

# Establishment of A Traceability Model of Fresh Milk Based on Blockchain

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**Abstract.** With the frequent occurrence of various food safety incidents in China, consumers' trust in the quality and safety of food and the food supply chain has gradually declined. The food traceability system, as a storage system that can connect products from production to circulation and manage and query the traces of products, is of great significance to guarantee the quality and safety of various products. This article intends to build a blockchain traceability mechanism based on the theoretical analysis of blockchain technology, introduces the traceability model of fresh milk based on blockchain technology, and hopes to provide a reference for related research in blockchain traceability.

**Keywords:** Food Traceability, Blockchain, Hyperledger Fabric, Whole Food Production Chain

## 1. INTRODUCTION

With the development of informatization of the food industry chain, people are paying more and more attention to the security and authenticity of the information in the food traceability system. At present, some prominent problems such as serious centralization of the traceability system of some products, easy information tampering, and opaque information are present in front of people, constantly eroding people's trust in the traceability system. The characteristics of blockchain decentralization, non-tampering, openness and transparency, make it have a wide range of application prospects in food traceability, and provide solutions to the problems of traditional traceability system.

## 2. DEMAND ANALYSIS FOR THE CONSTRUCTION OF A TRACEABILITY MODEL OF FRESH MILK BASED ON BLOCKCHAIN

In the past ten years, dairy safety accidents have broken out frequently. In 2001, some students in 6 elementary schools in Tianjin developed nausea and vomiting symptoms, which were confirmed by investigations to be caused by hydrogen peroxide contamination in milk bags<sup>[1]</sup>. In 2002, there was another storm of

"antibiotic-free milk" and "reconstituted milk". In March 2003, there were 2566 primary school children's soy milk food poisoning incident in Haicheng City, Liaoning Province, and the "tuberculosis milk" incident in Guangdong Province in July 2003, until the "big head doll" incident in 2008 and the "leather milk" incident in 2009. There has been an upsurge of consumer distrust of dairy companies. The frequent occurrence of various dairy safety accidents has increased the demand for dairy traceability. Dairy industry supply chain process is long and complex, because of information asymmetry leads to dairy safety issues, led to all kinds of food-borne disease events<sup>[2]</sup>. The emergence of the dairy traceability system effectively records the data information of each link in the production process of the product to monitor the acquisition of product raw materials, production and processing, logistics and transportation<sup>[3]</sup>. However, in the practice of the fresh milk supply chain, the traditional traceability technology has exposed many problems, mainly as follows:

- The traceability standard is missing and the traceability system is inconsistent;
- The traceability system can be tampered with internally and easily stolen externally;
- The traceability information chain is short and information sharing is lacking.

The traditional traceability system uses centralized data sharing, and its central point needs to independently maintain data interaction with other nodes and ensure data security, which requires a large amount of overhead. Moreover, since the control of core data is in the hands of a small number of relevant companies, traceability information cannot be open and transparent, and there is a possibility of tampering with the information.

Therefore, on the basis of traditional traceability technology, using the characteristics of blockchain technology such as decentralization, hard to tamper with, and secure encryption, a fresh milk traceability model based on blockchain technology is proposed. In the traceability model based on blockchain technology, each participant (each node in the blockchain network) is independent and equal, and there is no need for an authoritative transaction center (central node) to host transactions. And with its credit endorsement, the fairness

and fairness of the transaction can be maintained. Blockchain data on the chain requires certain rules (consensus mechanism). These rules are the methods and methods for data verification that all blockchain system users think are reasonable. Using a certain rule to write data into the system can ensure that all system users agree on the operation of the data and make the information clear and transparent among all users of the system, so blockchain technology has unique advantages in the traceability system. Due to the unique chain storage structure and consensus mechanism of the blockchain, once the data generated in each link of the supply chain is collected in the blockchain traceability system, even if there is a data loss in any link, the traceability data service provider cannot supplement data. Therefore, in the entire blockchain traceability model, each participant needs to be responsible for the information and data on the chain. The non-tamperable evidence of the blockchain technology will increase the cost of enterprise fraud, so that the system can achieve anti-counterfeiting traceability.

