A Secure Cloud Based Food Supply Chain Traceability Provenance using Blockchain

Prabu Devan S[1], Ruthara Kumar V[2], Prasath N[3]

[1]UG Student, Department of Computer Science, KPR Institute of Engineering and Technology, Arasur, Coimbatore, India

[2]UG Student, Department of Computer Science, KPR Institute of Engineering and Technology, Arasur, Coimbatore, India

[3]Associate Professor, Department of Computer Science, KPR Institute of Engineering and Technology, Arasur, Coimbatore, India

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Abstract - *On the internet of Things (IOT) state of affairs, the block-chain and, in general, Peer-to-Peer approaches might play an overriding role within the development of decentralized and data-intensive applications running on billions of contrivances, conserving the privacy of the users. Our research goal is to grasp whether the blockchain and Peer-to-Peer approaches are used to foster a decentralized and private-by-design IOT. As a primary step in our analysis method, we tend to conduct a systematic Literature Review on the blockchain to accumulate cognizance on the present utilization of this technology and to document its current degree of integrity, obscurity and adaptableness. We tend to found eighteen use cases of blockchain within the literature. Four of those use cases area unit expressly designed for IOT. We also found some utilize cases that are designed for a private-by-design information management. Additionally, we found many problems within the integrity, obscurity and adaptableness. Concerning obscurity, we found that within the blockchain solely pseudonymity is ensured. Concerning ability and integrity, we discovered that the integrity of the blockchain for the most part depends on the high effortfulness of the Proof-of-Work and on the sizable voluminous variety of veracious miners, however at an equivalent time an arduous Proof-of-Work limits the ability. We documented and categorized the present utilization of the blockchain, and provided a number of recommendations for future work to handle the above-named problems.*

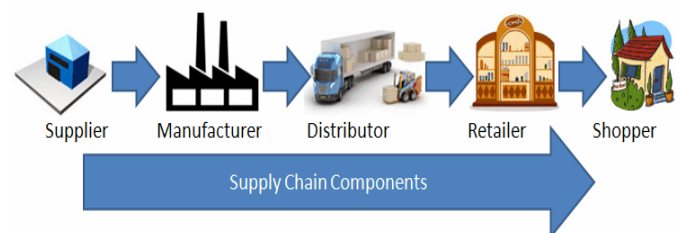***Key Words***: **blockchain technology, supply chain management, distributed ledger, food chain, decentralized supply chain**

1. INTRODUCTION

Today, the overwhelming majority of ancient supplying info systems in Food supply chains just track and store orders and deliveries, while not providing options as transparency, traceability and auditability. These options would sure improve food quality and safety, so they're additional and additional requested by customers[1]. Thus, many analysis & Development communities square measure concentrating their efforts on adopting some specific internet of Things (IoT) technologies like RFIDs and Wireless device Networks,

or everyday-cheaper connected devices, to enabled remote observation of the conditions in food transportation situations and at a awfully fine coarseness on the total Food supply chain, e.g., from production to consumption . However, the bulk of the present IoT solutions still admit heavily-centralized cloud infrastructures, wherever there's sometimes an absence of transparency, and naturally presents security threats together with convenience, information lock-in, confidentiality and auditability[12].

Blockchain technology originated from the bitcoin technology in 2008, that are chiefly characterised by distributed, trustless, uneven cryptography, good contract, and time stamp[3]. The key contribution is that the blockchain permits building mutual confidence and trust among individuals while not centralized authority, by providing mathematical solutions to the matter of trust. the fundamental plan is to confirm that the data is authentic and not tampered with by establishing a collection of "public books" on the web by "sharing" and "checking" all accounts within the network. the most options of blockchain technology may be summarized as decentralization, accord trust, collective maintenance and reliable information[3][8].

Fig -1: The process of food supply chain.

Fig -1: depicts the typical life cycle of a packaged food item as it makes its way through the FSC. The raw materials are sourced by the primary producers and sold to wholesale suppliers. The manufacturers purchase the necessary ingredients from the supplier and process them to produce the packaged food items. The items are then passed on to the distributer and shipped to the retailer where they are finally purchased by the consumers. There are some subtle differences for certain food items, e.g., fresh produce may not

require processing. However, we will use Fig. 1 as a representative example of the FSC throughout this document [6].

The process of collating data from various disparate repositories to form a product story and ensuring the integrity of data are key challenges, especially at the manufacturer stage where different raw materials are assimilated to form one product. There is a possibility that data inaccuracies may arise either due to errors or malicious intent. Although there are traceability systems based on centralized repositories, organizational siloing makes the process of tracing provenance information from these distinct sources tedious and fraught with delays.

