A Blockchain-based Information Model of Cross-Border E-Commerce

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Abstract: Blockchain technology provides us a new tool to solve the product traceability problem in supply chain. This in-progress paper focus on the cross-border e-commerce context, to develop blockchain-based information models for products and transactions. A general blockchain-based product information traceability framework is introduced. The framework is applied in cross-border e-commerce context. We also designed a multiple chain structure and the data management model following the framework. In the future works, we will develop the key distribution, anti-counterfeiting and other approaches following this framework, and also verify them with real data and simulation.

Keywords: blockchain technology, cross-border e-commerce, product traceability

1. INTRODUCTION

In 2008, Satoshi Nakamoto [1] proposed a completely decentralized electronic money trading system based on cryptography and distributed networks. This is the first case of blockchain technology. In the case of a non-trusted organization, conduct peer-to-peer digital currency transactions. In 2013, Vitalik Buterin [2] combined the smart contract with the blockchain to launch the Ethereum project, which enables users to create contracts to complete any state transfer function and automate business processes by building a blockchain system in Turing's complete language. Melanie Swan [3] first launched the block trading technology based trading platform Linq in December 2015, which became an important milestone in the decentralization trend of the financial securities market. In January 2016, the British government released the blockchain topic. The research report ("Technical report by the UK government chief scientiflc adviser ") actively promotes the application of blockchain in financial and government affairs; the People's Bank of China convened a digital currency seminar to explore the feasibility of using blockchain technology to issue digital currency to improve the efficiency, convenience and transparency of financial activities.

Since the rise of blockchain technology, the industry and academia have not yet accurately defined it. Yuan and Wang [4] describe the blockchain from the aspects of data structure, encryption characteristics and network structure. It is a chronological order for data blocks. A data structure consisting of a linked list approach, and cryptographically guaranteed non-tamperable and unforgeable distributed decentralized ledgers, capable of securely storing simple, hierarchical data that can be verified within the system. Fedotova and Veltri [5] believe that the blockchain is a distributed database solution that records the data list through mutual confirmation of each node in the network. The data is recorded on a public ledger, and the data information includes the complete information of the transaction. Babbitt is the earliest blockchain information website in China, providing information for blockchain entrepreneurs and investors. It believes that the blockchain is composed of a database generated by cryptography, and each block contains the hash of the previous block is connected from the creation block to the current block. Each block is guaranteed to be generated after the previous block in chronological order, otherwise the hash value of the previous block is unknown. These features make bitcoin double-spending difficult.

There are still some open issues on the integration between blockchain and supply chain management. Achieving product information traceability in decentralized blockchain requests a new design of the system to

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reflect the domain knowledge of supply chain management. The great amount of data generated from supply chain needs a more efficient structure model in the blockchain system.

In this research, these gaps are filled by introducing a blockchain-based framework and a set of corresponding models and methods. Focusing on product information traceability in the context of cross-border e-commerce supply chain, the framework utilizes a multi-chain structure to store data in blockchain, according to the different characteristics of data. The data management model, block structure model are also proposed.

2. A BLOCKCHAIN-BASED PRODUCT INFORMATION TRACEABILITY FRAMEWORK

In this section, we proposed the blockchain-based product information traceability (PIT) framework for supply chain management to make product information traceable throughout the production process, to facilitate product inspection and accounting audits by relevant departments, and to increase the speed of performing various operations in the supply chain. According to blockchain-based application development framework for supply chain management proposed by Kshetri [6], we divide the data that can be stored in the blockchain into the several categories。

We consider that the amount of data involved in each entity in the supply chain is huge, which may affect efficiency of product traceability, audit trails, and system operation. We propose a multi-level blockchain based-on product information traceability model, which is described as Figure 1.

