Using Blockchain for Electronic Health Records

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Abstract

Blockchain has been an interesting research area for a long time and the benefits it provides have been used by a number of various industries. Similarly, the healthcare sector stands to benefit immensely from blockchain technology due to security, privacy, confidentiality, and decentralization. Nevertheless, Electronic Health Record (EHR) systems face problems regarding data security, integrity, and management. In this paper, we discuss how blockchain technology can be used to transform EHR systems and could be a solution to these issues. We present a framework that could be used for the implementation of blockchain technology in the healthcare sector for EHR. The aim of our proposed framework is firstly to implement blockchain technology for EHR and secondly to provide secure storage of electronic records by defining granular access rules for the users of the proposed framework. Moreover, this framework also discusses the scalability problem faced by blockchain technology in general via the use of off-chain storage of records. This framework provides the EHR system with the benefits of having a scalable, secure, and integral blockchain-based solution.

1. INTRODUCTION

The recent advent in technology is affecting all parts of human life and is changing the way we use and perceive things previously. Just like the changes technology has offered in various other sectors of life, it is also finding new ways for improvement in the healthcare sector. The main benefits that advancement in technology is offering are to improve security, user experience and other aspects of healthcare sector. These benefits were offered by Electronic Health Record (EHR) and Electronic Medical Record (EMR) systems. However, they still face some issues regarding the security of medical records, user ownership of data, data integrity etc. The solution to these issues could be the use of a novel technology, i.e., Blockchain. This technology offers to provide a secure, tamper-proof platform for storing medical records and other healthcare related information.

Before the advent of modern technology, the healthcare sector used a paper-based system to store the medical records, i.e., using handwritten mechanism. This paper-based medical record system was inefficient, insecure, unorganized and was not tamper-proof. It also faced the issue of data-duplication and redundancy as all the institutions that the patient visited had various copies of the patient's medical records.

The healthcare sector faced a trend shift towards EHR systems that were designed to combine paper-based and electronic medical records (EMR). These systems were used to store clinical notes and laboratory results in its multiple components [1]. They were proposed to enhance the safety aspect of the patients by preventing errors and increasing information access [2]. The goal of EHR systems was to solve the problems faced by the paper-based healthcare records and to provide an efficient system that would transform the state of the healthcare sector [3].

The EHR systems have been implemented in a number of hospitals around the world due to the benefits it provides, mainly the improvement in security and its cost-effectiveness. They are considered a vital part of the healthcare sector as it provides much functionality to healthcare [4]. These functionalities are electronic storage of medical records, patients' appointment management, billing and accounts, and lab tests. They are available in many of the EHR systems being used in the healthcare sector. The basic focus is to provide secure, tamper-proof, and shareable medical records across different platforms. Despite the fact that the notion behind the usage of EHR systems in the hospitals or healthcare was to improve the

quality of healthcare, these systems faced certain problems and didn't meet the expectations associated with them [3].

A study was conducted in Finland to find the experiences of nursing staff with the EHR, it was concluded that EHR systems faced the problems related to them being unreliable and having a poor state of user-friendliness [5].

The Electronic Health Record (EHR) system faces several challenges:

A. Interoperability: Different systems have varying capabilities, making it difficult to exchange information universally.

B. Information Asymmetry: Patients have limited access to their own records, which are usually controlled by healthcare organizations.

C. Data Breaches: EHR systems are vulnerable to cyber-attacks, leading to compromised data.

These challenges call for a decentralized platform like Blockchain, which offers security, transparency, and data integrity. This paper proposes a framework for a decentralized platform to store medical records, aiming to solve issues like information asymmetry and data breaches.

1.2 Scope of the Project:

The scope of this project encompasses the exploration and implementation of blockchain technology within the healthcare sector, specifically focusing on Electronic Health Record (EHR) systems. The aim is to address the challenges faced by traditional EHR systems, including issues related to security, data integrity, and management. The proposed framework aims to leverage blockchain technology to transform EHR systems by providing a secure, decentralized platform for storing medical records. It also seeks to address issues such as interoperability, information asymmetry, and data breaches commonly encountered in traditional EHR systems. Additionally, the framework emphasizes the importance of granular access rules to ensure privacy and confidentiality for users of the system. Moreover, scalability concerns associated with blockchain technology are addressed through the incorporation of off-chain storage solutions.

