2020 19th International Symposium on Distributed Computing and Applications for Business Engineering and Science (DCABES)

Integration of Internet of Things and blockchain for chattel asset pledge financial service

Mingjuan Wu
Wuxi SensingNet Industrialization Research Institute, WSN Institute
Wuxi of Jiangsu Province, China
40727329@qq.com

Haitao Liu
Wuxi SensingNet Industrialization Research Institute
WSN Institute
Wuxi of Jiangsu Province, China
liuhaitao@wsn.cn

***Abstract*—This paper demonstrates how to use IoT and blockchain to enable chattel asset pledge financial service. In the beginning, the background, the advantages and challenges for integration of IoT and blockchain technologies for industries are introduced, and then the relevant survey are studied. The actors in the chattel asset monitoring application scenario, relationships, data flow and interaction sequences among the involving actors are depicted, Finally, the conclusion has been given to summarize the paper.**

Keywords-financial service; IoT; blockchain; application; interaction.

I. INTRODUCTION

In traditional chattel asset pledge financial services, financial institutions usually can't obtain the real-time information of the chattel asset pledge, and lack efficient management for accessing, assessing and sharing the information of chattel assets among stakeholders neither. Further, there is no chattel asset monitoring and tracking system which can quantify and validate chattel assets used as pledge for loan applications. Even worse, some illegal actors get loan through duplicate pledges or fraudulent activities by using the loopholes because of the lack of information transparency, which damages both the financial and the chattel asset industries.

With the development of IoT and blockchain technologies, IoT systems with blockchain are highly applicable to real-time monitoring and tracking the chattel assets in warehouse or in transit, which resolves and avoids the unnecessary high risks in the financial industry.

II. RELATED STUDIES

A lot of survey on integration or collaboration of IoT and blockchain have been investigated. A review [1] is developed on the types of blockchain and how to adapt blockchain to the needs of IoT and lists typical blockchain-based IoT (BIoT) applications. A survey [2] on the convergence of AI, IoT, big data and blockchain points out the ultimate technology breakthrough can be realized when leverage the integration of IoT, AI, blockchain and frog computing. Big data has been largely applied in education, healthcare, urban planning, agriculture sector, etc. Because of the limited resources of IoT devices, the possibility of applying the existing consensus methods to a blockchain-based IoT network are considered [3], and the consensus protocols are compared in the terms of decentralization, scalability, latency, throughput, adversary tolerance, computing, network overhead, storage overhead, etc. A cost-aware IoT framework [4] with a reinforcement learning agent that controls the IoT devices' interaction with smart contracts and adapts to users' needs is proposed to leverage the security features of public blockchain while minimizing the corresponding cost.

The potential applications enabled by IoT and blockchain are exploited in the future digital market. Steve Huckle [5] explores the how to make use of the IoT and blockchain to create shared economy distributed applications, and presents examples including automatic payment and international tour in the context of and IoT architecture using blockchain technology. A novel blockchain-based transparent framework and decentralized business model with IoT service is applied in delivery insurance on supply chain [6], creating the solutions that record and share data on the business participants. Drivers for integration of IoT and blockchain include the exponential growth of IoT devices, the emergence of 5G network, the cloud computing and web services. The applications covering healthcare, supply chain, smart energy grids [7], and the challenges of cybersecurity, computation, storage, granularity of transactions, trust and privacy are faced.

For the subject of financial services including insurance service, financial technology, bulk commodity, etc., some papers develop the digitalized solutions with blockchain, big data, AI, and IoT. Su Lei [8] researches on the bulk commodity innovative business classification for digital supply chain finance based on the blockchain platform collaborated with IoT. Supply chain finance and logistics finance, especially financing for the retail sellers are supported by blockchain [9]. A framework for blockchain-enabled logistics finance execution platform (BcLFEP) is proposed, involving a hybrid finite state machine-based smart contract, and the dynamic inventory pledge model for the interaction steps of the participants in the supply chain retail and logistics scenarios. Blockchain displays its technical characteristics for financial services in traditional banks to reduce cost, control risks, and seek profit, and the critical success factors for the adoption of blockchain solutions within financial services are summarized [10].

