Using Blockchain for Electronic Health Records

Team 11:

1. Rishi Sunder - 2019103051
2. Sathwik - 2019103057
3. Suhaas Varma - 2019103610

Index

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 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, temper-proof platform for storing medical records and other healthcare related information.

Literature Survey

Paper name	Methodology	Advantages	Disadvantages
Using Blockchain for Electronic Health Records	This paper proposes a framework that creates such a decentralized platform that would store patient's medical records and give access of those records to providers or concerned individuals, i.e., patient.	Patients, doctors, administration and nursing staff were given granular access as they should have varying level of authority on the system.	Communication is not possible between parties.
A Decentralized Application for Secure Messaging in a Trustless Environment	Using the application, two users can engage in secure and anonymous communication which is encrypted end-to-end and resistant to network traffic analysis.	Users can assure the safety, confidentiality, availability of data and communication.	Application is not scalable.
Blockchain-based Electronic Patient Records for Regulated Circular Healthcare Jurisdictions	Blockchain transactions are validated by a miner network formed by the authority itself, healthcare providers, authorised medical stakeholders and other regulatory bodies.	This project makes a common view of patient data accessible by all providers possible, while at the same time, ensures that patients retain complete control of their medical record.	Sharing of records between providers is not possible.

Literature Survey Contd.

Securing Blockchain based Electronic Health Record using Multilevel Authentication	It is divided into four layers such as User Management Layer, EHR Generation and View Layer, EHR Storage Layer, and EHR Access Management Layer based on the functionality.	The proposed blockchain based healthcare system uses the multilevel authentication scheme to address the user wallet attacks by adding one more level of security.	The blockchain-based healthcare system needs huge storage for storing the blockchain that is still a challenging task
Blockchain Secured Electronic Health Records: Patient Rights, Privacy and Cybersecurity	Lists of data, termed *blocks*, are linked chronologically by cryptographic hashes in an encrypted linear *chain*. This provides an auditable record unalterable by a single party.	Blockchain can help in multiple ways; lowering transaction costs by the use of smart contracts to automate processes.	Distributed methods for data integrity validation are not alone sufficient to solve all cybersecurity hazards.
Health Record Management through Blockchain Technology	In proposed architecture Doctors and hospitals are considered as nodes which are connected to the eHealth Blockchain with the smart contract	The software gives real-time data access, keeps the data confidential, handles high volumes of data efficiently.	The system does not use role based access.

Literature Survey Contd.

Secured messaging platform using blockchain	Technology consists of a message end to end encryption model to protect the privacy of the user and a cryptographic hash mode to verify the integrity of the messages and smart contracts	potential for viewing chat history in a safe manner and also by eliminating a centralised approach, users can assure the safety, confidentiality.	Application is not scalable
A Framework For Electronic Health Record Using Blockchain Technology	The system is a two fold process where first we focus on the block creation and secondly secure the data using Elliptic Curve Cryptography (ECC) Algorithm.	Scalability was ensured for the system. The immutability was also maintained in the system and it was ensured that the system was not altered by other stakeholders other than the role allotted.	Communication is not possible between parties.
A Blockchain based Electronic Medical Health Records Framework using Smart Contracts	Hyperledger fabric hosts a smart contract called chain code in a containerized technology that integrates the application logic	The stakeholders will have to request permission to access a patient's history and commit the transaction to the distributed ledger	Since it is possible to distinguish the people engaged in the transactions, this could endanger their confidentiality and secrecy.

Problem Statement

The common issues in medical services within the country are mostly associated with doctors' referral process, data transfer between health institutions, and portals for patients to access their medical information. Specific issues arise, such as sharing health records across institutes or hospitals, problems with misuse of data once shared, no security, etc.

