Design of E-commerce Supply Chain Traceability System Based on Blockchain Technology

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Keywords: Block Chain, Electronic Commerce, Supply Chain, Traceability System

Abstract: The sustained and stable development of economy and trade depends on an efficient and safe supply chain. However, the existing supply chain is full of a large number of counterfeit products, which seriously infringes on the rights and interests of enterprises and consumers. Building an efficient traceability system through blockchain can effectively reduce counterfeit products. This paper mainly studies the E-commerce supply chain traceability system based on blockchain technology. Firstly, this paper constructs a traceability data security model to solve the problem of privacy data security through the node authorization scheme, so as to ensure the security of data in the traceability system. This paper designs the architecture of the traceability system and improves the physical and logical architecture of the system. Implement the system and test its performance. Through the performance test results, we can know that the processing capacity of the traceability system designed in this paper is normal per second, which is not easy to cause blockchain network congestion and meet the needs of daily use.

1. Introduction

With the rapid development of Internet technology, China's E-commerce industry is growing day by day, and the E-commerce economy has made remarkable achievements. The rise of E-commerce platforms not only provides people with more convenient shopping methods, but also provides more hidden and fast sales channels for counterfeit goods [1]. The problem of counterfeit and shoddy goods is not only serious in precious commodities, but also very common in medicine, food, health care products and other industries. This illegal act is a serious challenge to the market order, which not only damages the interests of consumers and merchants, but also weakens the market integrity. It even makes consumers lose confidence in high-quality products and trust in brands, which has an incalculable impact on individuals and the market. In order to safeguard the interests of businesses and protect the legitimate rights and interests of consumers, we should not only improve the guarantee mechanism and strengthen punishment from the aspects of legislation, law enforcement and anti-counterfeiting policies, but also carry out anti-counterfeiting technology innovation. At present, two-dimensional code anti-counterfeiting technology and RFID tag identification technology are most widely used. However, at present, most of the core data of traceability anti-counterfeiting system are stored in the centralized data center. The information comparison process between various systems is complex and it is difficult to trace commodity information [2]. The centralized system can be artificially controlled, and the data in the system can be tampered with by the manager at will. This situation still makes the current situation of commodity counterfeiting significant. Therefore, some more reliable and safer technical solutions are needed to achieve the purpose of commodity traceability and anti-counterfeiting. The emergence of blockchain technology provides new ideas for solving the problem of commodity traceability and anti-counterfeiting, but there is still a lack of practical and feasible specific technical solutions [3].

Traceability informatization has always been a research field committed by academia and industry, and some foreign scholars have studied it earlier. At present, there are many researches and actual project development based on blockchain technology to realize traceability system in the industrial and academic circles [4]. Some scholars learn from bitcoin technology to build a supply

  DOI: 10.25236/iwmecs.2022.005

chain control and traceability scheme based on blockchain. The main contribution of this scheme is to use the layered wallet technology in bitcoin to distribute secret keys. While building a layered coding system, it also ensures that all information can be effectively anti-counterfeited and verified [5]. In industry, multinational giants combine blockchain technology with food safety issues and use blockchain technology to change the food supply chain. Wal Mart, jd.com and IBM have jointly established a safe food blockchain traceability alliance with domestic universities to use blockchain technology to trace all links of food from production to sales and create a safe dining table [6]. IBM has also invested a lot of manpower and material resources in the blockchain field. The hyperledger fabric they developed, as the underlying blockchain technology, is widely used in various fields [7]. However, at present, the main research direction of blockchain traceability is focused on food, and there is a lack of traceability research on E-commerce supply chain.

At present, there are still some deficiencies in the traceability and anti-counterfeiting scheme that has been put into commercial use. Under the existing research background, this paper continues to explore the technical scheme of the application of blockchain technology in the traceability and anti-counterfeiting direction, in order to develop a safer and more reliable traceability and anti-counterfeiting system and make up for the defects of the existing traceability and anti-counterfeiting system.

