

Traceability in the Food Supply Chain

A Hyperledger Fabric Solution

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1 PROJECT BUSINESS CASE

The chain of custody for food must be traceable. In the existing system, tracing the origin of food is a time-consuming process that requires tracking in several databases or on paper records in a lot of situations.

Blockchain technology may be used in the food industry to record details on a specific product, including its origin and manufacturing processes. The creation of an accountable and traceable system allows for the generation and secure sharing of data by all parties involved in the food supply chain. A real-time record of a food item's journey from farm to table is made possible via data capture at key locations. The openness and immutability of a blockchain solution aid in removing supply chain bottlenecks, predicting the shelf life of items moving through the supply chain, and pinpointing the exact origin of products in the event of a recall. Instead of taking days, the origin of a product may be determined in seconds. This speedy turnaround reduces costs significantly in the food supply chain, but more crucially, it has the potential to save lives.

More reassurance and openness about the things that consumers buy is what they desire. Additionally, in order to build connections with customers, merchants and manufacturers must establish trust. These conditions are met by the food blockchain. Customers may obtain product information on their smartphones using a web-based interface by scanning the barcode or QR code on a product's label.

Transparency in the supply chain is made possible by the blockchain, which also makes data accessible that was previously difficult or impossible to get. Since the network's inception, all data transmitted between producers, processors, and distributors has been recorded in this database.

1.1 CHALLENGES IN THE FOOD SUPPLY CHAIN

- intricate product path (ingredients can be combined to create new products).
- A perishable good is food.
- Public health is at risk from foodborne illnesses.
- The requirement to monitor and manage stocks at each link in the supply chain, ensuring the legitimacy of the items at each stage and preventing fraud.

1.2 BENEFITS OF TRACEABILITY FOR BUSINESSES

- Time efficiency in the supply chain.
- Cost reductions.
- Product recalls and their economic effects. A 2011 Grocery Manufacturers Association analysis states that the majority of businesses that experience a Class One recall, in which the potential impact on public health is the greatest, may anticipate a financial hit of \$10 million or more. Almost one in four businesses indicate that a single recall had a financial effect of more than \$30 million.

- A decrease in insurance rates. The conditions of insurance coverage now required in transactions and international shipping, as well as how responsibility and indemnity are defined in supply chain management, might all be changed by blockchain technology.
- Decreased fraud.
- Brand loyalty and customer happiness.

2 DESIGN OF SOLUTIONS

2.1 MODEL OF GOVERNANCE

Multiple private permissioned companies can access the consortium blockchain.

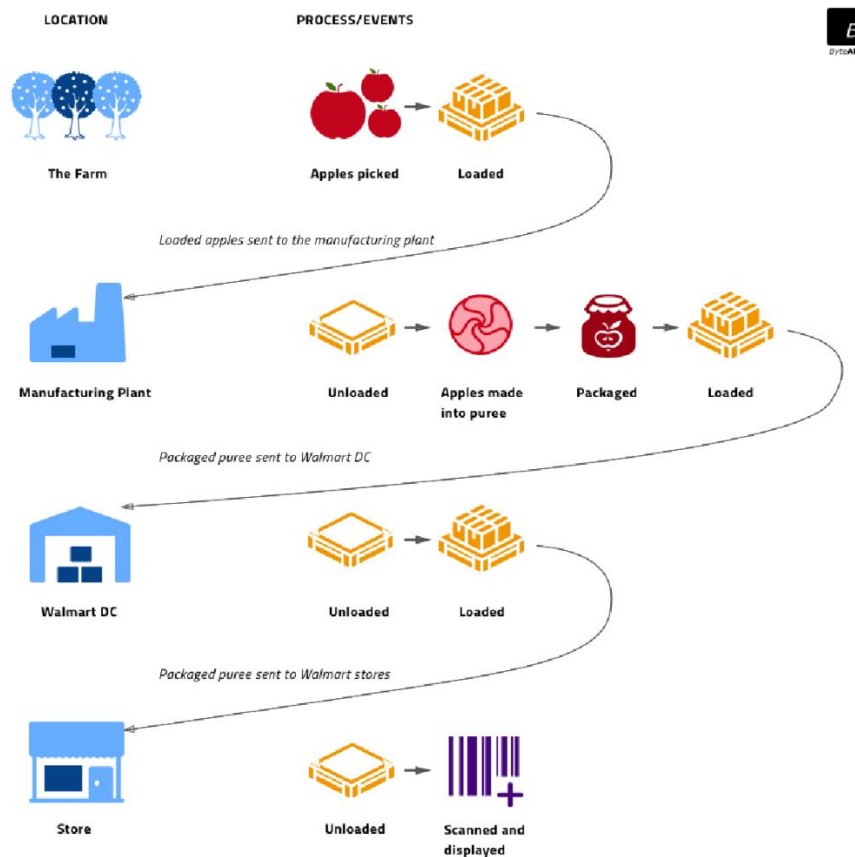
- Participants have known identities and have been granted permission in advance.
- In a situation of incomplete trust, consensus is dependent on voting. Consensus is attained and finality happens when the majority of nodes approve a transaction or block. The more nodes there are, the longer it takes to obtain agreement since voting-based methods need nodes to send messages to every other node on the network. As a result, scalability and performance are compromised. The number of nodes is constrained in this particular food supply chain network, which would speed up transactions.

