Blockchain in Healthcare

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Abstract – *Initially blockchain was offered through Bitcoin, study has been going on to extend its applications towards non-financial use cases. Healthcare is one of the industries blockchain is expected to impact significantly. This paper is concerned with the use of Blockchain in handling and allocating electronic health and medical records to permit patients, hospitals, clinics, and other medical participants to share data among themselves. The assortment of the Blockchain used architecture rest on the entities contributing in the built chain network. Even though the use of Blockchain may reduce redundancy it can even provide doctors with reliable records about their patients. It still comes with few challenges with privacy or potentially compromise the whole network. In this paper, we examine different Blockchain structures, look at current challenges and provide possible explanations.*

Keywords – Blockchain, Hyperledger, healthcare, digital health, data redundancy, patient data, smart contract

1. INTRODUCTION

Hyperledger Fabric is a "permissioned" blockchain architecture, providing a consistent distributed ledger, shared by a set of "peers". As with every blockchain architecture, the core principle of Hyperledger Fabric is that all the peers must have the same view of the shared ledger, making it challenging to support private data for the different peers [12]. blockchain is a distributed ledger involving network nodes, which records executable transactions between nodes. Information integrated in the blockchain cannot be modified or erased. Smart contracts are saved on blockchain which are directly written into lines of code. The objective of this paper is to reduce Data Redundancy, provide Data Security and help companies operate in the Healthcare Sector to an overview of blockchain based use cases by highlighting strengths, weaknesses, opportunities and threats for this technology.

2. OBJECTIVE

The objective of this project is to design a blockchain based healthcare platform to record the patient's medical data. Blockchain guarantees the security of sensitive data by tracking access to confidential medical records of the patients and ensuring authorized access to the data. We implemented healthcare based blockchain framework based on Hyperledger fabric. We have conducted experiments by scaling up the network to test the robustness of the system.

3. LITERATURE SURVEY

Healthcare sector always remains one of the most popular areas of research from the last few decades keep on finding innovative and more reliable ways to help the community and healthcare industry. Different stakeholders (practitioners, medical specialists, hospitals, therapists, patients, payers, etc.) need to organize, access and share health records without any modification in a secure and interoperable way. Data provenance is also essential to prove the authenticity of records. Blockchain technology is being implemented in different scenarios and has the potentials to address the key issues of the healthcare sector. However, it needs more research to be focused to deploy real-time applications of this technology. Given beneath are a few submissions of this technology in the healthcare sector.

We started the review by collected papers through two sources, including academic databases and Google Scholar. Overall, we perform the search in 14 journal databases related to information systems and healthcare and included published papers as well as articles in press (till March 2019). Appendix A illustrates the names of the 14 electronic databases. Through the database search, we have reviewed over 25 premier healthcare, information systems and business journals (provided in Appendix B). The nominated journals are ordered as Q1 in the SCImago Ranking system2, which was our early basis of inclusion in the review process. To automate data collection through databases, we developed a script in R programming language that accessed the journals metadata using Application Programming Interface (APIs) of the related databases. The citation from the script is offered in Appendix C3. The list of search terms included "blockchain", "block chain", "distributed ledger", "smart contracts" to satisfy PRISMA conditions (Moher, Liberati, Tetzlaff, Altman, & Group, 2009)4. The PRISMA (i.e. Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework lay down an evidence-based least set of items for broadcasting in methodical reviews and meta-analyses and has been widely utilised in the

academic studies, including (Kruse, Goswamy, Raval, & Marawi, 2016). The benefits of using PRISMA for the examination allowed to employ guiding principle to assess clearly formulated questions and use orderly and explicit methods to trace, select, and critically gauge relevant publication to address the research queries acknowledged earlier.

4. EXISTING SYSTEM

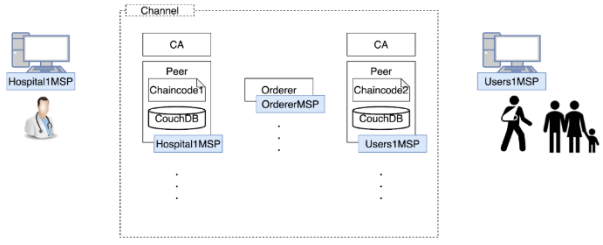
Currently most hospitals, clinics and other health care centres use a centralize mode to store data. This is not a secure way as data can be tampered with in this case. A centralized server stores all the data in a single server. These servers are mainly owned or rented. The doctors usually use the cloud or their local storage for backing up of the patient details. A centralized server stands a chance of losing all data at once or be allowed to tamper with the same.

