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Novel and Secure Blockchain Framework for Health Applications

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Abstract— Over the past ten years, the Internet of Things (IoT) has expanded significantly. In order for IoT applications to run successfully and continuously, this increase raises a number of difficult difficulties. Resource limitations, server overload on the central server, and the possibility of unauthorised use of sensitive data are a few of the issues that must be resolved. On the other hand, blockchain technology is becoming more and more well-liked and has experienced tremendous success with cryptocurrencies. It includes a variety of essential features, including a method for consensus, peer communications, confidence-building without the need for a reliable third party, and a transaction regulated by conditions and functions utilising the intelligent contract methodology. Blockchain is a great option for building a decentralised, autonomous IoT system that addresses the aforementioned problems. An IoT-Blockchain integration architecture is proposed in this paper employing an Addressing the issues brought about by the constrained IoT resources while using the Blockchain mining technique in IoT systems requires the use of Ethereum Blockchain infrastructure within a rich-thin client IoT strategy. The architecture depends on how the resources are loaded. Devices with fewer resources are called thin clients, whereas those with more resources are called rich clients. Both clients are able to access the blockchain and collect data, but the rich-client is limited to carrying out the mining operation. Additionally, we put into practise a healthcare system where surgical process management is carried out based on the suggested design. By putting the design to the test and contrasting it with other well-known IoT-based blockchain architectures, we also demonstrate the effectiveness of our solution. The outcomes demonstrate that the suggested blockchain-IoT architecture is appropriate for a variety of IoT applications while avoiding challenges generated by the constraints of IoT devices.

I. INTRODUCTION

A lot of technology sectors are developing quickly in the twenty-first century, impacting practically every part of our life. Nowadays, technology is involved in or controls all aspects of daily life. There are numerous instances of technology collecting data and embedding it in various formats for use in various applications. It can be observed while we go about our daily lives, both personally and professionally. Smart technologies (such smartphones and tablets) can, for instance, assist in calculating the distance travelled, the number of steps taken, the heartbeat and blood pressure, and the number of calories expended. This illustration and numerous other instances where sensors and communication tools resulted in the development of the Internet of Things (IoT), a novel idea. IoT devices frequently communicate with one another, share data, and even act on our behalf. IoT was first introduced by Kevin Ashton in 1999. Since then, the phrase has grown to represent a large area in the network industry. IoT offered a platform for numerous applications across numerous life domains. Smart houses and even smart cities can be built thanks to IoT. IoT's extensive evaluation results in a huge number of linked devices and the collection of massive data. IoT today faces a variety of difficulties and problems, which the researcher is working to address.

IoT's quick development and adoption brought to a number of issues that need to be resolved. IoT devices typically have minimal processing power, little storage, and constrained network bandwidth. Additionally, centralised system architecture is used in IoT. The centralised system architecture results in capacity and cost limitations, system-wide server failures, and security challenges. Despite the network layer, physical interface, and unforeseen attacks related to IoT security.

The effectiveness of blockchain technology in digital currency transactions has been established. In order to do that, researchers utilise the notion of blockchain and IoT integration. It serves as an example of how blockchain technology can be used to digitally revolutionise government functions. Blockchain has some advantages that make it a desirable tool to address IoT privacy and security issues:

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1) Decentralization: the absence of central control ensures scalability and robustness through the use of resources from all participating nodes, and the removal of traffic flows from many to one. This feature also eliminates delay and overcomes the issue of a single failing stage.
2) Anonymity: the inherent anonymity offered is well-suited for most IoT usage cases in which the user's identity must be kept secret.
3) Security: With multiple and heterogeneous networks, Blockchain recognizes a stable network over untrustworthy parties that is desirable in IoT.

II. BLOCKCHAIN AND IoT INTEGRATION

Fragmentation of IoT systems, low interoperability, IoT software resource constraints, privacy risks, and protection are some of the issues with IoT systems. Blockchain technology will boost IoT systems' interoperability, safety, and stability. Blockchain can also improve the scalability and stability of IoT networks. We refer to blockchain and IoT integration collectively as BCoT. BCoT provides potential advantages over current IoT systems.

Interoperability between IoT devices would be improved via blockchain. The transformation and storage of IoT data on the blockchain can considerably improve the interoperability of IoT systems. With this technique, various kinds of IoT data are transformed, processed, extracted, compressed, and ultimately preserved in blockchains. Additionally, because blockchains are constructed on top of the universal web access Peer-to-peer network, interoperability may be easily achieved across many different types of decentralized networks.

