



# An Overview of Blockchain Technology Use Cases in IoT

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**Abstract:** Since the start of Bitcoin in 2008, blockchain technology emerged as the next revolutionary technology. Though blockchain started as a core technology of Bitcoin, its use cases are expanding to many other areas including finances, the Internet of Things (IoT), security, and many more. Currently, many private and public sectors are diving into the technology. The rapid use of blockchain technology motivates to put an eye on the field of IoT. In this paper, we will study the implementation of blockchain for IoT to enhance its capabilities of IoT. Using this combination we can create many transformations across several industries, paving the way for new business models and novel, distributed applications.

**Index Terms - IoT, Blockchain Technology, Healthcare, Education, Smart Building, Management**

## I. INTRODUCTION

The quick improvement of the Internet of Things (IoT) is beginning to change how we live [1]. As additional actual gadgets like cell phones, wearable gadgets, and vehicles are interfacing with the Internet through installed frameworks and sensors, a lot of information can be gathered and shipped off the distributed computing framework to direct information examination for superior and quicker decision-making [2]. Also, these gadgets can perform commissions and assignments that people cannot achieve. For instance, automated elevated vehicles, otherwise called drones, which are a microcosm of IoT, perform far-reaching exercises from conveying a bundle to following harvest quality and tracking down ranch inconsistencies. Nonetheless, as IoT develops, the network is expanding, and the figuring foundation will turn out to be more intricate, opening up additional weaknesses for the digital assault. A portion of the actual gadgets are situated in unstable conditions and effectively altered by programmers. A greater amount of the information and the activity orders going over through remote sensor organization to the Internet, an untrusted correspondence channel, are probably going to be changed. Additionally, many existing IoT frameworks depend on centralized communication models to connect to servers or cloud computing that help to handle information stockpiling. The issue is that the server will turn into a bottleneck and another objective for digital assault, as well as a weak spot that will upset the whole organization and affect the information honesty. Thus, how to construct genuinely trusted and incorporated conditions to help these associated gadgets and registering foundation to move information remains tested. To tackle the above difficulties, we propose the utilization of a Technology known as BlockChain Technology.

Blockchain (BC) innovation that starts from Bitcoin, the first digital money framework sent off in 2008 [3], can give a powerful answer for IoT protection and security, because of its three central precepts: 1) Information in the blockchain is put away in a common, dispersed and shortcoming lenient data set that each member in the organization can share the capacity to invalidate enemies by tackling the computational abilities of the legit hubs and data traded is versatile to control, 2) Blockchain is decentralized engineering to make the structures vigorous against any disappointments and assaults and, 3) Blockchain depends on the open key foundation which permits the items to be encoded in a manner that is costly to break. With blockchain-based IoT design, all information tasks are straightforwardly and forever recorded. In this way, the trust among gadgets and backend servers can be laid out. The reason for this paper is to concentrate on different areas where IoT and Blockchain together are extraordinary achievements.

## I. BLOCKCHAIN TECHNOLOGY

Right on time in 2008, a “substance” distributed a paper through Satoshi Nakamoto, portraying digital money called Bitcoin [3]. The paper introduced an electronic money framework running over a shared (P2P) network that permits two unique gatherings to trade some digital currency straightforwardly, without utilizing an outsider to intercede in the activity. In Bitcoin, exchanges including two gatherings are made and put away in a block. Subsequently, each block contains a bunch of exchanges. On one hand, these exchanges are coordinated in a Merkle tree through a hash chain. Then again, blocks are requested and successively associated through the past block hash esteem. The blockchain idea depends on this block connect procedure, which contrasts with the hash chain utilized in the Merkle tree [4].

Before a block is embedded into the blockchain, initial an agreement calculation must be executed. Various kinds of agreement calculations may be executed before embedding an exchange in a block, for instance, Proof-of-Work (PoW), Proof-of-Stake (PoS), or Practical Byzantine Fault Tolerance (PBFT). Bitcoin, for instance, utilizes PoW agreement calculation (some of the time called a mining cycle), while BlackCoin [5] gets its blockchain through PoS calculation. BlackCoin utilizes a cycle called printing, rather than mining, to approve exchanges in light of how many coins the friends own. At first, blockchain was utilized as a conveyed public record for digital currencies, for instance, Bitcoin or Litecoin. Nonetheless, of late, new ideas were added to blockchain making its appropriateness more extensive. For instance, blockchains, for example, Ethereum, presented the brilliant agreement idea, which permits a client to compose a piece of code and add it to the blockchain. Besides, concerning application regions, blockchains are likewise being utilized to make a few tasks quicker than they were previously. For instance, the Ripple blockchain [6] comprises a decentralized permission record utilized in the financial framework, and through that, had an impact on how banks are trading cash.

