International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 5, Issue 6, pp 69-71, June-2021

https://doi.org/10.47001/IRJIET/2021.506013

Blockchain for Secure EHRs Sharing of Mobile Based E-Health Systems

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***Abstract* - Recent years have witnessed a paradigm shift in the storage of Electronic Health Records (EHRs) on mobile cloud environments, where mobile devices are integrated with cloud computing to facilitate medical data exchanges among patients and healthcare providers. This advanced model enables healthcare services with low operational cost, high flexibility, and EHRs availability. However, this new paradigm also raises concerns about data privacy and network security for e-health systems. How to reliably share EHRs among mobile users while guaranteeing high-security levels in the mobile cloud is a challenging issue. In this paper, we propose a novel EHRs sharing framework that combines blockchain and the decentralized interplanetary file system (IPFS) on a mobile cloud platform. Particularly, we design a trustworthy access control mechanism using smart contracts to achieve secure EHRs sharing among different patients and medical providers. We present a prototype implementation using Ethereum blockchain in a real data sharing scenario on a mobile app with Amazon cloud computing. The empirical results show that our proposal provides an effective solution for reliable data exchanges on mobile clouds while preserving sensitive health information against potential threats. The system evaluation and security analysis also demonstrate the performance improvements in lightweight access control design, minimum network latency with high security and data privacy levels, compared to the existing data sharing models.**

Keywords: Electronic health records (EHRs), EHRs sharing, mobile cloud computing (MCC), Internet of Medical Things (IoMT), blockchain, smart contracts, access control, privacy, security.

I. INTRODUCTION

Recently, there has been a growing interest in employing the blockchain technology to prompt medical and e-health services. Blockchain with its decentralized. E-health sectors such as secure sharing of Electronic Health Records (EHRs). Data access management among mulple medical enes. the emergence of innovave technologies, including Mobile Cloud Compung (MCC) and Internet of Medical Things (IoMT). Availability of complete EHRs on clouds also helps healthcare providers track paent health. proper medical services during diagnosis and treatment processes. Using it with android based sharing APIs it becomes.

- Every new innovation is the result of an attempt to solve a problem. Blockchain technology is no exception. It's quite evident after learning about the evolution of blockchain technology that it arose because of a need to address the inevitability of uncertainty in the existing economy.
- The need for decentralization is the key motivation behind the blockchain technology, and decentralization is achieved by distributing the computation tasks to all the nodes of the blockchain network. Decentralization solves several problems of traditional systems; the single point of failure is one such problem.
- Due to a blockchain's ability to share information in an open P2P network without any central authority governing it, the technology can have many different applications like healthcare.
- With emerging e-healthcare systems there are foundations acting like trusted third-parties which become a broker service for exchange of some information. Blockchain has ability to remove all the third-parties hence creating a trustless systems reducing cost of paper, data storage and sharing of ehrs data.

II. METHODOLOGY

We consider an e-health scenario on a mobile cloud platform where patient records are gathered from a network of local gateways and stored on a public cloud for sharing with healthcare providers as shown in Fig. 1. E-health records may include personal information and medical history which are provided by patients. Patients have their own patient ID PID and are classified based on their current living area with an area ID AID. In this model, we assume that the wearable sensor network is private and managed by its local user (patient).

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We also assume that EHRs can be collected from wearable body sensors by a mobile application integrated in patients' smartphone. Therefore, the address of a patient on blockchain can be formulated as Addr = {AID, PID}. Because it is infeasible to store medical data on blockchain, we suggest to only keeping addresses of patients on blockchain, while large medical records are stored on decentralized cloud storage. Further, to manage medical records, a cloud EHRs manager ME is proposed. Thus, in order to retrieve a certain health record on cloud, a participating entity needs to know patient addresses which are visible on the blockchain network.

