BLOCK CHAIN WITH INTERNET OF THINGS

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Abstract

The Internet of Things (IoT) has expanded internet connectivity to include the majority of the objects in our surroundings in addition to computers and humans. The IoT has the ability to connect billions of objects at once, improving the need for information sharing and ultimately enhancing our quality of life. Due to its centralised server/client approach, which limits the IoT's potential benefits, there are numerous obstacles to IoT adoption in the real world. For instance, the excessive quantity of IoT gadgets in the network can cause scalability and security difficulties. All devices must be linked to and authenticated by the server in the server/client model, creating a single point of failure. Consequently, putting the IoT system on a decentralised road could be the best option.

Keywords: Internet of Things, Internet of Things with Blockchain, Centralised, Decentralised.

1. Introduction

Billion of things can connect and interact at once thanks to the Internet of Things (IoT). It offers consumers a number of advantages that will alter how they engage with technology. Information from our environment can be gathered to improve our way of living using a combination of inexpensive sensors and connected objects [1].

"Like the Internet before it, the Internet of Things has the power to alter the course of human history. possibly more so"[2]. Later in 2005, the ITU gave the Internet of Things (IoT) its official definition, defining it as "a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on, existing and evolving, interoperable information and communication technologies" [3].

IoT solutions today are constructed using a centralised server/client approach

2. Related Work

In a few articles, the integration of blockchain with IoT has been studied. To create a distributed network of devices, the IBM Autonomous Decentralised Peer-to-Peer Telemetry (ADEPT) project [7] uses the blockchain. Regarding the ADEPT project, other other strategies are attempting to create a plan that will enable the fusion of all the various blockchain-based apps [8]. Additionally, Slock.it unveiled the first Blockchain and IoT application using the Ethereum platform [9]. Slocks are named after actual physical objects that can be managed by the Blockchain. They utilise an electronic device called the Ethereum Computer, which introduces Blockchain technology into the entire home and enables users to rent out access to any compatible smart object and receive payment Methods.

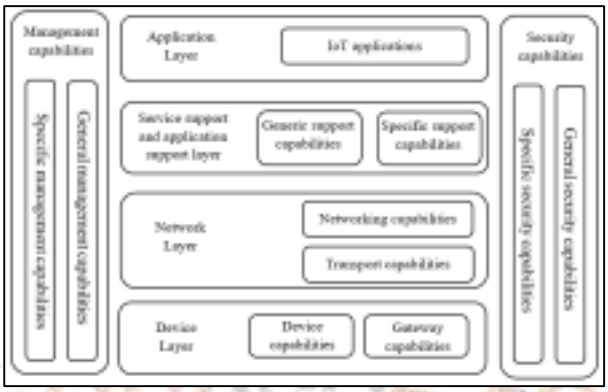
3.CENTRALIZED IOT ARCHITECTURE

In essence, the Internet of Things (IoT) involves the connectivity and communication of many objects. These gadgets are made out of networking nodes, either servers or computers, that are linked to one another to share data. All gadgets come equipped with sensors that gather information that can be communicated, saved, analysed, and presented in an efficient manner [13].

There are numerous IoT architectures that have gained widespread acceptance. Various researchers and organisations suggested various architectural designs. As depicted in Fig.[3], the ITU states that the IoT architecture is made up of four layers:

Layer of application

Application and service support layers, Network layer, and Device layer



IoT applications are included in the application layer. Healthcare, smart cities, and network architectural models are just a few of the IoT's many applications. It is made up of mechanical components and object-controlling controllers. These items stand in for IoT entities such as a variety of endpoints that transmit and receive different types of data. As an illustration, sensors that gather data about the environment [15].

The server/client approach, which is how the present Internet of Things architecture is constructed, is centralised. In this arrangement, all devices communicate with a centralised gateway rather than one another. The centralised paradigm has been used for many years to connect a variety of computer devices, and it will continue to support small-scale IoT networks.