2.2 REQUIREMENTS FOR SYSTEMS

The following conditions must be met by a food supply chain system design:

- Product tracing and tracking throughout the supply chain. In this specific instance, we are monitoring apples from an apple orchard owned by a farmer or supplier. Apples are contained in on a pallet with boxes. A special identifying code would be on each pallet. (The following For this project, granularity is at the pallet level.)
- A factory receives the cargo of apples, processes them, and turns them into apple sauce. The supplier is compensated for the apples. Jars containing the apple sauce are placed in cartons together with the jars. The pallet contains the boxes. Additionally, this pallet would have a special identifying number. A warehouse receives the pallet via shipping.
- At the warehouse, the apple sauce pallet is unloaded. To track the delivery, the ID is scanned. This results in the manufacturer being paid for the shipping. Boxes containing the items would probably be removed off the pallet and put on shelves.
- The retailer receives a pallet of goods. In a real-world application, this pallet would probably include a variety of items; nevertheless, for the sake of this project, it is believed that a pallet only contains one commodity. Additionally, it is believed that a pallet may only be shipped and received by its owner. A special identifying number would be attached to the pallet. The Warehouse receives payment from the Retailer.
- Data that is pertinent must be available to all parties. In the event of a future issue, knowing the farm and batch identifier would be helpful. For instance, the manufacturer would be able to identify the issue if there was a health hazard with the apples. The store would also be able to link backwards in the supply chain if there was a problem with the batch of applesauce by knowing which pallet the jars of the product originated from.

2.3 DIAGRAM - SYSTEM OVERVIEW



2.4 REQUIREMENTS FOR FARMER ONBOARDING

The following requirements must be met by farmers before they may be onboarded.