III. THE ADVANTAGES AND CHALLENGES OF INTEGRATION OF IOT AND BLOCKCHAIN TECHNOLOGIES

A. Internet of Things (IoT)

IoT is the information technology of the new generation, and its value and significance has been widely recognized. Currently, the IoT development has gone through the initial stage, and the environment for large

2473-3636/20/$31.00 ©2020 IEEE
DOI 10.1109/DCABES50732.2020.00051

scale of IoT applications has formed. It is a critical point for the rapid development of the entire IoT industry. However, due to the complexity of IoT and its difficulties of integrating IoT technologies with industrial applications, Currently, the focus of the IoT industry mainly relying on infrastructure construction and partial innovations, it causes a lot of issues of IoT development, such as high cost service, complex application approaches, and various security and privacy data risks. Meanwhile, the potential value of IoT application in various industries has not been explored in depth.

The IoT development faces kinds of issues which can be summarized as following:

1) Complex technologies: IoT includes a lot of technologies involving chips, hardware modules, terminals, network communications, information process, applications, data process and other technics. Market of IoT has not been fully opened, and therefore the transfer of the data value is very slow.

2) Interactions and cooperation framework: Interactions and cooperation framework among all types of stakeholders such as users, objects owners, equipment developers, service providers, and third-party resource owners are not mature, and the credit and value systems for the whole IoT industry are not mature; and this increases the difficulties of IoT applied with various industries.

3) The data privacy: Some centralized IoT service platforms collect and analyse users' data and even control users' devices without permission or authorization from users, which is a great threat to users' privacy and security.

Therefore, there still need new technologies to ensure the legal identities of IoT devices, the data validity, authenticity, consistency, and modified illegally to promote IoT applications.

B. Blockchain

Blockchain is a kind of data structure that makes it possible to create a digital ledger of transactions and share it among a distributed network of computers. It uses cryptography to allow each participant on the network to manipulate the ledger in a secure way without the need for a central authority. Blockchain origins from bitcoin as a famous digital encrypted currency, but now the popular project on blockchain can be found in the world in different applications, such as financial service, insurance, medical, energy and other sectors.

The transaction is verified and recorded by consensus nodes of blockchain, so it is impossible to distort the transaction data which is verified by the consensus. It provides a trustworthiness support for the services which is based on the blockchain technology. Blockchain can provide following benefits for IoT solutions:

1) The immutable data: It ensures the security of shared IoT data when it is stored on the distributed ledger.

2) Seamless connections between stakeholders. Each stakeholder can have their own replica of the distributed ledger on a node which they own and control. The process for adding transaction records to the ledger is performed by consensus algrithms and smart contracts, which are distributed applications that can be agreed among the stakeholders in a secure way.

3) Incentive mechanisms. Smart contract with incentive methods (e.g. a digital currency) can be used to reward the nodes that contribute to verifying and recording transactions. It encourages participation of the ecosystem in the entire solutions.

C. The advantages of integration of IoT and blockchain

Combining IoT and blockchain enables the creation of better solutions for many sectors, particularly where those solutions involve information associated with physical entities of cross sectors, and where the solution spans many organizations with a need for trusted information to be shared by those organizations.

The technological attributes of blockchain is really helpful for the IoT. It can support and push more secure and abundant IoT applications. Now blockchain has such technical attributes as device's identity and permission management, smart contract, data security and privacy protection, and trustworthiness mechanisms. It will reshape the value and credit system of online and offline business, which can further expand the space of IoT add-on services in the industries.

IoT enables the blockchain technology to be deeply used in real physical world. In the previous stage, the blockchain appears as a virtual digital currency and transfers transactions which seems to have little to do with the physical actions. If the blockchain is integrated with IoT, the data from the IoT gives a physical meaning for the data on the blockchain, and it builds a mapping from the physical world to the virtual world. IoT will generate the data of the entities, and blockchain facilitates the data and circulate the value of ecosystem among the stakeholders.