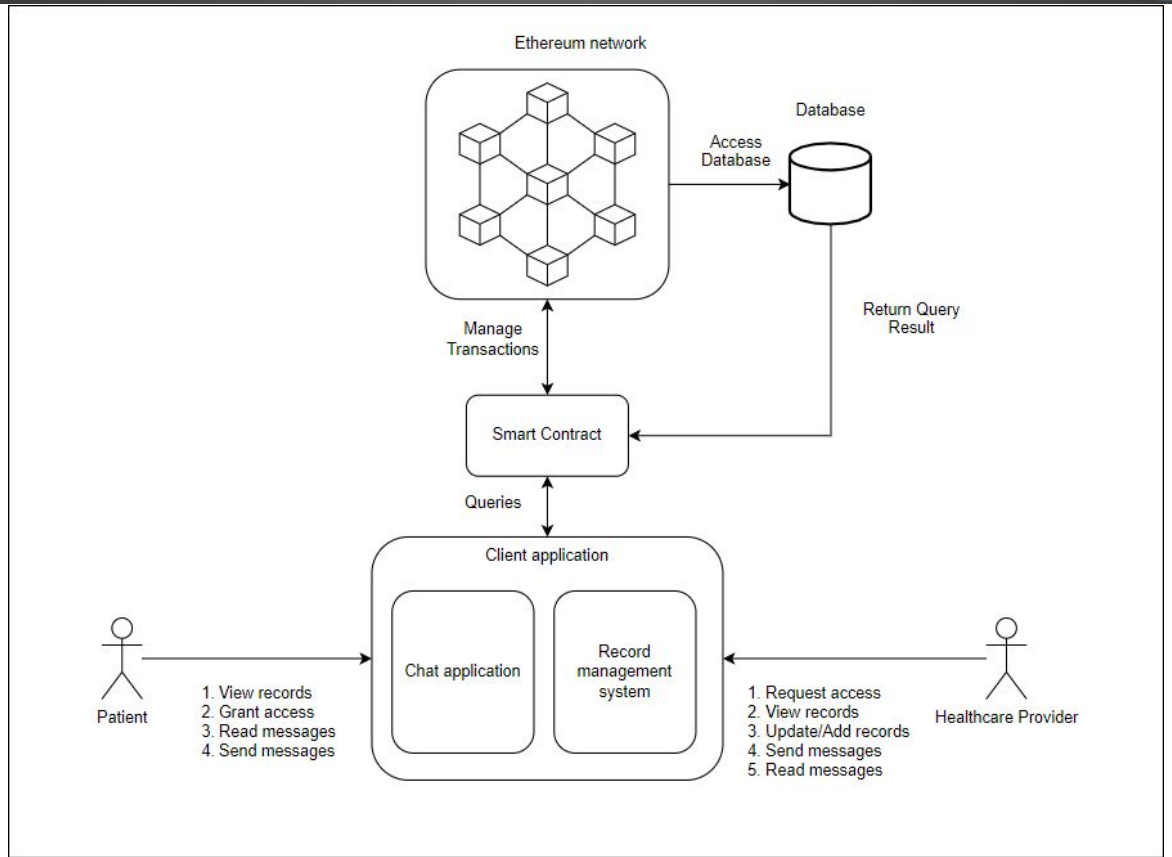
Issues include

- **Interoperability**
- **Information Asymmetry**
- **Data breaches**

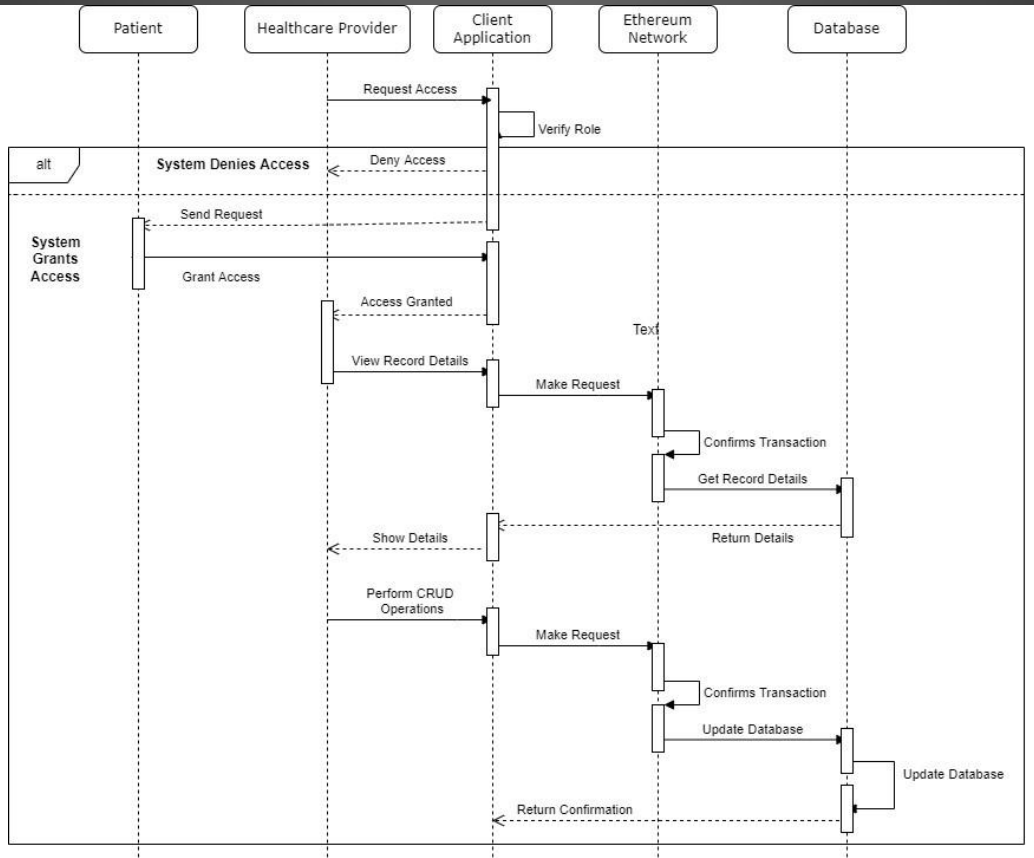
Objective

- This project aims to solve the healthcare sector's current problems by hosting medical record transactions on the Blockchain to create a smart ecosystem.
- The goal is to provide secure access to patient data, avoiding third party access to it without permission.
- EHR Framework uses blockchain technology to securely store the records and maintain a single version of the truth.
- The stakeholders will have to request permission to access a patient's history and commit the transaction to the distributed ledger.

System Architecture



Sequence Diagram

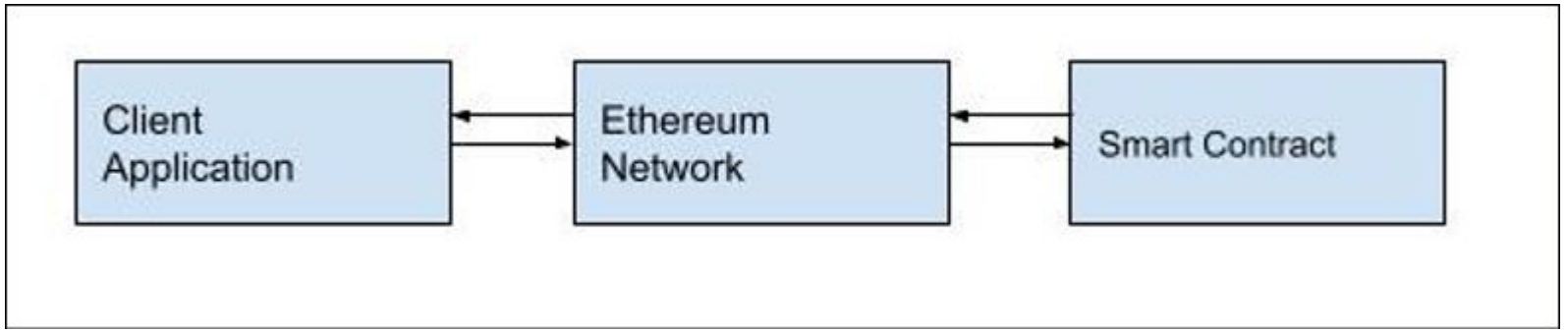


List of Modules

1.Client Application

2.Ethereum Network

3.Smart Contract



Client Application

- The users of this system could be patients, doctors etc.
- The main task of these users would be to interact with the system and perform basic tasks such as create and read the medical records.
- The users using this system would be accessing the system's functionality by a DApp.
- The GUI contains all the functions that could be accessed by a particular user.
- The user according to the assigned role could use this GUI for interacting with the other layer of the system, i.e., blockchain layer.

Ethereum Network

This layer contains the code or mechanism for interaction of user with the DApp which is functioning on the blockchain. This layer contains three elements inside it.

- **Blockchain Assets:** In Ethereum blockchain, transaction is the process by which external user can update the state of the record or information stored on the Ethereum blockchain network. These transactions are treated as *assets* by the Ethereum blockchain as they are piece of information that user can send to another user or to simply store it for using it later.

Ethereum Network Contd.