### 3. RESEARCH STATUS OF TRACEABILITY SYSTEM

Compared with foreign countries, the traceability system has problems such as late start, short development time, lack of policy support, and low popularity. However, with the learning of foreign technology, the progress of domestic technology and the increasing demand for food safety from the people, the research and application of food traceability in China is in a steady development stage. At present, the commonly known food quality and safety traceability technologies mainly include RFID identification technology, QR coding technology and blockchain traceability technology<sup>[4]</sup>.

Yan Shijie<sup>[5]</sup>, Jiang Deke<sup>[6]</sup> and others used beef as the traceability object and designed a traceability scheme that combines RFID radio frequency identification technology and wireless sensor network. Through the advantages of the application of the Internet of Things network technology in the factory assembly line, a complete data acquisition radio frequency network is established, and the database is used to store the data to realize the efficient and accurate upload of the data. However, the cost of RFID radio frequency identification technology is relatively high, and once the RFID tag approaches the reader, it will automatically send a message unconditionally, it is impossible to confirm whether the RFID reader is legal, and the privacy of the data cannot be guaranteed.

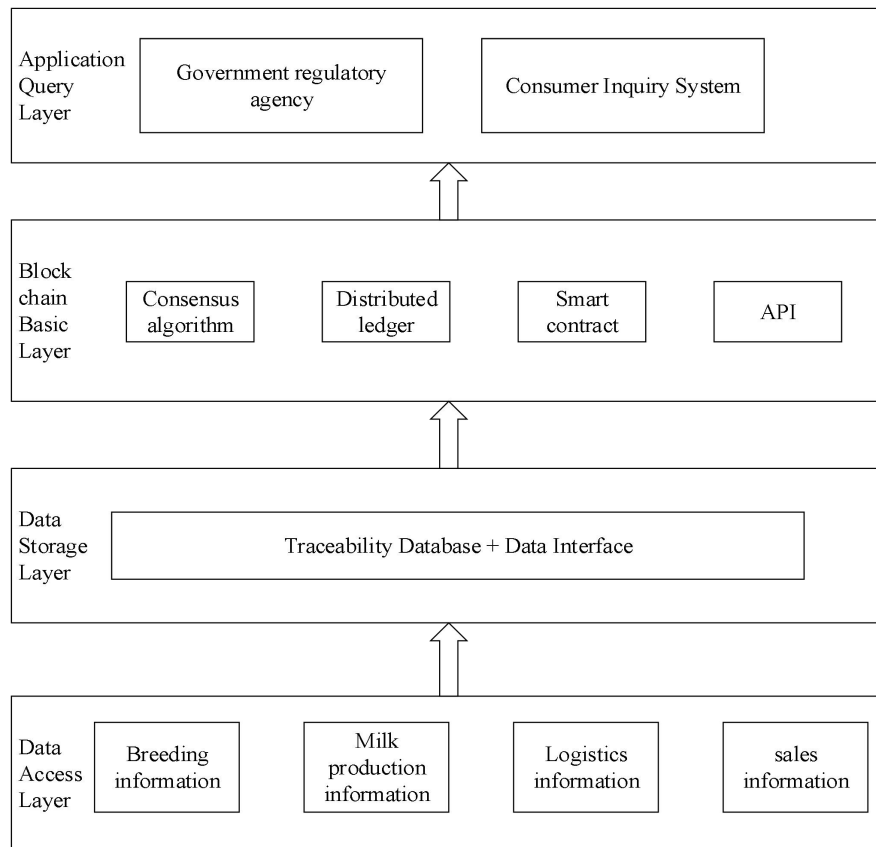
Li Jiulin<sup>[7]</sup> uses HTTP or HTTPS technology as the vegetable traceability information management platform of the data communication protocol, and uses QR code encoding technology and encryption algorithm to encrypt

and store vegetable traceability information, which is provided for enterprises related to vegetable planting, transportation, preservation, and sales. It has established the standard of information management and facilitated the management of this aspect by relevant government departments. Although the QR code technology has the advantage of a wide range of coding, as the application scenarios of the QR code technology become more extensive, it exposes more and more problems. The problems are mainly embodied in aspects such as easy leakage of QR code information and illegal tampering of QR code information.

