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Electronic Health Record System using Blockchain Technology

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Abstract— The healthcare sector is frequently known for being delicate and intricate.Individuals' sensitive information must be kept safe, secure, and protected.Blocks of the blockchain are secured and bound to each other using cryptographic principles.
By maintaining the patient at the centre of the medical ecosystem system and establishing greater security, interoperability, and privacy ofstored patient records, blockchain has the potential to eradicate the problems ailing the industry and transform healthcare.
By decentralizing and encrypting health records, blockchain ensures that patient data is securely stored and tamper-proof. Additionally, blockchain can facilitate the seamless exchange of medical information between different healthcare providers, leading to better coordination of care and reduced medical errors. By leveraging Ethereum's smart contract functionality, healthcare organizations can securely store and
share patient data, ensuring its integrity and confidentiality. Moreover, Ethereum's programmable nature allows for the development of decentralized applications (DApps) that can streamline various healthcare processes, such as medical record management, supply chaintracking, and clinical trials. Overall, the integration of blockchain in the healthcare industry has the potential to revolutionize the way healthcare data is managed, ensuring privacy, security, and efficiency in patient care.

Index Terms— blockchain, smart contract , ethereum , healthcare

I. INTRODUCTION

Blockchain is an unlinked collection of time-stamped, unchangeable data entries that are maintained by a group of unaffiliated computers. Cryptographic principles are utilised to protect and bind each of these data blocks, or chains, to one another.Because the blockchain network lacks a central authority, it is the epitome of a decentralized system. Given that it is an immutable and shared ledger, anybody can view the data within it. Therefore, by its very nature, anything constructed on the blockchain is transparent, and all parties involved take responsibility for their activities.

Data may be sent from point A to point B in an automated, secure, and straightforward manner with the use of the blockchain. Numerous machines throughout the internet, numbering in the dozens or even millions, have validated this block.

II. PREVIOUS WORK

A. Literature Review

Blockchain Technology has gained widespread acclaim primarily because of its three key attributes. Firstly, it is decentralized, meaning it is not owned or controlled by any single entity. Secondly, the data stored within the blockchain is securely encrypted, ensuring its confidentiality.[4] Lastly, the immutability of the blockchain guarantees that the data inside cannot be altered or tampered with. Furthermore, the transparency of the blockchain enables easy tracking and verification of data if required.

- Decentralization

In a decentralized setup, the data is not held by a single entity.Instead, all members of the network possess the data. The fundamental principle of Bitcoin was to enable direct interaction between individuals in a decentralized network, without the need for intermediaries.This means that you

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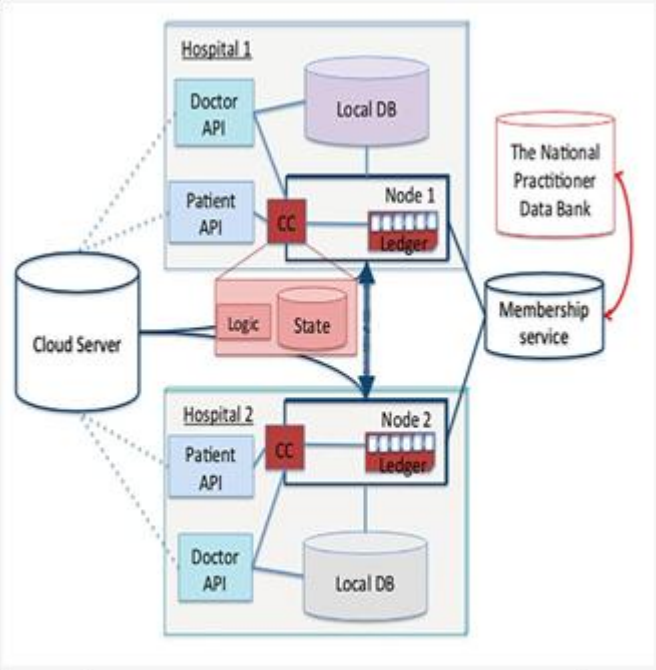
have complete control over your funds and can transfer them to anyone without involving a bank.

- Transparency

The concept of transparency in blockchain is often misunderstood. While some argue that it provides privacy, others claim that it is transparent. This confusion arises because a person's identity is concealed through complex cryptography and is only represented by their public address. Therefore, when viewing transaction history, one would not seethe name of the sender or receiver, but rather their public address.

