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doi:10.15199/48.2024.06.17

A Review on Blockchain Technology based Secure Intelligent Wearable Devices for 6G Systems

***Abstract**. Nowadays, Intelligent Wearable Devices (IWD) are vital in preparing patients' medical records in healthcare companies. These devices will measure essential parameters such as pulse rate, blood pressure, body weight, etc. Once measurements are over, they will quickly transmit the data to respective test centers. These devices will advise the patients on the next course of action, such as walking, jogging, eating, etc. With this approach, patients must visit the hospital frequently, reducing medical expenses. Moreover, this will improve the health status of patients and increase the life span of human beings. 6G systems and these networks are generally connected with human-centric communication. Blockchain is a technique used to implement a distributed database in which a list of records is maintained in an ordered manner. This paper enunciates the impact of Blockchain-based intelligent wearable devices for 6G systems so that the confidentiality of patient records can be protected and shared on demand.*

Streszczen ie**. Obecnie inteligentne urządzenia przenośne (IWD) odgrywają kluczową rolę w przygotowywaniu dokumentacji medycznej pacjentów w firmach z branży opieki zdrowotnej. Urządzenia te będą mierzyć istotne parametry, takie jak tętno, ciśnienie krwi, masa ciała itp. Po zakończeniu pomiarów szybko przesyłają dane do odpowiednich ośrodków badawczych. Urządzenia te poinformują pacjenta o dalszym sposobie działania, np. chodzeniu, joggingu, jedzeniu itp. Dzięki takiemu podejściu pacjenci muszą często odwiedzać szpital, co zmniejsza koszty leczenia. Co więcej, poprawi to stan zdrowia pacjentów i wydłuży życie ludzi. Systemy 6G i te sieci są zazwyczaj powiązane z komunikacją skoncentrowaną na człowieku. Blockchain to technika wykorzystywana do implementacji rozproszonej bazy danych, w której lista rekordów prowadzona jest w uporządkowany sposób. W artykule tym przedstawiono wpływ inteligentnych urządzeń do noszenia opartych na technologii Blockchain na systemy 6G, które umożliwiają ochronę poufności dokumentacji pacjentów i udostępnianie jej na żądanie.* (Przegląd bezpiecznych inteligentnych urządzeń przenośnych opartych na technologii Blockchain dla systemów 6G***)

Keywords: Blockchain, Intelligent Wearable Devices, Internet of Medical Things,
Słowa kluczowe: Blockchain, inteligentne urządzenia przenośne, Internet rzeczy medycznych,

Introduction

The vast advancements in IoT have significantly impacted healthcare companies concerning medical records. Generally, Intelligent Wearable Devices (IWD) transmit respective data to corresponding test centers. These devices measure heart rate, blood pressure, body weight, etc. The results of the test will be published quickly. IWD will infer from the patient's history and advise him for the following actions: walking, jogging, etc. Thus, IWD will give appropriate instructions regarding food in case of deficiency. By this methodology, the frequency of hospital visits will decrease.

Moreover, the medical expenses will decrease, and hospitals can concentrate on complex health complications. After taking the blood samples, those values are forwarded to pathological diagnosis. This approach can enhance the health status of patients and increase the life span of human beings. Initially, the cost factor of these devices will be higher, but later on, they will be affordable for ordinary people. Since human-centric communication is the key application of 6G, these networks are also found to be human-centric. Hence, security and confidentiality must be indispensable features of 6G networks. The demerits of 5G systems include various challenges through transparency, decentralization, security vulnerability, etc. The conventional encryption methods are based on RSA algorithms, which provide security for transmission in 5G systems [1, 2]. However, these algorithms are not always secured due to artificial intelligence and immense data pressure. This paper reviews the secure provision of IWD services to patients using blockchain techniques over 6G systems.

Literature Survey

In the context of 6G, the Internet of Medical Things (IoMT) will emerge and cater to various requirements for the welfare of human beings. These smart devices are wholly driven by AI, making decisions using communication techniques. Employing IoMT, medical things are linked to the internet. Typical examples are MRI and CT scans. The scanner will scan and send information to locations using the 6G technique, as illustrated in Figure 1. A real-time pathologist analyzes the above data, and immediate decisions can be made since things are connected to the internet. Thus, by using IoMT, the constraints of time, money, and space can be eliminated. With this methodology, cancer patients can be treated straightforwardly utilizing remote doctors. In the current situation, it is a time-consuming process to identify whether cancer patients are benign or not. This abnormal situation can be easily identified using the 6G communication technique in the coming days. Hence, by this approach, physicians and patients need not go to hospitals [3]. Figure 1 shows the integration of healthcare applications with 6G.

