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Study the Blockchain-Based AI Data Security in 6G Networks

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The deployment of 6G networks has been anticipated to revolutionize the connectivity landscape by enabling previously unobtainable data transmission rates as well as capabilities. It is of the highest priority to maintain strong data security in light of the growth of applications that use Artificial Intelligence (AI). With reference to 6G networks, this research investigates feasibility of combining Blockchain Technology (BT) with data security procedures that are driven by artificial intelligence. Specifically, the study studies the inherent weaknesses that are present in traditional data security protocols and investigates the potential of BT to strengthen security frameworks that are driven by artificial intelligence. The strategy that has been presented attempts to improve data integrity, confidentiality, and accessibility in 6G networks by utilizing immutable along with decentralized properties of BT. This paper investigates several blockchain-based consensus mechanisms, smart contract features, and cryptographic methods to improve data security in 6G settings via a comprehensive examination.

Keywords: Blockchain Technology, Artificial Intelligence, 6G network, Security.

1. Introduction

The recording of information causing it difficult to alter, manipulate, or else hack the system has been part of blockchain technology [1,2]. Implementation of authentication is an intriguing feature of BT, that results in the creation of a system that incorporates many levels of security as well as authentication [3]. Blockchain-based methods could be utilized to address authentication issues employing distributed ledger technology [4-6]. However, a substantial amount of work remains there that has to be done to aid with machine learning (ML) models that can anticipate impending assaults or security concerns [7]. Similarly, applications running on cellular networks and 6G networks have different vulnerabilities that must be fixed by implementing multifactor authentication techniques on the basis of BT [8]. Both of the aforementioned applications are highly vulnerable to encryption, hostile conduct, along data transfer because they primarily rely on AI Visible Light Communication (VLC) technology,

that may be a major cause of difficulties [9,10].

5th generation (5G) wireless networks will be commercially deployed worldwide beginning in 2020. Investigation as well as expansion of 6th generation (6G) wireless communication technology has been now underway in academia, business, as well as governments. This technology would be needed to satisfy requirements of networks in future in 2030 and beyond [11]. Superior network speed, very low communication latency, and deeper coverage are the primary characteristics of 6G networks in contrast with 5G networks. 6G networks would make full use of the millimetre wave, terahertz, and light wave portions of the ultra-high frequency wireless spectrum. 6G networks would combine technologies like satellite Internet, microwave networks, as well as terrestrial mobile communications to create a green network that can sense data intelligently, assess security in real-time, cover space and earth in coordination, and facilitate group collaboration of all things [12-14]. As the network enters the 6G era, it will face increased performance demands and application situations. In the 6G era, a fully covered and versatile network would be developed using an integrated air-space-ground communication technology [15]. However, 6G networks face greater demands for latency, bandwidth, connection density, flexibility , along with security due to a variety of utilization as well as communication scenarios, more heterogeneous network service , connections needs for excellent efficiency [16-18]. Fig. 1 depicts several concerns that the least futuristic 6G implementation should address.

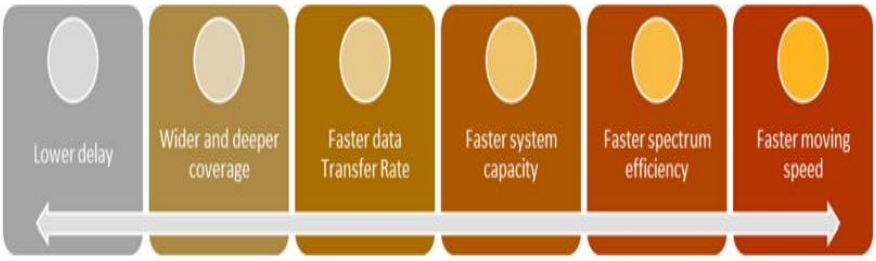

Figure.1 Different aspects that are covered by 6G [19].

AI is gaining more and further significance in this age of 6G technology [20]. The foundation of artificial intelligence is the mining of huge data for training and learning purposes, the constant improvement of processing power to handle increasing transmission rates, and the acquisition of more flexibility via continuous learning. Massive device connections and exponentially increasing data traffic will be difficult for 6G networks in the future. The complexity and latency overhead associated with managing and controlling these enormous data sets in real time has been destined to be significant. A major difficulty for 6G networks is how to dynamically assign wireless resources, precisely monitor and regulate network resources, and effectively perceive service characteristics. 6G networks might be capable to manage and govern enormous amounts of wireless big data because AI is used at both the application and network layers, making the network smarter and more automated [21,22]. This is how the rest of the paper is organized. An overview of 6G cellular network has been provided in Section 2. In addition, Sections 3 and 4 of this study is an overview of BT and AI. Section 5 gives a comparison of previous work and section 6 gives addition of BT as well as AI for wireless communications. In Section 7, the paper has been concluded.