5. PROPOSED SYSTEM

Blockchain technology has the potential to transform health care by placing the patient at the center of the health system and increasing the security, privacy, and interoperability of health data. This technology could provide a new model for health information exchange (HIE) by making electronic health records (EHRs) more efficient and secure. Blockchain being decentralized means no data is stored at a central server. This results in time saving and also data cannot be modified or erased.

Each patient has their own record which includes:

- Accesslist: people who can read the record and doctor can write on it.
- Allowedlist: list of patient id that can be accessed.
- Health records: history of medical records. Each doctor has their own patient list that they can access. Health Record system

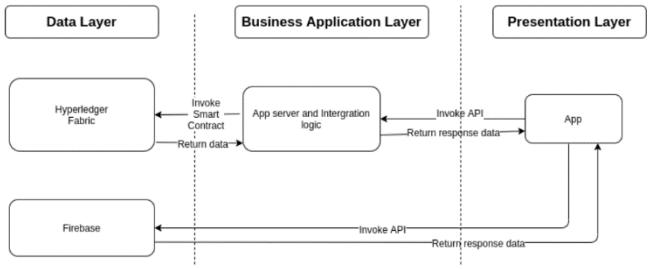


6. COMPARISON BETWEEN EXISTING AND PROPOSED SYTEM

In existing system, there is no mechanism to process the data onto a decentralized platform as the healthcare industry uses a centralized platform to store the patient health records.
But in proposed system, one network is sufficient to involve all the peers in the system to fetch status in order to process patient's health records using smart contracts. This results in time-saving and data cannot be modified or erased once uploaded onto the decentralized network.

7. SYTEM ARCHITECTURE

A. System Architecture Diagram



Three Layer:

- Presentation Layer: web application using Reactjs.
- Business Application Layer: server providing API using Nodejs and Expressjs.
- Database Layer: on-chain (Hyperledger Fabric) and off-chain (Firebase).

B. Flow of the application

1. A patient sign in or sign up their own account,
2. In the first time, they are asked to choose role and write their name (a specific record is made in CouchDB).
3. The patient allows a doctor to access his/her record.
4. Doctor selects a patient in his accessList and click button to query records of this patient.
5. After examination, the doctor writes a medical record into patient health record history.
6. Patients can get their medical records anytime.
7. If the patient sees another doctor, the patient adds the doctor into the permission list.
8. The patient can delete permission anytime.

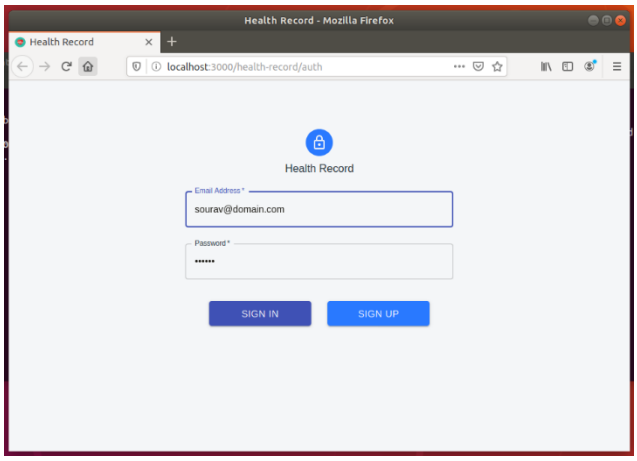
8. MODULES

a) Presentation Layer
b) Business Application Layer
c) Chaincode
d) Data Layer

C. Presentation Layer

Both the patient and the doctor are asked to sign up by entering their email id and password. Then they are redirected to the page where they are then asked to choose their role at the time of signing up to the application. This

presentation layer stores the user data in the data layer. The presentation layer is the front-end of the application through which the user interacts. The front-end or the presentation layer is made using *Reactjs framework.*



