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Optimizing packet transmission for ledger-based points transfer system in LPWAN: Solutions, evaluation and standardization

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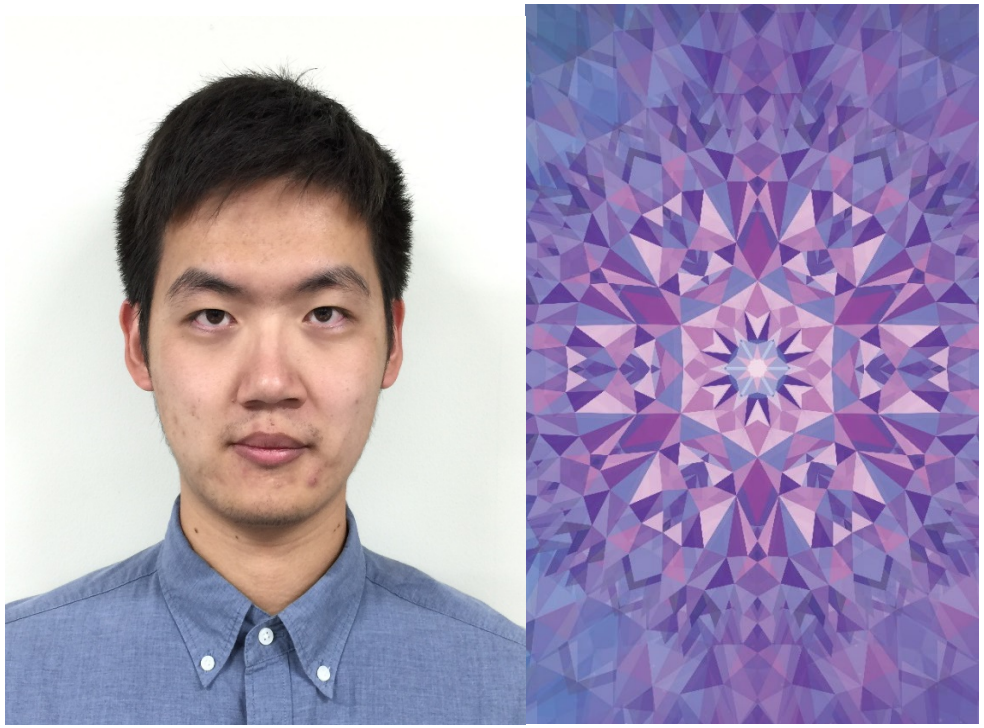


Session 2: Networking requirements and solutions for IoT and industrial applications

Paper S2.1:Optimizing packet transmission for ledger-based points transfer system in LPWAN: Solutions, evaluation and standardization

Optimizing Packet Transmission for Ledger-based Points Transfer System in LPWAN: Solutions, Evaluation and Standardization

The contributions of this paper

Solutions

- We propose an optimized packet transmission mechanism for the ledger-based points transfer system in LPWAN to reduce the data transmission volume of the whole system.

Evaluation

- Simulation results show that our proposed mechanism can well reduce the packet traffic in LPWAN and ensure the proper operation of the overall distributed ledger.