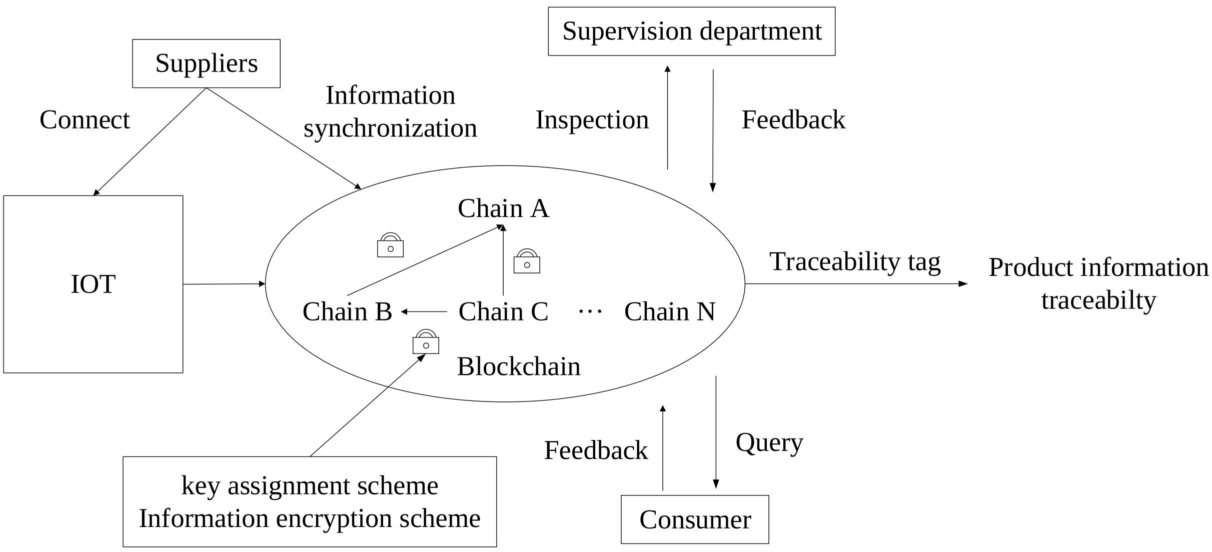

Figure 1. Product Information Traceability Model

3. PRODUCT INFORMATION TRACEABILTY MODEL IN CROSS-BORDER E-COMMERCE

In this section, we proposed a based on blockchain information model for cross-border e-commerce, which supports merchant and consumer peer-to-peer transaction without exchange settlements between banks, and regulatory agency (such as customs, tax) review and feedback legality of transactions. We also proposed a model of traceable product tags for cross-border e-commerce, even the tag is cloned, counterfeit. The Blockchain-based PIT-CE framework can provide highly trusted and non-tampering product information, and tag can get product related information in chain. In the proposed PIT-CE framework, we recommend adopting a multi-layer chain structure to store product information, which is divided based on the amount of data, the generation speed of data, and the degree of data encryption. We create a hash_index of information on the chain (except the first layer chain).When each block is generated, the hash_index is sent to the higher layer blockchain.

Simultaneously, considering the capacity of each block, we recommend using external storage to store long text information, pictures, video, audio, etc., and store the hash_index that can be available for indexing in the block. In the proposed PIT-CE framework, we propose a product tag design model based on elliptic curves cryptography, which provide a secure and accessible channel to get product information in enterprise database and has strong security and privacy. It is difficult that the tag is cracked and copied at low cost. PIT-CE framework provides a reliable, easy-to-supervise, non-tampering traceable product information model.

3.1 Trust Model

In cross-border e-commerce trade, the credit problems of both parties to the transaction are the biggest obstacles to trade development [7]. The core value of the blockchain is to establish an open and transparent rule through program algorithms, based on which to establish a trust network, to ensure trust and transaction security between points and to achieve trusted information in complex network environments [8]. We refer to the cross-border e-commerce logistics model and combine the blockchain technology to propose the trust model.

The big data application of the cross-border e-commerce platform owns all the consumer-related data of the platform and all the data of the supplier, so that it has the natural advantage of connecting upstream suppliers or manufacturers and downstream consumers, and can use the above advantages to establish a relatively complete The blockchain system integrates participants in all aspects of production, distribution, and consumption, and turns participants in each link into owners and profit-seekers of the blockchain system. At the same time, suppliers use the Internet of Things technology to upload the information of the goods (such as origin, production date, raw materials, etc.) to the blockchain system, and strictly restrict access rights. And other large amount data (such as pictures, videos, quality reports) is stored in IPFS [9], And provide a hash ID stored in the blockchain for user verification and review. The data stored in the blockchain cannot be tampered with, and when a node is damaged, there are still other nodes that can support data access. Consumers can find all the information of the product according to the transaction record to verify the authenticity of the product. Customs can conduct random inspections of inbound and outbound products and verify the correspondence between commodity information and information on the chain, which intercept false goods in time and review the transactions that have occurred [10].