- **Governance Rules:** Blockchain technology in general follows some consensus rules for its transactions to be done and computed. For this purpose it needs some consensus algorithms to keep the blockchain temper-proof and secure. Ethereum blockchain uses Proof of Work (PoW) consensus algorithm, the reason behind using it is also for ensuring that *governance* of blockchain is maintained in a trusted manner which is through consent from all the trusted nodes attached to the blockchain network.

Ethereum Network Contd.

- **Network:** Ethereum blockchain uses the peer-to-peer network. In this network all the nodes are connected as *peers*. With no node acting as the central node controlling all the functions of the network. The reason behind using this network was because the idea was to create a distributed platform not a centralized. So, using a network where all the connected nodes have equal status and right was the best choice this technology could have done.

Smart Contract

Smart contracts are programs stored on a blockchain that run when predetermined conditions are met. They typically are used to automate the execution of an agreement so that all participants can be immediately certain of the outcome, without any intermediary's involvement or time loss.

Smart contracts are an important part of DApps as they are used for performing basic operations. Following contracts are included in this framework:

- Patient Records
- Roles

Evaluation Metrics

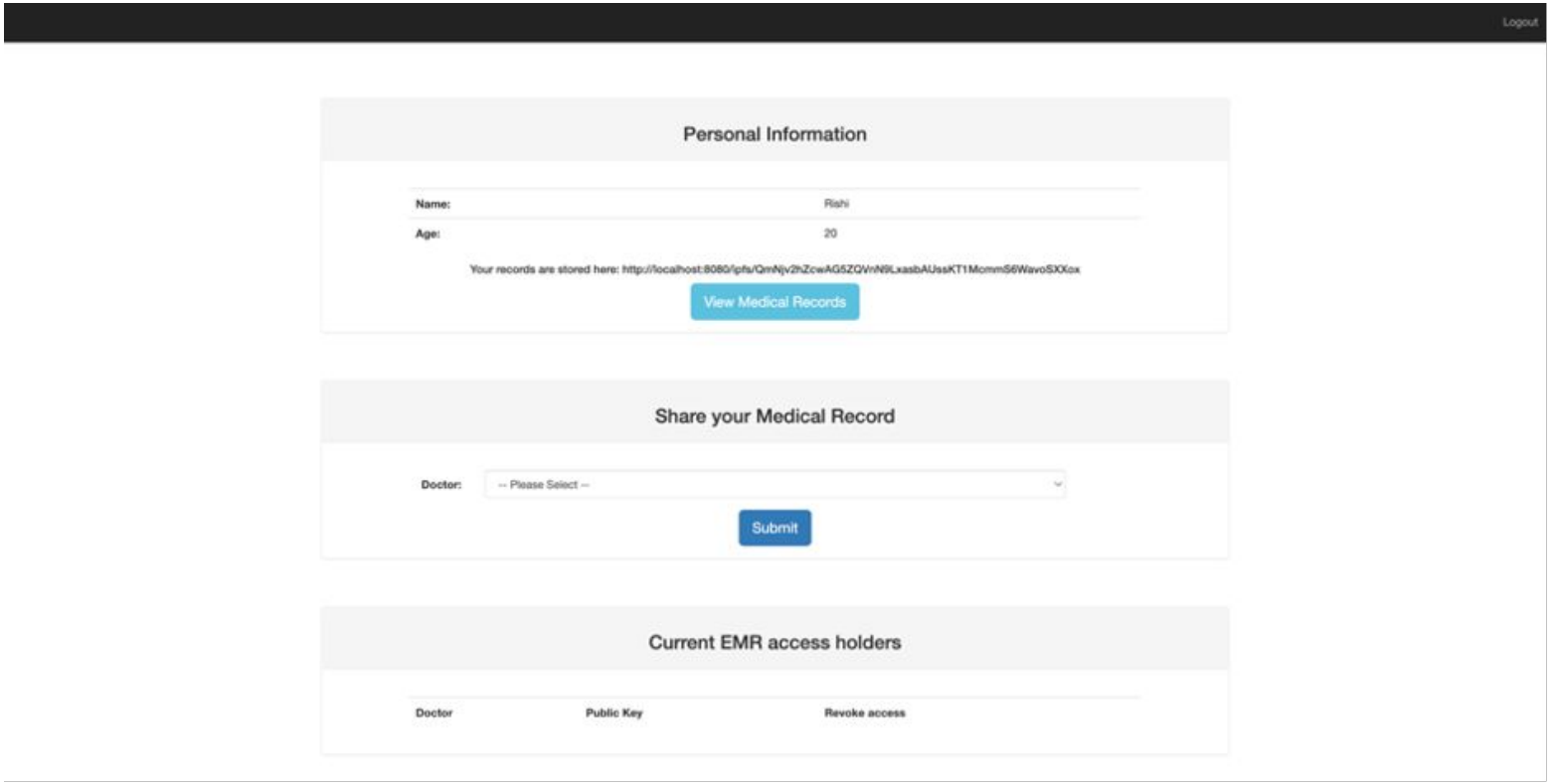
The metrics used for evaluation include the execution time, latency and throughput of the proposed framework. These are explained briefly as follows:

