Chapter 17
Blockchain-Empowered Big Data Sharing for Internet of Things

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ABSTRACT

A recent study predicts that by 2025, up to 75 billion internet of things (IoT) devices will be connected to the internet, in which data sharing is increasingly needed by massive IoT applications as a major driver of the IoT market. However, how to meet the interests of all participants in complex multi-party interactive data sharing while providing secure data control and management is the main challenge in building an IoT data sharing ecosystem. In this article, the authors propose a blockchain-empowered data sharing architecture that supports secure data monitoring and manageability in complex multi-party interactions of IoT systems. First, to build trust among different data sharing parties, the authors apply blockchain technologies to IoT data sharing. In particular, on-chain/off-chain collaboration and sharding consensus process are used to improve the efficiency and scalability of the large-scale blockchain-empowered data sharing systems. In order to encourage IoT parties to actively participate in the construction of shared ecology, the authors use an iterative double auction mechanism in the proposed architecture to maximize the social welfare of all parties as a case-study. Finally, simulation results show that the proposed incentive algorithm can optimize data allocations for each party and maximize the social welfare while protecting the privacy of all parties.

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INTRODUCTION

With the development of 5G and mobile cloud computing, data sharing plays an increasingly important role in IoT development since most IoT applications are deployed upon data sharing (Cao et al., 2019). It is estimated that 5 quintillion bytes of data will be produced by IoT devices and these data will be analyzed and shared among devices, which is producing a large-scale market (Li et al., 2017, Li & Asaeda, 2018). However, the current IoT data market is far from meeting those expectations. One of the main reasons is that the IoT data sharing usually involves multiple parties and so that leads to interest and security problems that make a user reluctant to share data (Barnaghi & Sheth, 2016). More specifically, it is difficult to balance multiple interests due to lack of consensus among participating parties, and on the other hand, there is a lack of secure control and supervision among the complex interactions of multiple parties, so that the privacy of participants cannot be well protected.

Blockchain is an immutable public ledger secured by the participants in a peer-to-peer network. As a major technology behind the emerging cryptocurrencies, it is being popularized and applied rapidly (Dai et al., 2019). Some inherent features of blockchains, such as decentralization, anonymity and automatic performance, make it be an attractive technology for building a shared IoT ecosystem. Consequently, inspired by these advantages, blockchain-based data sharing has been introduced and implemented in the recent research works (Kang et al., 2019, Yu et al., 2018, Xu et al., 2018, Jiang et al., 2018). For example, some proposed a blockchain-based data sharing scheme for the IoV by optimizing consensus management (Kang et al., 2019), and others proposed a new cryptocurrency named LRCoin to enhance the security of data trading in IoT (Yu et al., 2018). Although these approaches have brought blockchain technologies to IoT data sharing, they cannot achieve the efficient and trustable IoT data sharing due to the following challenges:

- **Scalability:** Billions of IoT devices will join the data sharing and they require to trade data in a real time manner. However, most of blockchain systems have the limitations of high latency and low throughput, and scale poorly. Thus, it is important to consider the scalability issues for the blockchain-empowered big data sharing.
- **Traceability:** IoT data sharing usually involves many parties that join the data sharing process and interact with each other to complete the data trading transactions, which makes it difficult to build trust or identify the malicious parties. Thus, a secure monitor and management are needed in IoT systems for a data sharing when involving complex and multiparty interactions.
- **Incentive Mechanism:** The privacy of data sharing participants cannot be well protected in traditional incentive mechanisms. IoT data sharing involves multiple parties and usually lacks of secure control and supervision in the complex interactions, which results in motivation decreases for participating in a data sharing.

To tackle the above research issues, the authors propose a blockchain-empowered big data sharing framework to build a trustable data trading ecosystem. With the proposed architecture, an aggregator manages data in a region area network (RAN) and interacts with the blockchain. Blockchain helps data sharing by working as a trustable data trading platform. In particular, the authors study how to control and manage a secure interaction among multiple parties in IoT systems. Moreover, to scale the blockchain designs, the authors present a sharding consensus to implement the partition of consensus, and use the InterPlanetary File System (IPFS) and Secure Multiparty Computation (SMC) to extend on-chain storages.