IoT Data Marketplace using Blockchain

Report of Mini Project

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CERTIFICATE

This is to certify that this Mini Project titled **"IoT Data Marketplace using Blockchain"** submitted by **Chandapu Shiva Krishna**, Regd. No. **22555**, Department of Mathematics and Computer Science, Prasanthi Nilayam Campus is a bonafide record of the original work done under my supervision as a Course requirement for the Degree of M.Tech in Computer Science.

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Abstract

The Internet of Things (**IoT**) data can offer insightful information about the IoT ecosystem, but managing and processing relevant information can be difficult without a data marketplace. The marketplace that we propose provides a platform for data exchange between different parties, such as the buyer and the seller. Therefore, we make use of blockchain technology to create a data marketplace for IoT data. In the suggested market, smart contracts are used to carry out various functions and preserve the rules governing data flow. Interplanetary File System (**IPFS**) is used in this data marketplace to store the data that will be traded. To show the potential of the suggested data marketplace, we look at the costs related to using smart contracts.

Keywords: Data marketplace, Blockchain, Smart contract, IPFS

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1. Introduction

The Internet of Things (IoT) refers to a network of physical objects equipped with sensors, software, and other technologies that enable them to connect and share data with other devices and systems over the Internet. With the increasing number of IoT devices, there has been a significant growth in the amount of data generated and exchanged over the Internet.

Data marketplaces provide a platform for customers to buy and sell data online. These marketplaces can be either free or paid, depending on the specific use case. Given the value of data, there is a significant interest in utilizing it for financial gain, with some application sectors having a potential annual value of hundreds of billions of dollars[1]. However, centralized data marketplaces face several challenges such as high infrastructure costs, trust and privacy issues, and single points of failure.

Blockchain technology has emerged as a popular solution for many problems, with its use as the foundation for cryptocurrencies like Bitcoin. It offers several features such as transparency, integrity, redundancy, and public verifiability. Smart contracts can be triggered by sending transactions to the blockchain, facilitating trustless data trade in a decentralized IoT data market. With a blockchain keeping the history of all transactions, data exchanges can be verified, adding another layer of security to the process.

2. Background

This section provides some background information about the technologies, specifically blockchain and data marketplace.

2.1 Blockchain

Bitcoin, the original cryptocurrency designed by Satoshi Nakamoto[3], is an example of how blockchain technology is fundamentally used. By utilizing cryptographic primitives like digital signatures and hash functions, the author proposed an electronic payment system devoid of the necessity for trustworthy third parties.

A blockchain is a decentralized ledger that consists of continuously growing lists of blocks that are safely connected to one another by cryptographic hashes (see Fig.1). The transaction data in a blockchain is organized in the form of a Merkle tree, where the leaves represent the individual data nodes. Each block in the chain contains a timestamp and a cryptographic hash of the previous block, which links it to the previous block and ensures the integrity of the chain. This makes it impossible to alter a transaction recorded in a block without altering all subsequent blocks, which makes blockchain transactions irreversible.

Blockchain is a peer-to-peer network that maintains an append-only distributed ledger of transactions. Each node in the network is responsible for validating transactions and storing them in its own copy of the distributed ledger. The decentralized

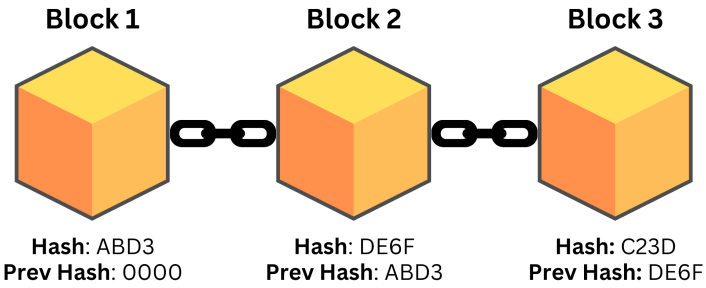

Figure 1: Blocks in a Blockchain

nature of the network eliminates the need for a centralized authority to maintain the ledger, reducing the risk of single points of failure and increasing the security of the system.

There are different types of blockchain systems, including public, private, consortium, and hybrid. Public blockchains, such as Bitcoin and Ethereum, are open to anyone and allow for anonymous participation. Private blockchains are restricted to a specific group of users, while consortium blockchains are controlled by a group of organizations. Hybrid blockchains combine the features of public and private blockchains to create a more flexible system that can be customized to meet specific needs.

