

A Survey on Blockchain Technology for Electronic Health Record

Deepa Mahajan¹, Madhavi Kale²

¹Assistant Professor, Department of Computer Engineering, Dr. D. Y Patil Institute of Technology Pimpri, Pune Maharashtra, India

²Assistant Professor, Department of Computer Engineering, Government College of Engineering Jalgaon, Maharashtra, India

Abstract: *Electronic health record (EHR) has been important in the healthcare system. The main role of EHR in healthcare systems is improve efficiency in healthcare service, patient safety, increase access to health care services, and more importantly, the need to reduce the costs of medical expenditures. The main goal of this paper is introduced current trends in the roles, and applications of EHR in the healthcare system. EHR has been very useful in various ways in the healthcare system electronic health records are shared and stored by providing safer mechanisms for health information exchange of medical data in the healthcare industry, by securing it over a decentralized peer-to-peer network. Blockchain-based healthcare applications have been mentioned and workflow also derived for healthcare raw data, blockchain technology, healthcare application, and stakeholders. Healthcare data management, Internet of Medical Things, Blockchain Model for Health Care these topics also describe for healthcare in Blockchain technology, Blockchain Application in Health information Exchange and challenges also mentioned.*

Keywords:-Blockchain technology, Digital healthcare, Trust, Data ownership, Electronic medical records, Decentralized privacy, Electronic Health Records, Healthcare Data Gateway (HDG)

1. INTRODUCTION: -

What are blockchain; Blockchain technology is information storage and transmission technology that is transparent, secure, and operates without a central controls body. It is a chain of blocks. Blockchain technology is a Distributed Ledger Technologies also a decentralized consensus platform [1]. Blockchain technology is a type of decentralized distributed ledger technology platform that proof of ownership without using a trusted third party intermediary transfer of ownership from one entity to another. A blockchain is a database that all the exchanges between its users since its creation. This database is secure and distributed because it is shared by its various users, without intermediaries third party which allows each one to check the validity blockchain technology implement for EHR and secondly to provide secure storage of electronic records by defining access of users. Health Record (EHR) and Electronic Medical Record (EMR) systems face some problems regarding the security of medical records, user ownership of data, data integrity [2]. Blockchain technology provides a secure, tem-

per-proof for storing medical records and other healthcare related information. Medical Blockchain plans to introduce blockchain technology to the electronic health records (EHR) industry [4].The sharing of healthcare data is an essential step to make the healthcare system smarter and improving the quality of healthcare service. An EHR is a structure in digital format of a patient's health data that are created and maintained throughout the patient's life, and it is stored and spread among multiple hospitals, clinics, and health providers. These providers retain primary access to the records, for easy access to past data by the patients. In situations where the patients have access to their health record, they are interacting with data in an exist manner that reflects how these records are managed [7].

One of the requirements for the healthcare industry is Interoperability. It is a two parties Based on ability, either human or machine, to exchange data or information precisely, efficient, and consistently The goal of interoperability in healthcare is to exchange of health-related information, such as electronic health record(EHR), among healthcare providers and patients, so that, the data can be shared throughout the environment and distributed by different hospital systems[10].If a patient wants to access his medical records he would have to follow a long and tedious process to access them. The information is centralized to only a single healthcare organization and its control is only provided to the hospitals or organizations. Many EHR systems are not designed to fulfill the needs and requirements of the patients and face the issues related to inefficiency [11].

This paper provide a framework that creates such a

Decentralized platform that would store patient's medical records and give access of those records to providers concerned individuals, i.e. patient. We also intend to solve the scalability problem of blockchain, as it is not in the design of blockchain to store huge volumes of data on it. So, use off-chain scaling method that makes use to solve the scalability problem by storing the data on that medium. Solve the above mentioned information asymmetry1 [13]

This paper is organized as follows the section I of this paper summarizes the basics of block chain technology and its dependencies; Section II defined Problems and Its Background section III explain related to work, Methods

and Procedure The section IV showed Blockchain Application in Health information Exchange, and section V discussed challenges faced by blockchain technology. The last section provides the conclusion and references.

II. THE PROBLEM AND ITS BACKGROUND

How to share medical data with known and unknown stakeholders for various purposes while ensuring data integrity and protection patient privacy this challenge faced by health care systems So need to maintain data security for each electronic health record (EHR) stores data using different workflows. All these workflow process transaction trust is very important. Create a trust to provide for decision-making is a challenge for the medical fraternity multiple providers can view, edit, and share patient data by authoritative and up-to-date record of diagnoses, medications, and services [3].

Health Data Are not stored in the Chain security of the data is a benefit of using blockchain technology but no one likes personal health data in their implementation of blockchain. MedRec not to 'store' the record directly that first encodes metadata that allowing records to be accessed securely by the patients. Is the example storing metadata MedRec stores basic information such as ownership and permission than the patient record is requested? Storing large amounts of data on a blockchain is recognized as big cost, both in financial and computational senses, due to the need to a cryptographically sign data, and encrypt it, data storage in a public chain and because of the replication requirements of a distributed data store[4].

