Blockchain based Internet of Energy Data Management

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***Abstract*—Blockchain, the great invention of 21^{th} century, is getting tremendous popularity around the world day by day. Initially, it was originated for peer-to-peer money transfer (Bitcoin) without any trusted third party but now it is no longer confined in monetary transaction. It is being applied in numerous sectors such as online marketing, electronic voting, government policy, carbon footprint reduction, and smart healthcare as it offers end-to-end data trading in a secure tamper-proof way. Data are stored in blockchain in a distributed manner. Conventional centralized cloud server is replaced by decentralized servers to mitigate the vulnerability of data storage systems and meet the demand for data security. As a result, the dependency on one central server is reduced and data privacy is enhanced. Storing transaction data in decentralized manner increases security and reduces the dependency on a central authority. In this short paper, we briefly propose blockchain based energy data management policy for Internet of energy (IoE) network.**

***Index Terms*—Blockchain, Internet of energy (IoE), data management, data security.**

I. Introduction

With the development of smart grid, the importance of Internet of energy (IoE) data security is increasing day by day. Current smart grids face several challenges as these use central cloud server for storing IoE data. Firstly, customer's power information may be stolen by potential attackers when it is stored in the cloud server. Secondly, any alteration or modification of cloud data cannot be investigated. Thirdly, the centralized data storage system carries the problem of single point failure that means if somehow the central server fails to run or is disconnected from the IoE network all the communication with the end users will be terminated immediately. Fourthly, centralising method of data transaction requires a third party for verification and authentication . This trusted party is accountable for any failure in updating data, dalays in delivery , or fraud [1]. Finally, to store a huge amount of IoE data, a high performance server is needed that has high storage capability.

Therefore, it is urgent to develop a decentralized IoE data management system, where the duplicate copies of IoE data will be stored in multiple servers that will reduce the risk of single point failure and bring high flexibility in IoE infrastructures.

Blockchain provides an excellent solution to mitigate these problems. It is not only applicable for data trading but also can be used for peer-to-peer energy trading. The existing electricity market is based on a centralized energy trading policy, where electricity producers supply electricity to consumers through trusted third parties such as banks. Peer-to-peer energy transaction is not possible in traditional energy trading policy. A blockchain-based energy trading allows peer-to-peer energy trading in both smart grid framework [2] and vehicular energy network such as vehicle to vehicle (V2V), vehicle to grid (V2G), and building to vehicle (B2V) [3]. Blockchain offers distributed storage capabilities and allows peer-to-peer transactions without having to rely on trusted third parties. This special technology has gained enormous popularity all over the world over the last few years due to various applications such as data management, cyber security, cloud storage, online money transfer, and energy management of the Internet on the Internet of Things (IoT) platform. Energy (IoE) platform, supply chain management, carbon footprint reduction, smart grid, electric vehicle, smart healthcare, real estate business, electric voting, government policy, etc.

A blockchain is a growing list of records, called blocks, which are linked using cryptography. Blockchain that can be accessed by both authorized and unauthorized users is called public blockchain (e.g. Bitcoin, Ethereum). Private blockchain allows only authorized users to participate in peer-to-peer data transaction. Private blockchain is generally used for corporate business or private company. Electricity marketplaces heavily depend on data integrity. In a blockchain-based scenario, it is also important to collect data packets from wireless sensor nodes in IoE network and verify them using elliptic curve digital signature algorithm (ECDSA). The IoE data will be stored in some cryptographic blocks that are connected with each other via cryptographic hash.

In the next section, we will briefly present our proposed model for blockchain based IoE data management.