2. LITERATURE SURVEY

The literature survey provides a comprehensive overview of research conducted in the intersection of blockchain technology and the healthcare sector. It highlights various studies exploring the feasibility, advantages, challenges, and potential solutions associated with implementing blockchain in healthcare

Blockchain technology, originally designed by Nakamoto [13], the basic idea was to have a cryptographically secured and a decentralized currency that would be helpful for financial transactions. Eventually, this idea of blockchain was being used in various other fields of life; healthcare sector also being one of them intends to use it. A number of researchers have carried out the research on this area, these research works focus on the fact that whether the idea of using blockchain for healthcare sector is feasible or not. They also identify the advantages, threats, problems or challenges associated by the usage of this technology. Some researchers also discussed the challenges that would be faced while actually implementing this on a larger scale.

Gordon and Catalini [14], conducted a study that focused on the methods by which blockchain technology would facilitate the healthcare sector. They identified, that healthcare sector is controlled by hospitals, pharmaceutical companies and other involved third parties. They specified data sharing as the key reason why blockchains should be used in healthcare. This study also identified four factors or approaches due to which healthcare sector needs to transform for usage of blockchain technology. These include way for dealing of digital access rights, data availability, and faster access to clinical records and patient identity. It also discusses the on-chain and off-chain storage of data. The study also included the challenges or barriers faced by usage of blockchain technology these were huge volume of clinical records, security and privacy, patient engagement.

Eberhardt and Tai [20], conducted a study to understand possible approaches to solve the scalability problem of blockchain and also to identify such projects that intend to solve this problem. They define blockchain as composition of various computational and economical concepts based on peer-to-peer system. The aim of this study was to find which data should be stored on-chain and what could be stored off-chain. This study presented five patterns for off-chain storage of data and also includes the basic ideas and implementation framework of these patterns. The authors explain on-chain data is any data that is stored on the blockchain by performing transactions on it. While off-chain data storage is to place data elsewhere on any other storage medium but not on-chain and it also would not include any transactions.

Vujičić et al. [21], presented an overview of blockchain technology, bitcoin and Ethereum. The authors define that information technology landscape is constantly changing and blockchain technology is benefiting the information systems. They explained bitcoin as a peer-to-peer distributed network used for performing bitcoin transactions. They also defined that proof-of-work consensus algorithm along with the mining of blockchain concept. The authors emphasize on the fact that scalability is a severe problem faced by blockchain and that certain solutions are proposed for solution of scalability problem these include SegWit and Lightning, Bitcoin Cash and Bitcoin Gold. The paper also explained Ethereum and its dependencies and it also differentiates Ethereum blockchain from bitcoins' blockchain.

Wang et al. [22], conducted a study that focused on smart contracts and its application in blockchain technology. They first introduce the smart contracts, their working framework, operating systems and other important concepts attached with them. The authors also discuss that how could smart contracts be used for the new concept of parallel blockchains. They identify that reason of using smart contracts in blockchain is due to the decentralization that is offered through the programming language code written in them. After introducing the basics of smart contract, the author explained the various layers of blockchain that combine together to keep system functioning. These layers are data, network, consensus, incentive, contract, and application layer. The paper not only discusses the architecture and framework followed by smart contracts but it also gives an insight on its applications and challenges. The paper also discusses an important future trend of parallel blockchain that intends to create such blockchain that can optimize two different but important modules.

3. OVERVIEW OF THE SYSTEM

3.1 Existing System

The existing healthcare record systems, primarily Electronic Health Records (EHR) and Electronic Medical Records (EMR), have significantly advanced healthcare management but are not without their drawbacks. These systems often face challenges related to data security vulnerabilities, user data ownership ambiguity, and data integrity issues. Security vulnerabilities expose these systems to risks of data breaches and cyber-attacks, compromising patient confidentiality and the integrity of medical records. Moreover, the ambiguity surrounding user

data ownership raises concerns about privacy and inhibits effective data management. Additionally, centralized systems may encounter problems such as data duplication and inconsistency, leading to inaccuracies and inefficiencies in healthcare data management. These limitations underscore the need for innovative solutions to address the shortcomings of existing healthcare record systems.

