Secure 6G Communication in Smart City Using Blockchain

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Abstract The next-generation cellular network will aim to overcome the existing Fifth Generation (5G) networks' shortcomings. At the moment, academics and business are concentrating their efforts on the Sixth Generation (6G) network. This 6G technology is expected to be the next great game-changer in the telecommunications sector. Due to the outbreak of COVID-19, the entire globe has turned to virtual meetings and live video interactions in various fields as healthcare, business, and education. We explore the most recent viewpoints and future technology trends that are most likely to drive 6G in this paper. The incorporation of blockchain in 6G, will allow the network to efficiently monitor and manage resource consumption and sharing. We explore the potential of blockchain for sharing in 6G utilizing a variety of application scenarios in the smart city. To strengthen security and privacy in 6G networks, we introduce potential difficulties and solutions with various 6G technologies. In addition, we examine the security and privacy issues that may arise as a result of the current 6G standards and prospective 6G uses. Overall, our study aims to give insightful direction for future 6G security and privacy research.

Keywords Big data · Cyber security · Edge computing · Industrial IoT · Network security

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1 Introduction

The 5G wireless communication standardization process is complete, and implementation has begun in several nations throughout the world. A variety of technologies can be developed to play important roles after the 6G research phase to achieve complete specifications for a 6G worldwide standard [1]. Major research efforts are now focused on quantum technologies, which will interact with 6G implementation. The architectural and performance components of the 6G mobile system are still mostly unknown.

One of the goals of this research is to develop a new comprehensive, effective and coherent vision for a 6G-enabled Industrial Internet of Thing (IIoT) system. The 6G IIoT system can be formed by the convergence of Information Communication Technology (ICT), Operational Technology (OT), and future 6G communications. The fact is that the 5G communication system is not yet complete but experts have already anticipated 6G mobile communication [2].

Blockchain is considered to be a crucial technology for 6G applications. Blockchain is a distributed ledger system that uses cryptography and hash functions to construct a chain of data blocks that are created when an event happens and validated in a decentralized manner using consensus methods. Blockchain is currently being utilized in various application domains in smart cities, while it was previously exclusively used for cryptocurrency. In blockchain systems, the consensus is a critical feature that guarantees that all nodes agree on the network state. 6G can be utilized with communication-intensive techniques like Practical Byzantine Fault Tolerance (PBFT) if the system has to converge quickly.

Our study focuses on the security of communication in smart city using integrated technology of 6G blockchain. The remaining paper is divided into parts. Section 2 explains the literature review, while Sect. 3 presents 6G applications in the smart city. Section 4 discusses the 6G challenges and Sect. 5 presents discussions and future studies. Section 6 concludes our work.

2 Literature Review

There is so much considerable research that has been conducted on the security and privacy solution of 6G technology in recent years. We summarize some recent literature analyses and show how our approach differs from previous research.

Alsharif et al. published a paper on the 6G wireless network in 2020. The authors of this paper focused on the most promising areas of research in common directions for the 6G project [3]. The authors of [4] highlight technologies that will help wireless networks advance to 6G, and which we see as enablers for a variety of 6G use cases. Another approach for emphasizing the major difficulties and potential in developing

Holographic Multiple Input Multiple Output Surface (HMIMOS) enabled communications is discussed in [5]. In [6], the authors described the future 6G wireless communication vision and network design.

In addition, the authors in [7] provided a system for delivering Distributed AI as a Service (DAIaaS) in the Internet of Everything (IoE) and 6G settings. The author of the paper [8] incorporates a comprehensive literature analysis of 6G, IoT, IoE, and IIoT to advance understanding and enable theory building. Similarly, the researchers of [9] proposed a new set of service classes, as well as corresponding 6G performance targets.

The ideas mentioned above present a broad vision of the future for research and innovation in these fields. We propose a blockchain integrated 6G architecture with the best resource management and data sharing via smart contracts to manage data access in smart city networks.

3 Application Area of 6G in Smart City

Most recent technologies and applications are being introduced in 6G with greater data speeds, high dependability, less latency, and secure transmission. The following sections will concentrate on a few of the most important 6G application fields recognized by the literature as shown in Fig. 1. At the same time, the security requirements for these application domains are strict. Here is a brief overview of the domain-specific security standards.

3.1 Automation

Automation, robotics, and autonomous systems are some of the topics studied by researchers. These technologies will be supported by 6G, which will allow direct communication between them. 6G will enable complete automation, including automated control processes, automated systems, and automated devices. Smart city planners can use blockchain to help them build an efficient transit network that allows people to check for and pay for services directly. The efficiency of public transit can be improved with smart mobility systems built on the blockchain.