2. Design of Traceability System based on Blockchain

2.1 Traceability Data Security Model

Among the main features of blockchain network, all nodes have equal status and data disclosure. This feature is contrary to the traceability scenario of E-commerce supply chain. Some data of supply chain nodes need privacy protection or targeted sharing. While taking into account the security of the data, we should ensure the authenticity of the data. Therefore, even the enterprise's private data needs to be uploaded to the blockchain network. The demand of private data is that it can be shared and can not be made public. Therefore, the data on the chain must be unreadable and ciphertext state, and the shared key has become the key to sharing data. In this paper, a node authorization scheme is proposed to solve the problem of privacy data security. The enterprise's privacy data is encrypted by using a symmetric encryption algorithm before being chained, and the private data is shared by sharing the key to the node [8-9].

The purpose of node authorization scheme is to solve the problem of private data sharing in blockchain network. The specific process is divided into two steps: private data encryption module and key sharing module. The specific implementation is realized in smart contract by means of encryption algorithm. The enterprise data is uploaded to the blockchain network through the smart contract. Firstly, judge whether the data type is private data. If it is true, first enter the private data encryption module for encryption operation. In the private data encryption module, the symmetric key is randomly generated, and the private data is encrypted with the symmetric key to generate the private data ciphertext. The privacy data ciphertext is uploaded to the blockchain network, and the corresponding symmetric key enters the key node authorization module. In the key node authorization module, each enterprise in the supply chain corresponds to the node in the blockchain network. Each node issues an asymmetric encryption key pair, and the enterprise saves its own private key and discloses its public key to the public. After the symmetric key enters the key sharing module, the public key of the authorized target node is used to encrypt the symmetric key to generate the symmetric key ciphertext. The symmetric key ciphertext and the information of the privacy data are uploaded to the world state of the blockchain network to form a key value pair, and the corresponding authorized node information is stored together with the privacy data. When the authorized node queries, the symmetric key ciphertext corresponding to the private data to be queried is retrieved in the world state. The node decrypts the symmetric key ciphertext with its own private key to obtain the symmetric key. The private data is retrieved in the blockchain network and decrypted through the symmetric key to complete the private data sharing. When the privacy data authorizes multiple nodes, it only needs to be done once in the privacy data encryption module, and

the key node authorization module can be called many times to perform the authorization operation on each authorized node [10].

2.2 System Architecture Design

(1) System physical architecture

The physical architecture of the system adopts distributed architecture design, and blockchain nodes are deployed in suppliers, manufacturers, transporters, retailers and regulators in the supply chain, so as to realize the mode of multi-party participation and complete decentralization.

The physical architecture of the system consists of main chain network, side chain network and external nodes. The main chain network is maintained by the regulatory authority and mainly stores the hash value of products. The side chain network is maintained by suppliers, manufacturers, transporters and retailers in the supply chain. Enterprises in one supply chain link will be assigned to the same side chain network. If a new enterprise in the supply chain joins, it needs to be reviewed by the regulatory authority first, and the review is passed to join the enterprise into the side chain network in the corresponding supply chain. As an external node, consumers do not participate in the consensus of the blockchain system and can only query the blockchain. Consumers can use smart phones, tablets, PCs and other tools to trace product information.

(2) System logic architecture

The system has six layers: collection layer, application layer, consensus layer, contract layer, network layer and data layer.

In the acquisition layer, in the traditional supply chain traceability system, data acquisition is mainly carried out with the help of Internet of things equipment. This system will also use this method to collect the information of product processing, production, transportation, sales and other processes. All parties in the supply chain can use scanners, environmental sensors, GPS locators and various intelligent devices to collect product traceability information and upload it to the application layer.

The application layer provides an interface for querying and uploading product traceability information. Using the unique identification code of the product, you can query the traceability information of the product, and the traceability information of the product is displayed to users through websites, apps and other forms. The upload interface is only open to internal enterprises in the supply chain. Enterprises upload the collected information to the blockchain storage through the upload interface.