A smart contract is a computer program that automatically executes based on predefined conditions, and it controls the transfer of digital assets between parties. It operates with automatic contract enforcement similar to a traditional contract, but it minimizes errors, both intentional and unintentional, and reduces risks introduced by trusted parties.

Smart contracts are stored on the blockchain and have a unique address to activate functions that can modify or read the current state of the blockchain. Once deployed on a blockchain, a smart contract becomes immutable, meaning that it cannot be altered or removed, providing tamper-proof characteristics.

2.2 Data marketplace

A data marketplace is a platform where users can buy and sell data. A data marketplace makes it simple for data providers to manage, sell, and advertise their data. Buyers can explore, compare, and buy data from many sources that have been compiled in a single, user-friendly marketplace via data marketplaces(see fig.3). Like any other online market that supports the trade of goods, a data marketplace works similarly.

One area of application for data marketplaces is the area of fitness and health data. Manufacturers of smartwatches, for example, may seek users' consent to share fitness or health data gathered by their devices in return for some form of compensation[4]. This data can then be compiled and offered for sale on a data marketplace, allowing interested parties to access and use it for research or other purposes. Data buyers may include medical researchers, insurance companies, or health and fitness businesses

Figure 2: Data marketplace

seeking to develop new products or services.

By participating in data sharing through a data marketplace, users can potentially earn income for their data while also contributing to advancements in the field of health and fitness. At the same time, data buyers can benefit from access to a wider range of data sources and insights that may inform new research or product development.

There are various proposals for data marketplaces, with different architectures and access restrictions. The focus of this work is on a decentralized IoT data marketplace based on blockchain technology, which eliminates the need for a trusted third party and provides transparency for all transactions. This makes it simpler to later verify data exchanges.

3. Related Work

Mišura and Žagar propose a model for a centralized (IoT) data marketplace[2], which takes into account the characteristics of data generated by IoT devices. The solution involves registering devices and consumers through a Web interface, saving sensor measurements in a database, and using a query mechanism to retrieve the data. This solution is based on a centralized approach, but it provides insights into design issues for (IoT) data marketplaces.

Centralized data marketplaces have several disadvantages, such as a single point of failure and trust and privacy issues. This can be problematic for applications that rely on the availability of certain data. Exploration of the application is necessary to address these issues.

Michael et al.[5] created a data marketplace using blockchain technology and the (IoT). The marketplace has three levels of architecture, and smart contracts are used to ensure that the marketplace's regulations are followed. A proxy allows providers and consumers to integrate IoT devices easily, and a broker helps with the data trading process, manages tasks that require a lot of resources, and resolves disputes if providers and consumers cannot agree on settlements. They analyzed the expenses associated with using smart contracts.

4. System Design

The proposed system will integrate blockchain as a trustworthy third party and rule enforcer. It will have transaction logs to determine the origin and ownership of traded data and use smart contracts to execute the functionality. If the blockchain platform is trustworthy, it can serve as a reliable third party that facilitates trading.

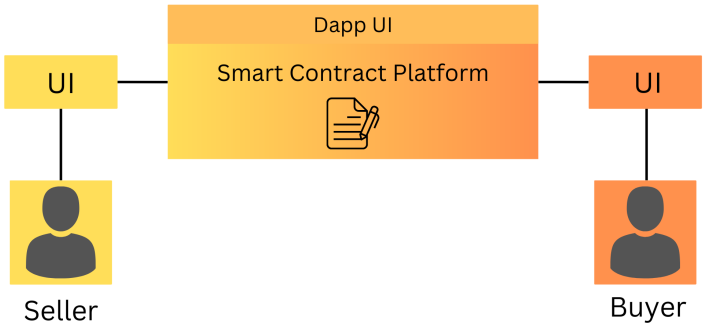

Figure 3: Basic architecture for the Data marketplace using blockchain

To take part in the data marketplace, users are required to register first. The user interface for this platform is built using the popular ReactJS framework. During registration, a new user is prompted to provide their name, public key, and password. These details are then stored securely in the blockchain once the user invokes the appropriate functions from the smart contract. Note that existing users cannot register again.

Once a user is registered and logged in, they can choose to either upload their data for sale or browse through the existing data offerings available for purchase. When uploading data, the user selects the file from their local system. The file is then encrypted on the front end and stored on the IPFS platform. The returned hash from the IPFS, along with a description and price for the data, is stored in the blockchain using the smart contract. This allows other users to view the data description and price.