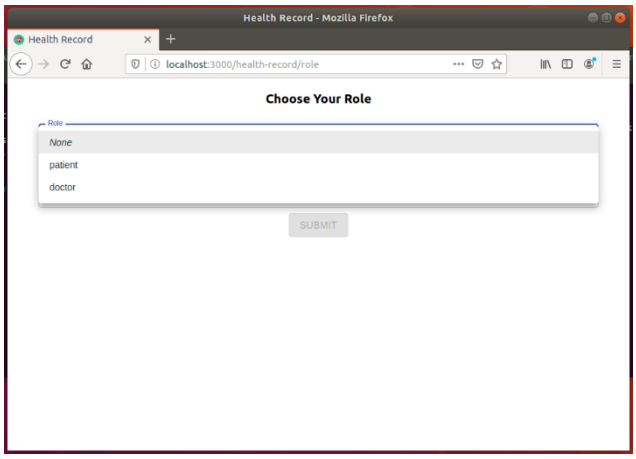


Fig 1: Registry

Fig 2: Assigning Role

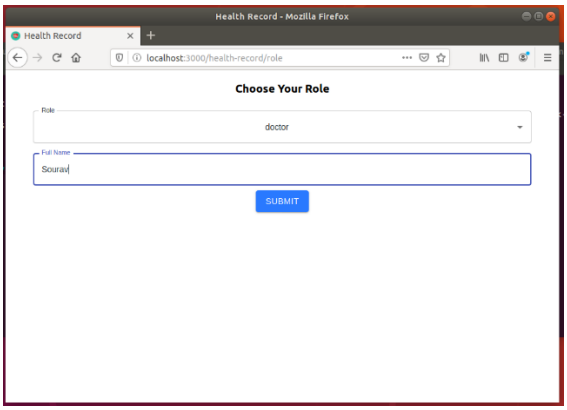


Fig 3: Details Submission

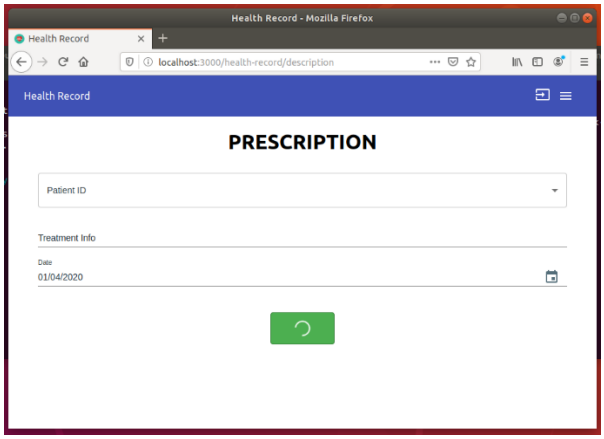


Fig 4: Medical Record Registry

D. Business Application Layer

The business application layer contains the main logic of the application which in turn is used to communicate between the *front-end* and the *Hyperledger Fabric*. This invokes the smart contract in Hyperledger Fabric when there is any activity by the user in the front-end. The main task to be followed out by the *Business Application Layer* is to invoke the API request from the presentation layer or the front-end of the application, the smart contract from the Hyperledger Fabric or the blockchain and then return data as per the patient's and doctor's request.

E. Chaincode

In Hyperledger, a *Chaincode* is a program that implements a prescribed interface. It prepares and brings about ledger state via transactions submitted by applications. Here in the chaincode we have prescribed it such that it is used to modify the records of the doctors and patients. It is used to create doctor and patient records, get medical information of the patient and to edit authorization permission.

F. Data Layer

The Data Layer is the *Back-end* of the application. This contains the database where all the records of the doctors and the patients are stored. Here all the medical records regarding the patient is stored as well. In the data layer we have two sections:

- Hyperledger Fabric: This is the blockchain part of the project which is used to validate and store the medical information of the patients. It is also used to provide the access permission to the documents uploaded to the doctor via the patient.
- Firebase: This is used to store the login data of the doctors and the patients which is used at the time of login to the application. It even updates when there is a new user signing up to the application by the role of either doctor or patient.

9. CONCLUSION

With the recent advancements in internet and network technologies, there is a clear need of the enhancement in the quality of medical and healthcare services. There are numerous shortcomings in the current healthcare systems that seek solutions based on distributed and decentralized approaches. In this context, blockchain technology can play a leading role in providing the solutions that are decentralized and can ensure the security and integrity of the medical data. Thus, the main focus of this work is to provide an outline of blockchain technology in the field of healthcare. This article identifies key application areas in the healthcare domain where blockchain technology can be a useful addition. Moreover, various requirements and challenges for blockchain based healthcare systems are presented in this work. Finally, the concept of smart contracts for blockchain based healthcare systems is highlighted.

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