D. The challenges for integration of IoT and blockchain

The challenges exist for integrating IoT and blockchain both on the technical side and the business side.

From the technical side, firstly, the high efficiency, low resource occupancy and high security of blockchain is important to satisfy the IoT application requirements of multiple partners' transaction, mass terminal access, and privacy protection. Secondly, it is necessary to further explore and apply the technologies of consensus mechanics, smart contract into the IoT devices, middleware, and system platforms.

From the business side, Enterprises, government and research institutes are cooperative of the industrial chain to create a security, well-organized, sustainable, and win-win business operation environment. How to exploit the advantages of blockchain so that it can solve the business operation issues of the IoT. How to achieve the transactions among multiple stakeholders and collaborative services in multi-industry fields by using the leveraged consensus mechanism, incentive mechanism, and smart contract.

IV. CHATTEL ASSET PLEDGE FINANCIAL SERVICE APPLICATION SCENARIO

The actors involved in the application scenario include:

1) Sensor nodes for monitoirng the chattel assets. They are IoT devices which acquire the data/information relevant to the chattel assets in warehouse or in transit, such as the number, weight, size, temperature, humidity, etc.

2) IoT gateway. It is an IoT device which communicate with the sensor nodes in the proximity network and aggregates the data/information from the sensor nodes, and transmits the aggregated data/information to the chattel asset monitoring platform by which it is authenticated first.

3) Chattel asset monitoring platform. A platform that provides the monitoring services of the chattel assets, supported by blockchain where the data of the chattel asset is stored. The chattel asset monitoring platform supported by blockchain is owned and operated by chattel asset monitoring service organizations.

4) APP. It is an application software for the users to access the service of chattel asset monitoring platform.

5) Financial service portal. It is a digital user as a financial application web for the enterprises to apply for financial service.

6) Bank. Participants who provide loan to enterprises according to the monitoring data and other data of the enterprises.

7) Enterprise. Organizations who apply for and obtain the loan from the bank with chattel asset pledge service.

The security issues for the application scenario include:

1) Data Security: The data security requirements are essential for the enterprises. For example, the data of the chattel asset monitoring platform should not be tampered, and the data should be encrypted and stored in a decentralized manner.

2) Privacy requirements: The privacy requirements are important for enterprises and chattel asset monitoring service organizations offering data service. Enterprises and the chattel asset monitoring service organizations who collect data/information with the chattel asset monitoring platform shall be authenticated. The data/information of enterprises and stakeholders should not be obtained by unauthenticated users.

3) Trustworthiness requirements: The chattel asset monitoring platform should provide banks with reliable and tamper-proof data/information.

The user requirements for each stakeholder which can be fully evaluated and tested include:

1) The user requirements for enterprises: To get loan and obtain other financial services by banks.

2) The user requirements for banks: To prevent and reduce the financial risks while providing enterprises with financial service through chattel assets pledge.

3) The user requirements for the organizations providing the chattel asset monitoring service: To build the chattel asset monitoring platform in order to get the tamper-proof and authenticated data, and to realize the easy interactions for the banks and the enterprises through the financial service portal.

V. INTERACTIONS

A. The basic interaction relationship

Figure 1 describes the relationships of the enterprises who own chattel assets and request a loan, bank, and the organization the provides the chattel asset monitoring services with IoT and blockchain technologies.

The interaction procedures for three stakeholders includes:

1) Loan application. Enterprises submit loan applications to the bank.

2) Authorization. The bank authorizes the organization to deliver the chattel asset status data.

3) Obtain the original data. The organization obtains the chattel asset monitoring data generated for the enterprises.

4) Reply the monitoring data. The organization reply the chattel asset status data to the bank for chattel asset evaluation, which acts as an important evidence in judging the loan repayment capability of the enterprises.

