International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 11 Issue: 03 | Mar 2024 www.irjet.net p-ISSN: 2395-0072

Blockchain Applications and Security for the Internet of Things

[1]Daneshwari N. Kori

Department of Information Science and Engineering
SDM College of Engineering and Technology
Dharwad, Karnataka, India

[2]Varsha Jadhav

Department of Information Science and Engineering
SDM College of Engineering and Technology
Dharwad, Karnataka, India

Abstract - Blockchain is presently a contentious topic because of its decentralized structure and security features. On the flip side, when threats and attacks rise, internet usage follows suit. The Internet of Things (IoT) is a huge worldwide network of billions of internet-connected physical objects that intends to gather and distribute data on a vast scale. IoT equipment and devices are revolutionizing the IT sector, but security is their biggest drawback. IoT attacks have received a lot of attention. The current technologies are not sufficient to fully safeguard IoT devices. Blockchain IoT employs the security features of the Blockchain to improve the security and communication risks vulnerability of the IoT.

Keywords - Blockchain and IoT.

I. INTRODUCTION

The term "blockchain" refers to the method of keeping transactional data in units called "blocks" that are linked to one another to form a chain. The number of transactions added to the blockchain increases its size. Blocks are recordings that capture and verify the time and order of transactions inside a specific network that is managed by consensus among network participants. These records are subsequently stored on the blockchain.

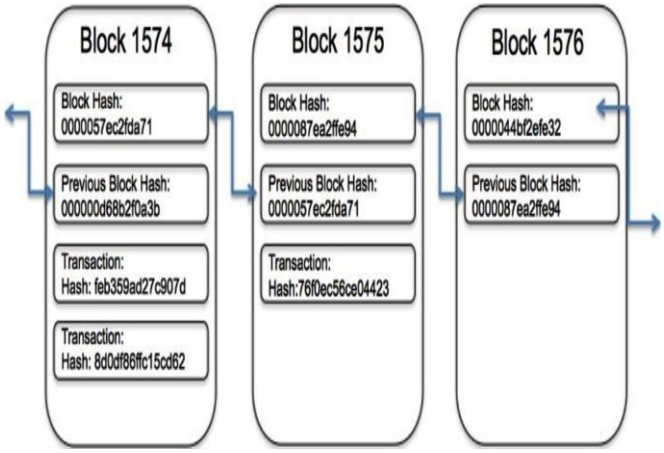

Fig. 1. Blockchain storing transaction data in interconnected blocks

Each block includes a timestamp for the preceding block, a hash (a type of digital fingerprint or unique identification), and batches of recently valid transactions that have been timestamped [1]. By connecting the blocks and preventing any more or modified blocks from being added between two already existing blocks, the prior block hash connects the blocks together. The blockchain is made stronger overall as each new block increases the reliability of the one before it. This method makes the blockchain tamper-evident, supporting its core characteristic of immutability. In other words, while the blockchain does contain transaction data, it does not entirely replace databases, messaging systems, transaction processing, or business processes. Verified transaction proof is present on the blockchain. While a blockchain is fundamentally a database for keeping track of transactions, it offers many advantages over a conventional database.

Public, Private, and Consortium blockchains are the three different types of blockchains [5]. Any number of users can share and independently verify transaction data on a public blockchain. It is a distributed, decentralized system. Similar to a public blockchain, a private blockchain is distinct in that only users with permission from the service provider (a company or organization) to join are permitted. A private blockchain is a centralized blockchain. This sort boosts security and transaction speed using centralized blockchain technology.

A consortium blockchain is one in which membership is limited to those who satisfy specific requirements or have received advance approval (such as businesses or organizations). It is a decentralized blockchain that is composed of a great deal of joint entities from various companies or organizations. This kind of blockchain is similar to private blockchains in that only authorized users' nodes (computers) are permitted to use it.

Two of the most revolutionary technologies—Blockchain and the IoT—are already reshaping the digital world of the future and will fundamentally change the way networks are now set up. The adoption of IoT has given the objects around us a life of their own, allowing them to communicate with one another and collect massive amounts of data by continuously capturing the physical environment. Following an analysis of this data, some wise decisions will be made in response to it. The fundamental basis of how we view the physical world has changed as a result, enabling us to achieve our aim of a smooth transition between the physical and digital worlds. The issue with contemporary IoT solutions is that they ask for a decentralized system, such as a distributed or peer-to-peer (P2P) system, although the original design concept called for a centralized party (such a cloud server), for connecting and interacting via the Internet. Because of this, the huge amounts of sensitive data that were

gathered were seriously compromised in terms of privacy and security.