Blockchain might improve the stability of IoT networks. IoT data is kept as cryptographically encrypted and signed blockchain transactions, therefore it can be secured using blockchains on the one hand. Additionally, by automatically updating IoT device configuration to remedy insecure infringements, the integration of IoT systems with blockchain technology can assist to strengthen the protection of IoT systems and increase system security.

The incorporation of Blockchain will ensure the traceability and reliability of IoT data. Data stored on a blockchain will always be able to be located and verified. All previous transactions in the blockchains can be tracked in the interim. For instance, Qinghua's work has created a blockchain-based traceability framework that provides producers and retailers with traceable services. In this method, the consistency and uniqueness of products can be examined and verified. The immutability of blockchains further ensures the veracity of IoT records because transactions kept there could scarcely be altered or misrepresented.

The independent communications of IoT systems are also supported by blockchain. Blockchain technology may automatically handle IoT devices or subsystems.

A. INTEGRATION ARCHITECTURES

In order to create the architectural structure for the integration of blockchain and IoT, too many parameters may be taken into account. The IoT's interconnections, such as communication amongst its supporting infrastructure, must be considered. It must be determined where these connections can happen when Blockchain is integrated: within an IoT and Blockchain hybrid architecture, or within an IoT or a blockchain solely. As a result, Fog Computing had modernised IoT through the insertion of a new layer between cloud computing systems and IoT applications. The following is a list of these options, along with their benefits and drawbacks:

a) Blockchain as a database: Because it can function offline, this option may be the quickest in terms of security and dependability. In order to connect, IoT systems often need methods for exploration and routing. IoT interactions would still occur without the usage of the Blockchain, but only a portion of the IoT data is saved there. When stable IoT data was used in low latency IoT interactions, this strategy can be useful.

b) Blockchain is integrated at every layer; with this technique, all interactions flow through Blockchain, creating an ever-present history of interactions. The versatility of IoT devices may be increased, and all the chosen communications are traceable because their information can be confirmed in the Blockchain. IoT applications that have an exchange or rental business model, including Slock. It is in order to provide its services. One of the well-known blockchain difficulties is that tracking all transactions would require increasing bandwidth and records. On the other hand, all of the IoT data associated with these transactions can also be stored on the Blockchain.

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B. BLOCKCHAIN SCHEMES FOR IoT

Blockchain has been called a game-changing technology with profound implications for numerous industries. We are concentrating on the most prevalent and useful IoT domains in this section. We are unable to examine all of the schemes since there are too many of them and they are always changing. The first blockchain network for cryptocurrencies was Bitcoin. It offers a system for quick, affordable, and secure financial transactions that may be used in applications as a secure payment option. Self-sufficient IoT devices can use Bitcoins, which essentially serve as wallets, to make small payments. Apps that limit Blockchain usage to micropayments are typically tied to the currency, which can be detrimental because coin deflation can negatively impact the software. Smart contracts serve as an example of how combining Blockchain and IoT is a common strategy. When conducting transactions, those phrases can be defined thanks to Bitcoin's scripting language.

As previously mentioned, one of the platforms that recently made a significant impact is Ethereum. One of the pioneers of smart contracts, including blockchains, was Ethereum. Both an embedded programming language (Solidity) blockchain and a globally governed, consensus-based virtual machine (Ethereum Virtual Machine EVM) can be used to define Ethereum. By incorporating smart contracts, the Blockchain is pushed away from monetary systems and is made simple to incorporate across other industries. This makes Ethereum, together with its active and large community, the most well-liked platform for the creation of apps. Most IoT programmes use or are compliant with Ethereum. The simplest method to represent systems that can publish actions and policies that result in changes is with a smart contract.

III. METHODOLOGY

This study proposes an Enhanced Rich-Thin-Client architecture (ERTCA) to address the limitations of IoT devices. The proposed architecture has two main contributions as the following:

a) To avoid the crash of overloaded IoT nodes, we provided a solution that aims to fit the resources as can as possible. The solution is represented by giving each node enough tasks to suites the device resources.
b) To enhance the connectivity between IoT and Blockchain platform, we propose to connect the Blockchain at a major node with high capabilities, and other poor nodes can take the benefits of Blockchain without overloading on them. Nodes classification depends on two factors, the computational power of the device and storage capability.

This contribution addresses some of the issues that other integration techniques face, such as the resource constraints at the IoT layer and the challenges associated with blockchain implementation. In order to more effectively address the resource constraints in the integration process, we evaluated the task and designed his integration architecture.

