

Product passport

Student name: Hao PENG

Student number: 810801

Executive Summary

This project is a blockchain-based ecosystem for supply chain, ensuring the origin, quality, genuine and tracking the item through network. We are experiencing the “trust issue” in the supply chain. There are some problems. First, we cannot get the information we need. Second, fraud issue, if someone tells us the information we need, we still cannot trust it. Third, opacity issue, the data is not transparent for us. Fourth, disruptions, the data may lose. Fifth, low efficiency, parties execute different agreements are not automatically.

This project tracks the goods from material to product in customers’ hands, focuses on the luxury products, the medicines, and food. The system is based on blockchain technology like, distributed ledgers, smart contracts to track transmissions in supply chain, and validate the position and condition of the product. From this way, we can make sure the transparency at every point, get the quality assurance and real-time information.

Project description

This project aims to create a reliable, consistent supply chain system, to make sure the quality, integrity and transparency of the product. And this system will solve the problems like fraud issue, unknown issue, disruptions issue, quality assurance issue, etc. So this project provides the solutions for that:

1. Fraud issue:
Using doubly-signed smart contracts, no fraud by middle man. It provides authentication and the data can be cryptographically verified.
2. Opacity issue:
Using decentralized nodes to check delivery states, and the collected data is available for any authorized parties.
3. Cannot Track:
Using Merkle trees to verify the validity of product. Users can verify the quality of any batch of products.
4. Disruptions issue:
This system provides immutability. Even though nature disasters happen, the system may be disrupted. But the data is secured, cannot be deleted or changed.
5. Complicate relationships between the parties, including many to many relationship:
Using two hashmaps, $\text{Map}\langle S, \text{Set}\langle C \rangle \rangle / \text{Map}\langle C, \text{Set}\langle S \rangle \rangle$ to solve the many to many problem. And also use the smart contract to make consensus between multiple parties.
6. Low efficiency
The multiple parties can automatically execute the agreements or offers by pre-defined disciplines.

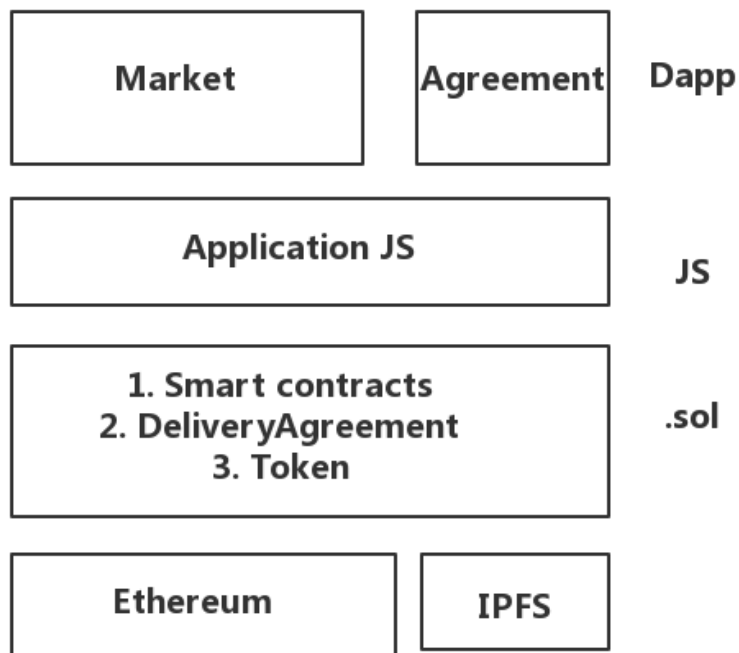
Technology:

The protocol of this product passport project layers on the top of the Ethereum blockchain. A JavaScript interface permits users to use the services our platform to track the information of the product without any blockchain programming knowledge. We use the truffle framework to build this platform and also use the Web3.js to provide some objects and functions for blockchain interacts.

1. Sensor system
We need the sensor system to quickly, reliably record and analysis the quality and validity of products. Sensors should be deployed along the whole supply chain, and it can capture all the important parameters about food.
2. Blockchain
The important parameters about food should be distributed recorded on the Ethereum blockchain. But we cannot store all the parameters on the blockchain, the large datasets can be stored off-line. And the hashes will be record as index on the blockchain. And in the future, we should build the interface for companies to integrate the information from other blockchain.
3. Smart contract
Firstly, A set of smart contracts can monitor and manage the data on the supply chain. Secondly, the contracts can give the different levels of users different authentication. Thirdly, the contracts can also provide different requirements for users to choose to get the information they want. Fourthly, we also define the rollback function to recovery the system.
4. Front-end web
This web is a dapp, it's designed for users that don't know the blockchain technology. Users only need to easily create, review and manage different agreements, offers, and also can track the product. The UI is designed quite sample and user-friendly.
5. Token
This project will issue one token that can be used two ways. First, it provides a incentive model for users and miners. They can easily earn the token from earlier state to improving the network. Secondly, it is used to get related services, like tracking the product, quality assurance, fidelity assurance and so on.

