International Journal for Modern Trends in Science and Technology, 6(11): 72-78, 2020

ISSN: 2455-3778 online
DOI: https://doi.org/10.46501/IJMTST061113
Available online at: http://www.ijmtst.com/vol6issue11.html

Record Storage and Management System Using Blockchain

Jatin Pahuja[1] | Dr. Neha Agrawal[2]

[1]B. Tech Scholar, Department of IT, Maharaja Agrasen Institute of Technology, Delhi, India
[2]Assistant Professor, Department of IT, Maharaja Agrasen Institute of Technology, Delhi, India

To Cite this Article
Jatin Pahuja and Dr. Neha Agrawal, "Record Storage and Management System Using Blockchain", *International Journal for Modern Trends in Science and Technology*, 6(11): 72-78, 2020.

Article Info
Received on 12-October-2020, Revised on 06-November-2020, Accepted on 10-November-2020, Published on 13-November-2020.

ABSTRACT

On a daily basis we deal with documents like educational records, health records, certificates etc. Medical records are still being stored on legacy systems which carries the risk of losing important documents. There are security and privacy concerns regarding the safety of documents on centralized server. To overcome these difficulties, we made a blockchain based record storage web app through which anyone upload their medical records on the blockchain and can access them with a private key. The patient or the user can download and access reports from anywhere and can also manage to share them with his doctor etc. Blockchain is a decentralized, distributed, peer to peer ledger on the internet. Blockchain technology helps to maintain security and reliability without placing any trust in a third party. The use of smart contracts in blockchain helps in making things much easier.

This paper examines the record storage system including the technologies involved and the methodologies. The approach used for making an electronic health record storage web app through which we can implement a more broader record storage system that can store and manage numerous types of records.

KEYWORDS: *Blockchain, decentralized, ledger, records, smart contracts*

I. INTRODUCTION

Being healthy is important to all the people in the world. Now with the coronavirus pandemic going on being healthy and disease free is the most important thing in the world. There are a countless number of treatments in the current living scenarios. Keeping track of those treatment records is important. Even though there is a tremendous change in the current technology, still there is a need for improvement in the medical field. Medical records are important to the patient for further treatments. Storing and accessing these medical records is significant. In the present scenario, the interoperability of medical records is difficult, time taking process and patient's access to the medical records is not permitted in some health care centers. A system where the patient can securely store and access all his medical records was needed to be developed. We developed an application using blockchain where the patient has access to all of his/her records

Blockchain is the major basis of the project. The blockchain is a cryptographic protocol that connects a network of systems to maintain the shared ledger information. Each block in the chain is a time sequenced chain of events that are created using consensus mechanism. All the blocks in the blockchain are linked using the previous hash value of the block.

We have built a Blockchain based health records storage system on a web application using MEVN stack, IBM Hyperledger fabric and IBM blockchain extension. The application will be integrated with IBM based blockchain to make the patient's data secure using reliable transactions. In our healthcare system a transaction equates to patients' hospital visits, administration documents, diagnoses reports, treatment details, physician's notes, laboratory results or reports, prescriptions, X-rays, outcomes etc. With our system, patients will have data sharing options. They now will have the right to choose what part of their medical history can be viewed by healthcare providers according to their need while keeping rest of the data private and secure. This model will be very useful for healthcare providers to treat their patients properly and efficiently. Blockchain being decentralized promotes interoperability across different hospitals or organizations and hence everyone can make use of one standard system to store health data.

The system aims at easing the work of healthcare providers by securing medical data as well as by gaining important and relevant information from a patient's medical history. By saving a lot of time and resources wasted in maintaining health records otherwise, doctors can utilize this time for better and efficient treatment of patients. Great care of patients will ultimately lead to a healthier society with first class healthcare providers. Hence our project has a great positive social and environmental impact.