Our intention in this research is to present a new way of sharing information and traceability system for the stakeholders involved in this process based on fundamental properties of distributed ledger technology (Blockchain) [4].

2. BLOCKCHAIN TECHNOLOGY

Blockchain is a data structure formed by blocks linked together in chronological order. Each block consists of a block header and a block body, which is a collection of industry data such as bitcoin transaction records, smart contract codes, and agricultural tracing records as in this article, etc. The block header includes the metadata of the block. The most important part includes the timestamp of the block, the hash value of the block, the ID of the block, the ID of the parent block. The existence of the parent block ID makes all the blocks form a chain structure, as shown in Fig.1. The insertion of new blocks is allowed only in the tail, while the existing blocks are not allowed to be modified, which is a key rule of blockchain.
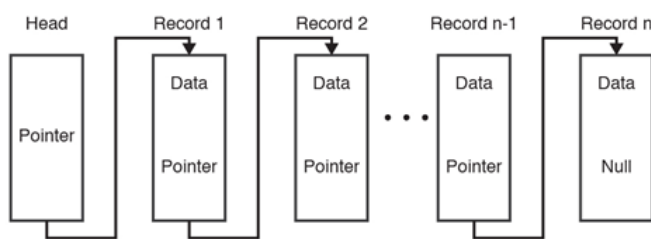

Fig -2: Structure of a typical blockchain

2.1 The Blockchain technology layout & its properties

The Blockchain technology allows digital information to be stored in a distributed shared ledger (distributed database) [8]. The stored information in the blockchain is checked by cryptographic algorithm before grouped to the "blocks" and enter to the distributed shared ledger [8]. The blockchain network consists of many nodes, which are distributed

geographically around the world, and their communication is a peer-to-peer mode. All the nodes in the network have the same data of blockchain that is automatically downloaded by using the peer-to-peer synchronization protocols [8]. This lead to unnecessary central authority. All the participants in the blockchain network rely on the interaction of the nodes in the network instead of central authority [9].

2.2 Related works based on blockchain in supply chain management

Beyond the crypto currencies, the blockchain technology finds its application in a variety of sectors including in Supply Chain Management and Logistics. The fastly emerging technology will distrupt many existing technologies. One among them is supply chain. Many supply chain projects are started. IBM sawtooth lake is a good example for the supply chain project.

3. HYPERLEDGER SAWTOOTH

The Hyperledger project proposes a set of open-source Blockchain technologies for business applications, like Sawtooth, Fabric, and Iroha [9]. These platforms are designed to be general purpose to accommodate as many use cases as possible, putting forward and emphasizing different features. None of them is built around a cryptocurrency. Nevertheless, many use cases of blockchain involve a form of asset/token transfer [9].

4. FOOD SUPPLY CHAIN TRACEABILITY SYSTEM

4.1 Introduction to RFID

RFlD (Radio Frequency IdentifIcation) is a non-contact automatic identification communication technology [12]. It can automatically identify multiple, high-speed moving objects simultaneously even under poor environment and without manual intervention. Moreover, it can tag, save and manage information of objects through a radio-frequency signal. Compare to bar code, RFID tag technology has a lot of advantages, such as convenience, antipollution, mass-capacity information and recyclable. In the logistics area, RFID has been widely used in production-processing, warehouse management, logistics tracing and product anti-fake, etc. With the extensive applications of RFlD, the level of supply chain management has been highly improved [12].

4.2 The basic concept of food supply chain traceability system based on RFID & blockchain technology

The food supply chain traceability system which we build in this paper mainly relies on RFTD technology to implement data acquisition, circulation and sharing in production, processing, warehousing, distribution and sales links of food supply chain. Besides that, it also uses blockchain technology

for guaranteeing the information which shared and published in this traceability system is reliable and authentic.

Thanks to RFlD & blockchain technology, this traceability system could realize the information identification, inquiry, tracking, monitoring and tracing for the whole supply chain, and it could also be a secure, transparent and traceable platform for all the members in the food supply chain. In addition, excepting RFID & blockchain there are many other technologies which can be comprehensively used in this traceability system, such as WSN, GPS, and GIS, etc. For example, GIS can be used together with RFID to control and track the production of the plants. Meanwhile, GPS can be used to make the vehicle positioning and optimal distribution route for distribution vehicles. In conclusion, all of these features enable this new traceability system to effectively guarantee the safety and quality of the food, and implement the precise recalling and responsible investigation for the defective product.