6G Cellular Network

Most nations in the globe are still stuck in the implementation of 5G technology with the scientific community debating the possibilities and opportunities that can arise with the materialization of 6G technology. The majority of academics, however, believe that the Internet of Everything (IoE) would be able to take off after 5G and Beyond 5G (B5G) technologies are completely implemented, which would justify the large demands for 6G [23,24]. Communication between linked devices, or thing-to-thing connection, would take centre stage in wireless technology's next generation (6G), as opposed to people-to-people connectivity, which was the focus of 1G-4G and 5G, respectively (Fig. 2) [25,26].

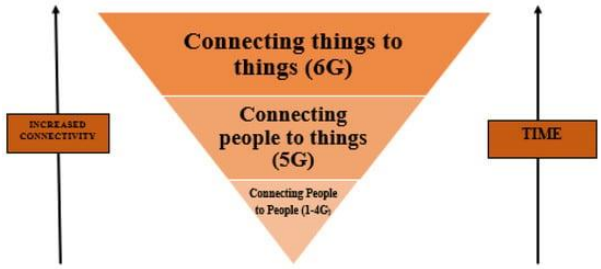

Figure. 2 Evolution of the Internet

Research on the internet is going to face significant shifts and problems shortly as a consequence of growing population who are connecting to the Internet and the enormous several devices that are linked to the Web. To address the issues that are brought about by 5G mobile communication, the research groups are actively exploring possibilities to find solutions. By the time 6G becomes a reality, it is anticipated that a significant number of these difficulties will have been resolved [27,28]. The applications and communication technologies which may be available with 6G network are revolutionary as well as powerful; nonetheless, there can be a great deal of special vulnerabilities. These applications would provide challenges in the areas of access control, communication, malicious behaviour, authentication, along with encryption (for an illustration of these challenges, see Fig. 3 below).

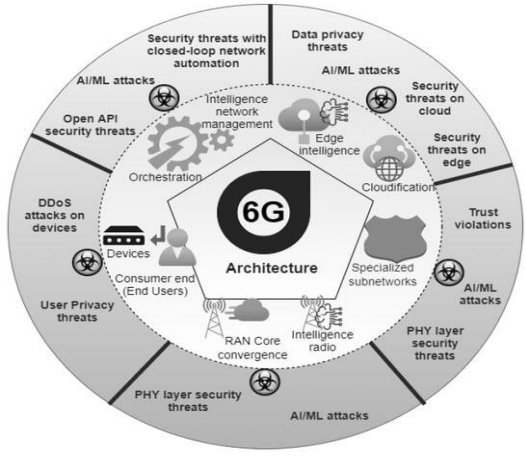

Figure. 3 Privacy and security concerns with 6G networks

This figure shows that 6G would enable AI and ML-powered autonomous systems, as well as applications built on technologies like molecular communication, THz, quantum communication, distributed ledger technologies primarily based on blockchains, etc. Blockchains and DLT are currently using multistep or multifactor authentication, so they can be pretty secure. AI applications, on the other hand, might have problems with malevolent behaviour, communication, and encryption owing to the large amounts of data sent.

Overview of Blockchain Technology

Block chains are distributed ledgers in which data is recorded, stored, and controlled over peer-to-peer network of individual computers. It has been a string of blocks that cannot be changed, have their timestamps verified, and are connected to one another utilizing cryptographic hashes. A unique code or hash value that relates to data that had been previously contributed to a block has been comprised in every novel block that is added at end of chain. One-way encrypted hash algorithm yields this corresponding hash result. Each network node has 2 keys: data has been encrypted utilizing a public key prior to transmission, as well as a private key that allows you to read and decode messages. It's the kind of cutting-edge innovation that could notably impact modern digital age. It implies transactions can be conducted in an open, efficient, and safe manner, without requiring a third party to act as an intermediary. Because blockchain has been a consensus-based system, transactions cannot be completed until more than half of participants, or else nodes, have given their agreement [30]. However, all blockchain transactions are public, if the information involved is very sensitive, only certain parties are allowed to see the details of the transaction. BT now has many potential uses in many different fields, including finance, cryptocurrency, smart contracts, voting, and more.

