Blockchain-IoT Demo for Supply Chain Management

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***Abstract*—The demo introduces a Proof of Concept (PoC) that integrates IoT devices with blockchain technology to create a secure transaction environment. The primary goal is to enable IoT devices to sign transactions on the blockchain independently, using their authenticated private keys. This approach is innovative and ensures scalability, efficiency, and real-time responsiveness. It accommodates a higher transaction volume, streamlines processes, improves efficiency, and eliminates delays associated with human interaction. The PoC code is publicly accessible on GitHub.**

***Index Terms*—Accessibility; Blockchain, Internet of Things (IoT); Supply Chain Management**

I. Introduction

When it comes to transporting hazardous materials and other items in the supply chain, it is crucial to take special precautions to protect human health and the natural environment [1]. This emphasizes the need for transparency and reliability among all participants in the supply chain. One way to achieve this is through the use of blockchain as a transaction log and Internet of Things (IoT) meters to provide real-time transportation information.

In order for IoT sensors to prevent man-in-the-middle attacks and provide reliable information, devices should function as autonomous users on the blockchain network, requiring internal wallet. Our proof of concept (PoC) integrates IoT devices with blockchain technology, allowing devices to sign transactions autonomously using their authenticated private keys. This eliminates the need for external wallets and provides real-time responsiveness, scalability, and efficiency benefits. By combining IoT and blockchain, we can unlock new possibilities for an efficient and responsive digital ecosystem.

II. Project Description

Fig. 1 shows the IoT device communicating with the blockchain network. We interfaced Arduino with Raspberry Pi such that the sensor's value from Arduino sends values to Raspberry Pi through a simple serial communication. As per our use case, we use one-way communication, i.e., the information is transmitted from Arduino to Raspberry Pi. The Raspberry Pi's GPIO pins are digital pins that set outputs or read inputs to high or low. One might use an ADC chip (Analog-to-digital converter) like MCP3008 to read the value

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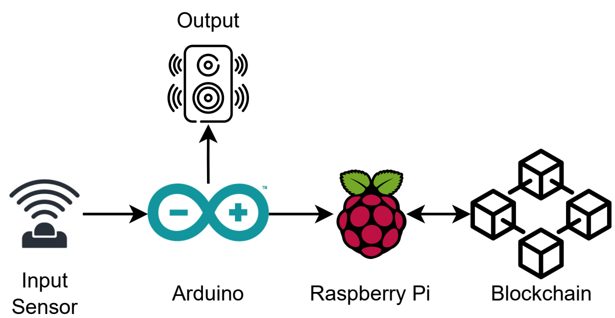

Fig. 1: IoT Integration with Raspberry Pi for Blockchain communication.

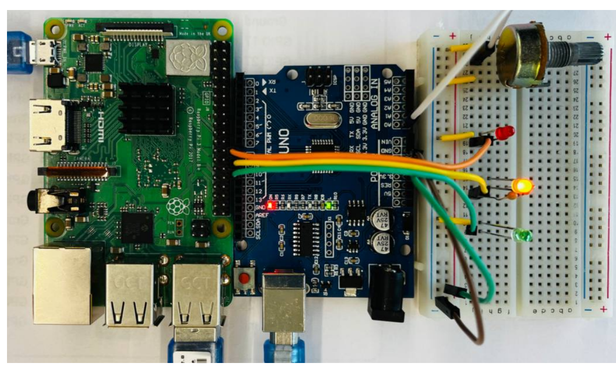

Fig. 2: IoT device consisting of microprocessor Raspberry Pi, microcontroller Arduino UNO, LED lights, and Potentio meter.

of analog input devices such as potentiometers. In our system design, we used Arduino for the analog input. The Adruino oneway communicates by sending values to Raspberry Pi, which interacts with the blockchain in writing and reading information directly [2].