3.2 PIT-CE framework

According to the definition of data attributes, we divide the data in cross-border e-commerce into three categories, which are stored in the account chain, transaction chain and IoT chain respectively, as shown in Table.1.

Table.1. Data in Cross-Border E-Commerce

	Account Data	*Transaction data*	*IoT Data*
Update speed	Low	Medium	High
Concurrent quantity	Low	Medium	High
Data model	Account-based	Transaction-based	Transaction-based
The degree of encryption	High	Medium	Low
Access frequency	Low	Medium	High
Hierarchical relationship	High	Medium	Low

The account chain stores to the details of the digital assets owned by the entity in the blockchain system, and the data is the result of transactions occurring in cross-border e-commerce, rather than the details of transactions. So the degree of encryption of the data is high, and the degree of openness of the data to different users is inconsistent, and the complexity of encryption is also high. Data is strongly related to data in other chains. In other words, some data is statistically derived from other chain data. So the update speed and concurrent quantity is low. The effect of the account chain data for other users is only the pre-purchase reference and the product verification after the purchase. The user will pay more attention to their actual transaction and the physical information of the product, so the Access frequency is lower than the other. At the same time, the account chain stores a large number of digital assets related to the user. It is necessary to maintain the account status in the system, so the data model is account-based.

The transaction chain stores transaction occurring in cross-border e-commerce (such as trade, publishing the product, sales return, etc.). Most of the data is only available to stakeholders, and its content is only accessible to stakeholders, so the degree of encryption is medium. The state of the transaction in the chain needs to be updated in real time, and the same type of transaction will also be occurred at the same time, so the update speed and concurrent quantity is medium. The data in the transaction chain supports the account chain data and obtains the actual execution of the transaction from the IOT data.

The IOT chain stores detailed data from IOT devices (such as temperature, humidity, chemical structure, geographic location, delivery information, etc.). The data stored in the IOT chain plays an important role in product information traceability, which is completely public or public to any product holder. The blockchain system often needs to access IOT data through smart contracts to obtain the execution of the transaction and perform transaction settlement. For users, they pay more attention to the details of the product than others (for example, when the user purchases the product, they will pay attention to the product's logistics information, not the order information). So the update speed, concurrent quantity and access frequency is the highest than others. IOT data is weakly related to other data, and the transaction-based data model is sufficient to meet the needs of the IOT chain.

3.3 Multi-chain Structure

In the blockchain based-on cross-border e-commerce, we adopt a three-level chain model to isolate those data, which stored in the same chain has the same characteristics. Information is transferred is a small amount between the two chains, which ensure the consistency of information in the blockchain. And we can determine the information in the blockchain is not tampered by two-way verification. When the transaction occurs, the transaction chain transfers the product ID to the account chain to confirm the product. When the transaction is completed, the transaction chain submits the transaction ID to the account chain as a backup, which proves that the transaction has actually occurred. When the transaction is happening, the transaction chain transfers the transaction ID to logistics chain, which obtains product transportation information. When the product is successfully delivered, the transaction status is automatically converted to completion.

The account chain stores the account information owned by each entity (such as domestic and foreign enterprise, consumer, customs and Quality inspection departments), including product information, transaction information (hash ID), funding status and permissions. The characteristics of the data in the asset chain are slow update speed and strong correlation between entities. The account chain data structure is described as Figure 2.

