IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

ISO 3297:2007 Certified ⁜ Impact Factor 7.918 ⁜ Vol. 12, Issue 3, March 2023

DOI: 10.17148/IJARCCE.2023.12313

# Internet of Things and Industrial IoT Using Blockchain: A systematic review

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**Abstract**: IoT privacy risks and security vulnerabilities are emerging from a lack of basic security technology, despite the IoT's rapid development and widespread attention in academia and industry. The blockchain technique was proposed as a decentralized and distributed approach to guarantee security requirements and encourage the growth of the IoT and IIoT because of its decentralization and information disclosure. First, we briefly overview blockchain's overall design and highlight its most important features before discussing the security measures needed to fully realize the Internet of Things and the Fourth Industrial Revolution. Then, we delve into how blockchain's security features can be utilized by the IoT for Industry 4.0. To promote the features and benefits of the blockchain technique on IoT and IIoT platforms, we explain the most important blockchain-based IoT applications. Finally, suggestions are made to help future blockchain researchers and coders get started.

**Keywords:** IoT; Security; IIoT; Smart Home; Data Privacy; Smart City.

## I. INTRODUCTION

The Internet of Things (IoT) improves upon conventional wisdom and makes it possible to network the vast majority of, if not all, physical things in our world. A more intelligent way of living for people is made possible by linking vehicles, home appliances, and other electronic devices on the network. The system can autonomously initiate events related to identification, location, tracking, and monitoring in real-time. In addition, IIoT relies heavily on IoT to realize its goal of creating "smart factories" that are intimately connected to their clientele and suppliers through digital networks. The Internet of Things (IoT) is expanding rapidly and drawing a lot of attention from academia and businesses. However, foundational security technology is still severely absent, leaving users vulnerable to privacy breaches and other security flaws. Due to its decentralized topology and the resource constraints of mobile devices, current security and privacy techniques are inapplicable to IoT [1].

Blockchain is suggested as a decentralized and distributed method for ensuring the safety of the IoT and IIoT. All the blocks are linked together, making this a distributed ledger. This system can track, synchronize, and store information from the IoT's billions of devices. Blockchain's primary benefit is decentralization, allowing credit-less, peer-to-peer interactions within distributed ledgers[5]. Motion time stamping, distributed consensus, data encryption, and financial rewards are all used in the system. It helps save money, boost productivity, and address the insecure data storage issue that centralized businesses face.

Using historical records, we'll examine the foundations of the blockchain and the internet of things. We investigate this issue by examining how various blockchain features—including decentralization, smart contracts, asymmetric encryption, and access management [3, 4]—could be implemented on an Internet of Things platform. We conclude that blockchain is well suited to advancing the Internet of Things and the Industrial Internet of Things. Some issues, however, remain unresolved. Scenario with several users using different framework functions, where three criteria are evaluated: execution time, transfer rate, and latency.

## II. IOT AND INDUSTRIAL IOT

### 1. IoT:

At the conceptual level, IoT refers to the interconnection and interoperability among our everyday devices (computers, laptops, phones, watches, and other handheld embedded devices) and device autonomy, perception, and situational awareness. A connected device with sensors or actuators senses its surrounding environment, understands what is happening, and decides intelligently and independently or communicates with the other nodes or users to make the best decisions. In short, IoT aims to add computer-based logic to many things (objects), which can then be monitored or controlled by analytics or engines. The development of the IoT is increasingly suited to the needs of humanity. It

  

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combines vehicles, healthcare, wearables, retail, logistics, manufacturing, agriculture, utilities, appliances, etc. [2]. The 2020 conceptual framework defines IoT as a simple formula [6].

IoT = Services + Data + Networks + Sensors
Thus, IoT combines data from sensors and networks that provide different intelligent services.

**2. Industrial IoT**

"Industrial Internet of Things" (IIoT) describes the current fad of connecting machines and exchanging data in the manufacturing sector. There are Internet of Things (IoT) applications, network augmentation system applications and cloud computing applications [18]. Industry 4.0, which employs the IIoT with Cyber-Physical Systems (CPS), aims to digitally transform the supply chain from procurement to distribution to retail to create more efficient, cost-effective, and individually tailored consumer goods. Computing-powered systems (CPS) include autonomous vehicles, smart homes, medical monitoring, and robotics systems, designed to function in tandem with their users and the internet. Based on IoT, IIoT combines many cutting-edge systems and methods, including but not limited to autonomous machines, advanced robotics, big data, cloud/edge computing, digital pervasiveness, smart manufacturing, machine learning, artificial intelligence, and cyber-physical systems.