II. Proposed Model for Blockchain based IoE Data Management

In our proposed blockchain based IoE model, all loads and customers' information are recorded in blockchain in a secure way. Electricity generation, transmission, distribution, renewable energy certification data, billing information, and tarrif data are also stored. For private energy company, private

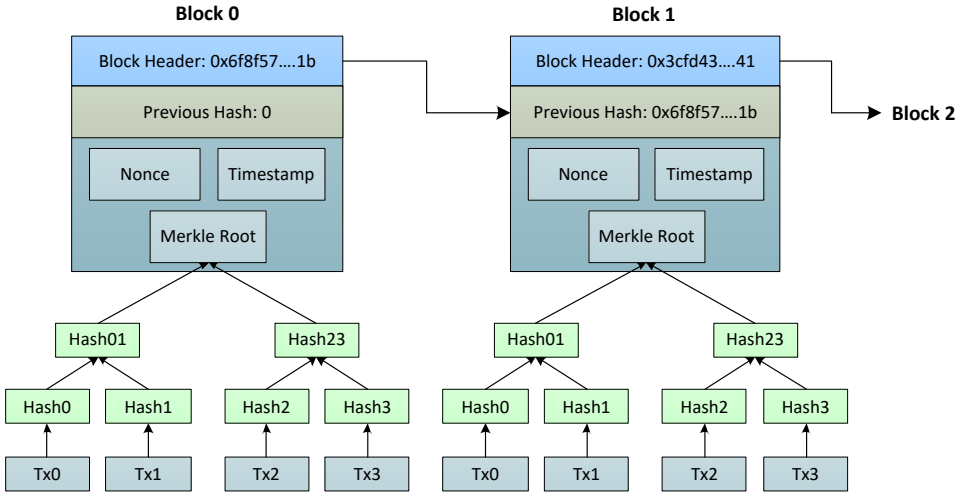

Fig. 1. Basic blockchain architecture.

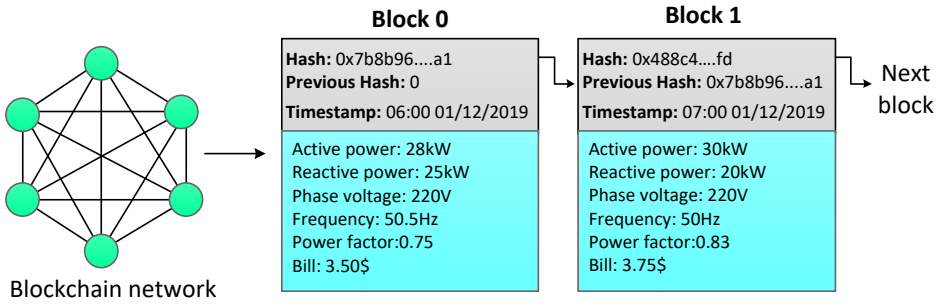

Fig. 2. Data to be stored in blockchain.

blockchain is used and for multi national energy company, we use consortium blockchain that is a semi public blockchain network.

The data is then added to the blockchain. The party receiving the data (Node 2) can verify the ownership of the data by verifying the signature with the public key of Node 1 that is publicly accessible. The recipient cannot check whether the sender had already used the same data transaction prior to the current transaction, which is known as double spending [4]. Only miners and the full nodes who have already downloaded the whole blockchain can check the double spending. Data is stored in some cryptographic blocks. Every block contains a hash value, which is a hash of the hash value of the previous block, a nonce, a timestamp, and a list of transaction. Each transaction data is connected with each other as they are distributed in a merkle tree as shown in Fig. 1 and Fig. 2. Once energy data is stored on the blockchain, it cannot be modified. Hacking a single block is not enough to hack an entire network. To hack the network, someone must hack at least 51% of the nodes in the blockchain.

III. Conclusion

A blockchain based IoE data management model has been proposed to enhance the security of energy data in IoE network. Conventional centralized cloud server is replaced by decentralized servers to mitigate the vulnerability of data storage systems and meet the demand for data security. As a result, the dependency on one central server is reduced and data privacy is enhanced.

IV. Acknowledgement

This research was supported by the MSIT (Ministry of Science and ICT), Korea, under the ITRC (Information Technology Research Center) support program (IITP-2018-0-01396) supervised by the IITP (Institute for Information & communications Technology Promotion).

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