IMPLEMENTATION OF BLOCKCHAIN IN SUPPLY CHAIN & LOGISTICS MANAGEMENT

CAPSTONE EXIT PAPER

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EXECUTIVE SUMMARY

Due to the rapid advancement in the supply chain and the constant need for fulfillment of the worldwide demand, organizations have turned increasingly to global sources for their supplies. Also, as the world is shrinking day by day with the advancement of technology, companies must look for more effective ways to expand their conventional supply chain integration beyond their own boundaries. This report illustrates the benefits and challenges in today's supply chain and the concept of embracing Blockchain into Supply Chain and Logistics.

In today's world, Blockchain can help organizations surpass their conventional approach and take the traditional supply chain and logistics management to a whole new level. To provide better insight, Walmart, history's greatest logistical and operational triumphs which is the world's largest, and the most powerful retail corporation has comprehensively explored to implement blockchain technology to create a food traceability system for the entire food supply ecosystem. They have designed this system by incorporating the Hyperledger Fabric blockchain technology which precisely helps Walmart for tracking and locating the source of any product around the world within no time and with much higher accuracy. This eventually helped Walmart to make the traceability process much faster so that they could act immediately and identify contaminated foods more efficiently.

Implementing Blockchain in Supply Chain and Logistics will lead to providing better transparency, traceability, security, trust, drive greater automation, enable new business models, alleviate friction in global trade, and have streamlined operations.

INTRODUCTION

What is Supply Chain Management?

A supply chain is a management that is used to provide products and amenities, from the raw material to the customers, through physical distribution, the flow of information or data (materials), and cash. A supply chain embraces a system of both processes and entities. SCM characterizes an effort by suppliers to develop and implement supply chains that are as capable and cost-effective as potential.

Supply chains cover all the things from production to the development of final products to the information systems needed to analyze and provide a basis for these implementations. By the appropriate management of the supply chain, businesses are able to minimize additional expenses and deliver products to the end-user sooner.

SCM is frequently defined as having five key elements: planning, sourcing of raw materials, manufacturing, delivery, and returns. The planning phase talks about developing an overall approach for the supply chain, while the other four elements focus on the key requirements for executing that plan. Companies must develop expertise in all five elements in order to avoid bottlenecks and have an efficient and effective supply chain.

Fig (a)

Benefits of Supply Chain Management

Supply chain management helps small businesses meet procuring and manufacturing requirements efficiently. By managing the supply chain, firms are capable of cutting extra costs and delivering products to the consumer faster. Good supply chain management facilitates a better flow of resources, materials, and products.

Also, SCM accomplishes better and improved data visibility by using analytics to track the day-to-day progress and to offer information on underperforming areas and anticipate future expectations with respect to the demand. Analyzing the supply chain data lets us observe potential risks before they occur.

By being proactive, rather than reactive, we can get better control of our supply chain and significantly lessen any adverse effects. Along with that, it enables the companies to attain a higher efficiency rate by reducing the expenses and delays in the processes, thus increasing the overall productivity.

Fig (b)

Challenges in Supply Chain Management

Currently, with the exchange of goods across different countries, or any exchange of information between the retailers, suppliers, and banks, there is often a lack of transparency and clearness. Also, these records or information are shared only on request as all the organizations preserve their own records in their database only accessible to them producing a lack of a universal database.

Also, product traceability is a major factor because it is challenging to trace a product when it is moved out for delivery purposes since there is a greater chance of personnel involved in the distribution process to alter the original product.

Suppliers, manufacturers, logistics, clients, and customers are spread across multiple countries, time zones, and continents, requiring careful coordination and management. International complexity, environmental changes, economic pressures, and trade disagreements all put a burden on the supply chain. This burden without any difficulty can turn into risks and concerns that snowball and escalate throughout the chain, triggering significant complications.

What is Blockchain?

Blockchain is a distributed digital ledger system where transactions of several sorts (i.e., not only monetary) between parties are documented redundantly in multiple databases that are protected. It is a time-stamped list of an immutable record of data that is controlled by a set of computers and not controlled by any central entity. It can be openly shared among different users and that crafts an unalterable record of their dealings and communications, each one time-stamped and linked to the previous one.