III. METHOD AND PROCEDURES

3.1 Smart Healthcare

Smart healthcare has many components, such as wearable devices, smart hospitals, smart emergency response and smart ambulance systems. The patient data be very important for the efficient treatment of patients., The patient data sharing among different hospitals will help nurses and doctors to judge a patient's condition Applying blockchain in smart healthcare, For, example, medical data can be stored on the blockchain in a secure and unable to change. Patients can control the use of their medical data, and manage the access to their data flexibly. In the following, the related on blockchain- based smart healthcare solutions will be summarized [7].

3.2 Health Data Sharing and Storage:

Healthcare is a large amount of medical data is created, stored and accessed daily. In the traditional healthcare system, a patient's medical data is scattered across dif-

ferent hospitals, resulting that each hospital does not have the patient's complete historical medical data, which has a bad effect on the treatment of patients, and the quality of healthcare services. Thus, it is necessary to share patients' medical data among different healthcare providers (e.g. hospitals). On the other hand, patients' medical data is very important for healthcare decisions. Any data tampering is not allowed. How to store the medical data securely, the data integrity, is a challenging task. The rapid development of blockchain technology promotes the sharing and storage of medical data. Patients' medical data can be shared and stored on the blockchain in, secure, and reliable way.

Distributed Electronic Health Records (EHR) storage and processing system that integrates the blockchain, IoT, and big data technologies. IoT devices can collect a huge amount of EHR data. The collected data is stored on the blockchain-based BigchainDB. Big data tools are used to process data. [7]

Healthcare Data Gateway (HDG)-centric healthcare architecture that enables patients to manage and control their medical data securely. The HDG-centric healthcare architecture is composed of three layers: data storage layer, data management. Layer and data usage layer

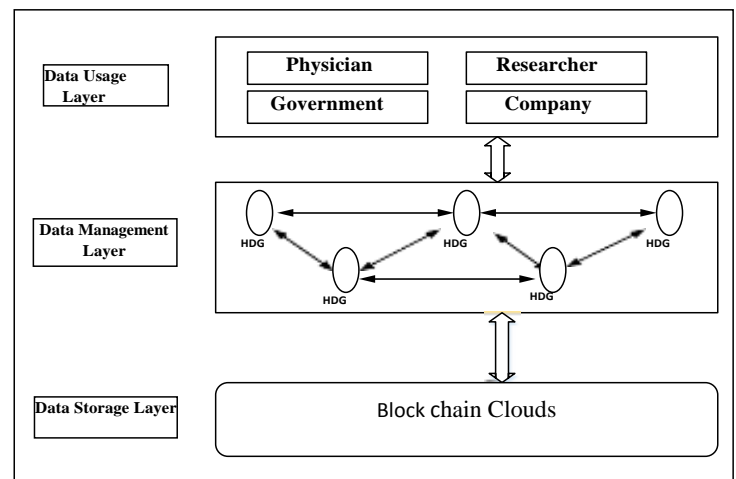


Figure 1:- The HDG-centric healthcare architecture.

The responsibility of data storage layer is to store medical data securely and immutably. A set of connected HDGs are included in the data management layer. The data usage layer consists of entities that use the patients' medical data.

The blockchain is used in the data storage layers to store personal medical data securely and immutably.

Blockchain-based smart healthcare system is proposed to protect physiological signals from the human body, which is shown in Fig. 1. The system is composed of a Body Sensor Network (BSN) and a health blockchain. The BSN is

deployed on a user's body to collect various physiological signals. This collected data are stored on the health block chain. Blockchain-based approach to share healthcare information among institutions effectively and securely. In the approach, an emerging standard, called Fast Healthcare Interoperability Resources (FHIR) [14], is chosen as the sharing format of electronic health records. To ensure blockchain consistency and interoperability, a Proof of the Interoperability mechanism is proposed [6]. A blockchain-based healthcare system is proposed to enable secure health data sharing among Pervasive Social Network (PSN) nodes. The system consists of two areas: Wireless Body Area Network (WBAN) area and PSN area. In WBAN area, an improved protocol based on IEEE 802.15.6 is proposed to establish secure links between sensor nodes and mobile devices. In PSN area, the blockchain is utilized to enable health data sharing among PSN nodes.

3.3 Health Data Access Control:

One of the requirements and the healthcare industry is Interoperability. It is a two parties on the basis of ability, either human or machine, to exchange data or information precisely, efficiently, and consistently. The goal of interoperability in healthcare is to exchange of health-related information, such as electronic health record (EHR), among healthcare providers and patients so that the data can be shared throughout the environment and distributed by different hospital systems [10].