5) Reply the loan result. After reviewing the loan application from enterprises and evaluating the asset status data, The bank makes its final decision if approve the loan application, and reply the loan application result to enterprises.

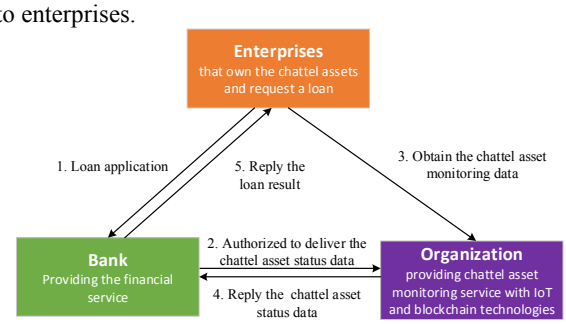

Figure 1. Interaction for the stakeholders

B. Data flow

There are three types of data flows in this chattel asset monitoring.

1) The monitoring data flow for chattel assets in warehouse

The monitoring data for chattel assets in warehouse is collected by different types of sensor nodes recording the weight, contour, movement, position and other information about the assets, analysed by the IoT gateway in warehouse, and recorded in the chattel asset monitoring platform integrated supported by blockchain, displayed for the IoT users, such as financial institution, chattel asset owner, and chattel asset monitoring organization.

2) The monitoring data flow for chattel assets in transit

The monitoring data for chattel assets in transit is collected by different types of sensor nodes recording the movement, vibration, tilting and other information, analysed by the IoT gateway in transit, and recorded in the chattel asset monitoring platform supported by blockchain, displayed for the IoT users, such as financial institution, chattel asset owner, and chattel asset monitoring organization.

3) The order receipt management data flow for the IoT users

The order receipt management data, including chattel asset status data (e.g., chattel asset type, specification, quantity, asset position in the warehouse, etc.) and chattel asset transaction data (e.g., pledgee, pledger, order number, order amount, etc.), is generated, updated, managed by a chattel asset monitoring organization, according to the order of the chattel asset pledge business.

The order receipt management data should be shared with the authorized IoT users, such as the financial institution and the chattel asset owner.

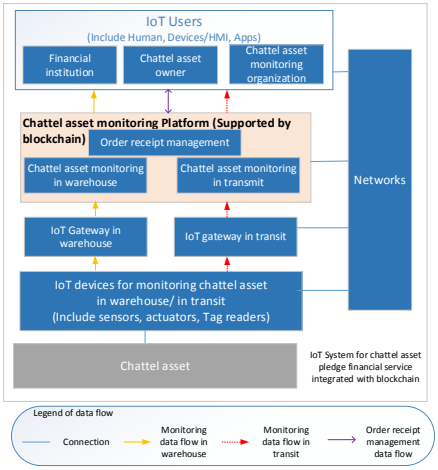

Figure 2. Data flow

C. *Interaction sequences*

This sequence diagram shown in Figure 3 describes the steps to set up the interactions for all the actors. The steps are briefly described as follow.

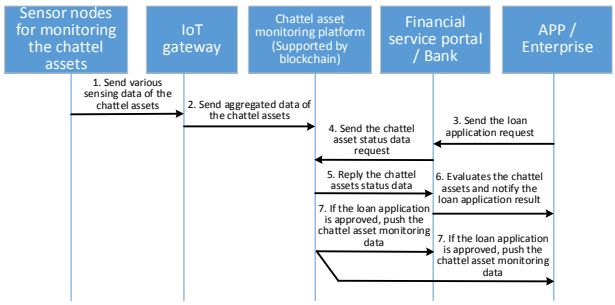

Figure 3. Interaction sequences for the actors

*1) Send various sensing data of the chattel assets.*Sensor nodes send the IoT gateway the sensing data of the chattel assets in warehouse and in transit.

2) Send the aggregated data of chattel assets. IoT gateway sends the chattel asset monitoring platform the aggregated data of chattel assets in warehouse and in transit.