Instrumentation, connected sensors, and other devices are primarily implemented in equipment, vehicles, and the energy and industrial sectors through the IIoT. IoT applications that have been around for a while, such as Internet-connected refrigerators, are a subset of IIoT. These are the four guiding ideas of its design:

1. Interoperability: the possibility that machines and related components connect and communicate with people.
2. Information transparency: the necessity of creating virtual copies of the physical world.
3. Technical assistance: essential comprehensive aggregation and information visualization to support human capabilities.
4. Decentralization of decisions: the ability of a network-enabled system to independently make decisions and perform its specialized functions.

The IIoT based on the IoT provides a seamless way for data transmission across different workplaces. Real-time monitoring systems and data transfer can optimize and increase productivity, get better quality products, and help businesses become more intelligent and efficient.

## III. APPLICATIONS OF BLOCKCHAIN IN IOT AND INDUSTRIAL IOT

The blockchain is a real-time ledger of data independent of any central authority and kept in a distributed, point-to-point fashion. Users can only access and modify the blocks for which they have the private key because each record is encrypted and time-stamped. Each block is connected to the one before and after, and the complete chain is updated every time a change is made. When data blocks are stored on the blockchain ledger, it is difficult or impossible to modify or delete them. Thus, it safeguards the confidentiality of transactions and communications. Blockchain has been and will continue to be extensively used to create IoT and IIoT because it has many novel features. Some representative blockchain applications are listed, and the following subsections explain them.

1. Electric vehicle clouds and edge (EVCE)

The EVCE network paradigm is appealing for gathering the depleted idle resource of cars into a single pool. In the coexistence of hybrid clouds and edge computing, information sharing takes place without the use of established trust relationships. The blockchain technique, which has decentralization, anonymity, trust, and co-participation features, is suggested as a possible remedy to security problems [7].

Energy resources and information are shared, worked on, and redistributed among vehicles in an EVCE computing network. Depending on the situation, the cars could be mobile data calculators, virtual power plants, or impromptu network operators. [7] describes a security framework that uses data and energy coins based on timestamps and hash tree methods like proof of work (PoW) and proof of stake to create distributed consensus. (PoS). The information and energy trading records between vehicles were encrypted and organized into blockchains in a linear, chronological sequence to prevent easy manipulation of the transaction information.

2. Trace Food Source

The largest blockchain application to advance IoT is a trace food source. Because the conventional food supply chain begins with manufacturers and continues through suppliers and vendors, it is more difficult to trace the origins of food,

  

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and knowledge about it is very confusing. The public address is used to locate the matching party on the blockchain, and the blockchain ensures that each transaction is time-stamped, digitally signed, and can be traced back to a specific period. This is due to the non-repudiation of the blockchain, which makes the system more dependable by preventing anyone from verifying the veracity of the author's signature on the document or the author's identity as the transaction they started. A business is given security and transparency for each iteration by converting the ledger's global status and the blockchain auditing function [8].

Blockchain guarantees supply chain security and can be useful in managing emergencies, such as product recalls due to security breaches. The public availability of blockchains enables users to identify susceptible IoT devices by linking transactions in a chain and tracking each product's origin of raw materials.

IBM and Walmart are now collaborating to make the food supply network transparent. To increase transparency and efficiency in supply chain record-keeping, they inked a contract with Tsinghua University. To document the fish supply line in the store, Tsinghua University is also collaborating with Yonghui Superstores. Blockchain offers an alternative transaction system instead of conventional paper recording and manual inspection systems. Retailers can find out with whom the vendors do business. Information cannot be changed quickly because transactions are not stored in a single node. Consumers can quickly access pertinent product information, such as production and expiration dates, plant and processing information, and service in the event of a defective product by scanning the QR code with a smartphone. The government can check the pertinent food departments' blockchains [38]. Walmart typically needs 6 days, 18 hours, and 26 minutes without blockchain to track mangoes back to their field of origin. Thanks to blockchain technology, consumers can get all the specific product information in just 2.2 seconds [10]. Alibaba also made Green Hand available to create e-passports for tangible products. Customers can scan a QR code to get comprehensive information about their purchases, ensuring the products' authenticity.

### 3. Smart Home

The term "smart home" refers to an essential use of ubiquitous computing that integrates intelligence into the administration and operation of homes. Each device in the house can request data from the other internal devices using blockchains to provide specific services. For instance, the motion sensor can transmit information to the light bulb to turn on automatically when someone enters the house. The miner can give the shared key to each other's direct communication device. The device will immediately communicate after receiving the key and confirming its validity. This strategy offers two advantages. The owners and miners have a list of the devices that share info, which is the first factor. Second, a shared key is used to secure contact between device nodes. Data can be locally saved and authenticated using a shared key without cloud storage. The device must submit a request for a key to the miner, and if the miner has storage rights, he or she will create a shared key and send it along with the device's request. The local storage creates a starting point holding the shared key after receiving the key. Devices can immediately store data in local storage with a shared secret. After getting the monitor transaction, the miner sends the requester the most recent data from the requested device. Until the requester makes a close request to the miner and cancels the transaction, the miner periodically sends the data if the requester can receive it for a certain amount of time. Homeowners can watch cameras or other devices that transmit periodic data thanks to monitoring transactions.