The distributed/P2P blockchain design also makes it possible to accomplish other goals in addition to access authentication, auditability, resilience, security, privacy, and data immutability. It provides a trustworthy and secure means of information sharing.

In order to improve accuracy, efficiency, and cost-effectiveness, any pertinent trades between machines can be recorded by the machines and preserved on the blockchain. Blockchain is used to automate IoT procedures in the use case of trade logistics. Among the numerous stakeholders involved in freight logistics today are manufacturing businesses, forwarders, shippers, customs agents, and insurers. Parties may have distinct objectives and employ various tracking techniques even though they are interconnected and constantly interact. A blockchain with IoT capabilities is employed as the shared ledger to track shipping containers as they move through the system. The IoT Foundation allows smart contracts to be automatically updated so that users can take advantage of IoT-enabled global trade on blockchain.

II. APPLICATIONS OF BLOCKCHAIN FOR IOT

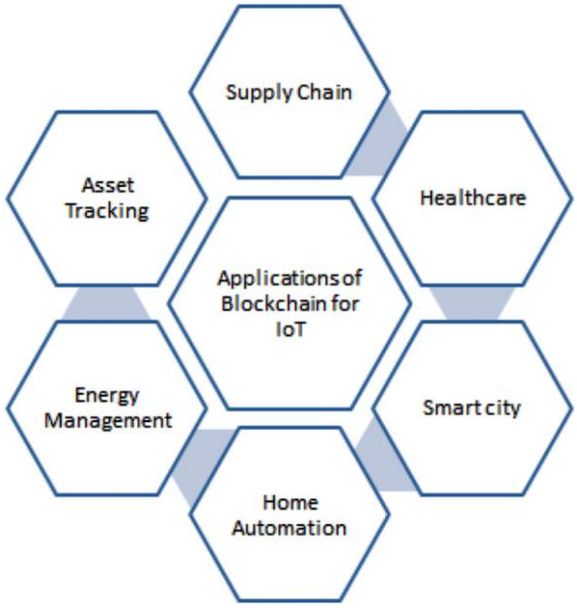

Fig. 2. Applications of Blockchain for IoT

1. Supply Chain

A supply chain management system built on blockchain provides a reliable record of all the information on the status of shipments, the whereabouts of vehicles, the conditions of storage facilities, and more. A shared distributed ledger is the foundation of it. A product's complete life cycle can be tracked across the supply chain using blockchain and IoT technology, which benefits both the company and the customer. All communications between IoT devices are kept in the blockchain, which is an accurate data record. It provides quick access to all product-related data, such as the day a fish was caught, registered, and sold - a detailed account of its journey from ocean to fork.

The usage of blockchain and IoT in cross-border trading guarantees secure freight shipping. Between all parties to a deal, the technology serves as an electronic contract. There is a possibility that the contract's terms and conditions are computer-encoded, enabling easy financial transfers between anonymous parties.

2. Healthcare

The Drug tracing, remote patient monitoring, and medical record management are the three main applications of blockchain in the medical industry. As wearable sensors and body sensor networks enable remote patient diagnostics in life-threatening situations, IoT in healthcare applications facilitates communication between patients and doctors. Because of the use of IoT in healthcare systems, patients' privacy may be compromised. Security must therefore be taken into account.

Blockchain is one of the trendiest study topics at the moment since it can be used in most IoT contexts. One or more of the primary motivations for adopting the blockchain in healthcare systems is its key features, which include Decentralization, Immutability, Security and Privacy, and Transparency.

3. Smart City

Transportation services in smart cities can benefit from the use of blockchain. It could aid in establishing a point-to-point vehicle network. With the help of such a network, it is possible to track vehicles effectively, register drivers and vehicles on a safe platform, and inform owners of critical updates.

The IoT is a set of connected sensors, meters, and lights that are used in smart cities for data collecting and processing. The cities utilize this information, among other things, to enhance their infrastructure, services, and public utilities. By maximizing energy efficiency and improving the management of energy resources, blockchain technology can enhance the urban ecosystem.

