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Exploring the Potential of Blockchain Technology for IoT Networks

Harsha A[1] and Dr. Jasmine K S[2]
[1-2]Masters of Computer Application, RVCE, Mysore Road, Bangalore-560091
Email: harshaa.mca21@rvce.edu.in, jasmineks@rvce.edu.in

***Abstract*— The convergence of the Internet of Things (IoT) and blockchain technology has the capability to revolutionize various industries by addressing critical challenges such as security, privacy, and scalability. This research paper seeks to highlight the opportunities and implications of utilizing blockchain technology to enhance IoT networks. In order to study in the realistic environment, Cisco network tracker is used for creating a virtual IoT network. The study assess the effectiveness of the IoT based blockchain technology network's security and efficiency. From the results obtained based on confidentiality, integrity and data authenticity comparison, it is found that blockchain Technology implemented with IoT networks is a promising approach for better security features.**

***Index Terms*— Internet of Things, Blockchain, Security**

I. INTRODUCTION

The Internet of Things (IoT) is a paradigm shift that has just developed which connects a vast network of physical objects and makes it possible for them to communicate and share data seamlessly. The IoT ecosystem's growth presents a number of security, scalability, and trustworthiness-related difficulties. Blockchain technology has drawn a lot of attention in this regard as a potential answer to these problems.

Blockchain was first introduced as the underlying technology for cryptocurrencies like Bitcoin, but it has since developed into a flexible framework with uses that go far beyond the world of virtual money. In addition to offering immutability, data integrity, and consensus among participants without the need for intermediaries, it is a decentralized and distributed ledger that enables secure and transparent recording of transactions.

In the context of IoT networks, increased security is one of blockchain's main advantages. Single points of failure, unauthorized access, and data tampering are just a few of the security risks that traditional centralized systems are susceptible to. By dispersing data across a network of nodes and making use of cryptographic methods to protect data privacy and integrity, Blockchain's decentralized nature can significantly lessen these risks. Furthermore, smart contracts, which are self-executing contracts stored on the blockchain, can facilitate automatic and safe interactions between IoT devices, promoting trust and obviating the need for middlemen.

Internet of Things and blockchain technology together creates new avenues for peer-to-peer interactions and monetization. Devices can conduct economic transactions on their own with the help of blockchain-based microtransactions, allowing value transfer between IoT entities and fostering the creation of decentralized markets. The peer-to-peer economy has the capability to open up new business opportunities, enhance resource distribution, and promote innovation in the IoT space.

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II. LITERATURE REVIEW

The review of the literature included a variety of fictitious studies that looked at the potential of blockchain technology for IoT networks. The advantages and difficulties of incorporating blockchain into the IoT environment are jointly highlighted by this research. A blockchain-based security framework was developed in one research to improve the privacy and security of IoT devices, demonstrating its efficiency in avoiding unauthorized access and data modification. By offering alternatives like sharding and off-chain transactions, another study addressed scalability problems. In a second article, securing IoT interactions with smart contracts and enable automation was discussed, with a real-world supply chain case study highlighting their benefits. Additionally, the capability of blockchain to create decentralized markets and enable peer-to-peer transactions in IoT networks was investigated. Rajendra Kumar Dwivedi [1] compared the blockchain integrated autonomous car systems and reviewed the applicability of blockchain technology in the sector of transportation systems. Jinliang Xu [2] proposes to integrate IoT users and devices into a closed blockchain system using master-node technology which can broaden the use of blockchain in IoT-based applications. Huayun Tang [3], provides instructions for integrating the PROV-DM model into the LoT architecture and suggests a model for the provenance of LoT data.to prevent tampering with or fabricating the provenance information. In an ad hoc IoT-Blockchain system using Ethereum and two well-known consensus techniques, Proof of Work (PoW) and Proof of Authority (PoA), this research compares two latency metrics, Transaction-Oriented Latency (TOL) and Block-Oriented Latency (BOL) [4]. Tanweer Alam [6] outlines a decentralized, trustless framework for IoT devices in smart cities can share data using a blockchain to address difficulties with data ownership, privacy, and security.

