A Survey on 5G Enabled IOT in Blockchain

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ABSTRACT

Blockchain, IOT and 5G are 3 distinctive buzzwords in today's high-tech world. Amalgamation of these 3 together can lead to solving complex and multifarious problems. Security is a growing concern and is the need of the hour for industries across the world in all domains and blockchain can be a big step towards tackling the security challenges faced these days. Also, as the speed of transmission grows (fast data travel) with the implementation of technologies such as 5G the security concerns will only grow. This is where blockchain can be coupled with 5G and a fast and secure network can be established amongst devices. Wide range of devices including Sensors, Smart watches, Virtual assistance and a host of other devices that we use in our day to day lives can be used efficiently with Blockchain and 5G. Data transfer between these devices can most likely change the way - for the better - communication between the devices is experienced today. There are a few domains in IOT which can be improvised using the combination of blockchain and 5G enabled IOT technology. Motivated by these possible advancements, we present a comprehensive study of blockchain applications in 5G enabled IOT.

KEYWORDS

Blockchain, 5G, Internet of Things, Smart devices, Healthcare, Industrial Automation, Vehicle automation.

INTRODUCTION

In this technologically advanced era, Blockchain, though it is still in its infancy, has started establishing its firm footing. A blockchain is a public digital ledger of transactions that records information in a way that makes it difficult to hack or alter. It is a decentralized and distributed data structure**.** Decentralization eliminates the possibility of single-point failure. It's based on a peer-to-peer system. The data is organized into blocks, which are then chained together to produce a linked list-like structure. The openness of blockchain has made it very popular. The 5G network will pave new and efficient methods in the upcoming years. Combined with the secure connected networks using blockchain, 5G will provide seamless connectivity for IOT devices. 5G promises a more IoT friendly ecosystem, with vast improvements over the current capabilities of the 4G. Not only will it allow extremely fast data speeds, such as to render 4G as sluggish, 5G also means latency of a mere 1 millisecond. It means, one can download an HD film in seconds. Compared to the 4G LTE, it will be able to embrace up to 100 times more connected devices per unit area. Which means that it will provide all requirements that seem necessary for an IOT system to be functional and become more prominent. The idea behind IoT is to have

multiple connected devices gathering data in real time over a particular period[2]. However, the continuous exchange of data puts a strain on the network and the battery life of the devices. Thus, with the seemingly fast 5G network and its capability to handle vast amounts of devices will help grow IOT[6].

BLOCKCHAIN IN 5G-ENABLED IOT

IoT refers to a network of numerous electronic or electrical devices that may communicate with one another through any open channel, such as the Internet. Sensor networks, radio frequency identification (RFID), near field communication (NFC), M2M, and ZigBee are all used to make this connection[3]. Then, with a plethora of industrial applications constructed with various sorts of sensors, the Internet of Things changed the area of ubiquitous computing[4]. However, there are a few constraints that must be overcome in order for it to progress into a more efficient system. The main setback for the IOT is its existence over an open network such as the internet which brings a question to the privacy and security of the data being transmitted[14]. As the number of IoT-enabled devices grows, a technology that can efficiently support such large amounts of data transmissions at exceptionally high bandwidth is required. Furthermore, the devices must be capable of handling these configuration modifications, such as increased bandwidth capacity, higher data rates, and lower latencies. The introduction of faster wireless technologies, particularly 5th generation wireless systems (5G), is propelling 5G-enabled IoT applications forward[7]. It also aids in the management of a large number of IoT devices. Massive-Input Massive-Output (MIMO), which helps to attain network capabilities beyond present 4G LTE, as well as "small cells," which allows for a more compact network infrastructure, are included in the term 5G. In comparison to current 4G technology, which uses frequencies below 6 GHz, 5G networks may support frequencies ranging from 30 GHz to 300 GHz. This pervasive connectivity is a stepping stone toward improved availability, which has been a goal of the cellular system since its creation. As a result, 5G technology becomes a critical enabler for IoT. As a result, it works in tandem with IoT to enable better data rates, lower latencies, lower energy consumption, and greater scalability[6]. The use of blockchain technology to improve security and privacy is a potential option. With an open, trusted, and auditable sharing platform, blockchain has the potential to revolutionize IoT[1]. Any information transmitted will be reliable and traceable.

BLOCKCHAIN DEPLOYMENT IN 5G-ENABLED SMART AUTOMATION

Smart city, Smart Home, Healthcare 4.0, Industry 4.0, Agriculture, Autonomous cars, and Supply chain management are among the areas of interest for blockchain-based applications in 5G-enabled IoT[18]. Blockchain and 5G are employed in all of these applications to improve security, expand bandwidth, and lower total operational and capital expenditures, respectively. The subsections that follow provide a full discussion of these applications.