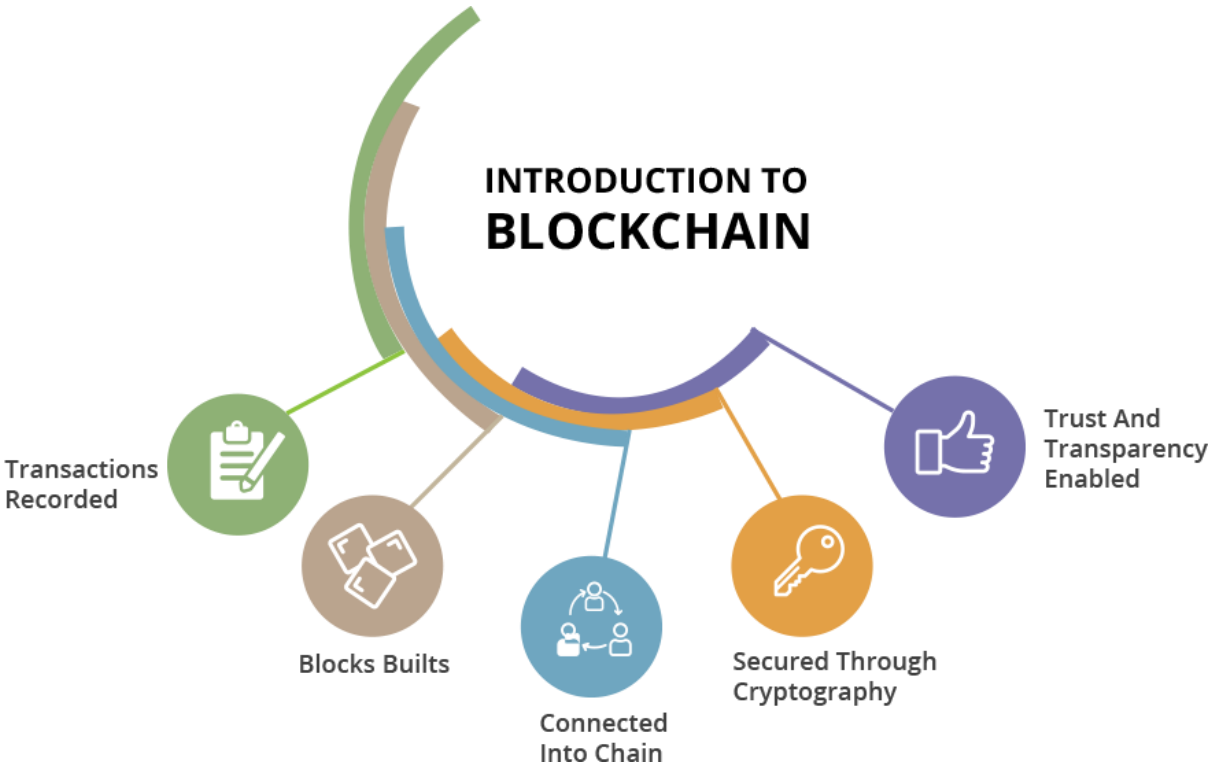


Fig (c)

Each digital record or transaction in the thread is called a block (hence the name), and it lets either an open or controlled set of users participate in the electronic register. Each block is associated with a specific member. Blockchain can only be updated by agreement between members in the system, and when new data is entered, it can never be erased. It contains a true and verifiable record of each and every transaction ever made in the system.

Each block contains:

- a cryptographic hash of the previous block,
- a timestamp,
- and transaction data (generally represented as a Merkle tree).

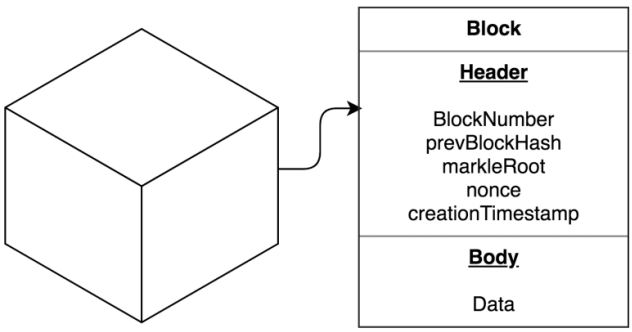


Fig (d)

Benefits of Blockchain

As mentioned earlier, with the exchange of goods across different countries, or any exchange of information between the retailers, suppliers, and banks, there is often a lack of transparency and clearness. This is where the implementation of blockchain comes into the picture. This report basically deals with solving these supply chain problems and issues by instigating blockchain into SCM because blockchain has the potential to transmute the supply chain industry by providing more traceability and security.