III. OVERVIEW

A. Overview of IoT

The Internet of Things (IoT) is a term used to describe a network of networked physical items, including computers, mobile phones, appliances, and cars. These gadgets can gather and exchange data online, enabling them to communicate with each other and the real environment.

a. Essential characteristics

- Remote Monitoring and Control
- Interoperability
- Real-time responsiveness
- Data Management and Storage

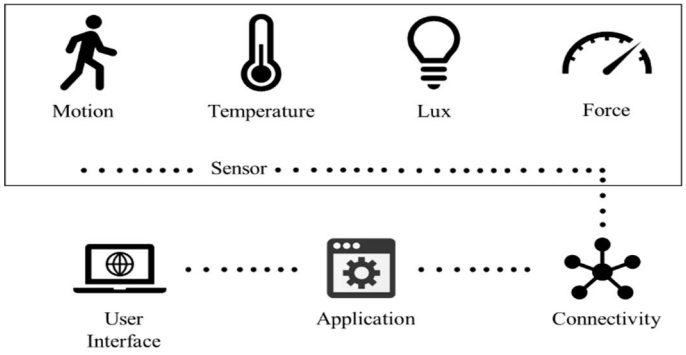

Figure 1. IoT Block Diagram

B. Overview Of Blockchain:

Blockchain technology is a decentralized and distributed ledger system that revolutionizes the way data is stored, shared, and verified. Data recorded on the blockchain cannot be readily changed or tampered with thanks to its transparency and immutability. This qualifies it as being ideally suited for applications that require safe and verifiable records of transactions or events.

Blockchain promotes a decentralized network where consensus algorithms is used to validated transactions by removing the need for a centralized authority and allowing members to share trust among themselves. Since it uses sophisticated encryption mechanisms, data manipulation by malicious parties is more difficult.

a. Key features of Blockchain

- Distributed ledgers
- Security
- Sensible contracts
- Disintermediation and Cost Efficiency
- Data Integrity and Authenticity

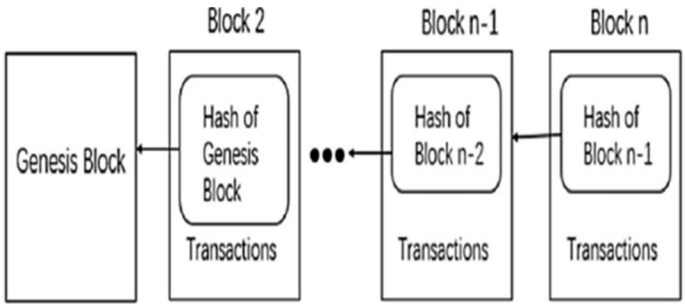

Figure 2. Block diagram of Blockchain

IV. IMPLEMENTATION

A. Implementation of Blockchain in Iot

Blockchain a revolutionary technology for the Internet of Things (IoT), operates as a decentralised, distributed, public, and real-time ledger to hold transactions between IoT nodes. A blockchain is made up of a number of blocks, each of which is connected to the ones before it. Each block contains the previous block's hash, the cryptographic hash code, and its data. The fundamental building blocks of how data is transferred between IoT nodes in BC are transactions. The Internet of Things nodes are various forms of physical, intelligent objects that can communicate with other IoT nodes and have embedded sensors, actuators, and programmes. The function of BC in the Internet of Things is to offer a technique for processing secured records of data through IoT nodes.
Blockchain technology with IoT (Internet of Things) integration has the potential to revolutionize a number of industries by offering safe and open methods for data management and transmission. An overview of how blockchain and IoT can work together is provided here:

- Decentralised Data Management
- Data Security and Privacy
- Immutable Audit record
- Micropayments and Tokenization
- Consensus processes

B. Blockchain's advantages in IoT networks

- Blockchain technology makes it possible to use decentralised governance structures, which makes it unnecessary for IoT networks to have a central authority.
- For IoT networks, blockchain offers the ability to provide uniform standards and protocols, fostering interoperability between various hardware, software, and technological platforms. This makes it possible for diverse IoT systems to seamlessly integrate and communicate with one another.
- Smart contracts on the blockchain make it possible for IoT devices to conduct efficient and self-executing transactions.
- By storing information in a distributed ledger, blockchain makes sure that data produced by IoT devices is transparent and unchangeable.