3.2 Industrial Applications

In recent years, the integration of Information and Communication Technology (ICT), IoT, and intelligent devices has revolutionized manufacturing and production systems Industrial IoT has changed the design of production units, transforming them from automated to autonomous [10]. 6G is a technique that is at the top of the

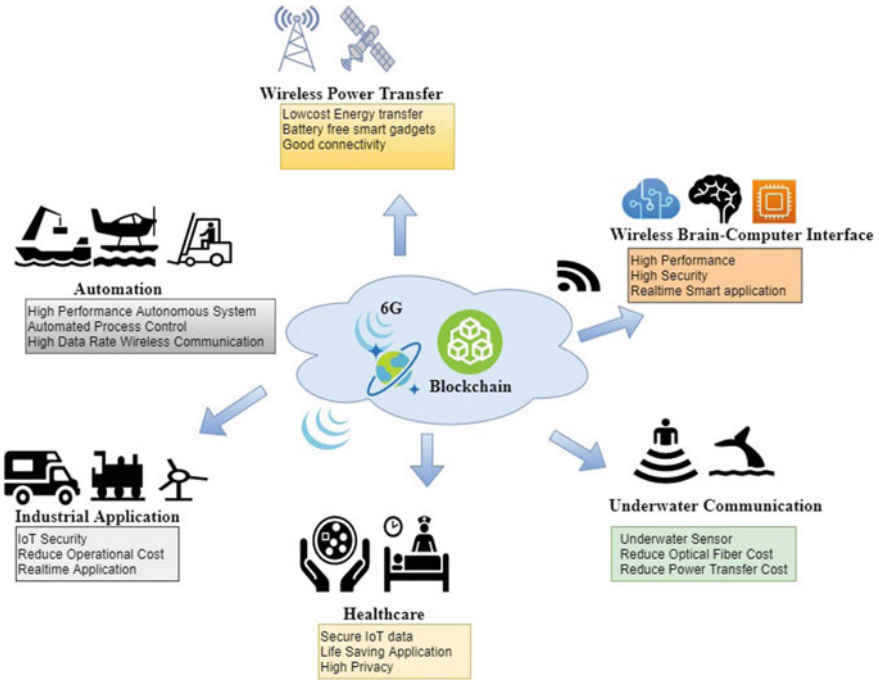

Fig. 1 6G applications and security requirements in smart cities

IIoT. The leaking of sensitive production information and the denial of access to a manufacturing device are two typical security attacks used in smart manufacturing systems. These security risks aim to interrupt either the manufacturing process or the production plan.

3.3 Wireless Power Transfer

Wireless Information and Energy Transport (WIET) is a revolutionary technology that will enable the creation of battery-free smart gadgets [11]. Traditional energy structures are centralized, fuel or coal-based. The wireless power transfer is a network of electricity generators, producers, and customers that is created by communication systems [12]. The primary goal of this system should be to ensure low-cost, and efficient energy transfer. WIET protection standards derive from domain-specific issues, including ensuring the integrity of data exchanged between power operators and customers.

3.4 Wireless Brain-Computer Interface

Wearable gadgets have become more popular in recent years with brain-computer interface (BCI) applications. The brain will be able to connect using BCI technology, which processes and translate brain signals. Computing technologies will also be used in BCI, in which gadgets will work differently based on the user's mood [13]. BCI application needs additional spectrum resources, a high data rate, extremely low latency, and excellent dependability. Five sense information transmissions will be supported by 6G, which will transport data created by the human's five senses, allowing interaction with the environment [14].

3.5 Healthcare

Health services have begun to adopt innovations to make healthcare more efficient and accurate. Such smart healthcare systems must deal with computational and security issues. Blockchain technology has several applications in smart healthcare. In this regard, blockchain will solve data protection, data confidentiality, accountability problems. 6G will enable the complete existence of remote surgeries through robotics, automation, and Artificial Intelligence (AI) [15]. Tera Hertz (THz) band's short wavelength facilitates communication and the creation of nano sensors, enabling the development of novel nanosized devices that can function inside the human body [16].

3.6 Underwater Communication

The underwater environment is unpredictable and difficult. Due to the significant attenuation of radio signals in saltwater, auditory communication is the only alternative for communication. The velocity and density variations in the water make node movement problematic [17]. Underwater sensors are costly, and they are intended to resist the harsh conditions of the ocean. It needs powerful transceivers and a huge memory. Because solar power cannot be used, the power source must be big. Optical fiber is the greatest option, but it is also the most expensive. 6G must overcome the obstacles of underwater conditions to provide effective underwater communication.