## II. IOT TECHNOLOGY

The Internet of things (IoT) is an exceptionally remarkable stage that is getting extremely famous step by step. The very justification behind this to happen is the headway in innovation and its capacity to get connected to everything. This component of getting connected has in itself given various open doors and a huge extent of improvement. The way that innovation in different fields has developed as the years progressed, is the motivation behind why we notice a quick change in the shape, size, and limit of different instruments, parts, and items utilized in day-to-day existence [7]. The Internet of Things offers us a chance to develop effective organizations, applications for assembling, life-saving arrangements, and legitimate development and that's just the beginning.

The IoT (Internet of Things) is an organization of Internet-empowered objects, along with web benefits that collaborate with these items. Underlying the Internet of Things are innovations like RFID (radio recurrence ID), sensors, and advanced mobile phones. The fundamental thought of the IoT is that practically every actual thing in this world can likewise turn into a PC that is associated with the Internet. To be more exact, things don't transform into PCs, yet they can include small PCs. At the point when they do such, they are much of the time called savvy things, since they can act more brilliant than things that poor person been labeled.

The IoT thought isn't new. Be that as it may, it has of late become pertinent to the pragmatic world, mostly as a result of the headway made in equipment improvement somewhat recently [8].

The mark "Web of Things" was formed in 1999 by Kevin Ashton and from that point forward this omnipresent availability network has cleared its direction into our everyday resides and has been distinctively utilized in genuine applications like protection, medication, industry, horticulture, energy and for the creation of savvy urban areas, homes, and gadgets. The utilization of the web and artificial knowledge it is making our reality more intelligent while limiting manual efforts and being increasingly more human-accommodating. The basic thought of an IoT framework is the exchange of information between machines which are inspired by the state of the art innovations like WSN (Wireless Sensor Networks) and RFID (Radio Frequency Identification) with the utilization of detecting gadgets with effective thinking abilities and wise calculations after which an activity is performed as needs be. IoT frameworks are conveyed effectively by empowering media transmission communication with the web in gadgets like sensors and actuators with capacity and handling segments for fruitful cooperation between machines. With the solace it offers, this new worldview likewise accompanies some protection and security issues that should be rectified for its legitimate usage and working [9]. The Internet of Things (IoT) structures a handling thought that depicts a future where ordinary actual things will be related to the Internet and will be proficient to perceive themselves to different gadgets.

IoT structures a cyclic peculiarity which joins the use of sensors to make an association and sense the client and an organization to speak with an individual as it further totals the norms and gives a machine increased insight which assists it with investigating, acting, and acting as indicated by the circumstance. The activity, creation, correspondence, conglomeration, and investigation of a gadget are the joined capabilities that make it interconnected to IoT by laying out an increased insight for itself and making it a Smart gadget. This IoT cycle works in a cycle with everything related to each other for its effective execution.

### NEED BLOCKCHAIN FOR IOT

In IoT applications, it is compulsory to communicate the information produced by the gadgets or sources to the web. Demonstrating network and inclusion is an overwhelming undertaking for IoT applications. The clients or sellers generally needed to gather information and break down it for additional handling for the better upgrade of their gadgets. It is important to appropriately approach new advances for conveying and handling information. Instead of going to another organization, a superior special organization particularly for its applications would be a decent decision. These days, businesses are effectively elaborate creating wired or remote correspondence channels or conventions. In any case, the expense and framework improvement assumes an essential part in creating innovation for IoT. For papers with over six creators: Add creator names on a level plane, moving to a third line if necessary for more than 8 creators.

RFID chiefly focuses on Near field correspondence and Radio-Frequency identification. In the most recent twenty years' different organizations are frantically dealing with the Internet of things.

As the fundamental guideline of IoT includes associating gadgets, it makes all that addressable and locatable which thus makes our life more straightforward [10]. Nonetheless, making everything associated with the web opens the entryway for programmers. Without appropriate confidence about protection and security, the client won't be drawn in towards IoT. Thus, it should have major areas of strength for managing security, and a portion of the issues that IoT could confront are recorded beneath. The essential issue the IoT confronts is unapproved Access to RFID. The RFID labels can contain any kind of data and an RFID tag can be effectively modified or perused by the peruser. This opens an entire bundle of danger for the client as the information can be handily gotten to by a lowlife peruser. Remote sensor networks' security break sensors hub in IoT is bidirectional. Obtaining information is likewise conceivable other than transmission. In this situation, a portion of the potential assaults remembers altering where the information for the hub can be extricated or modified. Next fooding makes a ton of issues in IoT.

Blockchain (BC) innovation that starts from Bitcoin, the first cryptographic money framework sent off in 2008, can give a compelling answer for IoT protection and security, because of its three central principles: information in the blockchain is put away in a common, disseminated network, Blockchain is decentralized engineering to make the models vigorous against any disappointments and assaults and, Blockchain depends on the open key foundation which permits the items to be scrambled in a manner that is costly to break.