Blockchain offers an end-to-end solution for corporations that want to run leaner, more organized, and executing more efficient operations. Widely popularized by its cryptocurrency capability, the blockchain can also provide assistance to firms by handling contracts and agreements and monitoring financial transactions and products.

The key concepts of blockchain are:

Decentralization

Decentralization is the essential feature of blockchain. The information stored in the blockchain is accessible to everyone who is in the blockchain's network and is not completely owned or maintained by a single person or process. In this way, the data is uploaded on the blockchain database in a decentralized fashion not controlled by a central authority but in a way, this is accessible to the authorized entity only.

Immutable

Immutability means non-alterable. Any data in the blockchain database cannot be fiddled by anyone in any way. Since the data is encrypted with the cryptographic hash function and interlinked with each other, it is impossible to tamper or hack in any manner. Proper authentication and authorization are required to access the data.

Transparency

The parties or entities which are a part of the transactions on the blockchain network can view all operations since those are documented on the shared distributed register. This enables people to view only the public address, by not sharing any personal details of that particular person.

The key benefits of blockchain are:

Automating the purchase process

Through smart contracts, blockchain enables the automation of purchase processes. Such contracts can include service payment, shipment authorization, etc.

Improving transaction flow

On average, handling daily transactions takes 3 to 6 days but due to blockchain, it happens within few minutes. This is done using smart contracts which in a way increases efficiency and enriches transparency and trust.

Securing the supply chain

As mentioned earlier, the preserved data is accessible only for those people who have proper authorization. This ensures the privacy of the firm in a way securing the supply chain.

Assuring data integrity and integral traceability

Blockchain being a distributed digital ledger ensures traceability since everything is recorded and registered in one database. This also provides integrity of information since the data cannot be altered by any unauthorized user.

Cost Reduction

As we know, SCM is a tiresome process in itself as it involves a lot of paper trail and man force for procuring and verifying the quality and quantity of goods and product till reaching it to the consumers throughout the chain of operations. Blockchain on the other hand eliminates most of the human involvement throughout the process by real-time tracking and record-keeping and also mitigates the risk of altering or tampering with the information passed along the chain. This eventually reduces the cost.

Enhancing Trust

SCM involves interactions between different suppliers, vendors, manufacturers, logistics, clients, and customers, and building trust among each other plays an essential role for successful execution of operations along the chain. Because of the use of smart contracts and avoiding human involvement, blockchain in a way automates the operations and processes.