SMART HOME

A smart home is a technologically enhanced living environment that attempts to improve the residents' quality of life. It gives the owners security, convenience, and comfort by allowing them to control the configurations via a smartphone application. Smart home systems employ the Internet of Things to communicate with gadgets and automate certain operations depending on usage statistics, allowing customers to receive real-time, uninterrupted services tailored to their interests. The following elements make up a smart home's general infrastructure: network connectivity (typically Wi-Fi), IoT-enabled sensor devices, and a smartphone app for remote access. Smart lighting, smart door locks, smart thermostats, video surveillance, and smart parking are just a few of the vital services supplied by smart homes[19]. These various services must continuously share essential information in order to coexist successfully and deliver the greatest possible experience to the individuals who live within it. A smart door lock is a necessary component of any smart house.

Its major goal is to keep unauthorised people out of the house. The information about the residents is maintained on a central server, which only enables white-listed people into the house. However, any intruder attempting to defeat the lock mechanism to obtain illegal access to the system could falsify the data handled by such a system. A blockchain-based smart door lock system that provides security characteristics such as authentication, data integrity, and non-repudiation could address this issue. The information regarding transactions using open/lock commands was kept in the blockchain network blocks[13]. The blockchain network's immutability makes it hard for an attacker to obtain illegal access to the system and change previously completed transactions. The latency of IoT devices (sensors) can, however, be a stumbling block in detecting any form of intrusion. This problem can be solved by implementing 5G wireless technology, which offers low latency, quick intrusion detection, and block mining of blockchain transactions[18].

SMART CITY

The rising trend of people migrating to cities, together with the associated process of urbanisation, generates a slew of difficult challenges for cities' general infrastructure and their ability to serve citizens with fundamental needs such as water, energy, transportation, and healthcare. Climate change, population expansion, and resource scarcity are all contributing to this unprecedented urbanisation. The concept of a "smart city," which ensures an optimal and effective usage of available resources by making use of technology such as IoT and cloud computing, is a proactive reaction to these difficulties. The intelligent parking system is a critical component of a smart city, as it aids in the development of traffic management systems and reduces the cost of recruiting qualified personnel. The goal is to reduce the number of times users are unable to find a parking spot while also lowering the average time users spend waiting for a parking spot. Certain security elements, such as a long waiting period and real-time deployment, are missing. The use of distributed ledger technology may be able to improve the security of such smart systems[20]. The information collected from IoT sensor devices is a crucial aspect to consider while thinking about smart cities.

This data is at the heart of constructing a smart city and is critical for designing the smart city's overall architecture. However, as the number and variety of IoT devices grows, the volume of data generated grows exponentially[2]. The present centralised communication approach, known as the client/server model, allows data to be stored on a central server, but it is inefficient as faster automated communication between IOT devices becomes difficult. A simulated Ethereum-based ecosystem can be proposed, in which blockchain is an efficient solution for IoT-based large-scale data management systems.

HEALTHCARE

Healthcare is one of the most important aspects of any country's overall growth. It can be viewed as a barometer of a society's overall health. The pressure on modern healthcare systems has increased in recent years as the population and disease issues have increased. 5G-enabled IoT is being looked at as a possible option to relieve pressure on the healthcare system. Remote health monitoring is one of the options, which entails using IoT sensor devices to remotely measure and analyse a user's health metrics[12]. The gathering of digital versions of patients' health information is known as electronic health records (EHR). In contrast, a personal health record (PHR) is a digitised record of a single patient. EHRs allow for secure, real-time sharing of patient medical and treatment histories with authorised medical personnel. MedRec, a decentralised record management system based on blockchain technology, has been suggested to handle EHRs[17]. It manages sensitive data and important factors including authentication, confidentiality, accountability, and data exchange. It encourages medical stakeholders including public health authorities, academics, and clinicians to join the blockchain network as miners in order to receive specific benefits. Certain other proposed systems necessitate data from multiple EHR and PHR, as well as

access to smart city data and infrastructure via technologies such as IoT and 5G, in order to provide citizens with meaningful real-time feedback. Because of the platform's trustless environment, a secure middleware was no longer required as the security issue was being addressed by the blockchain.