Classification of BT

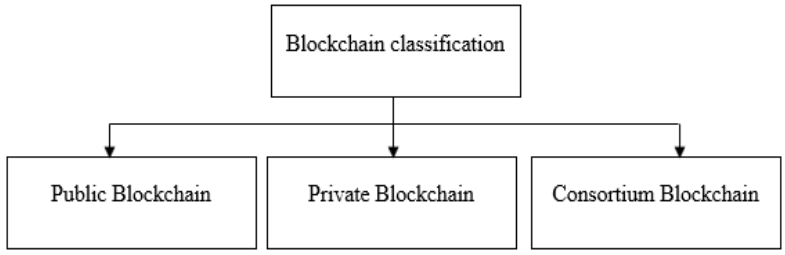

Figure. 4 Illustrates the difference between public, private, and consortium blockchains based on several parameters [31].

Public Blockchain

Public blockchain has been a platform which offers individuals from all organizations along with professions to transact, join, generate. There are no constraints on any of these variables. As a consequence, these blockchains are often known as 'permission-less' blockchains. Each user has unrestricted access to the whole blockchain and can inspect any transaction, conduct any audit, or look at any section at any moment. There are no central authorities or validator nodes in a blockchain system. Anyone can join the network, gather transactions, as well as start mining process to get mining rewards.

Private Blockchain

A BT that has been designed to allow for the secure and confidential transfer of information inside a single or between numerous organizations, with the mining power vested in a central authority or a small number of trusted users. It is also known as a permission blockchain because no one can join without first being invited. Depending on type of node, either a set of rules or network administrator controlling access.

Consortium Blockchain

Consortium blockchains may be thought of as kind of permissioned or semi-private blockchain where consensus as well as block validation have been handled not through a central authority but by a network of trusted nodes selected in advance. These hubs are in charge of vetting potential miners and network participants. For block validation, a multi-signature approach has been employed, whereby a block has been only taken into consideration valid if it has been signed by these users. As opposed to entirely centralized private blockchain along with completely decentralized public blockchain, this system is only partly decentralized since it is controlled by a subset of validator nodes [32]. Their distinctions and peculiarities are listed in Table I.

Table.1 Classification of blockchain and their characteristics

	Public	Consortium	Private
Participants	Without permission • Anonymous • Could be malicious	Permissioned • Identified • Trusted	Permissioned • Identified •Trusted
Consensus mechanisms	Proof of work, proof of stake, etc. • Large energy consumption • No finality • 51% attack	Voting or multi-party consensus algorithm • Lighter • Faster • Low energy consumption • Enable finality	Voting or multi-party consensus algorithm • Lighter • Faster • Low energy consumption • Enable finality
Transaction approval frequency	Long Bitcoin: 10 minutes or more	Short 100 ms	Short 100 ms

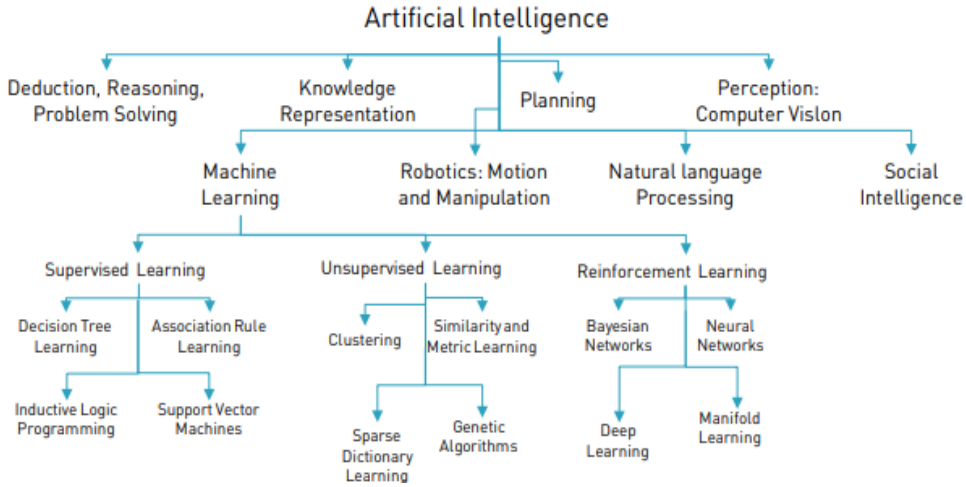

Figure.5 Significant AI and ML methods and fields [36].