4 6G Communication Challenges in Smart City

The deployment of 5G technology has just recently begun and there is no user experience on 5G. The 5G should experience many things in a real-world scenario rather

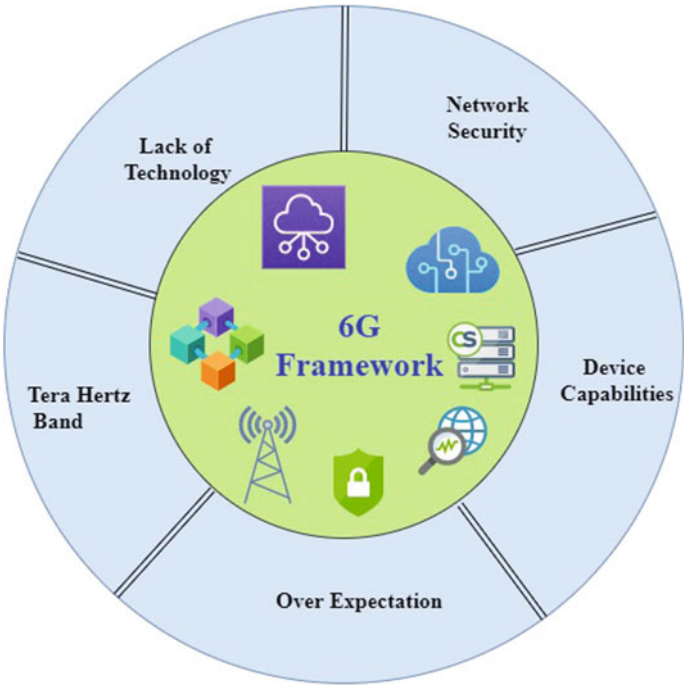

Fig. 2 6G communication challenges in smart cities

than in a laboratory [18]. Some challenging criteria in 6G wireless communication must be met to global technological demands shown in Fig. 2. The main challenging problems are analyzed and discussed in this part.

4.1 Lack of Technology

The 6G claims to deliver many promises, however, it is hampered by a lack of genuine technologies. The needs grow dramatically from 5 to 6G mobile communications. People have little experience with 5G technology, therefore a lack of 5G user experiences is a major concern. To accomplish 6G, significant changes to 5G technology are necessary. To progress 6G, AI must be integrated into 5G technology.

4.2 Over Expectation from 5G

Before creating 6G technology, problems with 5G must be resolved. Furthermore, 5G is primarily a campus-based solution that does not enable high mobility. Satellite

communication can help with high mobility, but it is highly expensive and beyond the reach of many people. Although there is no defined path for providing low-cost access to solve the problem.

4.3 THz Band

The THz band is the major issue in the 6G technology. The high data speeds and high frequencies will overcome the high path loss. To solve the problem of frequency dispersion, new multipath channel models must be created. Existing modulation and coding techniques are insufficient for the THz band [19]. Thus, developing new modulation and coding techniques is a difficult task. Furthermore, the researchers face significant health and safety problems as a result of the high power and frequency.

4.4 Device Capabilities

All wireless communication methods were not compatible with all devices. Industries have just begun developing 5G equipment, which should be able to handle 6G as well. Smartphones are consuming far more energy than in the past. Wireless energy transfer methods should be designed to enable multiple charging ways.

4.5 Network Security

Smart devices, AI, smart cities, and satellites will be connected via the 6G wireless communications network [20]. The security approaches applied in 5G will not sufficient in 6G. Thus, new security strategies based on creative cryptographic methods should be explored.

5 Discussion and Future Direction

This section gives an overview of issues, precautions, and potential research directions of blockchain and 6G integrated smart city applications as shown in Table 1.

The path to 6G is undoubtedly long, and the existing 5G will continue to improve. 6G will be a revolution rather than an evolution. Blockchain may be used to implement network security, surveillance, accountability, and governance. 6G networks must address the security concerns raised by innovative 6G applications. Blockchain systems can provide the highest level of security.

Table 1 Issue and precaution with research directions

Issue	Precaution	Potential research directions
Accessibility	The elasticity of the network Non-terrestrial networks	Resource management that is both flexible and automated Placement in 3-D space is difficult because there is a limited amount of energy available
Affordability	Convergence of multiple radio access technologies Everything is provided as a public service	Over diverse radio frequency and optical bands, smooth resource allocation Concerns about interoperability and cost-effectiveness
Spectrum	Spectrum cognition on a large scale Operators in the microscale	Instead of complicated data, only local information is shared New local entrants are encouraged by innovative business and regulatory frameworks
Maintenance	Maintenance that is predictive or preventative Automatic fallback	Mechanisms for real-time computation offloading are required Keeping services up
Power	Sharing of networks Automated energy management	In multi-tenant networks, full competition, autonomous control, and security services are all important Capabilities for component-centric energy metering combined with pervasive intelligence

With various combinations of computer science and telecommunication research, it will be fascinating to look into the commercial implications of the many options available when adopting IoE. Furthermore, it is still unclear how edge, fog, and cloud technologies should be distributed and used in diverse areas. Intelligent Transportation Systems (ITS) will likely be one of the most important applications to emerge in the next decade.

6 Conclusions

We explored the possibilities of blockchain and 6G for securing smart city communication. To make the relationship clearer, we have split 6G application needs into performance and security categories. We have demonstrated how blockchain's fully decentralized nature makes it easier to manage 6G networks with complicated structures. We listed the active 6G research projects that are mostly related to security and privacy. Furthermore, security-related concerns of 6G applications might be easily handled by selecting the right blockchain type and consensus methods. The combination of blockchain with 6G may enable safe and pervasive communication.

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