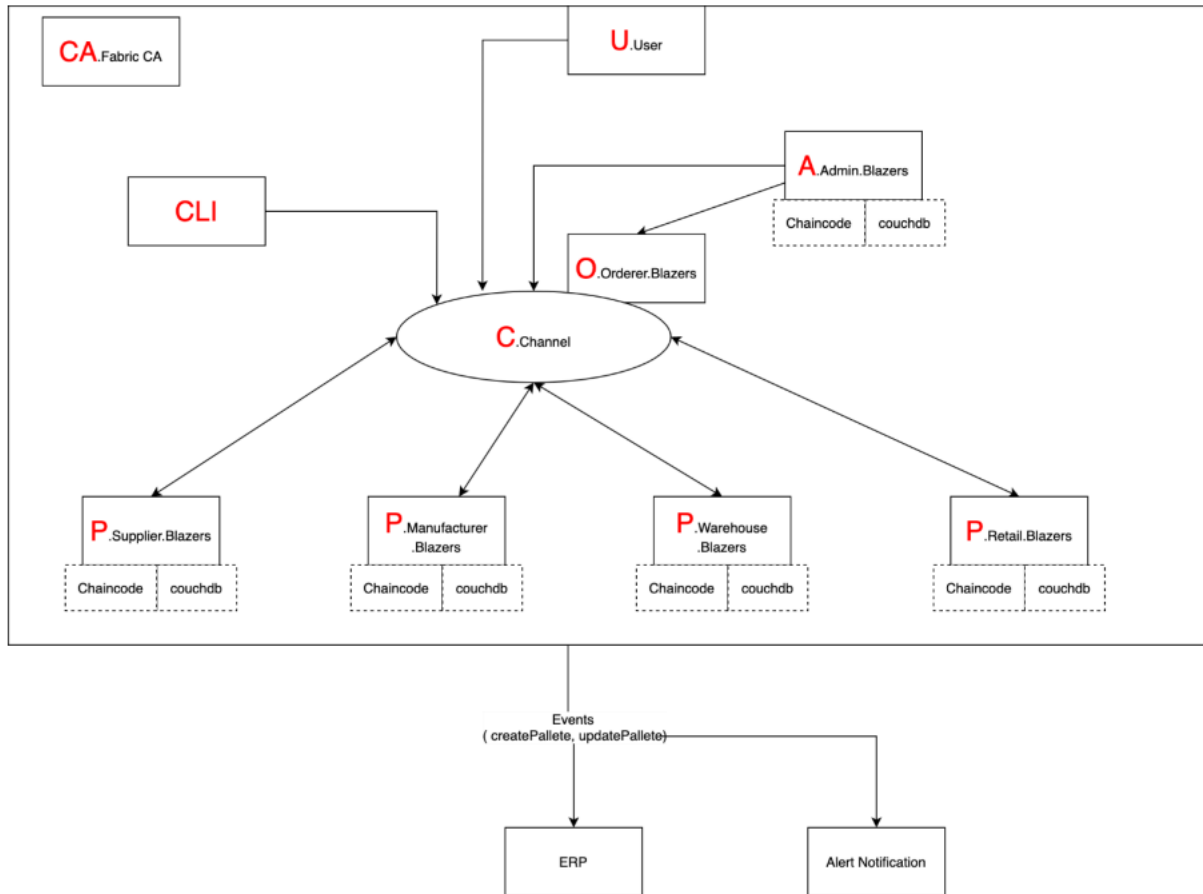
- There is a food safety plan.
- A water test demonstrating that the supply of water is suitable for washing and growing harvested food.
- Product liability insurance for the supplier.
- Certification supporting any claims made about the product (such as organic certification for vegetables grown organically).

2.5 FUTURE UNCERTAINTIES

The existing system has been streamlined. To create a more stable environment, finer granularity might be added. The following might develop in the future:

- Entering identity information in accordance with GS1 Standards.
- IoT Sensors: Environmental factors including humidity, temperature, and shock are monitored and data is generated in the form of alerts (bruised apples are used to produce cider, immaculate apples are used to make sauce, and hashes are saved on chains).
- Additional Inputs: Purchases of seeds, fertiliser, and financing from banks
- Aggregation: Small traders and farmer cooperatives
- Retailing: Grocery stores, restaurants, and traditional marketplaces

3 NETWORK ARCHITECTURE



4 CHAINCODE

This asset is created to list the product.