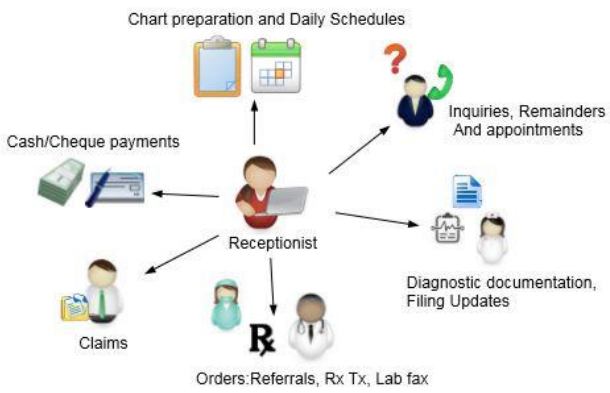

Figure 1: Existing healthcare system

II. INTRODUCTION TO BLOCKCHAIN

We are moving on from the era of information of the internet to the era of value on the internet. Soon you will be able to transfer things of value like properties, assets, records digitally on the internet. This will be made possible due to the revolutionary technology called blockchain. The first usage of blockchain was in 2009 when Satoshi Nakamoto [1] made the cryptocurrency called bitcoin, which is a secure peer to peer digital currency.

Blockchain as the name suggests is made up of two words block and chain, in a sense it is actually a chain of blocks where the blocks are made up of information. The information is the data of transactions which contains the hash key and transaction details. Blockchain is typically a distributed peer to peer open source ledger where each transaction is recorded with digital signatures. Think of it as distributed database stored in different computers where even if one computer fails the database would still be safe as its stored on different computers.

Blockchain works when transactions take place. The simple process is that first transactions happen then they get verified and the block gets added to the chain. Every transaction occurring in the blockchain is verified and validated by miners or nodes in the network. Proof of work is the consensus algorithm that is used in blockchain to verify the transactions in the blockchain. Now the verification of transactions is like a puzzle where the miners solve the Pow problem whose answer is the hash. Miners use their computational power to solve this and get rewarded in the form of cryptocurrencies etc. When transaction gets verified the block gets added to the chain. Blockchain is a protocol its open source and anyone can view it, the transactions remain anonymous or pseudo anonymous. Blocks usually contain about an average of 500 transactions. Blocks are made up of block header and transactions data. The block header further contains six different components viz [11].

1 the version number of the software

2 the hash of the previous block - As each block in blockchain is connected to the preceding block. Hash is basically the digital signature of the block.

3 the root hash of the Merkle tree - All transactions contained in a block can be aggregated in a hash. This is the root hash of the Merkle tree.

4 the time in seconds – The timestamp of the block

5 the goal of the current difficulty - The goal indicates how small the new hash must be to claim validity.

6 the nonce - A nonce is basically number only used once, which is a number added to an

encrypted block in a blockchain that, when rehashed, meets the difficulty level restrictions.

Another important aspect of blockchain are smart contracts which are essentially programs that are executed when conditions are met. These are used to transfer value in a blockchain. For example, when we buy a house, we need to get documents, registry, identification etc. now through a smart contract between the bank, dealer and lender so that there is instant transfer of ownership and funds between the two parties.

Blockchain is difficult to hack or tamper with because the entire chain is stored with so many nodes that even if someone tampers with one of the nodes and changes a block, he would have to change every block in every version of the chain which would be impossible. Blockchain isn't owned by a single entity. It's entirely decentralized protocol where there is no need to have trust in one single entity. The blocks are added with consent of majority of nodes which promotes integrity. Blockchain has high availability because its distributed in nature and data can be retrieved at any time. Hackers can't tamper with chain and the data at each stage is encrypted and every user has its own private key.

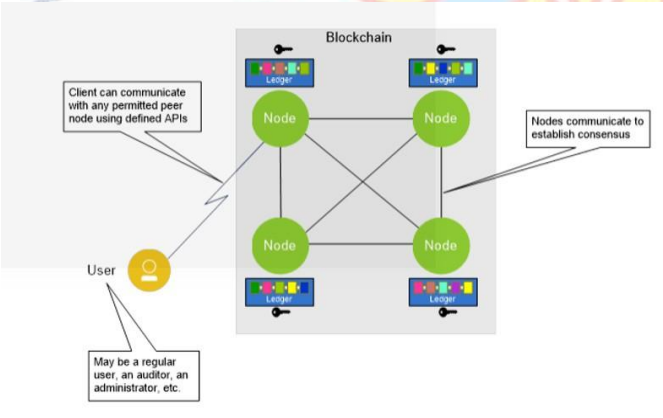

Figure 2: Architecture of Blockchain

III. SMART CONTRACTS

A smart contract is a set of programs or a block of code that self-executes when certain conditions are met on the blockchain [12]. The integration of smart contracts with the blockchain gives lots of flexibility to develop and design the solutions to the real-world problems without the involvement of third-party systems. When an event is triggered, automatically these contracts start getting executed. These contracts are immutable and distributed across the blockchain network. The output can be validated by everyone in the network. This makes the system open to the public.