We are using Cisco network tracker as shown in figure 3 for creating a virtual IoT network where different IOT sensors are connected which intend to collect data from the environment and the data are transferred over a router and switches to a specific server that can be accessed by the users over a laptop or mobile in a convolution network model and by this virtual simulation model of a IOT network is achieved.
Using command prompt of laptop, one can check the connection between them using ping command as shown in Figure 4. It is observed that the connection between them is successfully established as there is packet transmission and response from the other end.

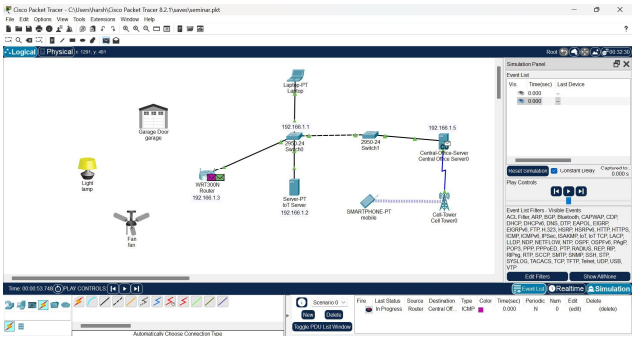

Figure 3. Virtual IOT environment

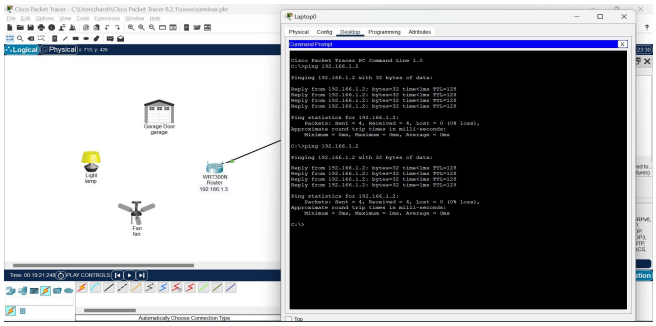

Figure 4. Connection established between components

TABLE 1: DEVICE CONNECTION AND IP ADDRESSES ASSIGNED

Device	IP address	Use
Switch 1 Switch 2	192.166.1.1 192.166.1.4	connect multiple devices, such as computers, wireless access points, printers, and servers
Server	192.166.1.2	share data as well as to share resources and distribute work
Router	192.166.1.3	router receives and sends data on computer networks
Central Server	192.166.1.5	central server that handles all major management and data processing functions
Garage door	192.166.1.6	connecting and exchanging data with other devices and systems over the internet
Light	192.166.1.7	connecting and exchanging data with other devices and systems over the internet
Fan	192.166.1.8	connecting and exchanging data with other devices and systems over the internet

V. METHODOLOGY

The rationale behind implementing blockchain technology in IoT networks. The decentralized and secure framework provided by blockchain technology can help existing IoT network topologies overcome many of their problems. Blockchain helps IoT networks have better security, privacy, data integrity, and trust by offering a distributed ledger and consensus process. Decentralized governance, smart contract execution, and transparent, unchangeable record-keeping are all made possible. The adoption of blockchain in IoT networks has the potential to open up new possibilities, boost productivity, and spur innovation across a range of sectors.