### 1. REAL-TIME IMPLEMENTATIONS

Blockchain at first arose as an empowering agent in monetary installments utilizing Bitcoins, and Ethereum. Be that as it may, the most recent couple of years has seen its applications in different areas also like Supply chain the board, and for keeping up with computerized personalities, and some more. A few ongoing works have perceived how Blockchain can be joined with IoT for working on the framework of IoT gadgets.

#### a. Trustworthy Management in Decentralized IoT Application using Blockchain.

It was broken down that the IoT application like protection, store network framework, brilliant city, and savvy vehicle endured trust issues among related clients is a significant issue. The ongoing unified framework doesn't give sufficient trust between clients. Utilizing Blockchain innovation the creators have demonstrated the way that trust issues among clients can be overseen in a decentralized manner so data can be discernible and recognized/check at any time. Blockchain has properties like circulated, carefully shared, and unchanging which improve security. For Blockchain execution, the Ethereum stage is utilized [11]. The application-wise IoT is the ongoing most broadly taken on innovations. The IoT is accustomed to checking the climate, and controlling what is happening, even in some basic areas like patient observing cases, and quake identification. However fundamental security and protection issues are tended to by the various scientists for low-end IoT gadgets. Trust the executive's issue is one of the major in certain applications. At the point when various exchanges and handling are finished in an organization trust of the executives should be kept up. In this paper, creators have thought about the protection area for instance. The creators have proposed the arrangement utilizing the idea of Blockchain innovation which gives trust among every one of the related hubs. As displayed in Fig.1 every individual from the framework is associated with the Blockchain framework. Patients, Insurance organizations, and hospitals can enroll in the Blockchain network utilizing the verification cycle in the Ethereum stage. The shrewd agreement has been customized in strength, which is an item situated programming language for composing the condition for the client. The shrewd agreement is sent to the Ethereum Blockchain organization. The shrewd agreement is an auto executable code that runs consequently when the information esteem coordinates with the condition and triggers the relating occasions. For Implementation reasons, one top-of-the-line framework is utilized to make the Ethereum stage. Utilizing the novel location from the Ethereum stage three hubs are made a patient, protection, and clinic. can be laid out among every one of the elements. The savvy contract for every one of these three substances is composed and sent in the Ethereum stage. anything that exchanges is finished between the element is recorded utilizing the Blockchain innovation and divided between all the client-making framework trust. Every one of the exchanges is send utilizing the computerized signature and public key and confidential key idea to make the framework sealed. Every one of the exchanges is approved utilizing the advanced mark. Utilizing the Blockchain innovation and Ethereum stage with the assistance of shrewd agreement in an IoT application trust.

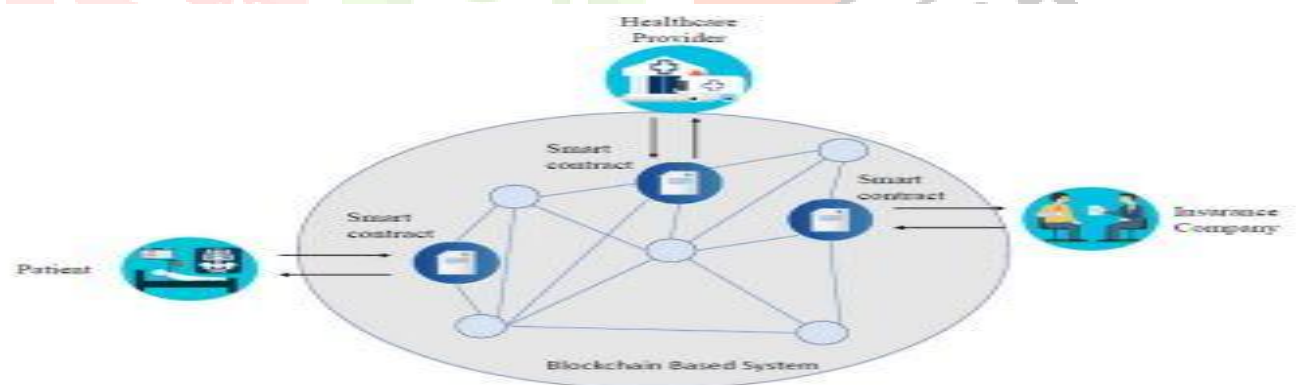


Fig.1 Blockchain-Based System [13]

#### b. IoT and Blockchain in Healthcare

It is a direct result of late IoT improvements, clinical gadgets have known an outstanding development over the most recent couple of years. Today, a huge assortment of IoT clinical gadgets and wearables are accessible on the lookout. They are utilized to gather, treat and offer well-being information to the clinical group. Nonetheless, due to depending on an incorporated model in light of a client-server design, the utilization of such gadgets opens delicate information to be controlled by third substances. This raises security and protection issues in regards to the control of the patient's information and can prompt a weak link.