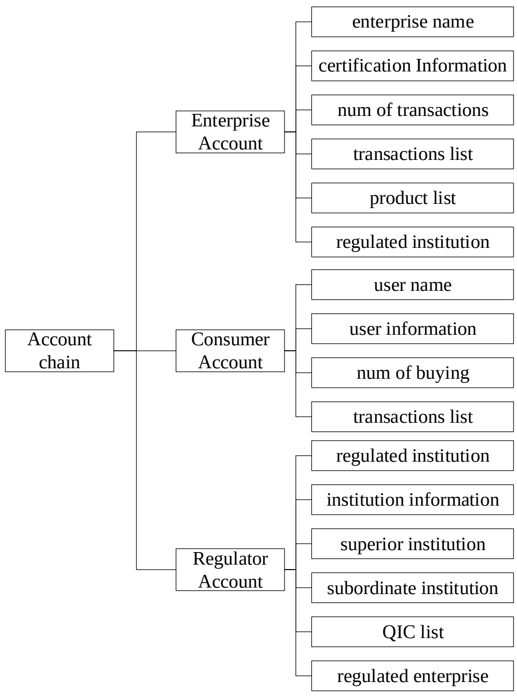

Figure 2. account chain data structure

The enterprise account is created by the provider of products and services in the supply chain. It includes the following contents: the enterprise name refers to the name of the enterprise registration; the certification information includes the registration number, registered address, legal representative, registered capital, business scope, company status, business type, business deadline, establishment date, registration authority, affiliated enterprise; num of transactions refers to the total number of transactions completed by the enterprise; the transaction list contains the TXID, which is synchronized from Transaction chain, each TXID can find the corresponding transaction information in the transaction chain; the product list includes product ID, product name, production parameters (such as: temperature, humidity, raw materials, origin, etc.) through IoT sensor collection such as RFID, quality inspection report and other related documents. Digital certificate (quality inspection report hashed).et al.; the regulated institution contains regulated institution who is ability to review corporate information and monitors business operations.

Consumer accounts are created by consumers, which transact product and complete the traceability process of product information. The account data includes the following contents: user name; user information including shipping address, credit score, etc.; num of purchases, and transaction list including TXID.

The regulated account is created by the government department, such as customs and quality inspection department. The account data includes the following contents: regulated institution; institution information; superior institution; subordinate institution (need to clear the associated institution, to prevent malicious registration from causing the network to be attacked); the QIC list displays the number of all inspection reports, the detailed quality inspection report is encrypted and stored in the cloud database; the regulated enterprise refers to a enterprise who can directly access it through a key.

The transaction chain stores transaction information, transaction records, execution records and other information. The transaction information includes transaction ID, product ID, num of product, sender, receiver, carrier, digital certificate of legally beneficial contract (the contract is hashed, the specific file is encrypted and stored in the cloud server), smart contract. The transaction record refers to the execution of the transaction, for example, in transit, signed, returned, and failed to deliver on time. The smart contract execution records mean that there are many scenarios for calling smart contracts during the running of the whole system. In order to find out the problems in time after the failure, all the information that the contract is called is stored in the chain. The publishing product means that enterprise need to declare the detailed information of the products in the blockchain now, and give the reference interval of the product parameters before publishing new product. The Performance test report is a report on the sampling status of products regularly given by the regulatory authorities. The transaction chain data structure is described as Figure 3.

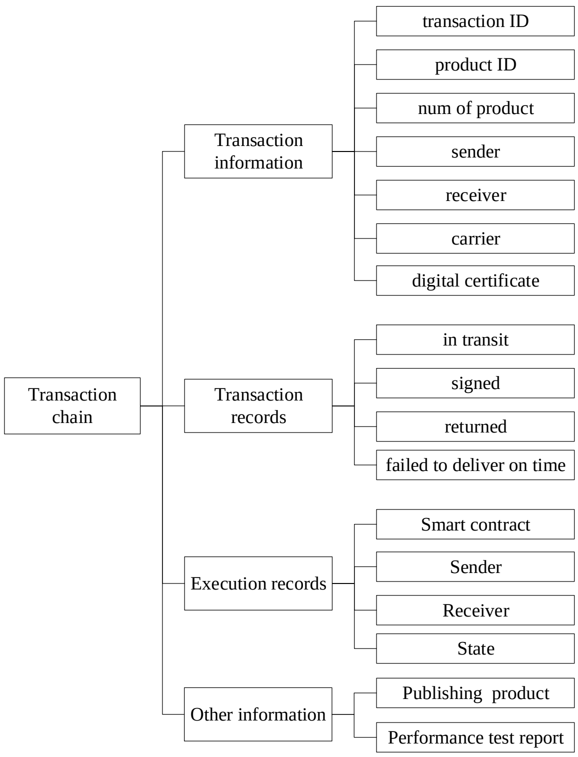

Figure 3. transaction chain data structure

The IoT chain mainly records the real-time logistics information of the product, obtains the location information of the product through the GPS system of the mobile terminal, the delivery information of the product through the sensor and parameters in the production process, for example, the commodity has been packaged and ready for delivery. The IoT chain data structure is described as Figure. 4.