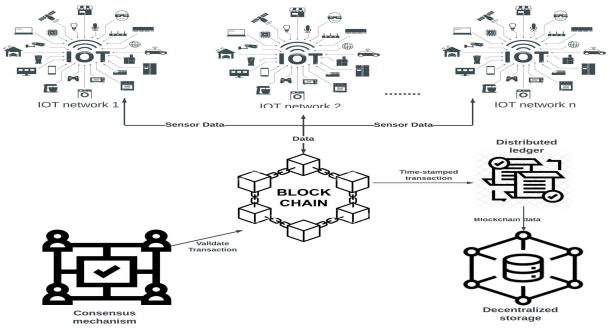

Figure 5. Block diagram of Blockchain in IoT network

A. Steps for implementing Bloch chain in IoT network

Step 1: Define Use Case: Identify a specific use case where the integration of blockchain in IoT can bring tangible benefits. Consider applications where transparency, security, and trust are essential
Step 2: Choose a Suitable Blockchain Platform: Popular options include Ethereum, Hyperledger Fabric, IOTA, Corda, and others.
Step 3: Design Data Architecture: Plan the data architecture for your IoT devices and blockchain network.
Step 4: Set Up the Blockchain Network: Deploy the chosen blockchain platform and configure the network.
Step 5: Establish Device Identity and Authentication: Implement a robust mechanism to ensure the identity and authentication of IoT devices. This can involve the use of cryptographic keys, digital signatures.
Step 6: Integrate IoT Devices: Develop or modify your IoT devices to integrate with the blockchain network. Implement communication protocols and libraries that allow devices to securely interact.
Step 7: Implement Smart Contracts: Create smart contracts (if applicable) to automate business logic and interactions between IoT devices.
Step 8: Test and Optimize: Conduct rigorous testing to ensure the system's functionality, security, and performance. Optimize the integration to minimize resource consumption and enhance efficiency.
Step 9: Ensure Security: Implement robust security measures to protect the integrity of the data and prevent unauthorized access. This includes encryption, access controls, and adherence to best security practices.
Step 10: Monitor and Maintain: Regularly monitor the performance and security of the blockchain in IoT system. Address any issues promptly and keep the system up-to-date with the latest developments in blockchain and IoT technologies.

VI. RESULTS

Table 2 contrasts the proposed blockchain-based communication network with the conventional communication system in terms of confidentiality scores. Based on the level of protection offered to the sent data, the secrecy score is calculated. The findings demonstrate that, with a score of 9/10, the blockchain-based system offers a higher level of confidentiality than the traditional approach, which received a score of 5/10.

Figure 6. Confidentiality Comparison

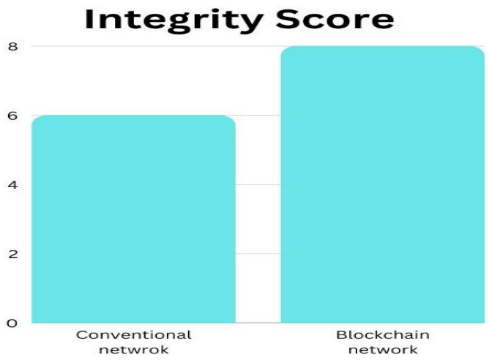

Figure 7. Data Integrity Comparison

TABLE 2: DATA CONFIDENTIALITY COMPARISON

Communication network	Confidentiality Score
Conventional network	5/10
Blockchain based network	9/10

TABLE 3: DATA INTEGRITY COMPARISON

Communication network	Integrity Score
Conventional network	6/10
Blockchain based network	8/10

TABLE 4: DATA AUTHENTICITY COMPARISON

Communication network	Authenticity Score
Conventional network	5/10
Blockchain based network	9/10

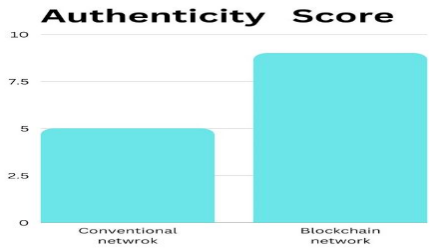

Figure 8. Data Authenticity Comparison

VII. CONCLUSION

In this research, we presented an IOT network based on blockchain technology and assessed the effectiveness of the network's security and efficiency. Our findings show how blockchain technology has the potential to increase the efficiency and security of the communication in the network. According to the study's findings, the suggested blockchain-based secure communication system scored better than the traditional communication system in terms of confidentiality, integrity, and authenticity where blockchain based network leads by 4 points in confidentiality measure by scoring 9/10 points ,leads by 2 points in integrity measure by scoring 8/10 points and has scored 9/10 points in providing authentication to the devices in the network where conventional network was only able to score 5/10 points. From these results we can conclude that incorporating blockchain technology in IoT networks can easily increase the reliability of the users on this network since it provides better security to the data that is being transmitted.The blockchain-based system's usage of encryption, decentralized storage, consensus mechanism, and digital signatures improves the communication system's security. The communication system was more effective since there was no longer a requirement for a central authority and because transactions could be processed simultaneously. The results of this study can help create effective and secure IoT network communication systems, which are essential for sectors where data security is their concern.In conclusion, the proposed blockchain-based secure communication system shows the potential of blockchain technology for more applications in this field and offers a promising solution for enhancing the security and effectiveness of communication in IoT networks.