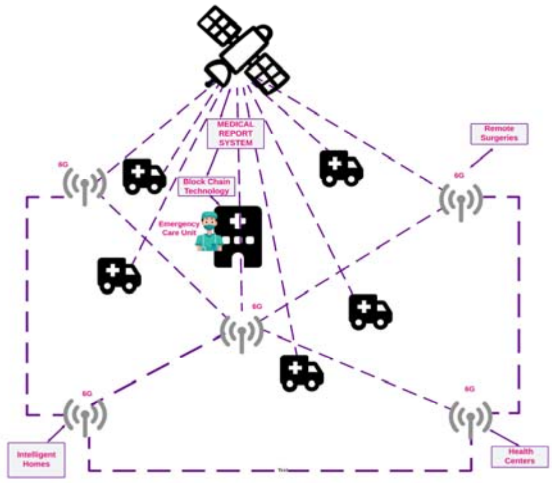

Fig 1. Healthcare applications integrated over 6G technologies

Precision medicine is a means of developing a particular medicine for treating patients appropriately. The doctors used to conduct research by integrating the people to prepare this medicine. The 6G technique can aid in preparing this precision medicine to provide healthcare in a personalized manner by employing AI [4]. An effective treatment will need the health information of patients to be treated. For example, cell therapy research is promoted for treating critical diseases. The health data will be collected using IWD based on real-time data. Hence, patients can come under the global observation of doctors with the aid of IoMT. The data is exchanged through physical and biochemical activities in the case of human beings. These activities include the transition and propagation of molecules. This exchange of information is called molecular communication in the field of communication engineering. Thanks to advancements in nanotechnology, various nanodevices are manufactured for critical applications such as biomedicine and nanoscale sensing [6-8]. Figure 2 shows five different human bond sensing. Nanotechnology is employed in biomedicine to execute various activities, such as the intelligent distribution of drugs through blood vessels and the monitoring of human organs that can enhance the outcomes of human healthcare. The efficiency in communication and transmission can be achieved by connecting these nanodevices to the internet [9]. An example of short-range wireless sensor networks is the Internet of Bio Nanothings, which includes various wearable monitoring sensors. These devices are implanted in our human body to enhance healthcare. Complete knowledge of the patient's previous medical data is essential for a particular medical emergency to start any medication for correct treatment. For instance, someone suffering from a critical disease who traveled outside the country may need emergency medical consultations. The doctor may require the patient's previous medical history for quality treatment.

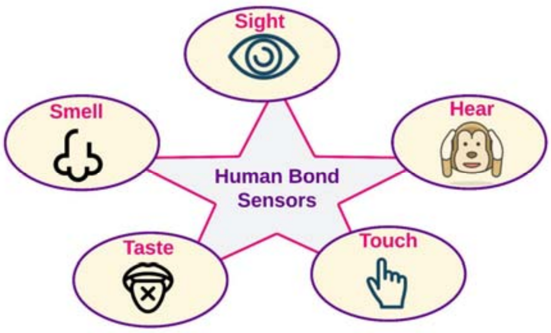

Fig 2. Five human bond sensors

Thus, the patient's medical record is essential for analyzing different parameters, such as allergy information to certain drugs, past treatment records, etc., which may aid in appropriate treatment methods. However, the present healthcare systems of management depend on manual processing methods, which do not provide traceability features at the global level [10, 11]. However, these features can be obtained by utilizing blockchain techniques.