As a result of the rapid growth in IoT devices, the network capacity will at least 1,000 times greater than it was in 2016. In 2020, the number of IoT devices is expected to exceed 20 billion, according to Cisco [16]. As a result, prices will certainly rise tremendously as more communication needs to be managed. The server/client model will always have a weak spot that can crash the entire network, even if costs and communication issues are controlled [6].

Furthermore, the centralised paradigm leaves room for data manipulation. Real-time data collection does not guarantee that the information will be used properly and effectively. As an illustration, if energy firms discovered that the analysis of data from smart metres will provide the proof that may occurs.

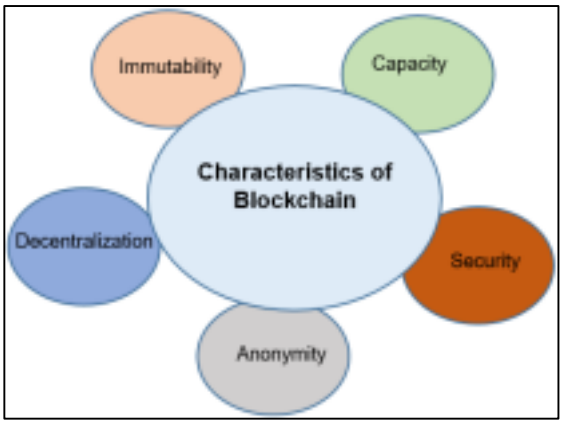
4.BLOCKCHAIN TECHNOLOGY

A secure, transparent, extremely resilient to outages, auditable method of recording transactions or any digital interaction is provided by blockchain technology. It will still be a few years before this technology is widely used in commerce because it is still in its infancy and is evolving quickly. To avoid disruptive surprises or lost opportunities, decision-makers across sectors and corporate functions should pay attention immediately and begin to examine applications of this technology [6].
The idea of Bitcoin was first suggested by Satoshi Nakamoto in 2008. By disseminating the widely read document "Bitcoin: A Peer-to-Peer Electronic Cash System" [18], this was accomplished. The study made a recommendation for dispersing electronic transactions rather than keeping the exchange reliant on centralised organisations [19].

There are numerous explanations to shut down the entire network.

5. Increased Capacity

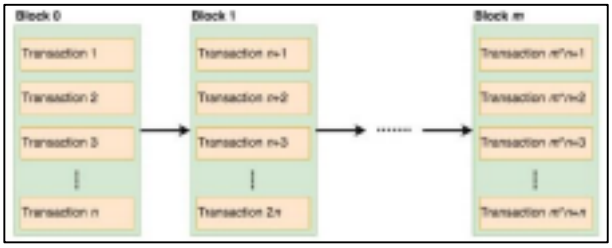
The ability of blockchain technology to expand a network's capacity is one of its key features. The combined power of thousands of computers can be more potent than a few centralised servers.



As seen in Fig.1, a blockchain comprises of two key components [6]:

The acts produced by system participants are referred to as transactions.

Blocks: keep track of transactions and ensure that they are recorded in the proper order and are unaltered.



6. CHARACTERISTICS OF BLOCKCHAIN

The IoT finds the blockchain to be very appealing for solving many of its problems due to its various features. According to [10], blockchain properties are represented in Fig. 2 and include:

1. Immutability: One of the main benefits of blockchain is the ability to create immutable ledgers. All centralised databases are susceptible to corruption, and maintaining the integrity of the data frequently means putting your trust in a third party. A transaction cannot be altered once it has been agreed upon and documented.

2. Decentralisation: By utilising the resources of all participating nodes and eliminating many-to-one traffic flows, the lack of centralised control ensures scalability and robustness, which in turn reduces latency and eliminates the single point of failure that is present in the centralised model.

3. Anonymity: By maintaining anonymity,The anonymity provides an efficient way of hiding the identity of users and keeps their identities private.