### 4. Smart Cities

One of the important goals of the IIoT is to build an intelligent environment, including providing autonomous machines, known as smart cities. Smart Cities are aimed to combine technology, government, and society to enable the following representative characteristics: smart economy, smart mobility, smart environment, smart people, smart living, and smart governance [11]. Blockchain provides a decentralization platform for building smart cities. For example, the real-time status of on-street parking can be understood through blockchain technology, which reduces parking trouble for the owners and relieves traffic pressure. Additionally, for the time being, there are already many cases in different industries combining blockchain and IoT applications. In the entertainment industry, B2EExpand is the first gaming company on Steam to create cross-game video games based on an Ethereum blockchain. Guts use blockchain technology to create a ticketing ecosystem to eliminate ticket fraud and the secondary ticket market. In the retail industry, Warranter makes it easier for users to access product information and support. In the financial area, Ripple is supposed to be a global payment solution provider by connecting payment providers, banks, companies, and digital asset exchanges for global, on-demand billing. The MedRec Company uses blockchain to record transaction information for patients, facilities, and medical providers in healthcare. It saves time, money, and repeatability between facilities and providers, enabling healthcare providers to access patient records securely. At the same time, they can access their anonymous medical records in large quantities for research. Blockchain has been applied to almost all aspects of people's production and life. The technology is mature in some areas, such as the mobile economy and tracing food sources.

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5. Mobile Commerce

Due to the mobile commerce boom (m-commerce), data security problems are becoming increasingly important and must be addressed. Blockchain as a distributed database was proposed to secure transactions at mobile nodes to support direct device-to-device m-commerce data exchange and sharing. An Android system-based implementation process was introduced in [12]. Blockchain ensures that the data exchange between devices does not need the involvement of any third party. The work in [13] introduced how smart contracts radically and transparently redefine the interactions between interacting parties on a distributed network. A smart contract is first built between the seller and buyer, containing the exact transaction information. Both participants confirm this contract and publish it in the blockchain system. As a result, both get what they want securely with the help of the blockchain.

Here is a table comparing the uses and statistics of IoT, IIoT, and Blockchain technology in the aforementioned fields.

| Field | Use of IoT and IIoT | Use of Blockchain | Statistics |
|---|---|---|---|
| Smart Home | Automated lighting, temperature control, security, entertainment systems, and more | Secure data sharing and privacy protection | The global smart home market is expected to grow at a CAGR of 26.9% from 2021 to 2028, and North America is expected to have 70 million smart homes by 2023 (Source: Grand View Research, Statista) |
| Smart Cities | Traffic management, waste management, energy management, public safety, and more | Transparent and efficient management of public services | Global smart cities market size is expected to reach USD 2.57 trillion by 2025 (Source: Markets and Markets) |
| Mobile Commerce | Online shopping, mobile payments, digital wallets, and more | Secure and decentralized transactions | The global mobile payment market is expected to reach USD 12.06 trillion by 2026 (Source: Mordor Intelligence) |
| Trace of Food Source | Tracking and monitoring of food from farm to table | Verification of food quality and safety | The global blockchain in the agriculture and food supply chain market is expected to reach USD 948 million by 2026 (Source: Markets and Markets) |
| Electric Vehicle Clouds and Edge | Remote monitoring and management of electric vehicles, charging infrastructure, and energy grid | Secure and transparent data sharing and management for charging infrastructure and grid | The global electric vehicle market is expected to reach USD 803.81 billion by 2027 (Source: Fortune Business Insights) |

## IV. CONCLUSION

In this paper, we intend to provide a thorough overview of blockchain for the IoT and Industrial IoT, which has garnered much interest. The combination of blockchain, IoT, and IIoT will be the huge technological leaps that bring significant improvements to various aspects of human life, such as Electric vehicle clouds and edge (EVCE), mobile commerce, food source trace, and so forth, all of which are going to make our society smarter.

The finding suggests that blockchain is a perfect and appropriate concept for advancing IoT and IIoT, which produces transparent, overseeable, secure, and practical industry chains. IoT-distributed apps and new, creative business models are made possible by combining blockchain and IoT. There are many ways to market the IoT and IIoT platforms' features, such as managing food logistics. There are still some issues that will need to be resolved in the future.

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