Whitepaper for Blockchain-Enabled Supply Chain Management DApp

EECE 571G

Blockchain Software Engineering

1. Introduction

This document outlines a decentralized application (DApp) designed to tackle critical issues within the supply chain industry, including counterfeit products, lack of transparency, and inefficiencies in tracking, etc. This DApp will utilize Ethereum's blockchain technology to provide a comprehensive solution for product tracking and authentication.

GitHub project repository: https://github.com/xichen1/EECE-571G-Team-4

2. Problems and Solutions

Nowadays, supply chains in global markets face significant challenges to trust, transparency and efficiency. There are many counterfeit products on the market, which not only damages consumers' trust in businesses, but also damages the reputation of various brands. The opacity of a product's origins and the process from manufacturing to selling prevents consumers from being certain of a product's authenticity. Additionally, supply chain complexity often results in tracking inefficiencies, leading to potential lost shipments, delays, and increased costs.

Our blockchain-based DApp solves these challenges by leveraging the immutable and transparent nature of blockchain technology. By assigning each product a unique digital identity at the time of manufacture, we ensure there is a tamper-proof record of each product's journey through the entire supply chain. The DApp also combines smart contracts which automate key processes such as payment and verification, significantly reducing the possibility of counterfeiting, ensuring transparency of product origins and streamlining tracking efficiency.

3. Technical Architecture

Our DApp's architecture integrates blockchain technology, smart contracts, Hardhat environment, a front-end user interface, and web3.js for the interaction with the Ethereum network.

3.1 Ethereum Blockchain Network

The Ethereum blockchain is an ideal choice for developing decentralized applications because of its mature ecosystem and extensive support for smart contracts. Ethereum's network provides the backbone for our DApp, ensuring immutability, security, and transparency of all transactions and data.

3.2 Smart Contracts

Our DApp uses Solidity-based smart contracts to manage the registration, tracking and verification of products within the supply chain. The usage of smart contracts can also automate the payment and product ownership transfer processes.

Key Functions Supported in Smart Contracts

- **Manufacturers:**

1. Create Products

Manufacturers should be able to register new products on the blockchain. This involves creating a new product entry with a unique identifier, product details, and the product's initial state in the supply chain. Also, manufacturers can set the price of each product at the time of product creation.

2. Request Distribution

After checking if the stock is sufficient, the products are ready for distribution. Manufacturers would use this function to send the distribution request to logistics providers. Also,

manufacturers should pay logistics fees and then the products would be handled by logistics providers and the manufacturers should update the product's status to shipped.

- **Logistics Providers:**

1. Ship Products

After receving the distribution request from manufacturers, logistics providers would use this function to ship products to retailers.

2. Update Shipping Status

Logistics providers use this function to update the status of shipments, including when a product is picked up, in transit, and delivered. This function allows them to record the movement of products accurately.

- **Retailers:**

1. Ordering Products from Manufacturers

This function is for the transactions between retailers and manufacturers, which initiates the movement of products through the supply chain towards consumers.

2. Receive Products

When a product arrives from a logistics provider, retailers would use this function to update the blockchain, marking the product as received.

3. List Products for Sale

Retailers can use this function to list received products for sale while setting or updating the sale price to consumers. It could also be used to update inventory status.

- **Consumers:**

1. Purchase Product

This function allows customers to purchase a product listed for sale by a retailer. It involves transferring Ether to pay for the product and updating the ownership of the product.

2. Verify Product Authenticity

Customers can use this function to verify the authenticity of a product before or after purchase by checking a product's history and manufacturing details, or a digital certificate of authenticity.

- **Security and Permissions:**

For all these functions, it's crucial to include access control mechanisms to ensure that only authorized parties can execute them. This can be achieved by using modifiers in each function to restrict access.

3.3 Front-End User Interface

The DApp has an intuitive and user-friendly front-end interface developed using the web technology **React.js** . This interface provides different stakeholders with tailored views and functionalities, from product registration by manufacturers to product purchasing and verification by consumers.

Interface Highlights:

- **Dashboard for Manufacturers and Retailers**: Offers comprehensive tools for managing product listings, viewing shipping statuses, and confirming payments.
- **Consumer Portal**: Allows consumers to verify product authenticity and view detailed product histories, promoting transparency and trust.

3.4 Web3.js Integration

web3.js plays a critical role in our architecture, which acts as the bridge between the Ethereum blockchain and our front-end application. It can interact with smart contracts for sending transactions, calling contract methods, and reading contract states to facilitate all blockchain-based operations of the DApp. Also, it can monitor blockchain events in real time, which allows the application to respond dynamically. In addition, this technology can manage Ether payments directly from the application, ensuring secure and efficient financial transactions within the supply chain.

4. Conclusion

By implementing the above technical architecture through the power of blockchain technology, our DApp can not only mitigate the prevalent issues within modern supply chains but also introduce trust and efficiency that traditional systems cannot match.