4. Better Security: Blockchain provides better security because there is no single point of failure

7. HOW BLOCKCHAIN WORKS?

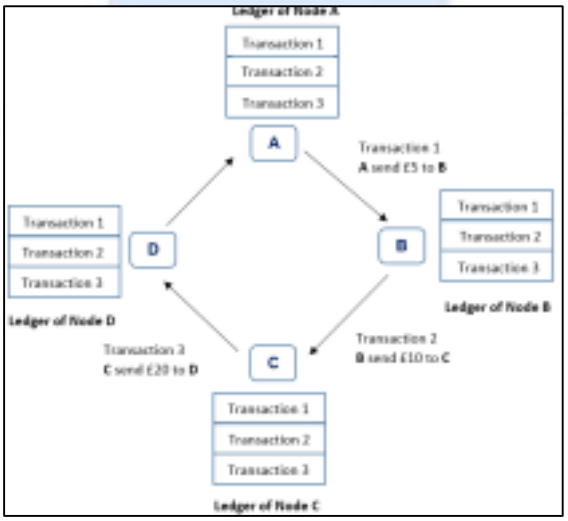
Although the blockchain is still in its infancy and is still being tested, it is seen as a revolutionary technology that can address concerns with decentralisation, identification, trust, data ownership, and data-driven decisions. [7].

Generally speaking, a blockchain is a database that organises all transactions into blocks. The sender broadcasts each new transaction to every other node in the network via the Peer-to-Peer communication channel as soon as it is created. The transaction hasn't been validated and is still fresh. The nodes verify the transaction after they get it and store it in their ledger [20].

Run predetermined checks on the transaction's actions and structure to complete transaction validation. Miners are unique types of nodes that produce new blocks by adding all or any of the following:

mining hardware with specialised processing power is used by the miners. Whoever solves their block's puzzle first wins, according to mining protocol. The block in the chain that he was a candidate for becomes the new block. As new transactions come in, they are added to the mining block, which means that the most recent block in the blockchain contains the most recent transactions [4].

Every network node receives a fresh block that has been time-stamped when it is created. Each node gets the block, verifies it, verifies the transactions, and adds the block to his ledger. The block becomes a valid and irreversible portion of the blockchain once it has been accepted by the majority of nodes. Every block also contains a hash value from the preceding block and some metadata in addition to the transactions. thus every block



The blockchain will be covered in this part with a straightforward example. Let's say that four nodes A, B, C, and D wish to send money using the blockchain because it is called Bitcoin. Decentralisation is the concept that eliminates the need for an intermediary third party to facilitate money transfers between nodes. As a result, money would be sent directly to node B if node A decided to

send it. As seen in Fig. 3, if node A wishes to give node B £5, a transaction will be generated and validated by every other node in the network before being recorded in the ledger. Additionally, if node B wishes to transfer node A £10, node.

8. BLOCKCHAIN WITH IOT

regarded as containing IoT

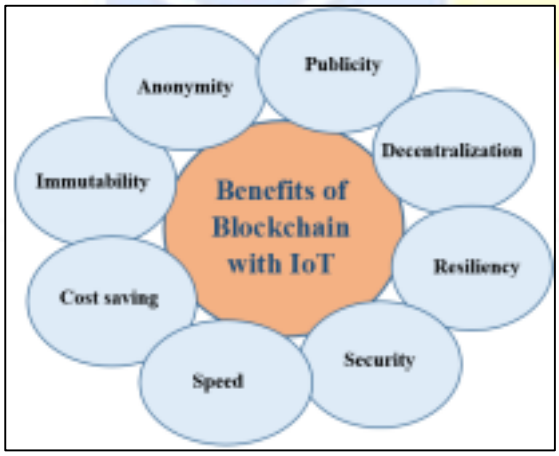
Blockchain technology has the ability to store an unalterable history of smart device usage in an IoT network. By removing the requirement for centralised control, this capability allows smart devices to operate autonomously [26]. A number of IoT situations that were challenging or even impossible to implement before will now be made possible by the blockchain. IoT solutions can offer secure, trustless messaging between devices in an IoT network, for instance, by utilising the blockchain [27]. In this scenario, the blockchain will handle device-to-device messaging as if it were a bitcoin network's financial transactions. Devices will use smart contracts to allow message exchanges, which will model the agreement between the two parties [20].