INDUSTRY 4.0

Automation of all industrial and business processes has become a reality. Massive technological advancements and their use in industry have resulted in the formation of Industry 4.0, a new approach to manufacturing and industry MO. It attempts to bring together the strengths of several technology sectors, such as the Internet of Things (IoT), Blockchain, and Cyber-Physical Systems (CPS). IoT is projected to bring promising revolutionary solutions to existing industrial systems as part of Industry 4.0. As a result, it is regarded as a critical enabler for the next generation of advanced industrial automation. Because of the fierce competition in the market, firms will go to any length to get a competitive advantage. This forces Industry 4.0 business process management systems to digitise and automate company processes in order to enhance revenues[8]. However, by incorporating autonomous agents into these commercial processes, the related transaction costs and hazards rise. One way to mitigate these hazards is for each agent to communicate directly with one another. It solves the problem of autonomous agent's transaction costs. However, there is a matter of trust between the agents involved. The usage of decentralised systems (blockchain technology) for efficient and safe communication between autonomous agents in a multi-agent system is highly recommended to address all of the aforementioned shortcomings. Real-time Quality of Service monitoring is also an important aspect of today's business processes. As the number of services available grows as a result of IoT and cloud technologies, it becomes more difficult to choose the most appropriate service for an efficient business process Composition of work flows. The QoS blockchain requires information to be updated in real time. In this case, the timely execution of a smart contract allows for real-time chaining of a new block to the main blockchain. UNCHAINET is a blockchain-powered heterogeneous cloud architecture that connects unused data resources with clients who require them. Furthermore, clients with excess processing capacity can earn UNET tokens by allocating their underutilised resources to the Unchained network. The purpose of the 'QoS chain' is to validate the network providers' quality, throughput, and reliability. It improves service quality, allowing Unchained to be adopted on a big scale.

AGRICULTURE

Smart agriculture makes use of cutting-edge technology like IoT, GPS, and Big Data to boost the quality and quantity of agricultural goods. Temperature, light, soil moisture, and humidity data can all be recorded in a central control system and analysed with AI algorithms. The integration of multiple technologies in smart agriculture aims to reduce the cost of the agricultural supply chain while maintaining product quality. DLTs (Distributed Ledger Technologies) are thought to have the best chance of increasing the efficiency and transparency of these agricultural supply networks. The most important benefit of DLTs is improved traceability[9]. Because agriculture and food supply chain are complimentary features, where agricultural end-products are virtually certainly employed as inputs in various multi-agent distributed supply chains, the usage of blockchain in agriculture is focused on food supply chain. The consumer is frequently the final client in such food supply chains. Food security may be jeopardised as food supply expands, necessitating a proper food traceability system capable of monitoring food quality and safety along the whole agricultural supply chain. Automation of irrigation systems combined with thermal imaging has been proposed as a feasible method for smart irrigation, which monitors soil water levels and controls irrigation actuators[9]. It is a step forward from the current planned irrigation, resulting in a more controlled use of water.

AUTONOMOUS VEHICLES

The expansion of Intelligent Transportation Systems (ITS) has been challenging, thanks to rapid technological breakthroughs in sensing, communication, analysis, and processing. Smarter, safer, and more convenient transportation facilities and services are now possible thanks to ITS[16]. However, one important security concern associated with ITS is its inclination toward centralization, which could result in centralised authorities becoming temporarily unavailable due to hostile external attacks. Furthermore, a lack of proper trust among ITS agents must be addressed. One of the blockchain's uses is real-time ride-sharing, dubbed a "block chained version of Uber," with the goal of creating an open-source, decentralised ride-sharing network to compete with existing private transportation services. The benefits of decentralised apps include eliminating the central system's undesired decisions and hazards, such as surge pricing and privacy leaks. Self-driving automobiles are becoming increasingly common as time goes on. Sensors in self-driving cars collect a lot of data, such as temperature, traffic, weather, GPS location, and so on. It takes a lot of energy to generate and assimilate such a large amount of data. In order to deliver optimal services, such automobiles rely substantially on real-time data transfer[7]. With high-speed connectivity and minimal latency, however, these intelligent automobiles will be able to collect all kinds of data, including time-critical data, on which algorithms may work to maintain track of the car's operating status and enhance future designs automatically with the intervention of 5G enabled blockchain.

LOGISTICS & RETAIL

5G connectivity will enable advanced IoT tracking sensors, which might completely revolutionise logistics operations[18]. Not only will fast speeds and low latency allow for real-time data collection, but the energy efficiency will also allow for the collection of data of a more diverse kind at all locations along a supply chain and over a lengthy period of time[4]. A customer would be able to see where the fish she just bought was caught, what temperature it was kept at during transportation, and when it was delivered to the shop. As retailers strive to shape customer involvement and experiences through mobile phones, the arrival of 5G and blockchain will have a favourable impact on IoT for Retail[7]. With better connectivity and a bigger number of devices linked to the network, they will be able to communicate with customers more quickly thanks to improved digital signage. Augmented Reality and Virtual Reality will grow more popular as new and novel means of client involvement emerge. Retailers will be able to improve the shopping experience by using more effective omnichannel retail methods.