The contract layer formulates rules for all institutions in the supply chain, which can operate the blockchain through smart contracts. In the contract, corresponding algorithms are designed for suppliers, manufacturers, transporters, retailers and consumers. Suppliers can input raw material information into the blockchain system through smart contracts. Transporters need to upload product processing information. Transporters and retailers upload product logistics information and retail information through smart contracts respectively. After the node joins the system, it is necessary to deploy the written smart contract to the node.

The consensus layer provides a consistency algorithm for the blockchain system. The blockchain system is a distributed architecture system. The nodes can verify the data and reach consistency through the consensus algorithm.

In the network layer, nodes communicate through P2P network protocol, and broadcast and verify block data by using communication mechanism and verification mechanism.

In the data layer, there are many participating nodes in the supply chain. If all information is stored on the blockchain platform with single chain structure, it will increase the operation cost of the system, which requires each node to have enough storage space. Combined with the actual application scenario of supply chain traceability, the supply chain traceability platform based on blockchain adopts the design of multi chain architecture. The platform is composed of multiple side chain networks and a main chain network. The product traceability information is first stored in the side chain, then the traceability information is calculated by Merkle algorithm, and then the hash value is synchronized to the main chain.

3. System Implementation and Performance Test

3.1 Network Deployment

Firstly, build a blockchain network based on Linux environment, simulate the distributed network environment with docker simulation, and realize application development with Java. The specific development environment is shown in Table 1.

Table 1. Development environment configuration

Development environment	Tool version
Operating system	CentOS 8.0
Blockchain framework	Fabric 2.3
Server	Node.js v8.16
Development framework	Spring Boot

After the environment is installed, configure the peer, org, orderer nodes and channels in the fabric network. Write the network configuration into crypto config Yaml file, and use the module cryptogen to call the configuration file to complete the initialization. First, you need to create a channel, then select peer to join the channel, and finally complete the chain code deployment.

3.2 System Performance Test

This paper uses the reprot performance test report (HTML form) generated by caliper for the traceability system, and completes the performance test analysis according to the test report results. We mainly analyze the performance according to the success rate, delay and throughput of the transaction, and show the availability of the system.

The chaincode tested by the system includes two types: read and write. Set the number of concurrent requests to 50tps, 100tps, 200tps and 300tps for pressure test.

4. Analysis of Performance Test Results

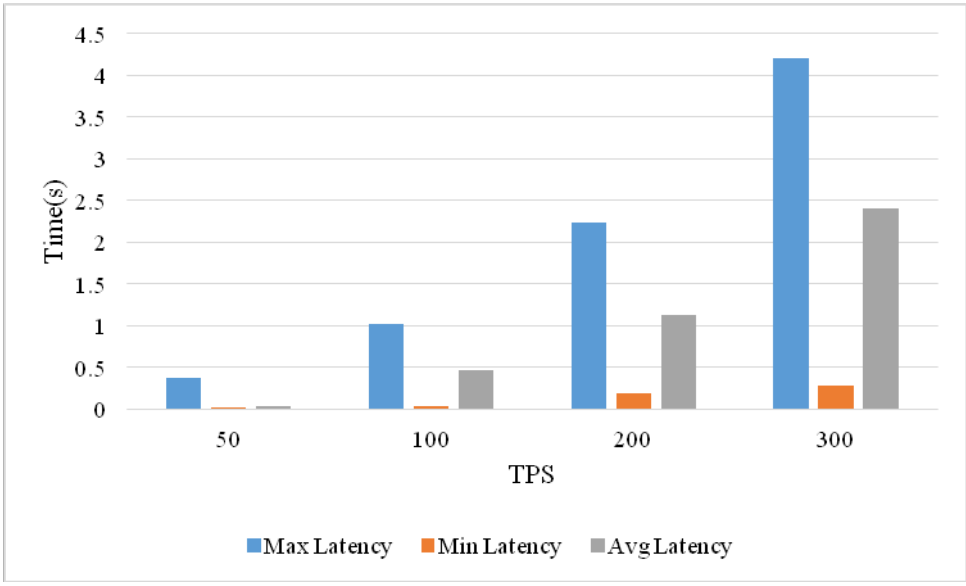

Figure 1.Transaction performance test(read)