9. BENEFITS OF INTEGRATING BLOCKCHAIN WITH IOT

The blockchain is ideally suited to become a core component of IoT systems due to its decentralised, autonomous, and trustless properties. Enterprise IoT technologies have quickly emerged as one of the leading blockchain technology early adopters, which is not surprising. But developing peer-to-peer connectivity will have its own set of difficulties, particularly in terms of security. IoT security involves far more than just safeguarding private information. Therefore, in order to prevent spoofing and theft, blockchain solutions will need to guarantee privacy and security in IoT networks and require participant validation and consent for transactions [6].

Blockchain technology is regarded as one of the primary solutions to the IoT's privacy and reliability problems. It allows for the processing of data from billions of connected devices.

1. Publicity: Because each participant has their own ledger, everyone can see every transaction and every block. Even though all participants may view the contents of the transaction, they are secure since the participant's private key [19] protects them. The Internet of Things (IoT) is a dynamic system that allows all linked devices to exchange information while also preserving user privacy.
2. Decentralisation: To approve a transaction and add it to the distributed ledger, the majority of users must first confirm it. No single body has the power to sanction transactions or establish particular guidelines for their acceptance. As a result, a tremendous level of trust is involved because the vast majority of those.
3. Resilience: Every node has a copy of the ledger, which records every transaction ever made in the network, on its own. Therefore, the blockchain is more resistant to attack. The blockchain would still be up and running even if one node were compromised [29]. It will be easier to share information if each node in the IoT has a copy of the data. It does, however, raise fresh processing and storage problems.
4. Security: The Internet of Things (IoT) requires a safe network over untrusted parties due to the large number of heterogeneous devices. Blockchain can provide this [10]. In other words, in order to launch an assault, every IoT network node must be evil.
5. Speed: A blockchain transaction is disseminated around the network in minutes and will be completed in that time.



10. CHALLENGES OF BLOCKCHAIN WITH IOT

Integrating blockchain would undoubtedly have many benefits. As Fig.5 illustrates, the blockchain technology is not a flawless model and has its own shortcomings and difficulties. The following is a summary of these difficulties:

1. Scalability: Blockchain scalability problems could result in centralization, which is a concern for the cryptocurrency's future. As the number of nodes in the network grows, the blockchain scales poorly. IoT networks are anticipated to have a significant number of nodes, making this problem severe [28].

2. Processing Power and Time: The processing power and the amount of time required to encrypt every object in a blockchain system. IoT systems utilise several device types with a 3. Storage: One of the key advantages of blockchain is that it does away with the need for a central server to keep track of transactions and device IDs, but the ledger must be kept on the nodes themselves [33]. As time goes on and there are more nodes in the network, the distributed ledger will grow in size. IoT devices, as previously stated, have extremely little processing power and storage [34].

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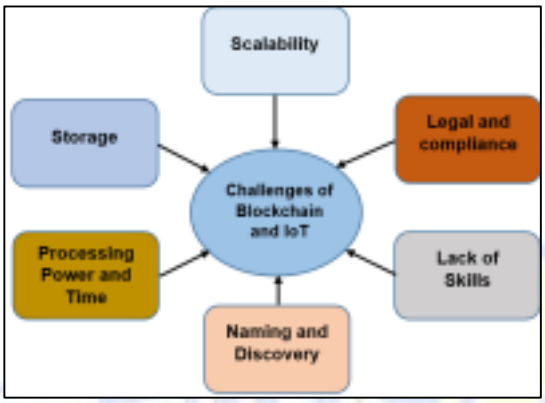
4. Skill gap: The blockchain technology is still in its infancy. As a result, only a select few possess extensive understanding and expertise concerning the blockchain, particularly in banking. There is a general lack of knowledge about how the blockchain functions in other applications [6]. Everywhere there are IoT devices.

5. Legal and Compliance: The blockchain is a novel technology that will be able to connect individuals from other nations without requiring them to adhere to any legal or compliance standards. This presents a significant problem for both manufacturers and service providers. The main obstacle to the adoption of blockchain in many industries and applications will be this issue [35].