Standardization

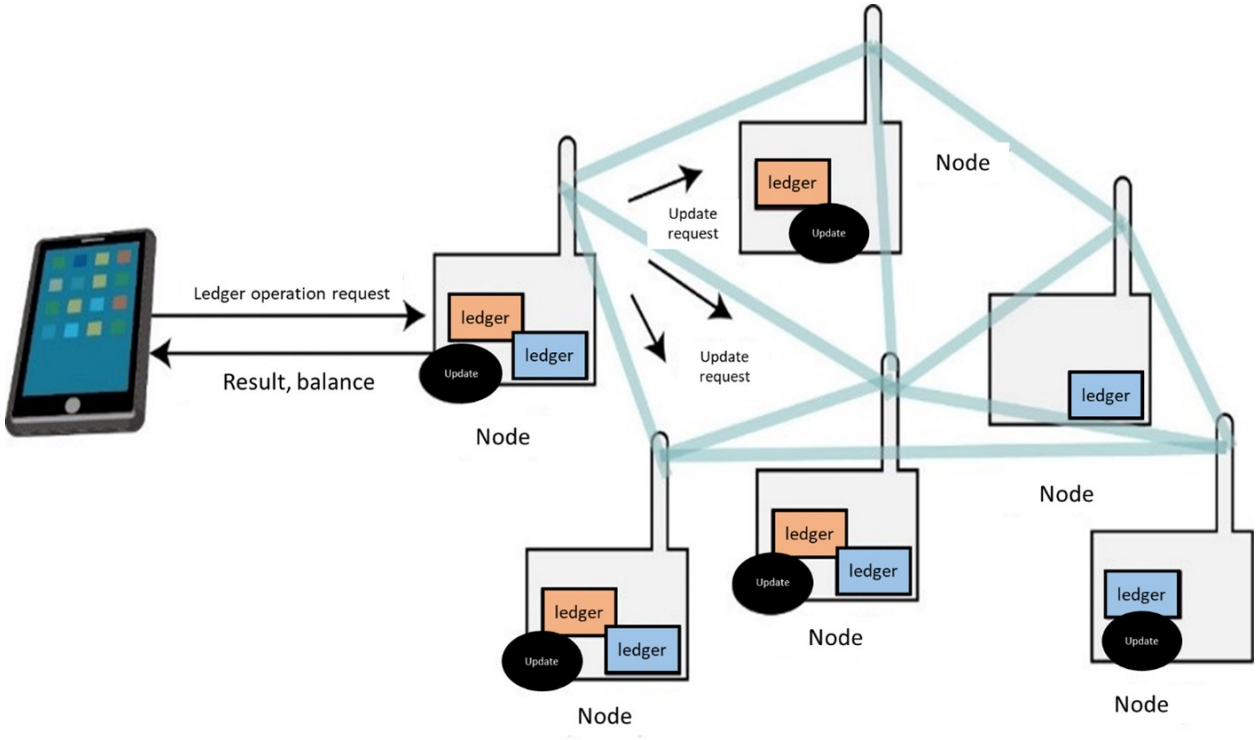
- We summarize the standardization work of ITU-T, ISO, IEEE on distributed ledger.

Optimizing Packet Transmission for Ledger-based Points Transfer System in LPWAN: Solutions

- Objective

The design principle of this system is to realize the points transfer from Tag A to Tab B. At the same time, the ledger strictly manages the user's points balance. This point transfer system is based on LPWAN, which can transfer points even in case of disasters.

The objective of this paper is to optimize the packets transmission for the ledger-based points transfer system in LPWAN.

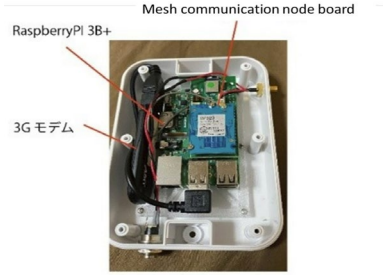


Optimizing Packet Transmission for Ledger-based Points Transfer System in LPWAN: Solutions

- *System devices*

1) Node

This node is used for Bluetooth communication between LPWA wireless communication modules and smartphones, etc. A BLE microcomputer and a commercially available microcomputer were used



Mesh communication node board+RaspberryPI

2) Payment operation terminal

We first developed a payment terminal using a commercially available microcomputer with a touch screen. The terminal also has Bluetooth communication capability to communicate with distributed ledger nodes.


