

Blockchain Based Farm-to-Fork Supply Chain Tracking

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ABSTRACT

Current systems for tracking agricultural products from their origination to consumption rely on separate actors and enterprise architectures. This makes any kind of tracing of concerns back to their sources very cumbersome and challenging. It also raises concerns for potential security risks such as data integrity and accountability. In this work, we propose implementing blockchain to reliably process agricultural data in a decentralized manner and use IoT devices for automated data capture and tracking. Our blockchain based approach offers a manageable semi-automated solution to track and trace agricultural products to ensure integrity and accountability of all stakeholders involved.

INTRODUCTION

- Smart farming is the application of smart technologies into traditional farming. [1]
- Farm-to-fork is the path an agricultural product takes throughout the different stages of the supply chain from when it is acquired by the farmer to when it is purchased by the consumer.
- A good portion of the data about an agricultural product gets collected at the farm.
- Having the information collected and stored in an easily retrievable way allows for:
 - Identifying the source of a problem
 - Auditing the history of a product
 - Naturally empowering the consumer
 - A healthy, competitive marketplace

PROBLEM DEFINITION

- Current systems for storing information about an agricultural are separated between in each organizations.
- Makes tracing details back to the origin of an item time-consuming and difficult.
- Also raises security concerns of the integrity of the data as well as accountability.

SYSTEM FEATURES

- Roles and permissions for authorized access
- Automatically keep track of the transfer of ownership
- IoT sensors able to record various data in the blockchain
- Web-based application that can interact with the blockchain
- Trace agricultural products back to their origin
- Quickly obtain information from RFID tags*
- IoT sensors able to interact with the RFID tags*
- Alert stakeholders of any irregularities*

* *Italics = Features not demonstrated in this work*

SYSTEM FRAMEWORK

- Consists of three primary components
 - IoT devices
 - RFID tags.
 - Blockchain

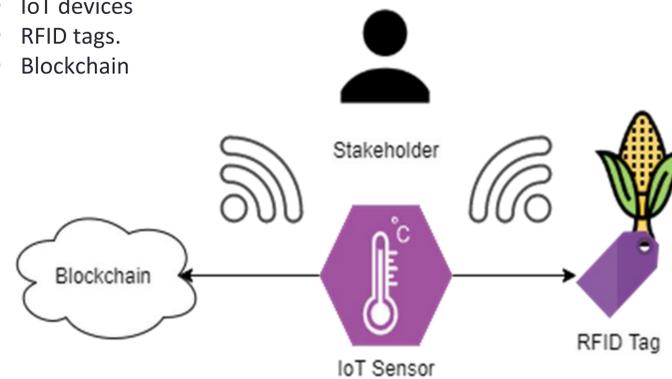


Figure 1: Farm-to-Fork Tracking System Framework

- Every stakeholder required to use IoT sensors for automated logging of data
- RFID tags put on bulk sets of products to hold useful information about a product at that time
- Uses Hyperledger Fabric for the blockchain because of how the benefits pair well with a supply chain tracking system

IMPLEMENTED NETWORK

- 8 organizations – 1 for each stakeholder and 1 for the orderer.
- Each organization given a single peer and its own certificate authority.
- All connected on one public channel
- Each stakeholder given a smart contract with only the functions needed for their job.

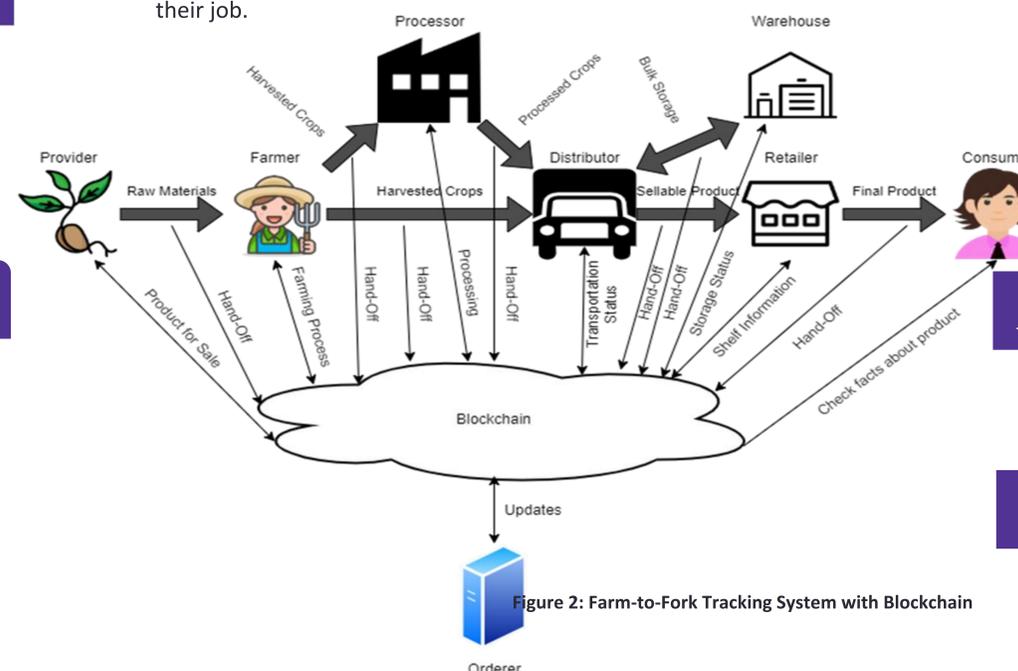


Figure 2: Farm-to-Fork Tracking System with Blockchain

Experimentation Plan

- Tested through writing the proper logic into the smart contracts
 - Roles and permissions
 - Ability to record a diverse set of data
 - Automatically recording the transfer of ownership
- Useability tests will show
 - Ability to track items all the way through the supply chain
 - Any data needed can be retrieved quickly from the blockchain
- IoT sensors recording the data they handle
 - Will use IoT sensors from a smart greenhouse
- Web-application that can interact with blockchain
 - Will build a website with the backend connected to the blockchain
- Performance tests will look at time to write a block and CPU usage

RESULTS

- Successfully limited what stakeholders could execute and see.
- Was able to handle any data given to it.
 - Transfer of ownership was handled in this because was just updating owner property
- Could retrieve the entire history of an object at an average of 0.029 seconds.
- IoT device was able to record the values it observed to the blockchain.
- Website could both query information from and write to the blockchain.
- Could write a block at an average of 2.581 seconds.
- Only seen about a 1% increase in CPU usage on each peer.

CONCLUSION & FUTURE WORK

- A baseline for a farm-to-fork supply chain tracking system using blockchain was demonstrated to execute all of its featured functionalities.
- Future work:
 - Improve security of IoT devices.
 - Create stricter roles and permissions more reflective of the real world.
 - Add more granular data input for the smart contracts.
 - Implement into a real-world situation.

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REFERENCES

- [1] J. Lin, Z. Shen, A. Zhang, and Y. Chai, "Blockchain and iot based food traceability for smart agriculture," in Proceedings of the 3rd International Conference on Crowd Science and Engineering, ser. ICCSE'18. New York, NY, USA: Association for Computing Machinery, 2018.