The importance of smart contract integration with blockchain technology has become a focus area for development because it provides a trustful environment for peer to peer transaction and database. Smart contracts are irreversible and trackable. Ethereum blockchain is the largest ones to use smart contracts and a high-level language called solidity which is used for developing smart contracts. We have the following smart contracts in our system.

• Patient Contract: This contract helps in storing general details of patient like name, email, age etc. and functions for storing and retrieving the patient details.

• Doctor Contract: This contract helps in storing the details of doctor like name, email, specialization etc. and contains functions for storing and retrieving the information of doctor.

• Hospital Admin Contract: This contract helps in storing the details of the hospital admin and include functions for updating and retrieving their information.

• Appointment Contract: This contract includes the list of attributes required for booking an appointment with the doctor like doctor id, patient id, date of appointment, problem description etc. and contains the functions for updating the appointment information and retrieving the appointment details.

• Lab Appointment Contract: This contract contains the attributes to store the summary of patient medical record which includes the problem of the patient and the treatment given by the doctor.

Using smart contracts, the cost that involves in processing can be reduced when used effectively. Niya [13] used the smart contracts to reduce the cost that was involved in storing the data. The figure below shows the smart contract for the doctors.

```
'use strict';

class Doctor {
  /**
   *
   * Doctor
   *
   * Constructor for a Doctor object.
   *
   * @param args.licenseId - the license number of the Doctor
   * @param args.name - name of Doctor
   * @param args.age - age of Doctor
   * @param args.phNo - phone number of Doctor
   * @returns - doctor object
   */
  constructor(doctorId, licenseId, name, age, phNo) {

      this.doctorId =  doctorId;
      this.licenseId = licenseId;
      this.name = name;
      this.age = age;
      this.phNo = phNo;
      this.type = 'doctor';

      return this;

    }

  }



module.exports = Doctor;
```

Figure 4: Smart contract for doctor

IV.LITERATURE SURVEY

New technology was developed to store the patient records digitally known as Electronic Health Records (EHR) or Medical Health records. Tom Joseph [10] explained the administrative needs that an EHR should have, like patient documentation, quality assurance, tracking patient utilization, health record portability. He also described the uses of EHR application for physician order entry, laboratory systems, clinical documentation, pharmacy system, administrative applications. Finally, he discussed some strategies for software implementation.

As health data is increasing day by day, managing health care records become more costly in terms of security. Interoperability is also a major issue in EHR. So, there is a need for the development of new technology to reduce the cost and has the same standard of interface and application throughout the medical cares. The blockchain is the only solution for those problems. There are many types of research done on the blockchain technology, the first application of blockchain was the bitcoin proposed by Nakamoto [1]. He came up with the idea of transferring the money without the help of third parties. His main idea was that all the transactions that were made should be immutable and can be trackable.

Robert [15] considered the nature of the EHR system and the problems that were being faced. Issues addressed on EHR were ownership of the records, lack of interoperability (sharing of the records/data), no common interface everywhere and security of data. Due to EHR design shortcomings, it would take physicians much time to access the patient data. In consideration to all those problems, he proposed to use blockchain technology because the protocols of blockchain are universal, the applications in healthcare would be compatible, never distorting the data itself so that all users could safely access the information.

The advantages of this model are patient becomes the owner of their records i.e. they can allow who can and cannot see their records. It can be a difficult task for a hacker to extract or tamper with the data because the data in the blockchain are protected by the private and public key of the patient.