4.3 Supply Chain Management

In Supply Chain Management (SCM), the flow of materials and services required in manufacturing a given product is managed, which includes various intermediate storage and production cycles until the delivery to the final point of consumption. Typically, multiple companies interact and trade on a global scale within a given supply chain. Due to this complexity, associated costs of managing the inventory, processes and failure detection are particularly expensive [13].

Traditional SCM is driven by planning and communication. The future demand is estimated based on the past and current demand, information is pushed to the involved stakeholders that hope to get the relevant information on time to respond to changes, delays or errors. Companies decide what product is released to the market at what time, and customers indirectly drive the demand.

Traditional SCM compared to blockchain-based Supply Chain Management. Traditional SCM is distributed, i.e. there is no central entity. A blockchain powered SCM maintains a distributed ledger where participant can update and read (pull) the current SCM state.

4.4 Decentralized Autonomous Organizations

DAO is outlined by a set of rules encoded in smart contracts that outline however the DAO behaves and the way it evolves. Typically, a DAO has several investors that then decide by option how the funds of the DAO ought to be endowed. as the goal of such an organization is to be ruled during a utterly decentralized approach and also the investors usually don't understand or trust one another, a permission less blockchain is of course a good suited such a design: The system is needed to store some state and

multiple mutually distrusting and presumably unknown writers exist [13].

Decentralized autonomous organizations are, however, a special case. For a few applications a dedicated permissioned blockchain could also be helpful for one DAO. In most cases, however, DAOs don't need their own blockchain but are instead higher suited to be built on prime of an existing blockchain with an already existing currency (such as Ethereum [2]).

5. SUPPLY CHAIN ARCHITECTURE

The process in the Blockchain based supply chain is explained with an architecture diagram. It contains the process of transfer of goods starting from the producer to the consumer. As the Blockchain makes the process transparent every process is visible to everyone. This makes the process impossible to change. Supply chain management includes the integrated designing and planning as well as the execution of various processes. This involves material flow, data flow additionally as money capital flow.
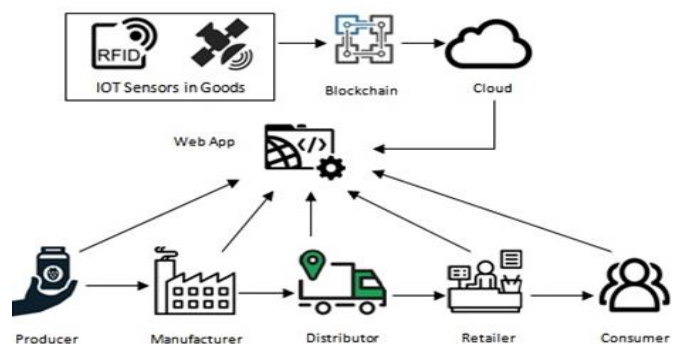

Fig -3: Architecture of the system

In the following we summarize the process involved in the supply chain:

5.1 Producing the goods

After the production of the goods the producer enters the details about the goods in the application built for the supply chain. The RFID is planted in this step and the details of the goods are stored within the ID. The GPS sensor is used to track the goods in the real-time. As we use smart contracts for the storing the data in the cloud using blockchain the sensor data is autonomously stored in the cloud without any manual work.

5.2 Manufacturing process

The position of the goods can be tracked with the web app any time. As the goods reach the manufacturer, they will finish their work in the goods and the timings are updated in the database using the web app.

5.3 Distributing the goods

The goods will reach the distributor after the manufacturing process. The distributor will distribute the goods to the retailer and the timings will be updated to the web app.

5.4 Selling the goods

Retailer receives the goods from the distributor and the goods will be available for the sale in the shop with the ID for the product.

5.5 Buying the goods

The consumers will visit the retailer's shop and the id is entered to the web app by the customer. The customer will get full details about the product. This make the customer satisfied about the products they are buying. And the reputation of the retailer will also increase with the trust among them.

6. CONCLUSION

In this paper, the IoT and Blockchain technologies is integrated. It results in creating a transparent, fault-tolerance, immutable and auditable records which can be used for Food traceability. Regarding the preliminary, very practical test even if the Hyperledger Sawtooth-based implementation had higher leads to terms of measured metrics with regard to the Ethereum one, each implementations have totally different properties and capabilities that require to be considered before selecting one over the opposite. The planning enforces a holistic model which may profit the provision chain participants, customers and audit management bodies. The framework additionally contributes in providing a novel group action vocabulary which may traceback to individual key ingredient with negligible time, a consortium ruled access management that guarantees no participant controls the blockchain, and sharded tiered specification so as to deal with measurability. There is no doubt that with the wide application of those rising technologies, product are often understood, carried, checked and trusty as they travel the provision chain. This can effectively enhance the standard and safety of food product.

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