- **Execution Time** is defined as time duration (in seconds) between the transaction confirmation and its execution in the blockchain network. Mathematically, it is (max (tx2) - min (tx1)).
- **Throughput** refers to the amount of data that could be transferred from one location to another in a unit amount of time.
- **Latency** is known as the delay that occurs when a system component is waiting for another component of the system to respond to an action. In terms of time it could be referred as the difference of deployment and completion time of transaction.

Implementation

```
function add_agent(string memory _name, uint _age, uint _designation, string memory _hash) public returns(string memory){
    address addr = msg.sender;

    if(_designation == 0){
        patient memory p;
        p.name = _name;
        p.age = _age;
        p.record = _hash;
        patientInfo[msg.sender] = p;
        patientList.push(addr);
        return _name;
    }
   else if (_designation == 1){
        doctorInfo[addr].name = _name;
        doctorInfo[addr].age = _age;
        doctorList.push(addr);
        return _name;
   }
   else{
       revert();
   }
}
```

```
pragma solidity ^0.8.0;

contract Agent {

    struct patient {
        string name;
        uint age;
        address[] doctorAccessList;
        uint[] diagnosis;
        string record;
    }

    struct doctor {
        string name;
        uint age;
        address[] patientAccessList;
    }

    uint creditPool;

    address[] public patientList;
    address[] public doctorList;
```


Logout
Personal Information
Name:
Rishi
Age:
20
Your records are stored here: http://localhost:8080/ipfs/QmNjv2hZcwAG5ZQVnN9LxasbAUssKT1MomnS6WavoSJXXox
View Medical Records
Share your Medical Record
Doctor:
-- Please Select --
Submit
Current EMR access holders
Doctor
Public Key
Revoke access

Logout

Personal Information

Name:	Rishi
Age:	20

Your records are stored here: http://localhost:8080/ipfs/QmcyUKqL3BEXPCsjP1iabz7nNhvYcHHxTkoTmyRLqVzLtg

View medical records

Share your Medical Record

Doctor: Dr Sathwik

Submit

Current EMR access holders

Doctor	Public Key	Revoke access
Dr Sathwik	0x38871c02cb7d57cf30af28afae07a2b988a0f0ca	Revoke access

References

- Akarca D, and Xiu PY, Ebbitt D, Mustafa B, Al-Ramadhani H, Albeyatti A, "Blockchain Secured Electronic Health Records: Patient Rights, Privacy and Cybersecurity," 2019
- B. L. Radhakrishnan, A. S. Joseph and S. Sudhakar, "Securing Blockchain based Electronic Health Record using Multilevel Authentication," 2019
- M. Abdulaziz, D. Çulha and A. Yazici, "A Decentralised Application for Secure Messaging in a Trustless Environment," 2018
- N. Poonguzhali, S. Gayathri, A. Deebika and R. Suriapriya, "A Framework For Electronic Health Record Using Blockchain Technology," 2020
- S. Alexaki, G. Alexandris, V. Katos and N. E. Petroulakis, "Blockchain-based Electronic Patient Records for Regulated Circular Healthcare Jurisdictions," 2018
- U. P. Ellewala, W. D. H. U. Amarasena, H. V. S. Lakmali, L. M. K. Senanayaka and A. N. Senarathne, "Secure Messaging Platform Based on Blockchain," 2020
- V. B, S. N. Dass, S. R and R. Chinnaiyan, "A Blockchain based Electronic Medical Health Records Framework using Smart Contracts," 2021
- V. M. Harshini, S. Danai, H. R. Usha and M. R. Kounte, "Health Record Management through Blockchain Technology," 2019

Thank You