Our approach involves creating an architecture combining IoT and Blockchain technology. This architecture will be used to develop and test an IoT layer that collects sensor data and communicates with the blockchain network. To collect data, we will use an IoT device (Fig. I) that interacts with the application deployed on the private blockchain network. The microcontroller reads information and executes virtual scripts based on the input, which is later injected into the blockchain. The device periodically sends updates to the blockchain with

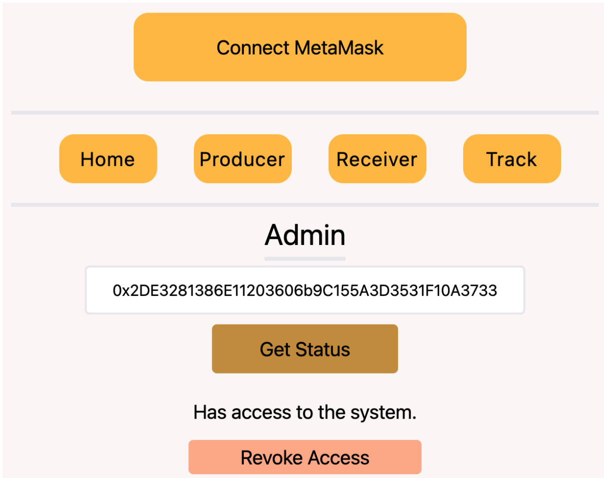

Fig. 3: The application interface for different actors. The Admin Dashboard allows for monitoring and managing IoT device access to the blockchain network. Easily track device status and manage access permissions, with the ability to revoke access instantly and vice versa.

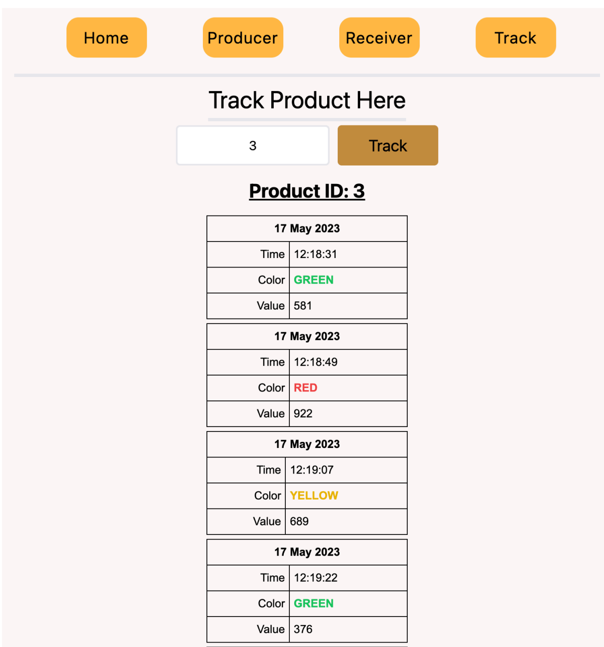

Fig. 4: The application interface for tracking products. The product's realtime status from blockchain, before being delivered, is shown and updated synchronously.

the sensor's value. However, continuous communication over the blockchain can be expensive. Therefore, the device will update the blockchain value at a specified interval determined by the smart contract.

The website is live at https://sensortracker-9c34e.web.app/.

III. Prototype Implementation

A. Technology Stack

We used a combination of programming languages, frameworks, and tools to build our IoT prototype and application. The PoC consists of three main components, i.e., IoT device, client-side (frontend), and server-side (backend). The frontend is developed using the vue3 framework. Vue3 is an open-source frontend JavaScript framework for building user interfaces and applications. The IoT prototype communicates sensor values from Arduino to Raspberry Pi through one-way serial communication. With the help of APIs, the device displays, retrieves, and presents on the application.

B. Application Product

The application features an intuitive UX flow, facilitating distinct tasks for various actors, including administrators (Fig 3), senders, receivers, and tracking (Fig 4). This is backed with a simple UI design.

The source code and instructions to run the project are available on Github [3].

IV. Conclusion

This demo article integrates IoT and blockchain to enhance the supply chain's security, transparency, and data visibility. This PoC showcases the potential benefits of enabling IoT devices to sign transactions on the blockchain independently, eliminating the need for external wallets. The PoC significantly improves efficiency, eliminates delays, and ensures real-time responsiveness by automating transactions and integrating IoT devices. The detailed workflow and simulation results presented in this study provide a practical insight into the proposed method, demonstrating its suitability for scenarios requiring continuous, automated interaction with the blockchain through IoT devices [4].

References

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