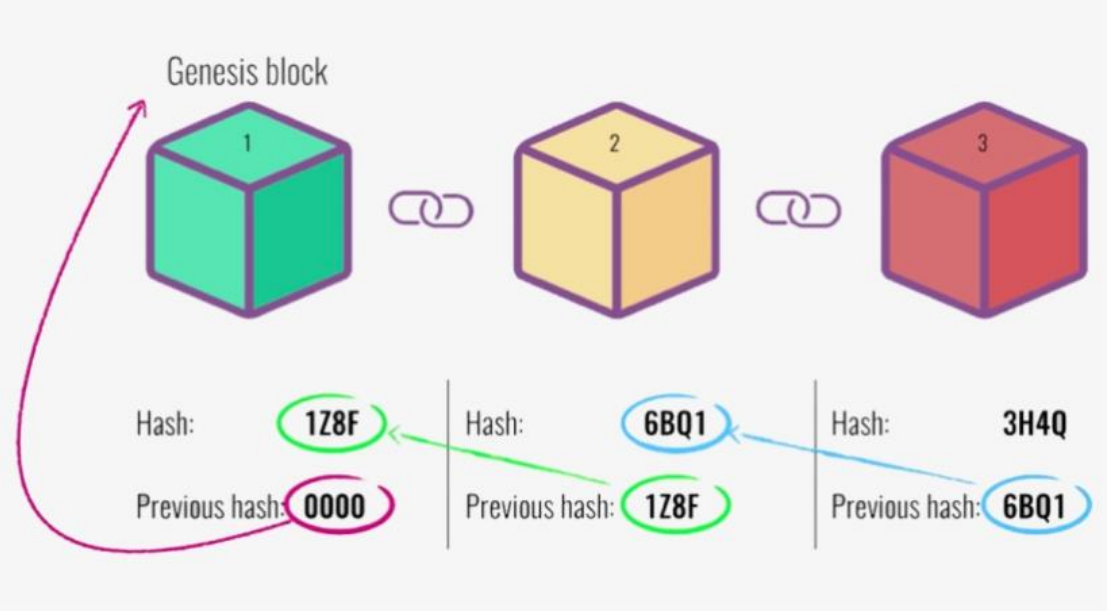


Fig (e): Blockchain


Capturing the Details of a Simple Transaction: Conventional vs. Blockchain Systems
The financial ledgers and enterprise resource planning systems now used don't reliably allow the three parties involved in a simple supply-chain transaction to see all the relevant flows of information, inventory, and money. A blockchain system eliminates the blind spots.
KEY
Retailer
Supplier
Bank
Information flow
Inventory flow
Financial flow
CONVENTIONAL RECORD KEEPING
FINANCIAL LEDGERS
BLIND PARTY
BLOCKCHAIN
BLOCKS ADDED
1. Retailer places order with supplier. Supplier acknowledges receipt of order.
2. Supplier requests loan from bank. Bank provides financing to supplier.
3. Supplier invoices and ships merchandise to retailer.
4. Retailer pays supplier for merchandise.
5. Supplier repays bank. Bank closes loan record.
6. Retailer returns unsold or damaged merchandise to supplier and invoices for it. Supplier pays invoice.

Fig (f)

Impact of Blockchain in Supply Chain Management

Blockchain is one of the crucial pioneering technologies modernizing digital SCM. The advancement in supply chains has led to the involvement of many diverse stakeholders and has become more dependent on many external intermediaries due to which the growth of the supply chain has become more intricate in nature. This is where blockchain has become apparent as a solid competitor for de-tangling all the data/documents/communication interactions and trades taking place within the supply chain environment.

Because of the cost-savings and increased efficiencies, blockchain has impacted these of the following areas of supply chain management,

Procurement

For all the supply chain related operations like purchasing or negotiating different terms with suppliers, blockchain can act as the only source of truth being transparent for all the subsidiaries, partners, etc. Blockchain can provide and give us an all-round view of the total volume of purchases, irrespective of who handled the purchase activity by keeping the pertinent information in the blockchain database from different authorized users. There is no need to cross-check the data all the time and also, we can easily calculate the precise volume discount based on total procuring and mathematically verify that it is appropriate without revealing each company's individual volumes.

Provenance and Improved Traceability

Businesses are discovering how blockchain can be used to verify the source and paths of goods sold and provide data on the legitimacy of those. To make tracking the chain of custody and characteristics of products possible, blockchain administers the transparency, security, authenticity, and auditability by which the customers can obtain the high-quality information required to make more informed decisions. Because of blockchain, the high initial cost/benefit ratio for members is significantly reduced by having transparency in a supply chain. Also, the central organizations are exempted from expensive and error-prone operational responsibilities due to their easily distributed design.