A. ERTCA

We offer an IoT solution for rich-thin clients for the Ethereum Blockchain. The constrained IoT and the centralised architectural challenge research aims would be met by the ERTCA design. Rich clients, thin clients, and entire Blockchain nodes can all be thought of as IoT devices with resources comparable to or similar to those of personal computers. Thin clients, which are in charge of user interface and data collecting, are IoT devices with limited resources. We employ our own Ethereum private Blockchain network as our fundamental Blockchain infrastructure. Ethereum supports smart contracts and makes it simpler to construct new blocks than Bitcoin, making it possible to establish relatively complex relationships between various IoT devices, users, and devices. The original encryption technique was the PoW and Ethereum account consensus system.

We employed a different level of the thin client—which isn't connected to the rich client—to collect data without engaging with the system, which is how our work differs from other work. Only sending the required data from the outside world is the second level thin client's responsibility. Second-level thin clients could be existing databases, sensors, or people. Because the burden on IoT devices will be more evenly distributed, that enhancement aims to make each layer of the design less difficult. Additionally, the smart contracts used by ERTCA rich clients are more complicated since they process unexpected input under application scenario conditions to generate knowledge and judgements.

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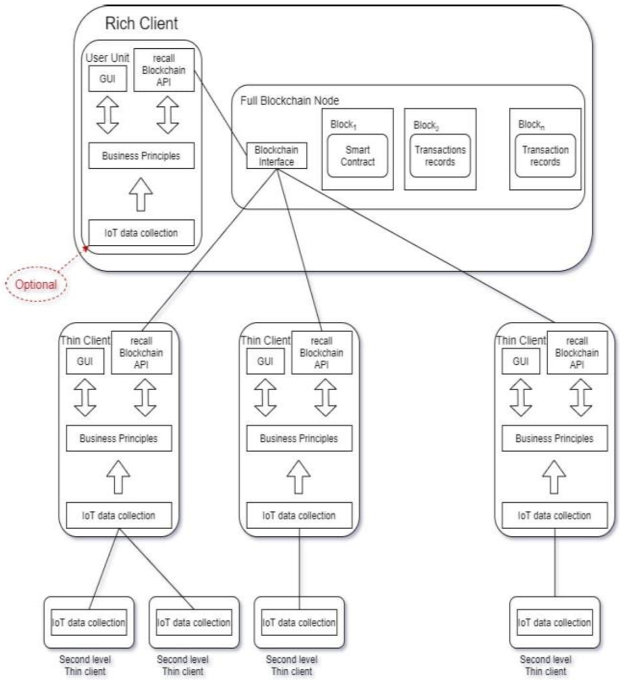

FIGURE1. The Enhanced Rich-Thin-Clients Architecture (ERTCA)

IV. CONCLUSIONS

Given the numerous advancements, innovative practises, and ways that are consistently being developed, health care is a recurrent and significant problem for society. There are presently a tonne of systems and applications for tracking healthcare and health-related activities. The development of techniques to encourage end-user acceptance and usage, particularly for a cooperative strategy that can help to prevent issues with healthcare management. In order to demonstrate the usability of this technology and enhance system efficiency, resource utilisation, data privacy, and security, this research offers a solution for a cooperative healthcare management system combining IoT and Blockchain integration architecture, ERTCA. We also discussed various advantages of utilising blockchain in private infrastructure or public networks. Additionally, it was discovered that increased transaction volumes on the main Ethereum Public network result in higher transaction fees. However, infrastructure performance, privacy, and security must all be taken into account when deciding to employ a private Blockchain system. Finally, we can draw the conclusion that blockchain and IoT can be combined in a way that could support the development of a collaborative health monitoring system, since it increases system security by ensuring data immutability, preserving business logic, and allowing for gamification by successfully completing health management tasks.

V. FUTURE SCOPE

There are several potential possibilities for this research's future work. In the beginning, we want to broaden the tests and compare our solution to existing IoT-Blockchain integration architectures, including modular architecture. Comparing ERTCA with various integration architectures would highlight the benefits and highlight the drawbacks, ensuring the thoroughness of this study and assisting in ERTCA improvement. On the other hand, we want to investigate the security and scalability of ERTCA by various experiments and thorough evaluations. Additionally, we want to assess smart contracts on other blockchains outside Ethereum, particularly those that use other consensus methods like Hyperledger Fabric.

In contrast, we want to test ertca on many application scenarios instead of health care to give the architecture a spirit. however, given how important healthcare is to society today, we would also wish to expand the system to include medications, information from medical consultations, and other tasks related to the administration of healthcare.

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