Linn [8] considered the interoperability problem of the present advanced EHR system. Because of the recent advancements in cryptocurrency and blockchain, he came up with a blockchain based solution to solve the interoperability problem. He used the public blockchain as an access-control manager to health records that were stored off the blockchain. His proposal was based on the three key elements, they are scalability, access security, and data privacy. The proposed model was designed based on the bitcoin blockchain. Storing the medical records in all the nodes is expensive, bandwidth intensive and causes the wastage of resources. In order to use the blockchain to its full potential, he stored indexes in the blockchain. The index acts as a catalo in a library. Each transaction in the block contains an encrypted link to the health record, a user's unique identifier, and a time stamp when it is created. To facilitate the user queries and data access efficiency, the transactions contain the data which is used frequently. The medical data is stored in the data repository called data lake which is scalable, stores a wide variety of data like images, document, etc., and the information stored is encrypted and digitally signed for ensuring the privacy and authenticity. Every time a new health care record is created, it is saved in the data lake and a pointer to the record along with the patient unique ID is registered in the blockchain.

Azaria [4] proposed a blockchain based solution and its implementation to the above problems that were discussed. They developed an application known as Medrec. It uses Ethereum based blockchain and smart contracts for the application. This application prioritizes the patient benefits providing trust and continued participation. It also prioritizes usability which aggregates references to all of a user's patient-provider relationships using contracts, thus providing a single point of reference. A synchronization algorithm handles the data exchange between the patient database and the provider database by confirming the permissions stored in the blockchain.

The constructed contracts contain data about the ownership, permissions and data integrity. These policies are designed to implement a set of rules to access a particular medical record. The system structures the records on the blockchain by implementing three types of contracts for navigating a large number of records. They are Registrar contract (RC), Patient-provider relationship contract (PPR), Summary contract (SC). The RC maps participant identification to the Ethereum address identity. This identification can also be restricted only to certified institutions. The PPR is issued between two nodes where one node stores and manages medical records of others. SC helps to locate the medical record history and it holds references to PPR representing all participants previous and current logs with other nodes in the system. The SC also implements functionality to enable user notifications. Two different models for mining are proposed. In the first method, the first node that solves the computational puzzle is given some ether as the reward. In the second method, the medical researches and health care authorities are encouraged to mine in the network as for the reward the network beneficiaries release access to aggregate, anonymized medical data as mining rewards.

The advantages of the proposed model are it manages authentication, confidentiality, accountability and data sharing-crucial considerations when handling sensitive information. It integrates existing local databases facilitating interoperability and making the system convenient and adaptable.

From the above, one of the important aspects of the application is linking all the records from the database (records are stored in the database) to the blockchain [9]. The reason for storing the data in the local databases is that a large amount of data cannot be stored in the block. It adds much overhead. In order to reduce the overhead and run the application smoothly, storing the index is much easier and takes less space. On each node, a hash table is maintained and it consists of the patient UID and the hash index. This is done to improve the search and retrieval queries when they are accessed. For example, whenever a patient wants to check his records, a request is sent to the nodes. Each node has a hash index that is stored along with the patient UID and the corresponding files are retrieved from the local database and shown as a whole to the patient.

In the current EHR, the data is being kept in the local databases of health care providers. This becomes a problem when the patient needs to access their data and sharing the data between two health care providers. Because of these disadvantages in using traditional relational databases for storing patient medical records, there is a need to shift to the new technology. We used blockchain technology for the implementation of the patient medical record management application. Blockchain technology offers many advantages like security, interoperability, etc. In the next chapter, we elucidate how blockchain technology is used for storing medical records and its implementation using various frameworks and tools.

V. METHODOLOGY

The web application has been made using MEVN stack and connected through Docker. MEVN stack is basically the use of 4 technologies namely MongoDB, Express.js, Vue.js and Node.js The smart contracts have been written in solidity language and executed using IBM Blockchain Extension.

I divided the project into 5 tasks as shown below:

1. Designing of the web app, the look and feel of the application using MEVN Stack (MEVN stands for MongoDB, Express.js, Vue.js, Node.js.). For the coding section itself, I divided this task into four separate parts: starting the Express web application, configuring the MongoDB models, creating the controllers, and defining the routes.
2. Making both client and server-side applications and connecting the mongo DB models to store the application data and using docker to make containers for the same. Also need to install certain libraries in python.
3. Writing code for smart contracts for both the patients and doctors and using IBM Blockchain extension on VS code. We are using the localhost for the implementation of the application and database for storing the login details of the users. The database contains two tables, one that stores the login information of the patient and the role id. The other tables contain the role id and the different roles that are assigned to the user. The user can take four different roles, they are receptionist, doctor, lab technician and patient.
4. Using IBM blockchain Platform to install smart contract on peers. Once the contract instance is created, we can use two main functions i.e. send Transaction, call. The send Transaction function is used to access the smart contract and update the

values in the contract. Whenever a send Transaction call is made, met mask pop ups the transaction interface. The transaction interface contains the details of the ether that is required to perform the transaction. When the user clicks accept, then the transaction is made and the values are updated otherwise, the values are not updated and the transaction is rejected