Although my country started late in the integration of food traceability and blockchain technology, there are still some outstanding work. The VeChain<sup>[8]</sup> team created by the VeChain team is committed to providing the public with services for supply chain issues through blockchain technology. VeChain creates a transparent supply chain platform through the combination of blockchain-based NFC anti-counterfeiting chips and mobile phone applications provided to users. Through the investigation and analysis of traceability research at home and abroad, it can be found that although some studies have introduced blockchain technology into food traceability, it only traces the origin of food, and does not realize the traceability of the complete food supply chain. When using the blockchain, the relevance of food traceability information is not considered, and the food supply chain information cannot be stored in a related manner.

### 4. THE OVERALL ARCHITECTURE OF THE TRACEABILITY MODEL OF FRESH MILK PRODUCTS BASED ON BLOCKCHAIN

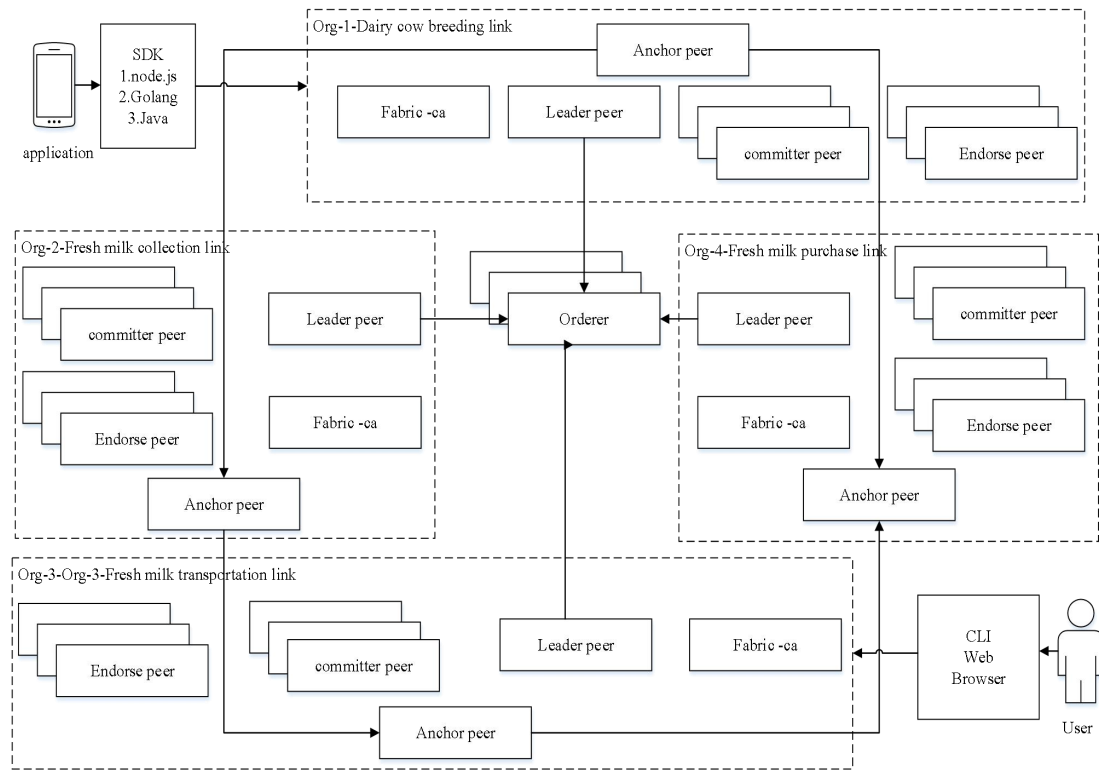
Blockchain types can be roughly divided into three categories at present: Public blockchains, Private blockchains and Consortium blockchains. Combining the research background of the traceability model, because the traceability process involves not only a single node, different nodes from different units need to be added to the blockchain network, and considering that the design of the public chain may waste a lot of resources due to the consensus algorithm, so the alliance chain is adopted. As a more mature development platform in the alliance chain, Hyperledger Fabric is not only more mature in development, but also has significant advantages in performance due to higher throughput and scalability<sup>[9]</sup>. Therefore, in order to make the development of the blockchain traceability system more convenient, this article chooses Hyperledger Fabric as the platform for the development of the blockchain system. The overall architecture of the blockchain system is mainly composed of four parts: data access layer, data storage layer, blockchain basic layer and application query layer, as shown in Fig.1:



**Fig.1** System architecture diagram.

In Fig.1, the data access layer lists the factory, warehouse, transporters, and stores that directly participate in the supply chain of fresh milk products. Each participant is an organization (Org) in the actual blockchain network system, and each organization can set up a node (Peer) according to the actual information entry situation, and each organization contains at least one node<sup>[10]</sup>. The internal logical structure diagram of the blockchain is shown in Fig.2. Each node is responsible for its own related information, such as dairy cow breeding information, fresh milk collection

information, logistics information, and sales information. After the entered information is judged to be legal by the smart contract of the basic layer of the blockchain, it is uploaded to the blockchain through the blockchain node. Each blockchain node synchronizes transaction information, generates blocks, and forms consensus blockchain data. Consumers and relevant regulatory authorities use blockchain nodes to manage and query related information to achieve the traceability and queryability of fresh milk production information.

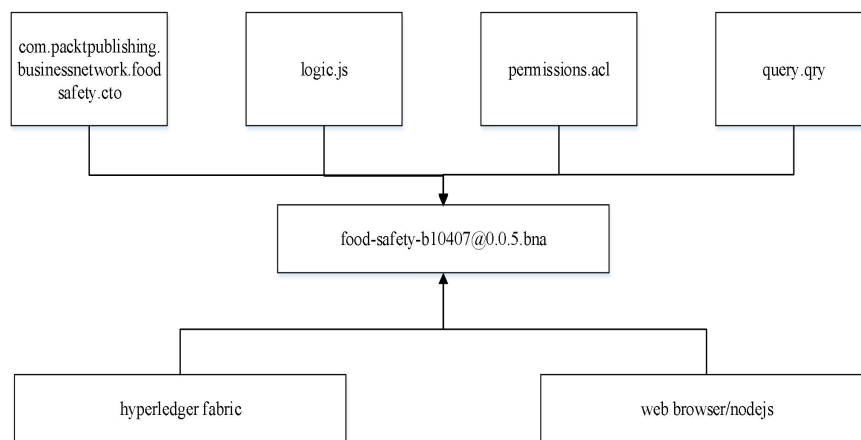


**Fig.2** The internal logical structure diagram of the blockchain.

## 5. THE TRACEABILITY MODEL OF FRESH MILK PRODUCTS BASED ON BLOCKCHAIN

The blockchain-based traceability model of fresh milk products intends to adopt the hyperledger composer

framework and use the hyperledger fabric blockchain network as the basic network environment to deploy the basic layer business network of the blockchain<sup>[11]</sup>. The blockchain business network structure of the fresh milk product traceability model is shown in Fig.3:

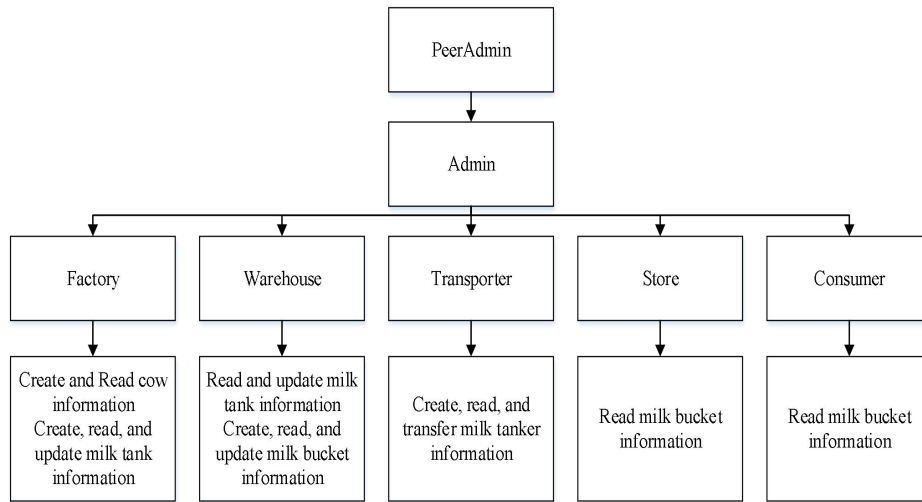


**Fig.3** Business network structure diagram of the traceability model of fresh milk products.

The `com.packtpublishing.businessnetwork.foodsafety.cto` file is used to define the participants in the blockchain business network of the fresh milk traceability model and the transportation entities in the fresh milk production process. The participants defined in the model are ranches, warehouses, transporters, purchasers and consumers; the consumer entities in the production process are cows, milk tanks, milk tankers and milk buckets.

The `logic.js` file is used to define the transaction function during the transportation of fresh milk.

The `permissions.acl` is used to assign different permissions to each participant. The logical structure diagram of participant permissions is shown in Fig.4.



**Fig.4** Logical structure diagram of participant permissions.

The query.qry file is used to define the query function.

The food-safety-b10407@0.0.5.bna file is used to package the above files into a blockchain business network archive file (.bna) and use this file to deploy the business network to the Hyperledger Fabric blockchain network. If the file in the business network is changed, the network operation can be updated by changing the version number and upgrading the deployed network<sup>[12]</sup>.

The network supporting the blockchain is a hyperledger fabric (hyperledger fabric) blockchain network, the operating environment is nodejs, and a web browser can be used to access the business network<sup>[13]</sup>.

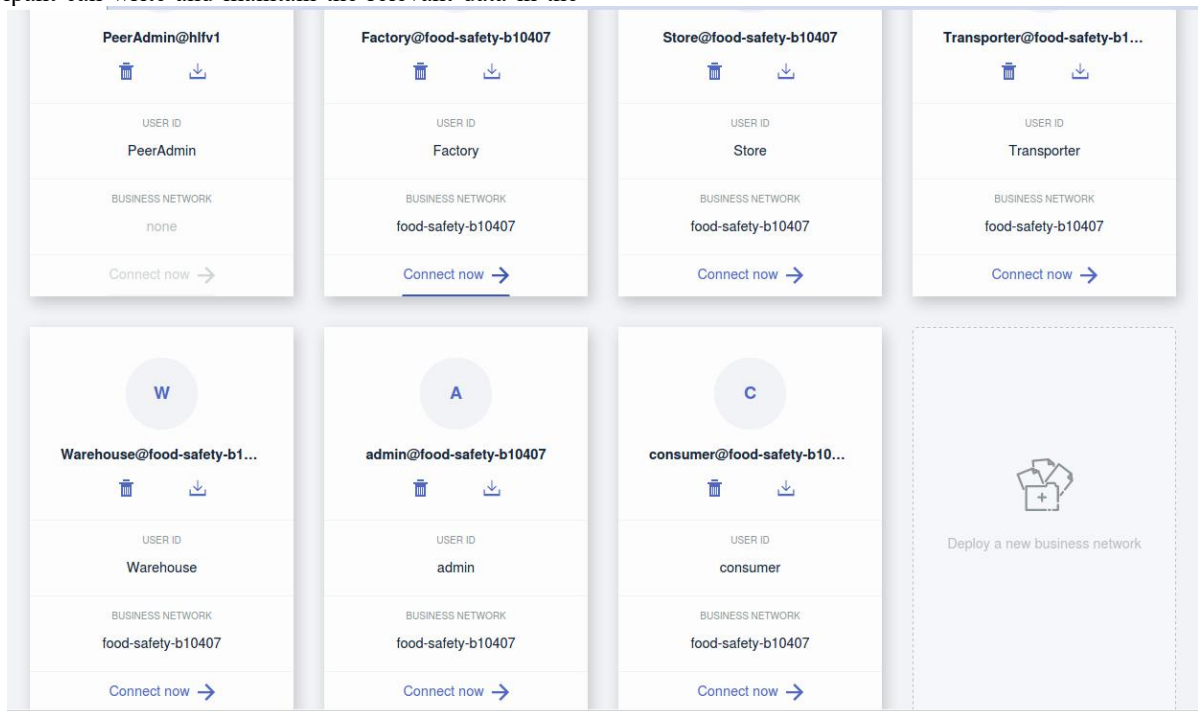
According to the different division of labor of the participants, the corresponding server ports of each participant also have different functions, and each participant can write and maintain the relevant data in the