Integration of Healthcare

Wireless attacks, such as integrity risks, denial of service (DOS), etc., impact healthcare device integration with 6G networks used for healthcare applications. The risk of security increases with the number of interfaces between the devices in the network. The centers for data management are specifically vulnerable to various wireless interface attacks. For example, embedded cardiac devices are prone to hacking when they connect to the internet. Hence, mitigation of risks must be considered to ensure a high-security level for 6G-based systems. The blockchain technique is more connected with 6G since IoT-based networks have characteristics such as decentralization and distribution, thereby providing integrity and security [12]. Figure 3 shows 6G-enabled IoT devices connected to various sensors for intelligent healthcare services. But, these devices require power consistently, which creates cost and battery life complications. The sensors employed on humans can receive solar energy from the environment for monitoring healthcare using a low-power module triggered by Bluetooth [13]. Innovative biosensors will impact the implants by finding biomarkers relevant to infectious diseases [14, 15]. Hence, AI-based training solutions integrated with hardware are implemented on IoT and wearable devices for intelligent 6G-based IoT networks [16].

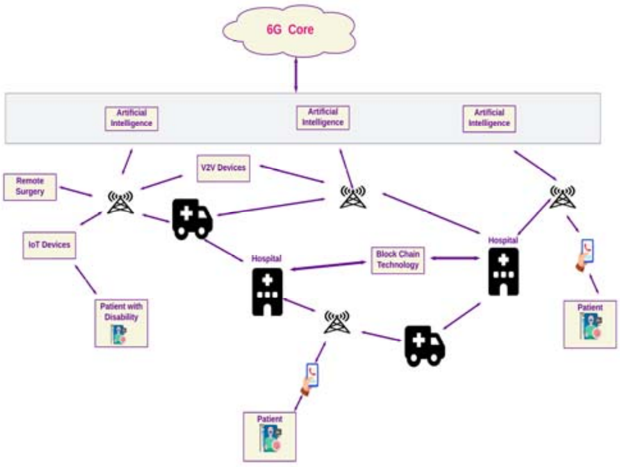

Fig. 3 6G IoT for future competent healthcare

1. Security Analysis

Data integrity indicates the verification of critical variables for the authentication process. Authentication of the fog layer means gateways in the fog layer that can verify each other. It employs a method of asymmetric encryption for transmitting the information. Figure 4 indicates a security analysis for avoiding attacks in 6G-based systems.

Security Analysis for prevention of Attacks

- Anonymity
- Unlinkability
- Mutual Authenication
- Data Integrity
- Forward Secrecy
- BAN logical proof
- Resistance to Replay Attack
- Resistance to Exhaustive Attack
- Resistance to Desynchronization Attack
- Resistance to Impersonation Attack
- Resistance to Compromised Threat
- Automated Validation of Internet Security Protocol

Fig. 4 Analysis for prevention of attacks

- Anonymity means that the real identification of the device cannot be known from transmitted data except by appropriate trusted devices.
- Un-linkability indicates the impossibility of connecting two authentication actions on the same device.
- Mutual authentication indicates a process of security in which two devices can verify each other's identification before the start of communication.
- If an adversary decides to be the legitimate device by transmitting already sent messages, it is called a resistance to replay attack.

- If an adversary receives plain information by dealing with hash results using a computer, it is called resistance to exhaustive attack.
- If an adversary interferes with the complete authentication process by blocking respective messages, it is known as resistance to a desynchronization attack.
- If an adversary informs the server employing a legitimate user and blocks authenticated messages, it is called resistance to impersonation attack.
- Forward secrecy always indicates the elements employed for changing the generated keys.
- If an adversary approaches a device for physical attacks needing secret data, it is called resistance to compromised threats.
- If the gateway and server verify each other, communicating with the same session key is Ban Logical Proof [17].

Blockchain Technologies in 6G Healthcare

Intelligent healthcare will produce large amounts of data with many connected devices for analysis. This data includes private, confidential information such as patient medical history and information about nearby environment. Intelligent algorithms and methodologies are required to protect the confidentiality of users in order to examine this data [18]. Efficient mitigation methodologies are necessary to enhance system performance, thereby managing connections relevant to 6G applications. Blockchain technique and deep learning are the methodologies needed for adaptive spectrum sharing. Healthcare information is essential and sensitive. Intelligent healthcare devices can enhance the quality of life, but at the same time, there are several concerns about data ownership. This data can aid doctors in planning their treatments for patients. However, insurance companies will monitor the patients taking their medicines and not give coverage to those who do not adhere to prescriptions. The complications to be sorted out depend on various factors such as collection of data, frequency of collection, consent of users, etc. Backscatter communication is wireless communication that activates interaction between batteryless devices by employing RF signals. Typical examples are television and mobile communication. The optimum data rate can be obtained within the range of short communication. The batteryless devices in the above communication will provide the path for broad connectivity in 6G networks. However, a constraint exists in obtaining the correct phase and state of channel for those devices in such systems. Non-coherent communication will be the right option to cater to these requirements. This sort of communication optimizes resources and services in network devices [19]. Proactive caching in 6G is a critical factor in improving the network's capacity and mobility significantly. This will increase the overload of downlink traffic as far as base stations are concerned. But this is a key solution for reducing access delay traffic load and improving the quality of user experience [20].

