SimBlock can facilitate blockchain network research.

II. SimBlock

SimBlock was developed by Distributed Systems group, Tokyo Institute of Technology to facilitate blockchain network

Fig. 1. Block propagation protocol between two nodes.

research. It simulates the peer-to-peer network of a public blockchain such as Bitcoin [2] and Litecoin [3] that consists of thousands of nodes, on a single computer.

It was designed as an event-driven simulator wherein each participating node behaves according to generated events, e.g., block generation and exchanging messages as shown in Figure 1.

Typical configurable parameters are as follows:

- Block size.
- Difficulty of block generation, expressed as an average generation interval.
- Number of nodes.
- Number of neighbor nodes on every node.
- Geographical regions each node is located in.
- Block generation capacity of every node.
- Network bandwidth (up/down) between each pair of regions.
- Average network delay between each pair of regions.

In the default setting, blocks are generated by a probability assuming Proof of Work and propagated along the simulated blockchain network. Other schemes such as Proof of Stake can be simulated by changing block generation-related parameters.

Furthermore, SimBlock has a visualizer for drawing nodes' behavior and block propagation.

To evaluate whether SimBlock appropriately simulates blockchain networks, we compared the simulated environments by SimBlock and the actual environments in regard to three public blockchain networks: Bitcoin, Litecoin, and Dogecoin [1]. Specifically, we compared the median number of block propagation time and the ratio of the fork occurrence.
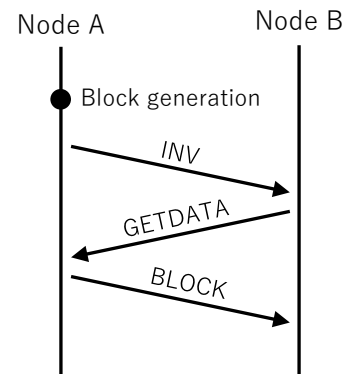
Fig. 2. Median of block propagation time with a neighbor selection technique.
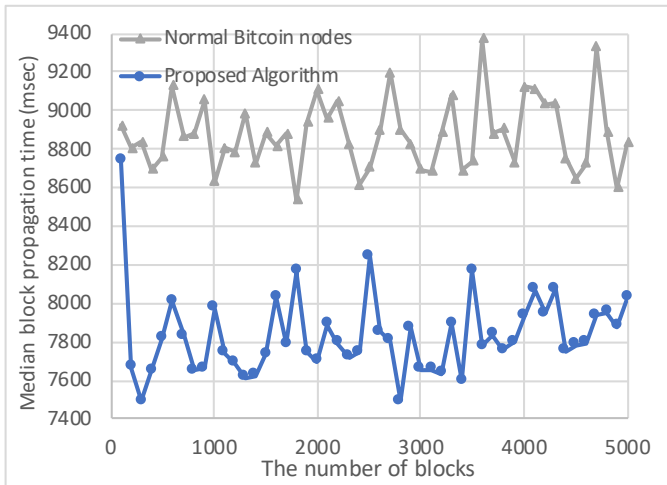

Fig. 3. Median of block propagation time with a relay network.

We confirmed that most of the measured values in the simulated environments and the actual environments are close.

III. EXAMPLE USAGE

This section shows our studies that SimBlock has enabled.

A. Exploring better neighbor selection strategies

One of the examples of our research topics that requires SimBlock is neighbor selection techniques.

Achieving high throughput is a challenge contributing to widen applicability of blockchain. The expected throughput of blockchain is the quotient obtained by dividing the number of transactions included in each block by the average block generation interval. In the case of Bitcoin, it is approximately seven transactions per second. This is quite small compared with Visa (approximately $1,700$ transactions per second [4]) and PayPal (approximately 290 transactions per second [5]).

One technique to safely improve the throughput is reducing the block generation interval by shortening the block propagation time [6]. Therefore, we are considering a better neighbor selection technique in blockchain networks.

Our algorithm makes each node to attempt to connect with nodes which send INV messages to it faster than existing neighbors. Besides, a few neighbors are randomly selected from all known nodes to find better neighbors.

Figure 2 shows the difference of block propagation time between our algorithm and the normal one used in Bitcoin. It is shown that blocks are propagated faster with our technique.

B. Assessing the influence of relay networks

The other example is assessment of relay networks.

Relay networks, e.g., bloXroute [7] and Falcon [8], are networks dedicated to block propagation. These are aiming to improve the propagation time, so that they could enlarge the throughput as like neighbor selection strategies.

However, the actual influence of relay networks is not sufficiently clarified, due to the difficulties of experiments as
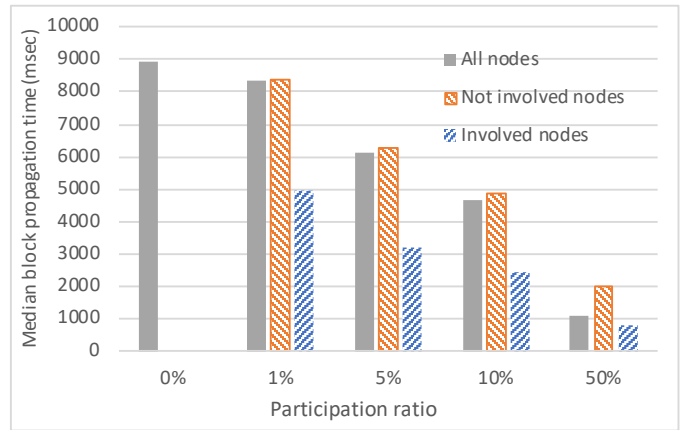
described in Section I. Therefore, we conduct some experiments to observe their influence by using SimBlock.

Figure 3 shows the block propagation times when changing the participation rate of the node to the relay network. We can see that high participation ratios involve remarkable improvement of the propagation time. Even if the participation rate in the relay network is as low as 5%, the propagation time of all nodes is improved to less than 70% of the original propagation time.

IV. CONCLUSION

We developed a blockchain network simulator SimBlock. SimBlock can easily change the behavior of nodes, so that it enables to investigate the influence of nodes behavior on blockchains. To show practical usage, we conducted two experiments which clarify the influence of neighbor node selection algorithms and relay networks on the block propagation time. The simulator could depict the effects of the two techniques on block propagation time.

SimBlock is publicly available[1], so that it facilitates studies to clarify the potential of blockchain techniques.

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[1]We will release SimBlock in April 2019.