a. Display the surrounding tags and nodes

b. Select the tag and amount when paying

c. Make payment

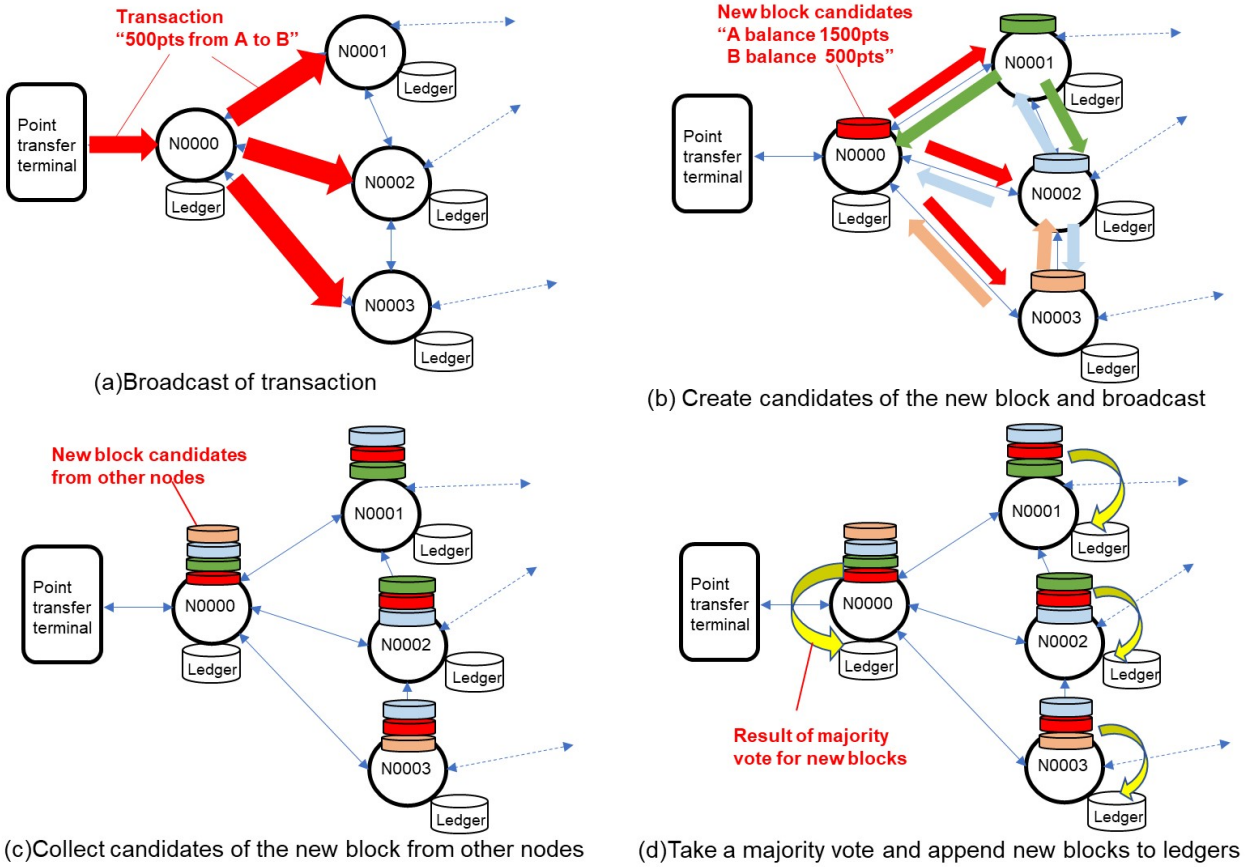
3) Tag

For the private key tag, we built a prototype using a commercially available microcomputer with low power consumption and Bluetooth communication capabilities to store the account ID and encryption key.

Optimizing Packet Transmission for Ledger-based Points Transfer System in LPWAN: Solutions

- *Problem statement*

If we use the ledger mechanism in right figure, the points transfer system in LPWAN-based environment is too slow to complete a transaction due to the performance limitation of nodes. According to the simulation results, in this system, it takes about 1742 packets to generate one transaction without considering the limitation of communication network. After calculation, packet size 64byte*1742=111488byte=891904bit. The LPWA speed is 1 kbps for one Nth of 50 kbps, which means it takes about 892s (14.2min) to complete one transaction. It is necessary to reduce the overall number of packets across the system to speed up transaction completion.



Optimizing Packet Transmission for Ledger-based Points Transfer System in LPWAN: Solutions

- *Optimizing Packet Transmission*

In this paper, we select some nodes rather than all nodes as ledger nodes to jointly maintain the transaction data of the whole system. Here, we use K-means clustering, a location-based method, to select nodes.

Step 1: Create N non-multihop nodes (normal nodes).

-Random generate N coordinates within range (x,y).

Step 2: perform k-means clustering (an example shows in Fig. 4).

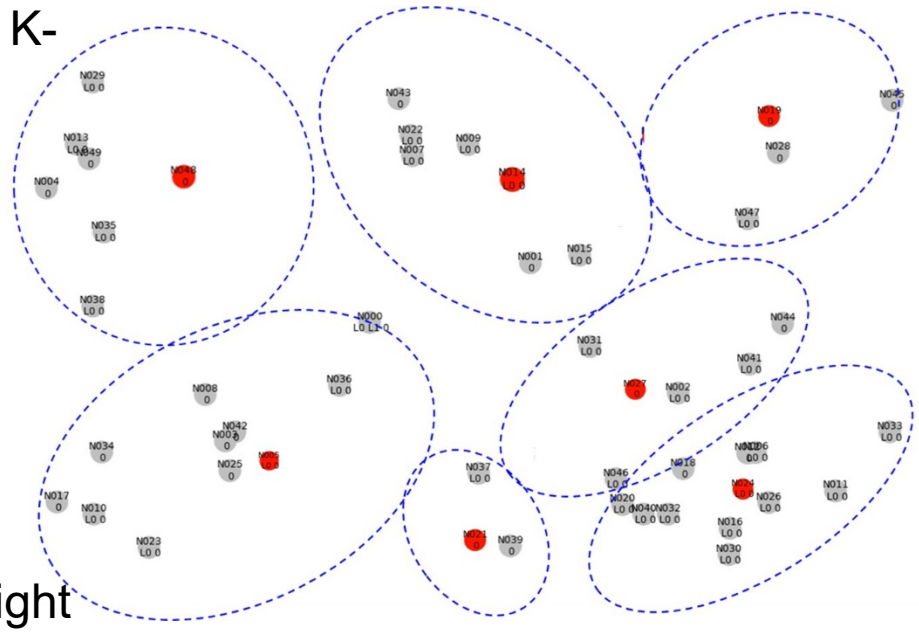
- Limited distance by preset maxrange(384).