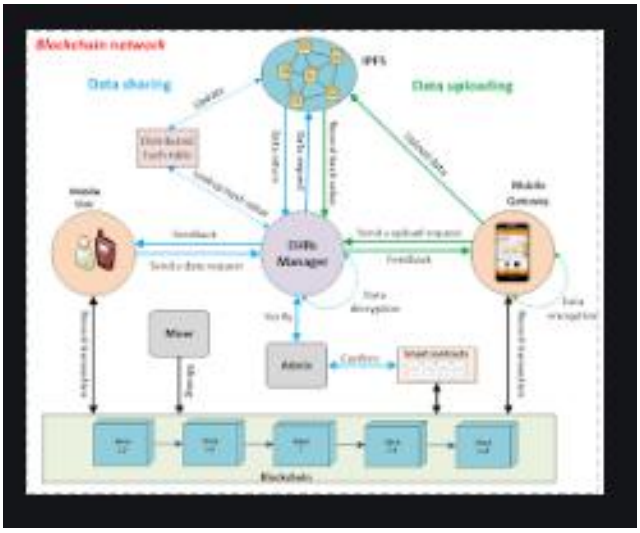

Figure 1: System Architecture

In this paper, we employ an Ethereum blockchain platform for building our e-health system [31], [32]. Typically, Ethereum is a new distributed blockchain network similar to most platforms such as Bitcoin [33]. A big advantage of Ethereum is its adaptable and flexible features, which allow building any blockchain applications such as e-healthcare. We review main components of an Ethereum network which will be used in our design. Like Bitcoin, the Ethereum platform has a blockchain, which contains blocks of data transactions and smart contracts. Blocks are verified and appended to the blockchain by an algorithm called proof of work by miners to achieve a secure, tamper-resistant consensus among all nodes in the network. Each block contains hash of its previous block in a chronological order. The cryptography hash algorithm on the platform guarantees that linked blocks are resistant to be modified and blockchain data is immutable. 1) ETHEREUM ACCOUNT Ethereum has two different accounts: externally owned accounts (EOAs) and contract accounts. Every account is indexed by a 20-byte address and defined by a pair of keys, a private key and a public key. To interact with Ethereum blockchain, each user needs to create an account to become an entity in the network. 2) SMART CONTRACT A smart contract [32] is a kind of self-operating computer program, which can be executed automatically when specific conditions are met. In the Ethereum blockchain, a smart contract is a special account, which contains data and code with multiple programmable functions. Users can use their Ethereum account to interact with smart contracts via application binary interfaces (ABI). Functions defined in smart contracts can be triggered by a new transaction sent from an account. This property allows entities to implement their job functionalities such as data transmission, request handling or access management. 3) TRANSACTION An Ethereum transaction is a data packet to transfer ether (Ethereum native token) from an account to another. A typical structure of transaction is as follow {Account Nonce, address of recipient, Gas price, Gas limit, Ether value, sender's signature, data field}. Below is an example of a transaction. Transaction Tx = new Transaction(getFromAddress(), gasPrice, gasLimit, to, value, data). In our model, we use the data field to declare request IDs to smart contracts for data request on cloud storage.

III. EXPECTED RESULT

A blockchain powered health information exchange could unlock the true value of interoperability. Blockchain-based systems have the potential to reduce or eliminate the friction and costs of current intermediaries. The promise of blockchain has widespread implications for stakeholders in the health care ecosystem. Capitalizing on this technology has the potential to connect fragmented systems to generate insights and to better assess the value of care. In the long term, a nationwide blockchain network for electronic medical records may improve efficiencies and support better health outcomes for patients.

IV. CONCLUSION

The proposed system removes unnecessary third-parties providers which come with extra charge. The system will contain EHRs which will remove the use of papers hence huge amount of money and paper will be saved each year. The system can also work with iot devices such as smart watches etc. The proposed network is made with assumptions that not all peers can be trusted hence the network should be fault tolerance. Based on the merits of our model, we believe that our blockchain enabled solution is a step towards efficient management of e-health records on mobile, which is promising in many healthcare applications.

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Citation of this Article:

Devidas Chavan, Shubham Raj, Chettaniya Verma, B.B.Gite, “Blockchain for Secure EHRs Sharing of Mobile Based E-Health Systems” Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 5, Issue 6, pp 69-71, June 2021. Article DOI https://doi.org/10.47001/IRJIET/2021.506013

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