5.Finishing and maintaining the model. Finding out the bugs and key takeaways in the model and trying to achieve more security in the model without compromising on data. Testing the application should be easier. The ganache does not provide any proof of work mechanism. If the application needs to be tested using proof-of-work mining algorithm then there are different Ethereum test networks that can be used to deploy and test the application in real time networks.

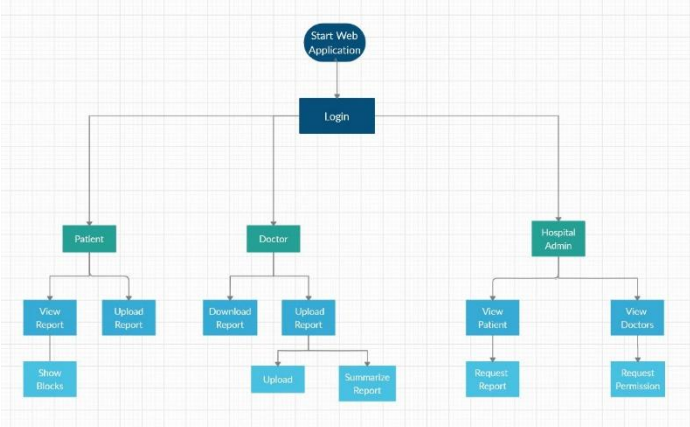

Figure 4: Workflow of the application

```
apt-get install python-software-properties
curl -sL https://deb.nodesource.com/setup_6.x | sudo -E bash -
apt-get install nodejs

npm install -g @vue/cli
npm install axios
npm install formidable

sudo apt install python3
pip install glob
pip install docx2txt
pip install networkx
pip install sklearn
pip install re
pip install nltk
pip install unicodedata
```

Figure 5: List of used Libraries

VI. RESULTS

As we all know how difficult it is to keep track of our medical history and to preserve the precious records so through this system, we have achieved a method of keeping your medical records on the internet with the use of Blockchain technology without the risk of having a centralized party snooping through our data. We have also made sure that the system is easier to use and access. The system has been designed using MEVN stack using IBM Blockchain. The system offers various advantages like

- Easy to share and manage who can see you your reports
- Blockchain itself is secured because tampering with the blockchain will change the state of chain and it does not allow it. Whereas in database, we need to have an extra protection layer for safely securing the data. System is encrypted and you can download and access reports using a private key.
- Once the data is entered in the blockchain, it cannot be deleted unlike in the database where there is a possibility of the data to be erased
- All the data is stored distributed in the blockchain unlike in the database where it is kept at a single place.

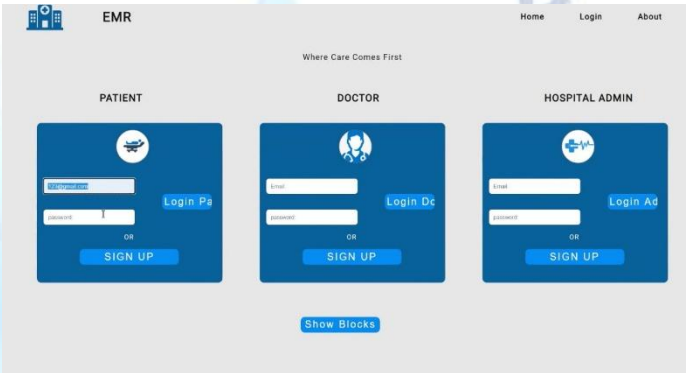

Figure 6: Homepage of Application

VII. CONCLUSION

In this report we have explained the record storage system in Blockchain. We have explained the technologies and the methodology behind it. The main advantages of this are that medical data is safe and can be accessed from anywhere. The patient can also manage to share his reports with doctors and hospitals. Unlike the traditional databases blockchain provides added security. Currently our system is confined to a single use case of medical records but this system can be used as the basis for different types of storage systems on blockchain. The opportunities are endless and with added hardware and software capability it can be used to make record storage for educational and other documents as well along with more added capabilities.