- Make sure k nodes' coordinates are within range(x,y).

- At least they line up with max distance maxrange(384).

- Please note that the "384" means distance in virtual space shown in right figure(H1920, V1080).

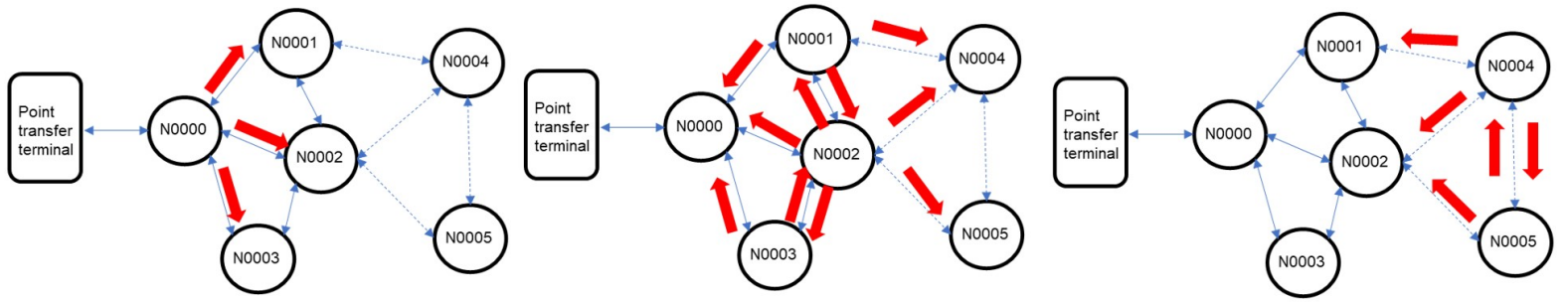
Step 3: Return k nodes coordinates. Step 4: Add multihop function to k nodes.



Optimizing Packet Transmission for Ledger-based Points Transfer System in LPWAN: Evaluation

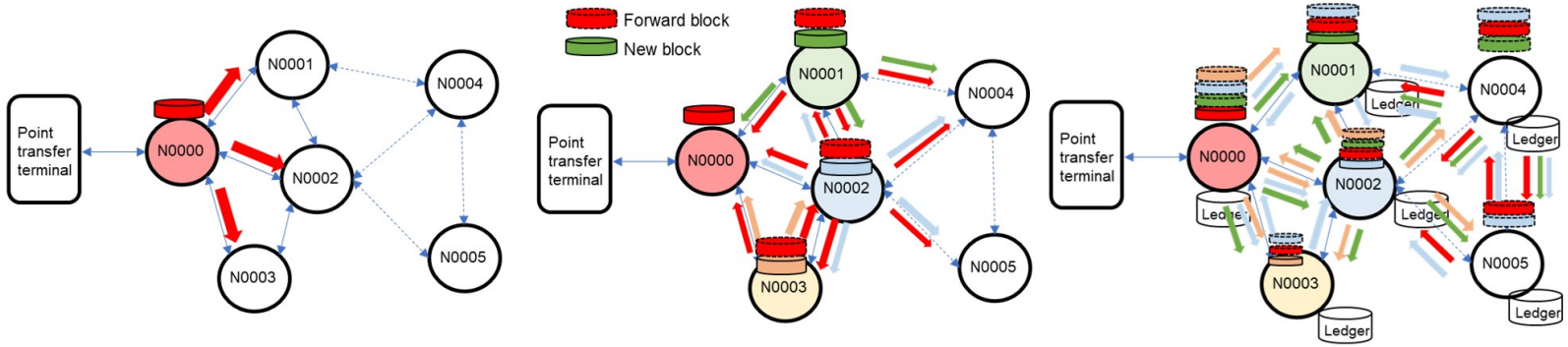
The simulator used in this experiment is based on python language, which generates randomly distributed nodes in a simulated LPWA wireless network environment, specifying the parameters of the nodes and other information. Depending on the actual LPWA network parameters, we can specify the number of transactions and the method of transaction requests in the simulator.