Digital Contracts and Payments

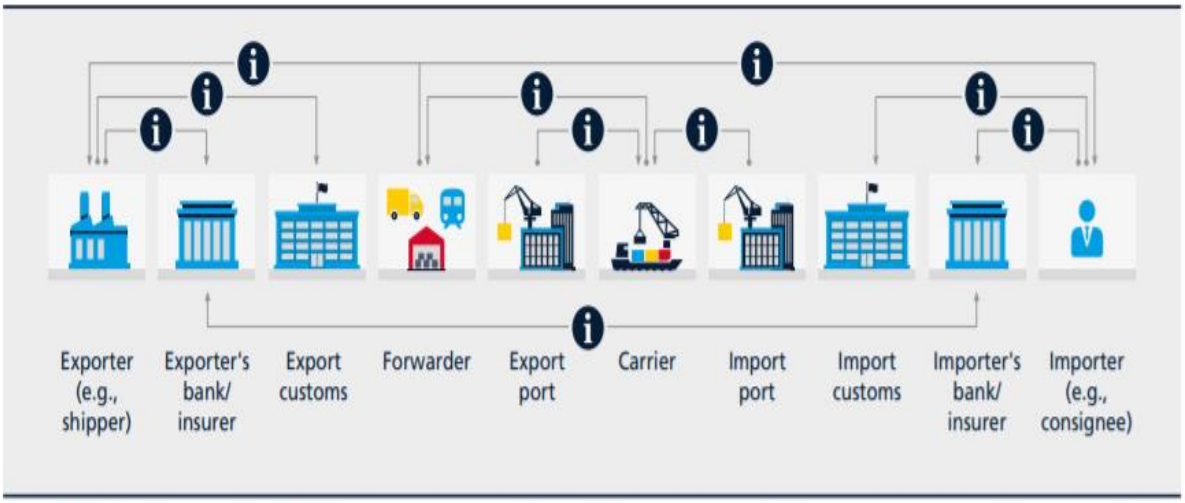
Automating the invoicing process and patching the costly procure-to-pay gaps is possible by using smart contracts. Payment conditions can be codified, and cash can be acquired instantly after the trade has been completed and proof of delivery can be obtained. Data redundancy can be reduced, and expensive mistakes can be totally eliminated through smart contracts. By implementing smart contracts, the only entries that can be accepted are the ones that match with the pre-programmed values. Also, it evaluates all the contract features and clauses by being unbiased and impartial. This makes sure that there are no errors or any ambiguous data present in the records and provides better security and maintaining consistency throughout the process.

Manufacturing

Because blockchain-based systems are impossible to manipulate, one major advantage of implementing such a system in manufacturing is its robust fraud detection. These systems can immediately spot any kinds of mishaps or accidents in the factories and act upon them promptly. Organizations are transforming by being fully transparent about their supply and manufacturing processes to mitigate the risks and increase their reputation in the market. Better control over the flows arriving from suppliers and on the production can be accomplished by the manufacturers.

Impact of Blockchain in Logistics

There was a time when moving products from one place to another was a simple job but, today's supply chains exemplify complicated environments in which a variety of products and materials go through thousands of various phases, all managed by completely independent and self-governing organizations and depended on geographically separate processes. The logistics industry even now relies on a substantial trail of documents, particularly while going through the customs process. This enormously reduces the transparency that companies have for keeping a track of the status of shipments throughout the supply chain process.



The information flow in international trade is complex, involves many parties, and is documentation heavy;

Fig (g)

Implementing blockchain in logistics can resolve some of the following issues,

Faster and Leaner Logistics in Global Trade

An estimated 90% of world trade is carried out by the international shipping industries every year. Since it involves different parties with a difference of opinions and priorities and also using different systems to track the shipments, the logistics behind the global trade is extremely intricate. The tensions and disagreements including procurement, transportation management, track and trace, customs collaboration, and trade finance

can be improved along with optimizing the cost and time as well as the documentation and processing of a shipment by implementing blockchain.

The end-to-end shipment tracking and trade plans can be digitized. Also, it allows the organizations to perceive the overall flow of process i.e., to know where the goods or containers are in transportation or transfer through the supply chain.

Improving Transparency in Global Logistics

Many projects in the logistics domain have been transformed by implementing the blockchain to improve transparency and monitor provenance. It gathers data about how goods are produced, what is their origin, and how they are handled and stores them in its decentralized system.

Due to this, the information becomes permanent and easily available and shared, giving logistics companies a broad track-and-trace ability than ever in the past. This information can form a basis of proof for the authenticity and validity of the shipments. This helps the customers to check whether a product has been ethically sourced, if it is original, and has been conserved in the right environments.

Automating Commercial Processes in Logistics with Smart Contracts

It has been estimated that currently, 10% of all freight bills and statements have inaccurate information which leads to disagreements as well as many other process incompetence in the logistics industry. These disputes can be solved through blockchain.

The digitized documents and shipment information can be stored and utilized as smart contracts which will in a way automate the business processes. By smart contracts we can track and trace a shipment from the moment it leaves the manufacturing plant to the final delivery to the consumer.

By combining blockchain with the Internet of Things (IoT) in the logistics industry will facilitate even smarter and quicker contracts in the unseeable future. Through smart contracts, the system can check whether the products are delivered or not by validating them spontaneously. There are many other things that can be automated like planning and scheduling a delivery, fleet management, freight forwarding, etc.