4. Home Automation

Blockchain is a decentralized platform, enabling the smart home with a smart hub. This approach enables the blockchain to store data from smart appliances. In addition to receiving a unique identification number for each device, users will also receive a private key that they may use to access the device on their cellphones. IoT makes it possible for internet-connected things to send data to private blockchain networks, creating tamper-proof records of shared transactions.

5. Energy Management

Blockchain provides a safe P2P trading platform that keeps track of the exchange of assets, such an energy unit, in

transactions. Data is transparently stored on a decentralized network using the distributed ledger technology known as blockchain. Asset tracking and transaction monitoring are done using it. Because to the integration of blockchain technology with IoT devices, consumers can trade and purchase energy directly from the grid as opposed to from retailers.

6. Asset Tracking

A more efficient and traceable supply chain is made possible by blockchain-enabled IoT asset tracking. For tracking the asset lifespan and reducing supply chain entropy while boosting visibility and transparency, DreamzIoT Asset Tracking is an end-to-end Blockchain powered IoT solution built for businesses.

III. APPROACHES TO INTEGRATING BLOCKCHAIN TECHNOLOGY IN AN IOT NETWORK

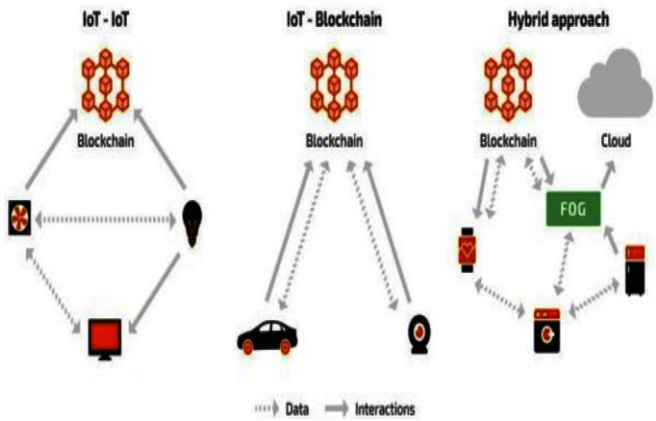

Fig. 3. Blockchain IoT Interactions

1) IoT — IoT

As all that is needed to store IoT data is a sharing register, this is actually the simplest way to integrate blockchain into the IoT network. Data will be sent away from the blockchain via a variety of routing techniques. Delays will be minimized and transactions will move along quickly as a result. Also, this approach allows the gadgets to operate offline. Because it doesn't necessitate major changes to the way IoT devices operate, all that is needed to implement this simple solution is to set up the data transfer, storing, and extraction from blockchain rather than a cloud or a server.

2) IoT — Blockchain

The blockchain, which serves as a cloud for conventional IoT networks, will be used in this method to facilitate communication between IoT devices. From one angle, this will improve the ability to trace data, communication security, and workflow automation. On the other hand, if the blockchain is not quick enough, the system will become significantly more sophisticated, which would result in delays.

The integration of this blockchain into IoT networks is challenging because it necessitates numerous adjustments to both the operation of IoT devices and blockchain development. A suitable blockchain should be employed as well, one with greater operating speed, capacity, and no fees. This blockchain may be built on IOTA, Modum.io, or Riddle & Code.

3) Hybrid approach

The IoT devices share the majority of the data and interactions, with the blockchain merely storing specific sorts of data. Even though there are many benefits to this, it is quite difficult to get IoT devices to operate quickly and with minimal latency in real-time.

In order to address the shortcomings of blockchain technology and Internet of Things devices, this solution also incorporates fog computing. For instance, you may utilize this computing technique to gather, store, and analyse private data using peripheral devices rather than the cloud, saving money on running expenses.

IV. USE CASES OF IOT-ENABLED BLOCKCHAIN TECHNOLOGY

Fig. 4. Use cases of IoT-enabled Blockchain technology [4]

a. Operational maintenance

For safety and maintenance, IoT devices monitor the condition of binding machines. Blockchain provides a tamper-proof log of operating data for anything from engines to elevators.

As a result, third-party repair partners are able to report their work back on the blockchain and keep a watch on it for preventive maintenance. The sharing of operating records with governmental bodies is another option for ensuring compliance.

b. Freight transportation

Freight transportation is challenging and requires cooperation from numerous parties. With the help of an IoT-enabled blockchain, it is possible to store information on the temperatures, arrival timings, and present condition of shipping containers that are in transit. The information is

reliable, so all parties may act to transfer the freight quickly and effectively.

c. Pharmacy

Because the pandemic altered our way of life, we are relying more on medications. In the pharmaceutical sector, however, the issue of fake goods is getting worse. In light of the fact that pharmaceutical corporations are responsible for the development, production, and distribution of medicines, it is crucial that certain steps be taken to guarantee that only safe medications are made available to the general population.