Request of a new transaction explain detailed protocol of CommandRequest (point transfer request)



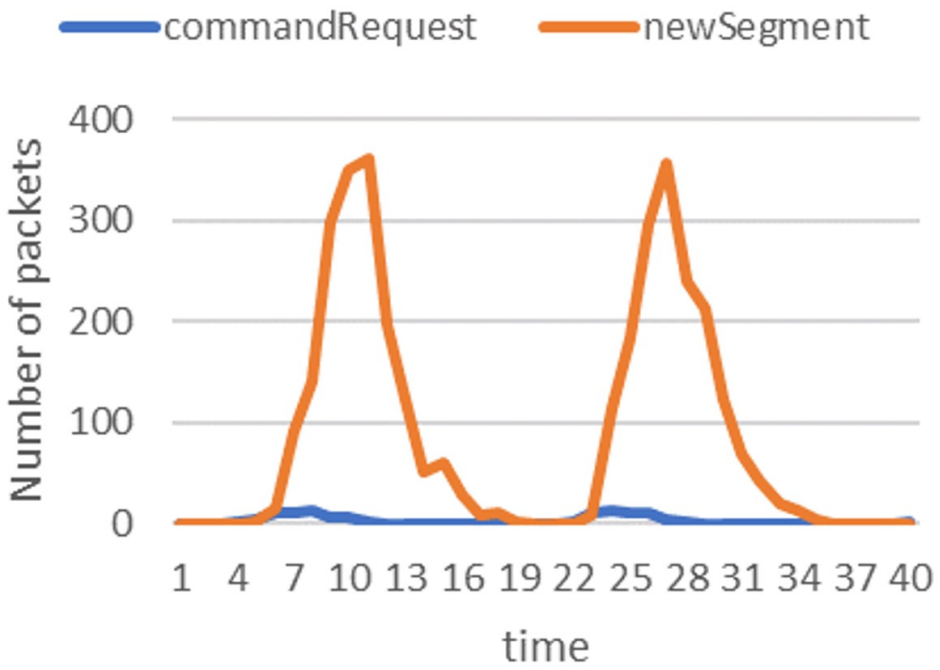
(a1) Send a new transaction to neighbor nodes (a2) Forward received transactions (hop1) (a3) Forward received transactions (hop2)

New blocks for the transaction explain detailed protocol of NewSegment (a new block candidate)



(b1) Send a new block to neighbor nodes (b2) Send and Forward new blocks (hop1) (b3) Forward new blocks (hop2)

Optimizing Packet Transmission for Ledger-based Points Transfer System in LPWAN: Evaluation



The number of packets when time is within 40 and the number of multi-hop nodes is 50

The number of packets

Optimizing Packet Transmission for Ledger-based Points Transfer System in LPWAN: Evaluation

Simulation results

K	10	20	30	40	50
Average number of packet (CommandRequest) (*1)	51	51	51	50.9	51
Average number of packet (NetSegment)(*1)	205.8	431.3	796.2	1172.6	1679.5
Average success rate (*2)	93	92.5	100	100	100
Number of request success rate less than 100%	27	25	0	0	0

*1) summation of packet through Time= 0 to 599 and calculate average value for the number of request (sum(commandRequest)/30).

*2) average success rate in 30 requests.

Optimizing Packet Transmission for Ledger-based Points Transfer System in LPWAN: Standardization

- ITU-T. According to information published on the ITU website, as of December 2020, ITU-T has released 14 standards related to blockchain/distributed ledger technology, 2 of which were approved at the end of 2019, and all 14 of which were released in 2020. Among the published standards, four are security-related, three are data management-related and three are IoT-related, which shows the attention of ITU to security issues and IoT and data issues.
- On September 12, 2016, ISO established the "Blockchain and Distributed Ledger Technologies Committee" (ISO/TC 307) to promote the development of international standards in the field of blockchain and distributed ledger technology.

- According to the information published on the IEEE standards website (https://standards.ieee.org/), in March 2020, the first IEEE blockchain standard "IEEE Standard for Data Format for Blockchain Systems" was successfully approved by the committee, which specifies the data format requirements for blockchain systems and gives specifications in terms of data structure and data types. As of December 2020, IEEE has published five blockchain-related standards, three of which are related to cryptocurrencies, as well as one data format standard and one data management standard.

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Thank you!