WALMART

Introduction

Walmart is a chain of hypermarkets, discount department stores, and grocery stores from the United States, headquartered in Bentonville, Arkansas. It was founded by Sam Walton in 1962. What began tiny, with just one discount store with a straightforward idea of selling more for less, has expanded over the last 50 years into the largest retailer in the world.

If anyone asks who the leader in sustainability, corporate philanthropy, and employment opportunity is, then the definite answer is Walmart. It is their firm dedication that generates various opportunities and brings value to its customers. Ensuring and sustaining to be ahead of others in such an extremely cutthroat and rapidly progressing business environment is only achievable if we have a persistent and unswerving quest of excellence by developing and innovating new and enhanced business processes and procedures.

Challenges

There are approximately 11,200 stores and clubs under 55 banners in 27 countries and eCommerce websites. Around 265 million customers visit these stores and shop online every week. Especially considering its food supply chain, when an outburst of a food-borne disease occurs, finding the source of cause can take several days to few weeks.

Companies can do something more rapidly and the livelihoods of cultivators and farmers will be safeguarded if they could quickly trace the source and get rid of it from any further use which will in a way avoid unnecessary risks to the health and well-being of many consumers consuming those products.

History

We sometimes consider the food supply chain as simply being a chain of procuring raw materials from the source to keeping the final product on the shelves for selling purposes, but we should understand that it is simply not a chain but an intricate network. So, any problems or issues will take several days to weeks to be resolved.

According to Walmart, a high standard of safety is maintained as far as the food products are concerned but sometimes it may happen that someone may fall sick. Such a scenario happened back in the year 2018 where 18 outbreaks of foodborne illnesses were reported in the USA especially with the romaine lettuce that they sold that time. If we are unable to find the source accurately then it may happen that federal authority may advise consumers to avoid buying such products. This is what happened with Walmart, where they had to dispose of millions of bags of romaine lettuce and even in the future, many people were reluctant from buying it.

That was the time when Walmart realized that better traceability and transparency could have made locating the source of the cause faster and easier by dumping the lettuce from the affected area. This is where they thought of achieving better transparency and traceability in their system by implementing blockchain technology. Walmart believed that the blockchain will be a good fit for their food supply chain as it primarily concentrated on trust, immutability, and transparency.

Integrating the Blockchain Technology

Walmart considered several blockchain technologies but finally decided to go for Hyperledger Fabric as it was an open-source, vendor-neutral blockchain, and also, it fulfilled most of the needs. It is a decentralized open-source distributed ledger framework that enables faster transactions, has updated smart contract technology, and streamlined data sharing.

Hyperledger Fabric is a modular blockchain framework that functions as a basis for developing blockchain-based products, solutions, and applications using plug-and-play components that are intended for use within private organizations. Also, another reason behind implementing Hyperledger Fabric is that private transactions and confidential agreements and bonds cannot be braced by traditional blockchain networks but Hyperledger Fabric being an open-source engine for blockchain looks after the most vital features for assessing and utilizing blockchain for commercial purpose.