UNMANNED AERIAL VEHICLES

An unmanned aerial vehicle (UAV), commonly known as a drone, is an airborne system or aircraft that may be controlled remotely by a human or autonomously by an on-board computer. UAV photographs can be used in a variety of industrial applications, including urban modelling, surveillance, large-scale mapping, distribution, communications and media, search-and-rescue operations, and agriculture. Several military groups and private organisations use unmanned aerial vehicles (UAVs). To be remotely accessible, the majority of commercial UAVs rely on Wi-Fi connectivity[10]. Wi-Fi connectivity, on the other hand, is insufficient for communication outside the visual line of sight (LOS). Instead, ubiquitous mobile networks like 5G can be employed to run them outside line-of-sight communication. Furthermore, they provide wide-area, high-speed, and secure wireless connectivity, which can increase the device's control and security. A significant range of assaults are directed towards such UAV networks, with the goal of jamming the communication network, injecting fake data, and interrupting network operations being just a few examples[15].

To protect UAVs against external cyber threats, a cyber-security system based on Intrusion Detection Systems (IDS) could be quite useful. Every UAV in this paradigm can keep an eye on

its peers' actions. If an IDS agent is suspected of being malicious, it cannot function as a monitoring node. It is challenging to manage strong encryption, which is typically used to safeguard data links. To address the issue, encryption capabilities must be streamlined so that data may be distributed to predetermined operating areas. It allows the UAV to focus on other activities such as validating users, transmitting critical information, or making operational changes to the path. Crowd surveillance is another application for UAVs[15]. Using Open-Source Computer Vision (OpenCV), create a UAV-based crowd monitoring model that uses facial recognition. When UAVs are connected with remotely controlled IoT devices in this approach, they can provide a variety of value-added services (VAS). UAVs can offer extreme real-time video surveillance and streaming when combined with more modern communication protocols such as 5G networks. Furthermore, unmanned aerial vehicles (UAVs) can be employed as a backbone to support 5G coverage.

Applications	Author	Year	Merit	Demerits
Smart Home	Roshan et al.	2016	Extensive study of challenges for IoT adoption in India	Ignored any potential solutions to the risks discussed.
	Dorri et al.	2017	Significant security and privacy benefits.	Added energy and time overheads.
Smart City	Pham et al.	2015	Proposed model implemented in real	Overlooked the Security aspects.
Healthcare	Cenedese et al.	2014	One-of-its-kind record management system, which handles sensitive medical data.	Limitations regarding privacy, while auditing
	Baker et al.	2017	Extensive discussion about wearable healthcare systems.	Perceivable impact of motion on sensors, which may hinder the purpose of these wearables
Industry 4.0	Viryasitavat et al.	2018	Service selection and composition in Industry 4.0	Proposed QoS blockchain is incapable of detecting transaction frauds
Agriculture	Kamilaris et al.	2018	Extensive survey of blockchain initiatives, in relation to agricultural sector	Detailed explanation of agricultural supply chain was missing.
Auto. Vehicle	Yuan et al.	2016	Case study of La'zooz.	Issues and challenges of the model were not discussed
UAV	Kapitonov et al	2017	Secure communication system within a multi-agent system.	Issues of AIRA protocol were not discussed.

Table 1 *Survey of existing approaches for different applications of Blockchain in 5G Enabled IOT*

CONCLUSION

End users will benefit from 5G services in the future, and the integration of blockchain with IoT devices will be a game changer. We provide readers with information regarding the industrial uses of blockchain in 5G-enabled IoT devices in this article. The discussion is organised into three parts: the background of blockchain, IoT, and 5G is briefly reviewed first, followed by industrial applications. Finally, open difficulties and challenges for industrial applications have been addressed. The deployment of the technologies discussed in this paper on a common platform is still a long way off due to high-end hardware requirements and a lack of compatibility for

high network connectivity. This work has addressed the majority of industrial applications, where blockchain will be utilised to ensure data security and flow more quickly. However, in addition to small-scale development and deployment of individual applications, a significant amount of technological research is required to solve the special demands associated with the collaboration of various technologies. Finally, on the basis of particular factors, a comparative analysis of existing blockchain-based industrial applications is undertaken. In the future, we want to focus our discussions solely on healthcare and propose a blockchain-based, safe healthcare system.

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