6. Naming and Discovery: Since blockchain technology was not created with the Internet of Things in mind, nodes were not intended to be able to locate one another in the network. An illustration of this is the Bitcoin application, where the IP addresses of some "senders" are stored within the client and used by nodes to construct the network topology. The IoT will not benefit from this strategy since IoT devicesus integrating blockchain with IoT would be beneficial.



11. FUTURE RESEARCH DIRECTIONS

The idea of centralised authorities has evolved as a result of the blockchain. Opening new businesses and applications will begin with the integration of blockchain and IoT. Future research directions using blockchain and IoT are covered in this section. The following can be used to sum up this:

Smart Contracts, first

Scripts for smart contracts are kept on the blockchain. They are adaptable, which is why they are so strong. They can be programmed to use the data within a self-executing logical workflow of actions between parties, and they can encrypt and store data securely, restrict access to it to only the appropriate parties, and do all of this automatically. By converting business processes into computer processes, smart contracts significantly increase operational efficiency [5].

Smart contracts will offer an effective solution to increase the security and integrity of IoT data within IoT systems. The following research issues must be resolved in order to implement smart contracts in IoT systems:

A1: Can the billions of IoT devices' billions of event functions be executed by smart contracts? Q2: Since the Internet of Things (IoT) is a dynamic system, how will the smart contract react to changing environmental conditions?

What platform is best for integrating smart contracts into IoT systems?

Fig.5. Blockchain and IoT challenges

X. FUTURE RESEARCH DIRECTIONS

The blockchain has changed the concept of centralized authorities. The integration of blockchain with IoT will be the starting point for opening new businesses and applications. This section discusses future research directions of blockchain with IoT. This can be summarized as follows:

A. Smart Contracts

Smart contracts are scripts stored on the blockchain. They are so powerful because of their flexibility. They can encrypt and store data securely, restrict access to data to only the desired parties and then be programmed to utilize the data within a self-executing logical workflow of operations between parties. Smart contracts translate business process into the computational process, greatly improving operational efficiency [5].

Using smart contracts within the IoT systems will provide an efficient way to improve security and Integrity of IoT data. The research questions that need to be addressed regarding conducting smart contracts within IoT systems are:

Q1: Are the smart contracts able to execute all event functions of IoT devices, which are in billions? Q2: How the smart contract will respond to changing environmental conditions of the IoT as it is a dynamic system?

Q3: What is the appropriate platform to implement smart contracts within IoT systems?

B. Regulatory Laws

Regulatory laws are the processes developed by government bodies and local administrative organisations to specify the acceptable uses of a product or technology within a given nation or region. As previously said, blockchain is a novel technology without any established compliance standards. Regarding legal and compliance matters relating to blockchain, the following research question needs to be answered:

What international regulatory guidelines enable the optimum use of blockchain in the Internet of Things?

C. Safety

Security is still the most difficult issue attracting attention from organisations and researchers for all new technologies. As it leverages the majority of participants' consent to confirm transactions, integrating blockchain with IoT can increase security by preventing spoofing and theft.

What is the best platform for IoT and blockchain integration?

How can a safe IoT system be provided given the limited capabilities of IoT devices?

D. IOTA

IOTA is a brand-new type of public and distributed ledger that makes use of the "Tangle" idea. A new data structure called The Tangle is based on a Directed Acyclic Graph (DAG). IOTA offers free real-time transactions that are effective, safe, lightweight, and efficient. It is a decentralised, open-source cryptocurrency created especially for the Internet of Things [36].

12. CONCLUSION

Every home in the universe is now included thanks to the Internet of Things (IoT) technology. It has the capacity to link commonplace items to the Internet. We can improve our quality of life by gathering a lot of data from the environment using inexpensive sensors. But there are several problems with the present server/client-based IoT architecture that need to be solved, including scalability and security. Blockchain is one approach to addressing IoT problems. Blockchain offers a distributed peer-to-peer communication network that enables unreliable nodes to interact with one another in a verifiable way without the use of a third party. In this article, we outlined the advantages and difficulties of combining blockchain with IoT. Future research directions were also a major topic of conversation.

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