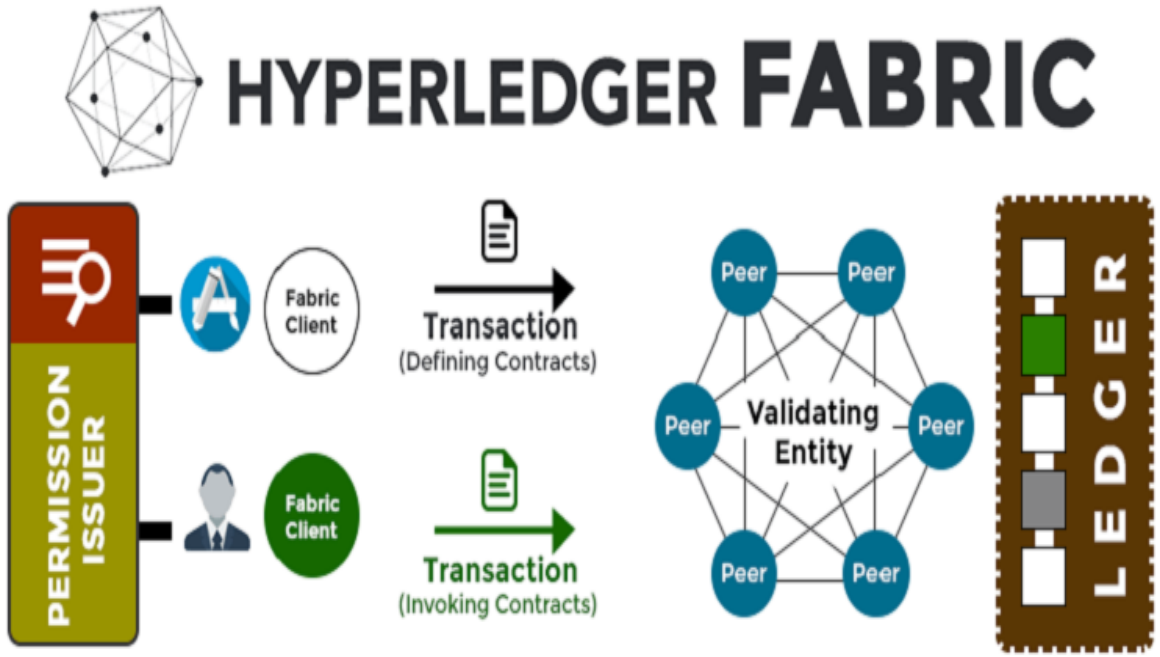


Fig (h): Hyperledger Fabric Framework

The components of the Hyperledger Fabric network are,

- **Ledgers** (consists of blockchain and state database),
- **Smart contracts** (aka chaincode),
- **Peer nodes** (performs read/write operations on the ledgers),
- **Ordering services** (orders transactions on a first-come-first-serve basis),
- **Channels** (blockchain overlay which allowing data isolation and confidentiality),
- **Fabric Certificate Authorities** (identity registration, certificate renewal, etc).

The above framework basically performs the following operations,

- The Permissioned system has strong identity management.
- Users and validators have distinct roles.
- Users deploy a new piece of code (chaincode) and invoke them through deploy and invoke transactions.
- Validators evaluate the effect of a transaction and reach a consensus over the new version of the ledger.
- Ledger is the total orders of the transactions, plus the hash of the global state.
- Pluggable consensus protocol, currently PBFT & Sieve.

In October 2016, Walmart implemented the Hyperledger Fabric technology on two projects; one was for locating the source of mangos sold in the US stores and the other was designed to track the pork sold in its China stores.

It was seen that the traditional approach for locating the source of a particular mango took around 7 days as it involved calling and emailing the distributors and suppliers, which in a way was quite remarkable as per the industry standards, but the Hyperledger Fabric blockchain-based food traceability system took just 2.2 seconds for locating the source which was an unimaginably incredible accomplishment.

The same was the case with tracing the pork in the China stores as it was relatively easy to upload documents and records of authenticity and validity into the system which eventually brought more trust to the system which previously used to be a problem as the results were unsure due to lack or mismanagement of proper invoices and other supporting documents.

Results

The integration of Hyperledger Fabric blockchain-based food chain was a major success for Walmart. Today, Walmart can easily track and locate the source of over 25 products from 5 distinct suppliers by employing this robust and effective system.

In the future, they are intending to implement this system on more items and that too within different categories and groups. Not long ago, they have revealed that they will make a prerequisite for their suppliers of fresh leafy greens (like salad and spinach) to track and locate their products using this system.

CONCLUSION

Incorporating Blockchain technology will revolutionize the Supply Chain and Logistics by making the process simpler and safer and ultimately efficient. This unnavigable system will definitely see to it that any kind of fraud, hacking, data theft, and information loss will never occur. By implementing this blockchain-based food supply chain system, Walmart improved its information-sharing safety and food traceability which eventually made the source tracking process easier, quicker, and much leaner. This made Walmart enhance their supply chain risk mitigation which facilitated them prevent any safety or health issues for their consumers in the future which in a way led to the growth of trust among its consumers. By looking at Walmart's example, we can clearly say that in the near future, organizations will start incorporating this technology in their supply chain models with the objective of enhancing sustainability and products' traceability and facilitating everything from manufacturing to delivery of products. This change will not occur immediately but definitely.

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