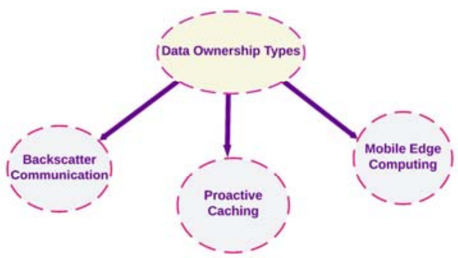

Fig. 5 Types of data ownership

Edge intelligence is an advancing technique that stimulates requirements for service environments of communication and intelligent configurations. Smart mobile phones do have the capacity to meet the features of efficiency, artificial intelligence, and integrated sensing. Devices belonging to 5G technology will not support certain vital elements of 6G, which may lead to an increase in cost factor. The compatibility between 5G and 6G devices will be challenging. Hence, there is a need for 6G technology to sort out communication-to-computing devices, determining improvement in performance and compatibility with that of 5G [21].

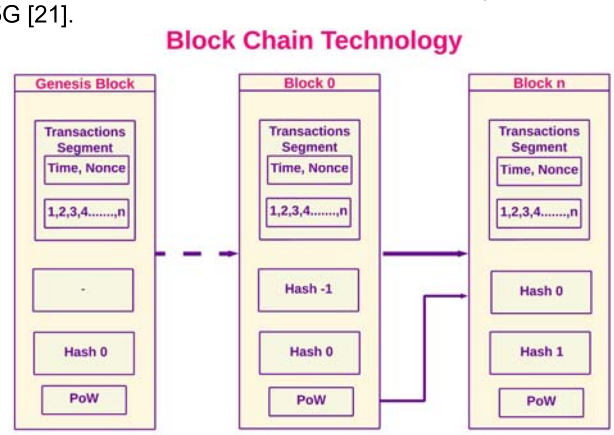

Fig. 6 Blockchain technology for 6G systems in healthcare

Some trust mechanisms are given to blockchain users. In case of adding a new node to the network, the network participants have to ensure node information in the blockchain. Various types of blockchains are available, which can be grouped as private, consortium, and public. The participation of any person in the network is called a public blockchain, whereas if the participation is authenticated, it is called a private blockchain. If the blockchain is a hybrid one, it is called a consortium blockchain. Generally, blockchain architecture includes decentralized networks, hashing methodologies, and consensus algorithms. A blockchain is a series of interconnected blocks using the hash number of the previous block. A block preserves data such as the index of the league, hash value, and transactions. Figure 6 shows the blockchain technology for 6G systems in healthcare applications. It includes a ledger for transactions where each transaction is distributed to all network nodes. If the new transaction is acknowledged in the ledger, then the transaction will be cleared. Every block in the chain will indicate transactions starting from 1, 2, 3 . . . . n, as shown in Figure 6. Thus, each block of the chain will have a hash value corresponding to the previous and current blocks with the help of information stored in that block. Hence, modifying the information in a blockchain is not acceptable. This hash value is an unacceptable component in the chain, providing security to data in a block. The arrangement of nodes that authenticates a certain number of transactions is known as the consensus mechanism [22].

Conclusions

Intelligent Wearable Devices (IWD) will significantly impact healthcare companies' preparation of patients' medical records. These devices will quickly measure the required medical information and transmit it to respective test centers. This methodology will help patients visit the hospital rarely, reducing their medical expenses. Moreover, this will improve the health status of patients and increase the life span of human beings. Blockchain is employed to implement a distributed database in which a list of records can be maintained in an ordered manner. In this paper, the impact of Blockchain-based intelligent wearable devices for 6G applications is discussed in a detailed way to protect the confidentiality of patient records. In the future, these devices may integrate multiple features into a single device to make measurements of all medical parameters easier.

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