The speedy and secure supply of drugs from one location to another can be tracked thanks to blockchains transparency and traceability.

d. Smart homes

The IoT is essential to our daily existence. Because all of the appliances in a "smart home" are interconnected, one device, such as a laptop, tablet, smartphone, or gaming console, may access every appliance. A single home automation system can manage the thermostat, door locks, cameras, house monitors, and kitchen appliances.

Smart homes have never been more feasible because to blockchain's capacity to solve security problems and do away with centralized infrastructure. To avoid the misuse of data collected by smart devices, you can implement security features like biometric and facial/voice recognition.

e. Supply chain management

The capacity to track parts used in automobiles, aeroplane, and other products is essential for safety and legal compliance. The provenance of components may be seen by all parties throughout the entire life cycle thanks to the IoT data that is kept in common digital ledgers. It is simple to share information with shippers, regulatory bodies, and manufacturers.

f. Insurance

The process of managing claims, fraud, and property and casualty insurance has been significantly improved by smart contracts and IoT data from location-based sensors (home alarms, factories, warehouses), sensors on products, and wearable personal technology (shipping containers and vehicles).

V. CHALLENGES ENCOUNTERED WHILE IMPLEMENTING BLOCKCHAIN IN IOT

Blockchain offers a solution by transferring decision-making to an IoT device network that runs on consensus. However, when developing the architecture for IoT devices that utilize blockchain, the following challenges must be taken into account:

i. Scalability

One of the issues with IoT development that arises frequently is scalability. How can one handle the enormous volumes of data generated by a wide network of sensors while also potentially reducing transaction processing latencies? That is a very difficult question. A clear data model that has been designed beforehand makes it simpler to launch the product.

ii. Security risks

An IoT-powered blockchain system can be enhanced with smart contracts. Smart contracts can boost productivity by automating contract management. Security issues could make it more difficult for IoT to utilize blockchain technology.

Decentralized public blockchain networks are hard to hack, but the underlying smart contracts may have flaws. The worst part is that cyber criminals look for common smart contract vulnerabilities. If you wish to avoid this problem, thoroughly analyze and test smart contracts. Although you can never be guaranteed that your smart contracts won't have defects, you can reduce the possibility that they will and that this will lead to improper operation of your blockchain and IoT architecture.

iii. Sensor reliability

How reliable are the current sensors? This can make it difficult to assess the circumstances necessary to complete a transaction accurately. In order to create a safe and secure environment for data recording and transactions, it is imperative to take steps to prevent external interference from shifting sensors.

iv. Network privacy and transaction confidentiality

It is not possible to use the public blockchain to give a network of IoT-connected devices access to the shared digital ledger's transaction history. This happens because information about the identities of the user or device that are hidden by public keys is inferred through transaction pattern analysis.

Companies must evaluate their privacy requirements to see whether hybrid or private blockchains may better meet them, and then take the necessary action.

v. Computing power and time required

Blockchain is required by IoT in order to offer the best level of security possible, necessitating the "Proof of Work" (POW) consensus process. The steps are simple to follow. Yet, it requires longer intervals of intense, rapid-fire number crunching. Hence, computationally demanding procedures and associated expenses serve as a disincentive to cybercriminals.

vi. Complex IoT and blockchain projects

Due to the fact that blockchain technology is still a relatively new concept, integrating it with IoT solutions may not be as straightforward as one may assume. This is due to the fact that experts in both professions must possess the abilities and information required to handle any eventuality. The initiatives will undoubtedly be impacted by the unfortunate possibility that it would be challenging to get top talent in this area.