traceability process of the fresh milk. Next, set the organization and server port corresponding to each participant. The organizations and server ports corresponding to each participant are shown in Table 1:

**Table. 1** Correspondence between participants and organizations

Participants	Organization name	Server port
Factory	Factory	Port:3000#
Warehouse	Warehouse	Port:3001#
Store	Store	Port:3002#
Consumer	Consumer	Port:3003#
Transporter	Transporter	Port:3004#

The browser interface display is shown in Fig.5:

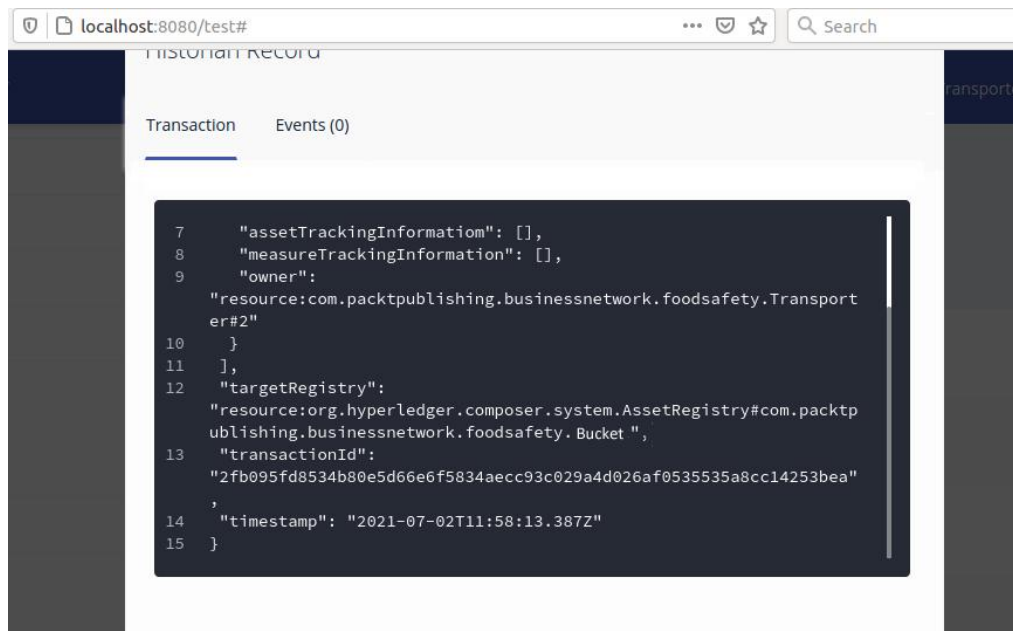


**Fig.5** Participant browser interface display.

Test the participant permissions on the browser interface: use the Warehouse to create the milk bucket and transfer it

to the Transporter, and query the status of the milk bucket as shown in the figure below:





**Fig.6** Milk bucket status display.

We can see all the operations performed by the participants on the milk bucket, from creation to transportation, the ID number of each transaction and the time of the transaction.

## 6. CONCLUSION

Blockchain technology can simplify the information sharing process through the mechanism of sharing the ledger<sup>[14]</sup>. The combination of the blockchain network and the food traceability mechanism provides new ideas for the end-to-end traceability of products<sup>[15]</sup>. The fresh milk traceability model based on blockchain technology combines the blockchain technology with the fresh milk production process, and stores the key information in the fresh milk production process in the blockchain system to realize the traceability of the fresh milk products. To a certain extent, the safety and traceability of fresh milk product information is guaranteed, and the key information in the fresh milk production industry chain is more transparent and easier to supervise.

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