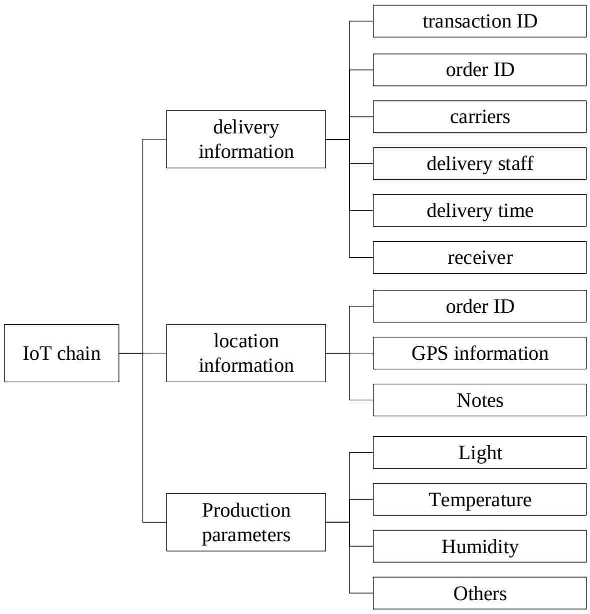

Figure 4. Logistics chain data structure

4. CONCLUSIONS

This in-progress paper focus on the cross-border e-commerce context [11], to develop blockchain-based information models for products and transactions. A general blockchain-based product information traceability framework is introduced. The framework is applied in cross-border e-commerce context. We also designed a multiple chain structure and the data management model following the framework.

For the future works, we will develop the key distribution, anti-counterfeiting and other approaches following this framework, and also verify them with real data and simulation.

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REFERENCES

[1] Nakamoto, S. (2008). Bitcoin: A peer-to-peer electronic cash system. https://bitcoin.org/en/bitcoin-paper

[2] Buterin, V. (2014). A next-generation smart contract and decentralized application platform. white paper. https://github.com/ethereum/wiki/wiki/White-Paper

[3] Swan, M. (2015). Blockchain thinking: The brain as a decentralized autonomous corporation [commentary]. IEEE Technology Society Magazine, 34(4), 41-52.

[4] Yuan, Y., Wang, F.. (2016). Blockchain: The State of the Art and Future Trends. Acta Automatica Sinica, 42(4), 481-494. (in Chinese)

[5] Fedotova, N., & Veltri, L. (2006). Byzantine generals problem in the light of P2P computing. Paper presented at the 3rd Annual International Conference on Mobile and Ubiquitous Systems-Workshops.

[6] Kshetri, N. (2018). 1 Blockchain's roles in meeting key supply chain management objectives. International Journal of Information Management, 39, 80-89. doi:10.1016/j.ijinfomgt.2017.12.005

[7] Chen, B. (2017). Empirical Study on Cross Border E-commerce Enterprise Logistics Model under the Background of Economic Globalization. Revista de la Facultad de Ingenier á, 32(12). (in Chinese)

[8] Swan, M. (2015). Blockchain: Blueprint for a new economy: O'Reilly Media, Inc.

[9] Benet, J. (2014). IPFS-content addressed, versioned, P2P file system. https://arxiv.org/abs/1407.3561

[10] Kamble, S., Gunasekaran, A., & Arha, H. (2018). Understanding the Blockchain technology adoption in supply chains-Indian context. International Journal of Production Research, 1-25. doi:10.1080/00207543.2018.1518610

[11] Koh, T. K., Fichman, M., & Kraut, R. E. (2012). Trust Across Borders: Buyer-Supplier Trust in Global Business-to-Business E-Commerce. Journal of the Association for Information Systems, 13(11), 886-922.