As shown in Figure 1, when the average delay of read increases from 50tps to 300tps, AVG latency increases from 0.04s to 2.41s, and the maximum value of Max latency is 4.21s. When the number of requests is low (50tps), the average delay of query ledger operation is within 1s, the reflection speed of query traceability data is normal, and the data information can be returned quickly to meet the basic needs of user query operation; When the request data is high (300tps), the maximum delay in reading the ledger is about 4S, and the response speed is relatively slow.

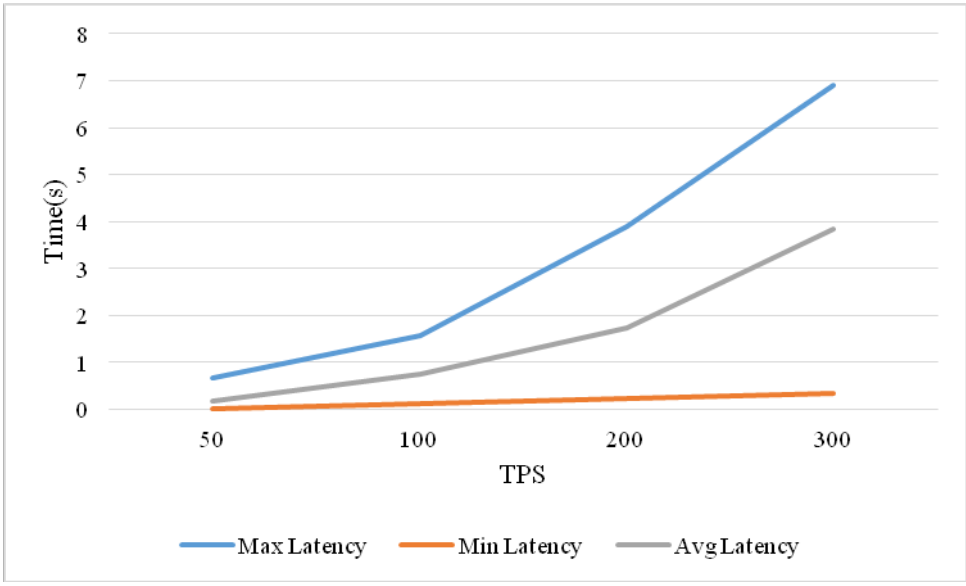

Figure 2.Transaction performance test(write)

With the in-depth research of blockchain technology and the demand analysis of E-commerce supply chain traceability, it has become an inevitable trend to combine the three mechanisms of decentralization, distribution and tamper proof of blockchain technology with the sub commerce supply chain traceability system. According to the idea of software modeling, this paper designs the overall architecture of the logistics information traceability system based on blockchain, abstracts the functional module points, refines them, and designs the database required by the system. With the increasing development of blockchain technology, the system designed in this paper still needs to be improved in practical application. For example, the introduction of auxiliary storage will be further considered, and only the summary of important data will be recorded on the blockchain to ensure the balance between data security and reliability and performance cost.

5. Conclusions

With the expansion of the scale of E-commerce and express the tells the development of the industry, city logistics distribution business also got great development, urban distribution business needs "loose" and "small", the urban road traffic I complex, how to scientifically plan distribution path has become each big city to the enterprise important means to reduce the cost, improve market competitiveness. In this paper, the method of logistics distribution path is optimized by improving the quantum genetic algorithm, and the physical distribution path planning system is designed. However, due to the limited time and personal ability, some work still needs to be further studied, which can be improved from the following aspects in the future: This paper considers that customer service is not in order, but in real life, important customers need to be served first, which can be used as a research direction.

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