Pallet Object

- creator
- palletNumber
- createDateTime
- productName
- productQuantity
- price

States

- CREATED: 1
- PURCHASED: 2
- SHIPPED: 3
- RECEIVED: 4

Transactions

- **PalletContract.create**
- **PalletContract.purchase**
- **PalletContract.ship**
- **PalletContract.receive**

5 FOR FUTURE CONSIDERATION: DATA DICTIONARY UTILIZING GS1 STANDARDS (REFER TO APPENDIX)

5.1 Grower/Supplier

Field	Description
GTIN	Global Trade Item Number
LOT	Batch/Lot Number
DATETIME	Date and Time Stamp
GLN_FARM	Global Location Number (physical location of farm)

- Global Trade Item Numbers + Lot Numbers are used to identify raw produce.
- Global Serial Shipping Container Codes are used for products distributed from the farms with batch/lot information.
- Each physical location is identified with a Global Location Number

5.2 Manufacturer

INPUT	
Field	Description
GTIN	Global Trade Item Number of Raw Materials
DATETIME_RECEIVED	Date and Time Shipment Received
GLN_FACTORY	Global Location Number of Factory
OUTPUT	
SSCC	Serial Shipping Container Code
DATETIME_PRODUCED	Date and Time Product Produced
DATETIME_PACKED	Date Product Packed

- Internal traceability is maintained in the key processes: receiving, transformation of raw materials to semi-finished or finished goods, storage and distribution.
- GTINs and production data (batch/lot & expiry date) are printed on products to be despatched.
- Links between goods received and despatch of final product are always maintained through the GTINs and batch/lot numbers

5.3 Warehouse

INPUT	
Field	Description
SSCC	Serial Shipping Container Code
GLN	Global Location Number of Warehouse
DATETIME_RECEIVED	Date and Time Received

OUTPUT	
SSCC	Serial Shipping Container Code
GLN	Global Location Number of Warehouse
DATETIME_SHIPPED	Date and Time Shipped Packed

- Internal traceability is maintained in the processes of receiving, storage and distribution.
- Global Trade Item Numbers + batch/lot or expiry date is used to assure accuracy of products when aggregated and disaggregated. These cases are linked and tracked with a pallet using the Serial Shipping Container Code.
- Despatch Advice containing Global Trade Item Numbers, Serial Shipping Container Code and Global Location Numbers are sent to customers.

5.4 Retailer

INPUT	
Field	Description
GTIN	Global Trade Item Number of Carton/Case
GLN	Global Location Number of Warehouse
DATETIME_RECEIVED	Date and Time Received
OUTPUT	
GTIN	Global Trade Item Number of Carton/Case
DATETIME_UNPACKED	Date and Time Unpacked and put on Shelves
DATETIME_SOLD	Date + Time Sold to Customer

- Retailers provide product information to their customers at Point of Sale.
- Master data and event data (for traceability purposes) can be provided to consumers on product labels or through scanning of barcodes.

6 INTERFACE

The system receives information from input media. Data entry displays, optical character readers, and bar scanners are a few examples of input devices used in a food supply chain system. IoT oracles would also be utilised to guarantee that the environment, including humidity, temperature, shock, was suitable. - monitors data and produces alarms (good apples for sauce, damaged apples for cider, chain-stored hash).

7 SYSTEM INTEGRITY

To access and start transactions on the Hyperledger Fabric network, which is a private permissioned blockchain, all stakeholders must first register with membership services to create an identity. The relevant permission levels for various stakeholders can be decided by validators during network setup. Sensitive data must be collected and used in order to construct a food supply chain system. Internal security must be implemented in order to limit access to important data items to just those access types that have permission, and verification procedures must be in place for any critical data additions, deletions, or modifications.

8 REFERENCES

Accenture Report: Tracing the Supply Chain

<https://www.accenture.com/ca-en/insights/blockchain/food-traceability>

Blockchain And Supply Chain: A Dynamic Duo

<https://blockgeeks.com/guides/blockchain-and-supply-chain/>

Case Study: How Walmart brought unprecedented transparency to the food supply chain with Hyperledger Fabric

<https://www.hyperledger.org/resources/publications/walmart-case-study>

Continuous interconnected supply chain: Using Blockchain and Internet-of-Things in supply chain traceability

<https://www2.deloitte.com/content/dam/Deloitte/lu/Documents/technology/lu-blockchaininternet-things-supply-chain-traceability.pdf>

GS1 Standards

<https://www.gs1.org/industries/foodservice>

IBM And Maersk

<https://www.youtube.com/watch?v=tdhpYQCWnCw>

IBM Food Trust. A new era for the world's food supply.