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REFERENCES

[1] “Blockchain Enabled Autonomous Vehicle Based Vehicular IoT System” Hemani , Daya Shankar Singh ,Rajendra Kumar Dwivedi ,April 2023
[2] "A Novel Blockchain-Based loT Data Provenance Model" Shuang Sun, Huayun Tang, Rong Du March 2023
[3] "Latency Evaluation in Ad-hoc IoT-Blockchain Network" Yue Su; Kien Nguyen; Hiroo Sekiya Oct -2022
[4] "Implementing Security in IoT Systems via Blockchain " Venkat Sai Ram Mukkamala , Pavan Raj Ravi , Mohammad Yasir Hussain Dec -202
[5] “Blockchain-based security for the internet of things: Challenges and opportunities”, Al Omar M, Zhang Y, Salman O and Al Ghamdi, pp-1926-1927 , Nov-2021
[6] “A survey on the security of blockchain systems. Future Generation Computer Systems”, Li X, Jiang P, Chen T, Luo X and Wen Q ,pp-841-853, Feb-2020
[7] "A Blockchain-Enabled Edge-Computing Platform for Intelligent IoT-Based Apps" - Jinliang Xu, Shangguang Wang , Ao Zhou, Fangchun Yang April-2020
[8] "Blockchain and its Role in the Internet of Things (IoT)" Tanweer Alam May-2019

[9] “A study of internet of things with blockchain technology” Dr K Prasanna Lakshmi, K Archana, Y Prasanthi, V Padma, the Third International Conference on Trends in Electronics and Informatics – 2019
[10] “A survey of the state-of-the-art in blockchain technology for IoT”, Raza S, Wallgren L and Voigt T, IEEE Internet of Things Journal, pp-4309-4323, Sept-2019
[11] “A comprehensive study of blockchain for IoT: Current status, challenges, and solutions”, Ouaddah A, Rachkidi E, and Abou Elkalam A ,IEEE Communications Surveys & Tutorials, pp-3817-3838, Dec-2019
[12] “A survey on blockchain-based internet of things”, Sorniotti A, Datta A and Banerjee S ,IEEE Communications Surveys & Tutorials, 20(4), pp-3292-3313, Jan-2018
[13] “Blockchain for the Internet of Things: a Systematic Literature Review” Marco Conoscenti, Antonio Vetro, Juan Carlos De Martin, Apr-2018
[14] “Blockchain-based cloud data storage system” ,Zhang Z, Wen Y, Rodrigues J J and Qin Z, Journal of Parallel and Distributed Computing ,pp- 37-45, July-2018
[15] “A secure and efficient data sharing framework for IoT using blockchain and smart contracts”, Liu Y, Teng F, Zhang J and Hou X ,IEEE Internet of Things Journal, pp-4716-4727 , Aug-2018
[16] "Applications of Blockchains in the Internet of Things:A Comprehensive Survey" Muhammad Salek Ali, Massimo Vecchio , Miguel Pincheira, Koustabh Dolui, Fabio Antonelli ,Dec 2018
[17] "Blockchain for IoT Security and Privacy: The Case Study of a Smart Home" Ali Dorri , Raja Jurdak, Salil S Kanhere, Praveen Gauravaram March 2017
[18] “Blockchain for IoT security and privacy: The case study of a smart home”, Dorri A, Kanhere S. S and Jurdak R, pp. 618-623,Aug-2017
[19] “A taxonomy of blockchain-based systems for architecture design”, Xu X Weber, I Staples, Zhu, In Proceedings of the 2017 International Conference on Software Architecture , pp. 243-252, June-2017
[20] “Blockchains and smart contracts for the internet of things” Christidis K & Devetsikiotis M, IEEE Access- 4,pp- 2292-2303, May-2016