If a user is interested in purchasing data, they can directly pay for it using a wallet called Metamask. Once the payment has been made, the user receives the hash of the encrypted data stored on IPFS. During the trade, ownership of the data is transferred to the buyer, and the seller no longer has access to it.

If a buyer wants to negotiate the price of the data (see Fig: 4), there is a chat feature available on the platform. This is similar to any other chat application, but it allows the buyer and seller to negotiate prices. The smart contract ensures that only the seller can respond to the negotiation request. The seller can either accept the proposed price or send a counter-bid if they are not satisfied. The buyer can then choose to accept the counter-bid or propose a new one. This process can continue until both parties have agreed on the terms of the data trade. The data marketplace offers a secure and transparent platform for buying and selling data. With the use of

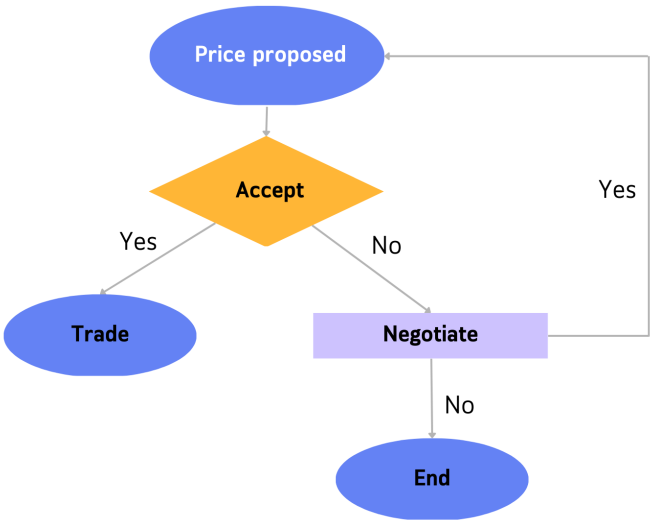

Figure 4: Negotiation process

blockchain technology, all transactions are recorded and verified, ensuring the integrity and accuracy of the data being traded.

In addition, the use of encryption and IPFS storage provides an additional layer of security, protecting the data from unauthorized access and manipulation. This ensures that both buyers and sellers can trust the authenticity and quality of the data being traded.

The platform's user-friendly GUI created using the ReactJS framework allows for easy navigation, making it simple for users to upload and sell their data or purchase data from others. The chat feature provides a convenient way for buyers and sellers to negotiate prices and come to an agreement, making the transaction process more efficient and effective.

Furthermore, the smart contract ensures that transactions are carried out fairly and transparently. This eliminates the need for intermediaries, reducing transaction costs and making it more accessible to individuals and organizations of all sizes.

5. Conclusion

In conclusion, the proposed data marketplace for IoT data utilizing blockchain technology and smart contracts offers a secure and efficient way for parties to exchange data. By leveraging the benefits of blockchain technology such as transparency, immutability, and decentralization, this platform can ensure the integrity and security of the data being traded. The use of IPFS also provides a reliable and decentralized storage solution, further enhancing the platform's functionality.

While there may be some costs associated with the use of smart contracts, the benefits of this technology far exceed the costs. Smart contracts can automate various functions and ensure compliance with rules and regulations, which can ultimately save time and resources for both buyers and sellers. Moreover, the proposed data market-

place can enable more efficient and effective decision-making in the IoT ecosystem by providing access to valuable and relevant data.

We are currently in the process of designing the entire system and this is just a prototype. The primary goal of the prototype is to gain a better understanding of potential scalability and performance issues that may arise during implementation. By doing this, we can refine the design and ensure that it meets the necessary requirements.

6. Future work

There are several areas where future work can be done to improve and expand the proposed data marketplace for IoT data.

One area of future work is to explore the use of advanced analytical and machine learning algorithms to extract insights and patterns from the data being traded on the platform. This can help buyers and sellers make more informed decisions and can lead to the development of innovative solutions and products.

Another area of future work is exploring the scalability of the platform and finding ways to handle large volumes of data and transactions can be an important area of future work. As the number of devices connected to the IoT ecosystem continues to grow, the demand for data exchange platforms like the proposed marketplace is likely to increase, and it will be important to ensure that the platform can handle this growth in demand.

Another area of future work is Enhanced Search and Filtering Capabilities in the front end: Search and filtering features can help users to find the data that they are looking for quickly and easily. By incorporating features like auto-complete, auto-suggest, and users can find relevant data more quickly and efficiently.

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