Characteristics of AI

In this section, they will talk about some of the most significant aspects of artificial intelligence, such as environmental perception, data driving, uncertainty, along with scalability.

1. Data Driving: Artificial intelligence is now in process of completing the technological leap from AI-driven knowledge expression to AI-driven knowledge learning powered by big data. AI can readily benefit from the increase in the quantity of data and processing as it rarely requires human engineering [37]. For instance, An information-driven ML network simulates function by considering function to be performed as an impenetrable black box, replacing it via an ML network, subsequently connecting input as well as output utilizing a mountain of training data.

2. Uncertainty: There is a great deal of mystery around AI because, like any other field, it has certain commonalities and some unique characteristics when compared to fields like cognitive psychology, physics, mathematics, and physics. Majority of AI branches do not develop in a manner that aligns with general physical ideas or accepted mathematical procedures. The mathematics and technical foundations of AI will forever be dominated by the necessary connections to cognitive and behavioral psychology. The AI framework is still in its early stages, according to predictions.

3. Environmental Perception: The capacity for understanding the external world should be generated by the AI system with aid of sensors along with other devices. Like humans, AI may take in data from its surroundings via sight, sound, smell, and touch, and it can also respond appropriately to external input in the form of words, faces, and body language. These responses have an impact on human and environmental decision-making as well. An ideal AI system would be able to learn and exhibit certain adaptive traits. In other words, AI can adapt to new data, tasks, or environments by adjusting parameters or updating optimization models.

4. Scalability: The AI software and hardware infrastructure has evolved, allowing for larger and more complex AI models. AI has been becoming better and better at tackling problems with ever-increasing complexity. Novel learning algorithms along with architectures designed for DNNs (Deep Neural Networks) would undoubtedly open up more possibilities for AI's potential uses.

Comparison of Previous work in related Studies

It provides a thorough examination as well as point of view on the current state of BT along with AI research development for 6G wireless technology (Table II).

Table 2. Comparison of existing related research

Research work	Year	Blockchain for 5G/6G	Ai for 5G/6G	Blockchain and AI for 5G/6G	Key Technologies
Wang et al., [38]	2021	Yes	No	No	Blockchain, RAN
Nguyen et al., [39]	2020	Yes	No	Limited	Blockchain, IoT, SDN, NFV
Yue et al., [40]	2021	Yes	No	No	Blockchain, D-Apps

Tahir et al., [41]	2020	Yes	No	No	Blockchain, RAN, D2D, SDN
Bhat et al., [42]	2020	Yes	No	Limited	Blockchain, IoT, MEC
Sharma et al., [43]	2021	Limited	Ye	No	ML, DL, IoT, Blockchain
Sun et al., [44]	2020	Limited	Yes	no	ML, FL, Blockchain
Rekkas et al., [45]	2021	No	Yes	No	ML
Liu et al., [46]	2020	No	Yes	No	ML, FL
Shafay et al., [47]	2022	No	No	No	Blockchain, DL, ML, FL
Wang et al., [48]	2021	No	No	No	Blockchain, AI
Yang et al., [49]	2022	No	No	No	Blockchain, AI
Dhar et al., [50]	2021	Limited	No	Limited	Blockchain, AI
Dibaei et al., [51]	2022	Limited	Limited	Limited	Blockchain, ML, DL

Blockchain and AI Integration for Wireless Communication

BT along with AI may work together to solve current challenges, and their combination can make them even better. New use cases and performance standards would be met by the network as it enters the 6G era. Rising expectations on mobile communication networks result from a wide diversity of factors, encompassing but not resected to diverse applications, communication situations, very heterogeneous network connections, and needs for extremely high-performance services [52]. Combining BT with AI has the potential to optimize and improve several 6G network services and applications while also capitalizing on each technology's unique strengths [53-55]. Fig. 6 shows 6G Internet of Things (IoT) smart apps and 6G secure services; this part will review these and other general uses of blockchain and AI in 6G networks.