3.1.1 Disadvantages of Existing System

Security concerns: Existing systems face challenges related to the security of medical records, as they are vulnerable to data breaches and cyber-attacks.

Lack of data ownership: Patients often do not have full ownership and control over their medical data, leading to privacy concerns and potential misuse.

Data integrity issues: The centralized nature of existing systems can lead to data duplication and inconsistency, affecting the accuracy and reliability of medical records.

3.2 Proposed System

Proposed blockchain-based systems offer promising solutions to address the shortcomings of existing healthcare record systems. These systems leverage the inherent security and decentralization of blockchain technology to enhance the management, security, and accessibility of medical data. For example, researchers have introduced scalable frameworks that integrate blockchain with existing databases, such as Hadoop, to improve the scalability of healthcare data storage and management. Additionally, blockchain-based solutions ensure data integrity and immutability, minimizing the risk of unauthorized access, tampering, and data breaches. Furthermore, these systems prioritize patient data ownership and control, providing patients with greater autonomy over their medical records and fostering trust between patients and healthcare providers. By streamlining data sharing and access, blockchain-based systems facilitate efficient communication and collaboration among healthcare stakeholders, ultimately improving the quality of patient care and healthcare outcomes.

3.2.1 Advantages of Proposed System

Enhanced security: Blockchain technology offers a decentralized and tamper-proof platform, ensuring the security and integrity of medical records.

Improved data ownership: Patients have greater control and ownership over their medical data, enhancing privacy and confidentiality.

Efficient data management: Blockchain-based systems can streamline data sharing and access, reducing duplication

and improving the overall efficiency of healthcare data management.

3.3 Proposed System Design

In this project work, there are three modules and each module has specific functions, they are:

1. Patient

2. Doctor

3. Admin

3.3.1 Patient:

patient will register into the application by providing all the necessary details and therefore he can login into the application using username and password and patient can upload the files to application and share with the other registered doctor. He can also view the files uploaded by him and can also view the requests for secret key and block chain key from the other doctor and we can respond and the key and block chain will be sent to user by mail. Using that key, he can download the file and view the information.

3.3.2 Doctor:

Doctor will register with application and get user name and password. Doctor can see all encrypted files uploaded by all users and send request to respective user and get approval to download data and block chain hash and security keys for RSA are shared to owner email which can be used for owner download.

3.3.3 Admin:

Using this module admin can register with application and store information of each user and owner who uploads and requests for data. Details which are stored in admin are upload to Drive hq cloud.
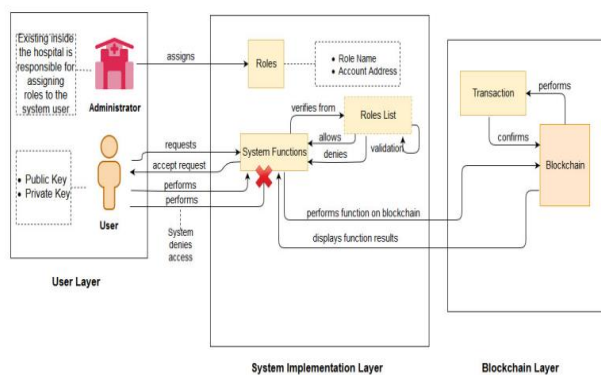
3.4 Architecture

Fig 1: System Architecture

4. RESULT SCREEN SHOTS

5. CONCLUSION

In this paper, we discussed how blockchain technology can be useful for the healthcare sector and how it can be used for electronic health records. Despite the advancement in the healthcare sector and technological innovation in EHR systems, they still faced some issues that were addressed by this novel technology, i.e., blockchain. Our proposed framework is a combination of secure record storage along with the granular access rules for those records. It creates such a system that is easier for the users to use and understand. Also, the framework proposes measures to ensure the system tackles the problem of data storage as it utilizes the off-chain storage mechanism of IPFS. And the role-based access also benefits the system as the medical records are only available to the trusted and related individuals. This also solves the problem of information asymmetry of EHR system.

For the future, we plan to implement the payment module in the existing framework. For this, we need to have certain considerations as we need to decide how much a patient would pay for consultation by the doctor on this decentralized system functioning on the blockchain. We would also need to define certain policies and rules that comply with the principles of the healthcare sector.

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