- Immutability



The concept of immutability in the blockchain ensures that once information is recorded, it becomes unalterable, providing a valuable asset for financial institutions. This feature can prevent numerous cases of embezzlement by eliminating the possibility of manipulating financial records. The blockchain achieves immutability through the use of cryptographic hash functions. These functions take input data, such as transaction details in cryptocurrencies like bitcoin, and produce a fixed-length output, making it impossible to tamper with the recorded information.

A. Background

The use of blockchain technology in healthcare has the potential to revolutionize the industry by prioritizing the patient and enhancing the security, privacy, and interoperability of health data. This innovative technology can introduce a new approach to health information exchange, making electronic health records more efficient and secure. [1]

Over the years, EHRs have undergone continuous innovation and improvement, resulting in the advanced systems we have today. These modern EHRs go beyond simply replicating paperrecords and offer a range of capabilities.[3] They provide real-time, patient-centered health records that can be accessed and transmitted instantly by authorized medical professionals. This faster access not only streamlines provider workflows but also enhances the efficiency and quality of care for patients. One notable early attempt to improve patient record-keeping is the problem-oriented medical record (POMR), which was developed by Dr. Lawrence Weed in 1968 and is still utilized by some medical and behavioral health providers. In 1972, the Regenstrief Institute in Indianapolis collaborated with Clement McDonald to create the first version of what we now recognizeas an EHR.3. And unveil the intricate network of Hospital 1 and Hospital 2, where doctors, patients, and data converge within a system comprising local databases, APIs, ledgers, and cloud servers.

III. PROPOSED CONCEPT

The main concept is to store patient records on Blockchain[2]. The following would be the workflow:

1. Anyone can sign up as a patient or a doctor on the Blockchain network.
2. Each time a patient sees a physician, the physician will beauthorized to keep a copy of the patient's medical records, including logs of diagnoses, on distributed ledgers spread throughout the Blockchain network.
3. To generate and edit a patient's records—who would be uniquely recognised by a patient ID—the physician would have to sign the transaction, which would be cryptographically encrypted using his private key.
4. A patient's medical records are available from any hospital.
1. We can discover the seamless integration of Hospital 1

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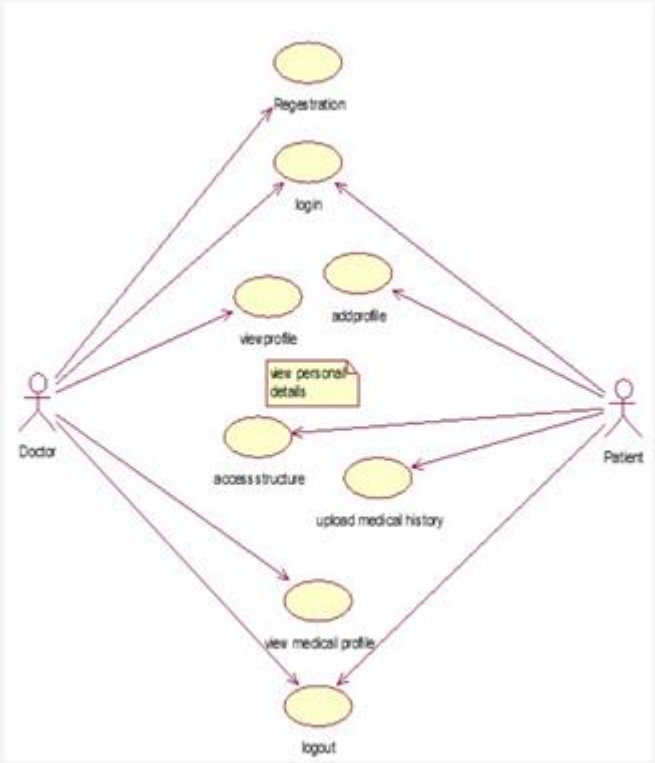
and Hospital 2 through a comprehensive system encompassing doctors, patients, databases, APIs, ledgers, and cloud servers.

2. We can explore the interconnected world of healthcare with Hospital 1 and Hospital 2, as doctors, patients, and data flow seamlessly through local databases, APIs, ledgers, and cloud servers.

IV. METHODOLOGY

There are four components to our system:

- Network overlay



A peer-to-peer network with a dispersed architecture is called an overlay. The network is linked to the nodes. These nodes are grouped into numerous clusters, each of which is led by a cluster head. Using the Diffie-Hellman algorithm, each cluster head has a distinct public key that is shared with other clusters. The public keys of the nodes that are permitted to view network data are also stored by the cluster head. All that is there in these networks is the block hash. We may approach it similarly to the blockchain because every block also hash the previous block.