<https://www.ibm.com/blockchain/solutions/food-trust>

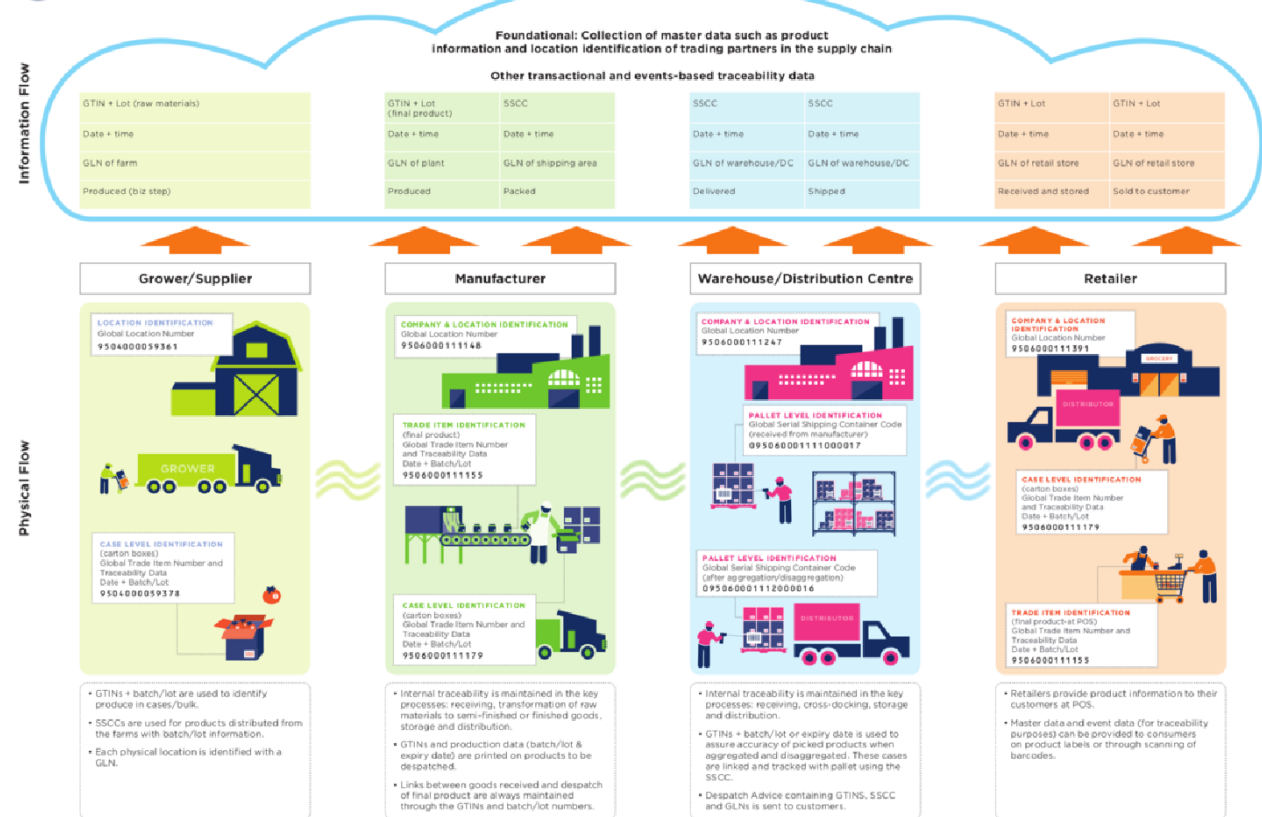
Six Ways Blockchain is Being Used in Food and Agriculture Supply Chains

<https://medium.com/cultivati/six-ways-blockchain-is-being-used-in-food-and-agriculturesupply-chains-68a7305fd533>

9 APPENDIX



GS1 standards enabling traceability in the food supply chain



Note: All GS1 keys are available in a barcode format. All GS1 key numbers highlighted above are for illustration purposes only and should not be used within an actual operation.

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