References

[1] Nakamoto, Satoshi (2009), "Bitcoin: A peer-to-peer electroniccash system." URL https://bitcoin.org/bitcoin.pdf/.

[2] Alhadhrami, Zainab, Salma Alghfeli, Mariam Alghfeli, Juhar Ahmed Abedlla, and Khaled Shuaib (2017), "Introducing Blockchains for Healthcare." In 2017 International Conference on Electrical and Computing Technologies and Applications (ICECTA), 1–4.

[3] Arlindo, F. da Conceic, Flavio S. Correa da Silva, Vladimir Rocha, Angela Locoro, and Joao Marcos M. Barguil (2018), "Eletronic Health Records using Blockchain Technology." Research gate, INCT of the Future Internet for Smart Cities.

[4] Azaria, Asaph, Ariel Ekblaw, Thiago Vieira, and Andrew Lippman (2016), "MedRec: Using Blockchain for Medical Data Access and Permission Management." In 2nd International Conference on Open and Big Data, Institute of Electrical and Electronics Engineers, 25–30.

[5] Hiroki, Watanabe, Shigeru Fujimura, Atsushi Nakadaira, Yasuhiko Miyazaki, Akihito Akutsu, and Jay Kishigami (2015), "Blockchain Contract: A Complete Consensus using Blockchain." In Institute of Electrical and Electronics Engineers 4th Global Conference on Consumer Electronics, 577–578.

[6] Kate, Barlow (2018), "The blockchain: The first step towards its healthcare transformation." URL http://www.global-engage.com/life-science/ the-blockchain-the-first-steps-toward-its-healthcare-transformation/.

[7] Krawiec, R J, Dan Housman, Mark White, Mariya Filipova, Florian Quarre, Dan Barr, Allen Nesbitt, Kate Fedosova, Jason Killmeyer, Adam Israel, and Lindsay Tsai (2016), "Blockchain: Opportunities for Health Care." URL https://www2.deloitte.com/content/dam/Deloitte/us/Documents/ public-sector/us-blockchain-opportunities-for-health-care .pdf.

[8] Linn, L. A. (2016), "Blockchain for health data and its potential use in health it and health care related research." ONC/NIST Use of Blockchain for Healthcare and Research Workshop, Gaithersburg, MD, USA: ONC/NIST.

[9] Macdonald, Liu Thorrold, and Julien (2017), "The Blockchain: A Comparison of Platforms and Their Uses Beyond Bitcoin." The University of Queensland, Research gate.

[10] Tom Joseph, Seymour, Dean Frantsvog, and Tod Graeber (2014), "Electronic Health Records (EHR)." American Journal of Health Sciences, Research Gate.

[11] Marko Vidrih (2018), "What Is a Block in the Blockchain?". URLhttps://medium.com/datadriveninvestor/what-is-a-block-in-the-blockchain-c7a420270373

[12] Mohanta, Bhabendu Kumar, Debasish Jena, and Soumyashree S Pand (2018), "An Overview of Smart Contract and Use cases in Blockchain Technology." Institute of Electrical and Electronics Engineers, 9th ICCCNT, 12–20.

[13] Niya, Sina Rafati, Florian Shupfer, Thomas Bocek, and Burkhard Stiller (2018), "Setting up Flexible and Light Weight Trading Contracts with Enhanced UserPrivacy Using Smart Contracts." IEEE/IFIP Network Operations and Management Symposium, Institute of Electrical and Electronics Engineers, 1–2.

[14] Pinyaphat, Tasatanattakool and Techapanupreed Chian (2018), "Blockchain: Challenges and applications." In International Conference on Information Networking, Institute of Electrical and Electronics Engineers, 473–475.

[15] Robert, Pearl (2018), "Blockchain, bitcoin and the electronic health record." URL https://www.forbes.com/sites/robertpearl/2018/04/10/ blockchain-bitcoin-ehr/.