3) Send the loan application request. Enterprise sends financial service portal the loan request data including basic information of enterprise and the relevant orders of the chattel assets.

4) Send chattel asset status data request. Financial service portal sends chattel asset monitoring platform the request data including the basic information and orders of chattel asset for the enterprises.

5) Reply the chattel asset status data. Chattel asset monitoring platform sends financial service portal the chattel asset status data including the proof of the order for the chattel assets.

6) Notify the loan result after the financial service portal evaluates the chattel assets. Financial service portal sends the loan result if it is approved and the loan limit to enterprise.

7) If the loan application is approved, push the chattel asset monitoring data. Chattel asset monitoring platform sends financial service portal and APP the chattel asset monitoring data, such as the status, move-in, move-out and in-transit data, the ownership of the chattel asset, etc.

ACKNOWLEDGMENT

This paper gets help from the national key research and development plan in China, titled key technology research and standardization of IoT terminal evaluation platform, with the project number 2018YFB2100200.

VI. CONCLUSION

This paper illustrates the technical background, potential advantages of integration of IoT and blockchain, and the chattel asset pledge financial service application scenario with the IoT system supported by blockchain. Compared with the traditional financial service, the technical integration promotes the data traceability, and provides involving stakeholders with the peer-to-peer credible platform to build the financial service ecosystem.

REFERENCES

[1] TIAGO M.FERNANDEZ-CARAMES, and Paula Frafa-Lamas, “A review on the use of blockchain for the Internet of Things,” IEEE Access,2018,Volume 6, pp. 32979-33001.

[2] Kefa Rabah, “Convergence of AI, IoT, big data and blockchain: a review,” The lake institute Journal, 2018, Vol 1, pp. 1-18.

[3] Mehrdad Salimitari, Mainak Chatterjee, Yaser P. Fallah, “A survey on consensus methods in blockchain for resource-constrained IoT networks”, Internet of Things, 2020, Vol 11, pp. 1-19, doi:10.1016/j.iot.2020.100212

[4] Naram Mhaisen, Noora Fetais, Aiman Erbad, Amr Mohamed, Mohsen Guizani, “To chain or not to chain a reinforcement learning approach for blockchain-based IoT monitoring applications,” Future Generation Computer Systems, 2020, pp. 39-51, doi:10.1016/j.future.2020.04.035.

[5] Steve Huckle, Rituparna Bhattacharya, Matin White, Natalia Beloff, “Internet of Things, blockchain and shared economy applications,” International workshop on data mining in IoT systems (DaMIS), 2016, pp. 461-466.

[6] Mehmet Demir, Ozgur Turetken, Alexander Ferworn, “Blockchain and IoT for Delivery assurance on supply chain (BIDAS),” IEEE International Conference on Big Data (Big Data), 2019, pp 5213-5222.

[7] A. Ravishankar Rao, Daniel Clarke, “Perspectives on emerging directions in using IoT devices in blokchain applications,” Internet of Things, 2020, Vol 10, pp.1-16. Doi:10.1016/j.iot.2019.100079.

[8] Su Lei, Li Haiyue, Wang Haiying, Tian Weiyu, “Research of innovative business classification in bulk commodity digital supply chain finance,” International Conference on Computer Engineering and Application (ICCEA), 2020, pp.170-173.

[9] Ming Li, Saijun Shao, Qiwen Ye, Gangyan Xu, George Q. Huang, “Blockchain-based logistics finance execution platform for capital constrained E-commerce retail,”, Robotics and Computer Integrated Manufacturing, 2020, Vol 65, pp.1-14, doi:10.1016/j.rcim.2020.101962.

[10] Victor Chang, Patricia Baudier, Hui Zhang, Qianwen Xu, Jingqi Zhang, Mitra Arami, “How blockchain can impact financial services – the overview, challenges, and recommendations form expert interviewees,” Technological Forecasting & Social Change, 2020, Vol 158, pp.1-12, doi:10.1016/j.techfore.2020.120166.