VI. BLOCKCHAIN-BASED IOT SECURITY

a) Data integrity for quality control

Blockchain technology can offer a strong framework to procedures to quickly and correctly detect data alterations because of its immutability.

b) Fault detection using device tracking

Due to the vastness of IoT networks, identifying failure trends may be challenging. The blockchain provides monitoring tools to find problems and gives each IoT endpoint a unique key, making it easier to spot mistakes.

c) Security

Blockchain-based data chunks are encrypted, integrity-protected, digitally validated, and authenticated.

d) Faster automation with smart contracts

Automation made easier by smart contracts. IoT technology alone makes automation possible, but when combined with smart contracts, automatic responses can be approved through this network.

e) Decentralization for enhanced security

Because the blockchain is decentralized, hackers won't be able to attack a single server and damage its data, regardless of the connectivity techniques employed.

f) Trust

Because of the immutability of the blockchain, even if the owner's key is revealed, blocks cannot be changed (except for block in the current break).

g) Usage logs for employee performance

Going beyond sensors, blockchain technology can also track users' behavior to enable you know who, when, and how they have used a device. This information may be utilized to improve employee performance.

h) Upgrade & Update

Incorporating IoT systems with blockchain technologies (such as smart contracts) can help to increase the security of IoT systems by automatically updating IoT device firmware to address security problems.

VII. CONCLUSION

The enhanced security and efficiency of blockchain technology, as well as its ability to support decentralization and the usage of smart contracts, can benefit IoT networks. IoT device maintenance, data transport, and data management costs can be decreased by using a decentralized ledger to store data on IoT devices. This helps organizations safeguard the information. Businesses can also do away with a central IoT gateway thanks to blockchain technology. The adoption of blockchain in IoT can speed up processes. Because of this, it works well for a variety of IoT applications. Yet, the decentralized nature of blockchain could present a problem for IoT. Most IoT platforms are built on hub-and-spoke or client-server designs, which depend on a centralized authority to carry out transactions. Because of this, IoT platform designers must make sure their systems are interoperable with blockchain networks.

VIII. REFERENCES

[1] Sameeka Saini; Ankit Maithani; Diksha Dhiman; Ankur Rohilla; Nisha Chaube; Amita Bisht, "Blockchain Technology: A Smart and Efficient Way for Securing IoT Communication", 2021 2nd International Conference on Intelligent Engineering and Management (ICIEM), London, United Kingdom, 28-30 April 2021.

[2] Hong-Ning Dai; Zibin Zheng; Yan Zhang, "Blockchain for Internet of Things: A Survey", IEEE Internet of Things Journal, no. 19, Volume: 6, 05 June 2019.

[3] Nallapaneni Manoj Kumar; Pradeep Kumar Mallick, "Blockchain technology for security issues and challenges in IoT", International Conference on Computational Intelligence and Data Science (ICCIDS), 2018.

[4] https://www.intuz.com/blog/iot-in-blockchain-benefits-use-cases-and-challenges.

[5] Riya Thakore; Rajkumar Vaghashiya; Chintan Patel; Nishant Doshi, "Blockchain - based IoT: A Survey", 2nd International Workshop on Recent advances on Internet of Things: Technology and Application Approaches (IoT-T&A 2019), Halifax, Canada, August 19-21, 2019.

[6] Bhabendu Kumar Mohanta; Debasish Jena; Somula Ramasubbareddy; Mahmoud Daneshmand; Amir H. Gandomi, "Addressing Security and Privacy Issues of IoT using Blockchain Technology", IEEE Internet of Things Journal, no. 9, Volume: 8, 13 July 2020.

[7] Muhammad Salek Ali; Massimo Vecchio; Miguel Pincheira; Koustabh Dolui; Fabio Antonelli; Mubashir Husain Rehmani, "Applications of Blockchains in the Internet of Things: A Comprehensive Survey", IEEE Communications Surveys & Tutorials, no. 42, Volume: 21, 18 December 2018.

[8] Siddharth Rajput; Archana Singh; Smiti Khurana; Tushar Bansal; Sanyukta Shreshtha, "Blockchain Technology and Cryptocurrenices", 2019 Amity International Conference on Artificial Intelligence (AICAI), no. 4, Dubai, United Arab Emirates, 04-06 February 2019.

[9] Tareq Ahram; Arman Sargolzaei; Saman Sargolzaei; Jeff Daniels; Ben Amaba, "Blockchain technology innovations", 2017 IEEE Technology & Engineering Management Conference (TEMSCON), no. 5, Santa Clara, CA, USA, 08-10 June 2017.

[10] Henry Rossi Andrian; Novianto Budi Kurniawan; Suhardi, "Blockchain Technology and Implementation: A Systematic Literature Review", 2018 International Conference on Information Technology Systems and Innovation (ICITSI), no. 5, Bandung, Indonesia, 22-26 October 2018.