- Cloud-based storage

We employ cloud storage servers to store the patient data rather than directly storing the IoT healthcare data on blockchain. User data is stored in the cloud in identical blocks, each assigned a distinct block number. Overlay networks and cloud storage are linked. After data is stored in a block, the cloud server sends the hash of the data blocks to the overlay network. The block is then encrypted using the user's shared public key.

- Smart contracts

Smart contracts enable the establishment of agreements on any device that are carried out when the terms specified in the contract are fulfilled. When readings from the wearable device deviate from the prescribed range, think about establishing the condition for the patient's blood pressure at its peak and lowest points. Healthcare providers can access the patient's blood pressure readings in real time by using the smart contract, which will also record the aberrant data in the cloud and send an alert message to the designated person or healthcare practitioner.

- Healthcare providers

Patients and healthcare providers: Insurance companies and patients designate healthcare providers to conduct diagnostic procedures and administer treatments. After receiving an alert from the network, healthcare services treat patients. Patients are the proprietors of their own personal information, and they are in charge of giving, withholding, or canceling access to that information from any third parties, including insurance companies or medical providers.

Steps defined:

1. Simplify your registration and login process, add profiles, view profiles, access structures, upload medical history, and log out with ease on our website.

2. Streamline your registration and login process, manage profiles, view profiles, access structures, upload medical history, and log out effortlessly on our platform.

3. Experience a seamless registration and login process, effortlessly manage profiles, view profiles, access

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structures, upload medical history, and log out on our user-friendly website.

Test Cases

Validation is important as it ensures that the user has the necessary tool (meta-mask extension) and access to the application in order to proceed with the desired action. By displaying the error message, the user is prompted to resolve the issue by connecting the meta-mask extension or granting access to the application, thereby preventing any potential errors or disruptions in the process.
The entered data must be valid in order for the information to be stored. If the data is not valid, the smart contract will check the entered information and prevent it from getting stored.
When a user does not have sufficient ether for a transaction, they will encounter an error message or notification stating that the transaction cannot be completed. This error occurs because every transaction on the Ethereum network requires a certain amount of ether to cover the associated gas fees.
Gas fees are the fees paid to miners for processing and validating transactions. If a user's ether balance is insufficient to cover these gas fees, the transaction cannot be executed. To proceed with the transaction, the user will need to acquire or transfer enough ether to cover the required fees. This can be done by purchasing or receiving ether from another user. Once the user's ether balance is sufficient, they can retry the transaction and it should be successfully processed on the Ethereum network.

The response time to fetch patient's data from the blockchain is 380ms.To fetch Doctor's Data – 240ms
Fetch files uploaded by patient or accessed by doctor – Depends on network speed

A. Results and Analysis

This system offers numerous advantages for both patients and doctors, including improved continuity of care. As patients often see multiple healthcare providers throughout their lives, it allows new providers to quickly and easily access their medical information. This eliminates the need for lengthy delays in care and ensures that providers have all the necessary information to provide effective treatment.[5]

Our health record system enhances efficiency by reducing wasted time in communication between clinicians, pharmacies, insurance providers, and diagnostic centers through a centralized chart. This eliminates the need for follow-up calls and reduces the incidence of lost messages.

It also improves emergency preparedness and response by providing clinicians with the right information at the right time, which can significantly increase efficiency in natural disasters and other emergencies. This is especially important as dealing with paper records can lead to worse outcomes for patients.

Electronic Health record not only provides the highest level of care, but also ensures the highest level of security for patient information. It goes beyond being a mere storage for digitized health records and actively utilizes a patient's information to benefit them. Behavioral health providers can leverage it to automate note-taking, enabling more precise charting in less time. This enhances accuracy, facilitates tracking of patient progress, and enables more effective treatment and prescription decisions.

V. SUMMARY

B. Future Scope

Examining how Blockchain and the Internet of Things (IoT) operate together in the healthcare industry could be a potential path for future research, with the goal of achieving network scalability gains by enabling low-end devices.

By sending automated reminders, a secure messaging system lowers the number of no-shows, and fully electronic intake removes the time and waste associated with paperwork.

With an integrated system that enables providers to receive payments and produce statements, a strong EHR can even simplify billing.If at all possible, we ought to endeavor to incorporate these functionalities into the upcoming system.

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