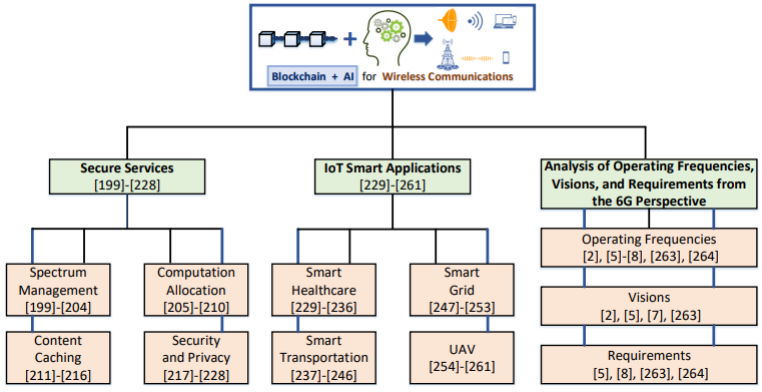

Figure.6 Taxonomy of blockchain-AI wireless communications integration

Fig. 7 shows how blockchain and AI are coming together for use in wireless communications. In addition, they go into detail on 6G's operating frequencies, visions, and needs. A study of how blockchain and AI could collaborate to provide safe services is shown in Table III.

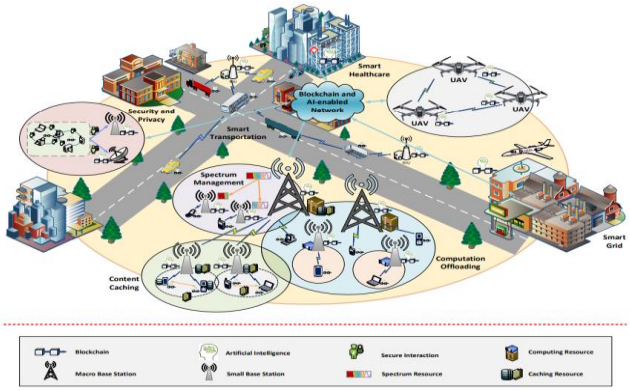

Figure.7 Blockchain-AI convergence for wireless communications

Table.3 Analysis of blockchain-ai integration for secure services

Taxonomy	Reference	Year	Key Technologies	Main Contributions
Spectrum Management	[56]	2021	Hierarchic-al blockchain, DRL	In 6G and future networks, DRL proposes a dynamic resource-sharing architecture that is powered by BT and AI, allowing the user to optimize their profit margin.
	[57]	2022	Blockchain, AI, Deep RNN	The 6G network would allow for infrastructure and spectrum sharing among many cell carriers using a blockchain- as well as AI based multi-plane architecture.
	[58]	2020	Permissioned blockchain, Digital twin, FL, DRL	Introducing a blockchain-based, permissioned digital twin edge network architecture for spectrum resource allocation along with user scheduling.
	[59]	2020	Blockchain, MEC, DRL	Developing a multi-entity consent (MEC) framework on top of the blockchain to handle adaptive resource allocation; using DRL to solve the optimization issue of both spectrum resource allocation and block creation simultaneously.
Computation Allocation	[60]	2021	Private blockchain, RL, Edge computing	Offering a smart contract for the private blockchain network's computing resource allocation and a generic system architecture for blockchain-assisted edge computing.
	[61]	2021	Blockchain, Edge computing, naïve Bayes learning	A blockchain-guided offloading method for edge user distributed resource management was presented using Naive Bayes' linear identification of offloaded and non-offloaded instances.

	[62]	2021	Blockchain, DRL, Edge/cloud computing	The goal of this effort is to address the need for offloading and security in mobile edge-cloud IoT networks by creating a method that combines BT with distribution ledger technology.
Content Caching	[63]	2020	Blockchain, DL	The AI-Chain framework is being built using BT and deep learning to address shared resource allocation issues in networking, edge computing, and content caching.
	[64]	2020	Permissioned blockchain, Edge computing	An intelligent and secure content caching strategy for vehicle edge computing networks that combines permissioned blockchain with distributed ledger technology.
Security and Privacy	[65]	2020	Permissioned blockchain, ML	Enhancing the security performance of distributed heterogeneous IoT networks with the integration of permissioned BT and artificial intelligence.
	[66]	2021	Hierarchical blockchain, Transfer learning	The ATLB system uses BT with transfer learning to provide a safe method of user identification.

2. Conclusion

The combination of AI and BT has emerged as a viable option to meet the growing difficulties of data security. This is because advancement of wireless communication technologies has been progressing towards the installation of 6G networks. To strengthen data security within the framework of 6G networks,

Furthermore, the study delves into AI's function in augmenting security measures within 6G networks. By leveraging machine learning algorithms and intelligent threat detection systems, AI contributes to real-time monitoring and adaptive response mechanisms, ensuring a proactive approach to potential security breaches. Finally, a thorough investigation into the frequently used secure services that are backed by blockchain along with AI had been carried out. Spectrum management, compute allocation, security, privacy services, as well as content caching had been among services that were the focus of this inquiry.

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