Protection and Security are quite possibly the main issues these days in the scholarly world and industry. Because of the asset requirement component of IoT, it is not appropriate to existing security arrangements. The proposed engineering answers a large portion of the security and protection dangers while considering the asset imperative component of IoT. In this paper, the creators presented an original crossover approach that joins the upsides of the confidential key, public key, blockchain, and numerous other

lightweight cryptographic natives to foster a patient-driven admittance control for electronic clinical records, equipped for giving security and protection [12]

### c. *Blockchain and IoT in Higher Education*

Building the creative blockchain-based engineering across the Internet of Things (IoT) stage for the schooling system could be a captivating component to support correspondence productivity inside the 5 G organization. Remote systems administration would have been the primary exploration region permitting individuals to convey without utilizing the wires. It was laid out toward the beginning of the Internet by recovering the website pages to associate starting with one PC then onto the next PC. Moreover, high velocity, clever, strong organizations with various contemporary advances, like low power utilization, etc, seem, by all accounts, to be accessible in this day and age to associate among one another. The expansion of mist highlights on actual things under IoT is permitted in this present circumstance. One of the intricate errands all through the area of versatile interchanges is to plan another virtualization structure given blockchain across the Internet of Things design. The objective of this exploration is to interface another review for a schooling system that contains Blockchain to the web of things or keeping things cryptographically secure on the web. This examination consolidates with its improved blockchain and IoT to make a productive connection framework between understudies, educators, businesses, designers, facilitators, and accreditors on the Internet. This predefined structure is a point-by-point exploration's incredible estimation proposed research shows a mix of the IoT and blockchain for the school system. The Blockchain is utilized to make a hyper-disseminated public credible record to record the exchanges. The examination opened another open door around here. The structure is carried out utilizing an alternate arrangement of IoT hubs and tried. This study can be a significant structure to further develop correspondence security and effectiveness in the school system. This structure is proper for giving correspondence security where colossal information is sent in a heterogeneous climate later on. Creators have tried the framework in various situations like memory and processor utilization in the coordinated framework and its effect on the exhibition of generally the framework. They tracked down that the proposed structure, builds the throughput, as well as the immediate association among IoT hubs, are laid out which makes the framework more steady. The results of this exploration laid out another IoT structure with blockchain innovation for the current school system [13].

## 2. *Integrated IoT and Blockchain Platform for Sensing Data Integrity*

With the quick improvement of communication technologies, the Internet of Things (IoT) is escaping its earliest stages, into complete development, and will, in general, be created in a dangerously fast manner, with an ever-increasing number of information communicated and handled. Subsequently, the capacity to oversee gadgets sent overall has been given more and high-level prerequisites in down-to-earth application exhibitions. Most existing IoT stages are exceptionally unified models, which experience the ill effects of different specialized constraints, for example, a digital assault and weak link. Another arrangement course is vital for improving information getting to while managing it with government orders in protection and security. In this paper, a coordinated IoT stage utilizing blockchain innovation to ensure detecting information uprightness is proposed. The point of this stage is to bear the cost of the gadget proprietor a reasonable application that gives a thorough, unchanging log and permits simple admittance to their gadgets sent in various spaces. It likewise gives attributes of general IoT frameworks and takes into consideration constant observing and control between the end client and gadget. The business rationale of the application is characterized by the brilliant agreement, which contains rules and conditions. The proposed approach is moved by a proof of idea execution in reasonable IoT situations, using Raspberry Pi gadgets and a permissioned network called Hyperledger Fabric. In conclusion, a benchmark concentrating on utilizing different execution measurements is made to feature the meaning of the proposed work. The examination results show that the planned stage is appropriate for asset-compelled IoT engineering and is adaptable to be reached in different IoT situations. Albeit the coevolution of blockchain and IoT research studies is still in its earliest stages, this work investigates the expected uses of IoT and blockchain to further develop proficiency and bring computerization, to upset vigorous business arrangements in different IoT situations [14].

### *Conclusion: IoT and Blockchain in system design of Smart Building*

The authors examined the utilization of coordinated BIM, IoT, and blockchain advances in the framework plan of a smart building. The creators consider these advancements as integral improvements that can cooperate empowering secure capacity and the executives of information and data connected with the structure-activity and working on gave IoT administrations. The creators accept the proposed plan can be taken on in numerous classifications of public and confidential structures where the proficiency of development, well-being of people and resources, and security of information and data are profoundly significant. At last, the creators accept that coordinated BIM, IoT, and blockchain advancements make an imaginative system supporting computerized change in the development business [15].

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