Architecture:

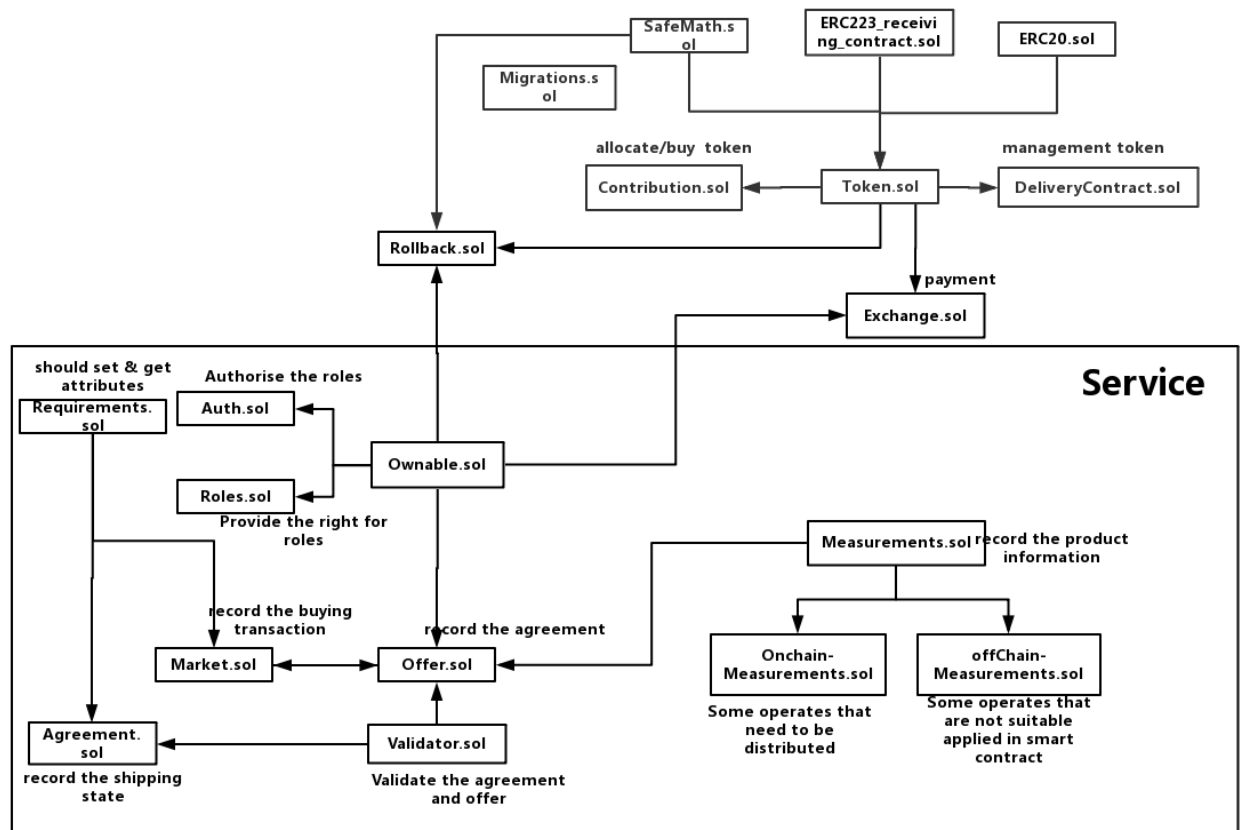
This project is a layered architecture, the lowest level is Ethereum and IPFS, Ethereum is used as blockchain and the IPFS as a distributed storage, and the second lowest level is a set of smart contracts, these contracts provide the logic of business and data storage. And a JavaScript layer is used for running software that don't need to be distributed and only need to be run offline. The top layer is Dapp layer, this layer provides UI components and just as a front-end web-side, can be accessed by any web browser.



Project goals:

1. Smart contracts:
A set of smart contracts on the Ethereum platform based on the standard smart contracts, including:
 - a. ERC223_receiving_contract.sol
 - b. SafeMath.sol
 - c. ERC20.sol
 - d. Token.sol
 - e. Contribution.sol
 - f. DeliveryContract.sol
 - g. Ownable.sol
 - h. Auth.sol
 - i. Roles.sol
 - j. Market.sol
 - k. Agreement.sol
 - l. Validator.sol
 - m. Measurement.sol
 - ...

The relationship between contracts are as follow: (Entity Relationship Diagram)



And the properties of the smart contracts include:

2. A web based front end to access these contracts.
This web will provide the user-friendly interface. It should be easy to pay the token to get the services, and as stable and security as possible.
3. Testing
This software testing should make sure the software is security and stable that meet the software standard.
4. Thesis
This thesis should include basic knowledge about the steps which I develop this system and the role of the smart contract, the future of this system.

Use case:

Let's take the coffee for example:

Coffee bean provider, coffee processing factory, buyer, sales can apply for attending this system. The "Auth.sol", "roles.sol", "ownable.sol" will provide authentication and usability automatically. And they should buy some tokens and use some tokens to get relative services. They also need to agree with some particular agreements or offers, they can request some specify requirements. After that the whole chain is ready to run.

From the beginning, the coffee bean is collected and the system will create new chain for each batch that has the same requirements provided by users or factories. And the relative parameters of coffee bean should be recorded on the public blockchain.

Secondly, the truck, ship or airplane will transport the coffee bean separately to processing factories. And for each checkpoint, the relative data will be recorded.

Thirdly, the coffee bean will be processed in the factories. Each steps will also be recorded and should follow the agreements and offers. And the coffee will be reclassified and packaged by agreements and requirements the factories agreed before.

Fourthly, the means of machine will transport different kinds of coffee to shops or sales. And the shops or sales sale the coffee to buyers. For each time, the owners change or the state of product change, the relative data should be recorded and uploaded.

So all the steps from coffee bean providers to buyers are immutably stored on the blockchain. And each steps should be verified and each checkpoint should take responsibility for previous steps.

Customers can track the information they want from the chain, and it also ensure the quality and fidelity assurance. Because every checkpoints monitor the products, if some of them cannot meet the requirements, these products cannot be continued.

Project Timeline:

W1 - W2: Confirm the direction and expected output

W3 - W4: Build and test the environment

W2 - W5: Study relative solidity language

W5 - W7: Write and Deploy the smart contracts.

W7 - W8: Write and Deploy the testing smart contracts and test

W8 - W9: Web based front end and testing.

W10: Write thesis and prepare presentation.

Product passport