If a patient wants to access his medical records he would have to follow a long and tedious process to access them. The information is centralized to only a single healthcare organization and its control is only provided to the hospitals or organizations. Many EHR systems are not designed to fulfill the needs and requirements of the patients and face the issues related to inefficiency [11].

3.4 Blockchain-Based Healthcare :

Blockchain is adaptability and abilities to segment, secure and share medical data and services in unprecedented way. Current developments in the healthcare industry Blockchain is the center. Blockchain-based healthcare technologies are divided into four layers, blockchain technology, healthcare applications, and stakeholders including data sources [2].

All the data combined from medical devices, labs, social media, and many other and create raw data. Blockchain platforms users to create and manage their transactions. Several blockchain platforms had created and use, such as Ethereum, Ripple, and Hyper ledger Fabric the main components of the blockchain are smart contracts, signatures, wallet, events, membership and digital assets. Or communicating with other frameworks, or even across

different networks, a wide range of protocols could be used. There is including for instance, P2P, centralized, decentralized, and distributed. Once the platform is created by blockchain technology, the next phase is to ensure that the applications are integrated with the whole system [3]. Stakeholder layer is the Top of the hierarchy, which consists of parties who are benefit from blockchain, based healthcare applications such as business users, researchers, and patient. The main concerns of users at this layer is to share, process, and manage data security and privacy [9].

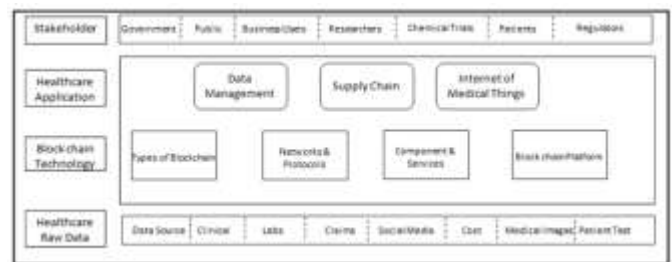


Figure 2. A workflow of blockchain-based healthcare applications. The workflow is composed of four main layers including healthcare raw data, blockchain technology, healthcare application, and stakeholders. The blockchain as a decentralized technology enables multiple stakeholders to benefit from healthcare applications.

3.5 Healthcare data management:

Seven steps to show workflow of blockchain, which are given below like Electronic health-related data, cloud healthcare data storage and patient data privacy protection regulations, new opportunities are opening for health data management, as well as for patients' convenience to access and share their health data in Blockchain-Based Healthcare Management [64]. Securing data, storage, transaction, and managing their smooth integration are immensely valuable to any data-driven from organization, especially in healthcare where blockchain technology has the potential to resolve these critical issues effective way [9]. Fig 3 illustrate type of healthcare Data Management.

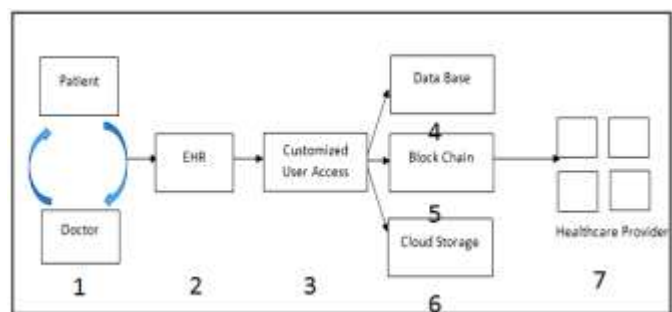


Figure 3. Healthcare data management in blockchain

Step-1: specialists are the primary data, and interaction between a patient and their doctors this data consists of medical history, current problem, and other physiological information [9].

Step-2: In the step primary data collected for each patient by EHR. Other medical information such as those generated from nursing care, medical imaging, and drug history are also included in HER [9].

•Step-3: suppose Parties who want to access such valuable information have to request permission which is forwarded to the EHR owner, and the owner will decide to whom access will be granted. : Individual patient who has the ownership of sensitive EHR, and customized access controls given only to the owner of this property

•Step-4, 5, and 6: Database and cloud storage store the records in a distributed manner. Blockchain provides privacy for customized authentic user access. These three steps are part of the basic of the whole process including database, the blockchain, and cloud storage.

•Step-7: Healthcare providers ad hoc clinic, community care center, hospitals are the end user who wants to get access for a safe delivery which will be authorized by the owner. For example, your health record will be available and accessible on your phone and validated through a distributed ledger such as blockchain [9]. Blockchain based applications like data sharing, data management, data storage (e.g. cloud-based applications) and EHR, which are discussed in details below

3.6 Data Sharing:-

Healthcare system will make smarter with the help of sharing healthcare and medical data and improve the quality of healthcare providers. Sharing health records would be happened between individuals. In first meeting patient want to share his medical history with a doctor [7]. As well sharing will be happened between an individual and a stakeholder when a patient sharing his medical history with an insurance company or a research center. Today's health-related systems have some limitations. Patients hardly have access to their health records is one of the limitations. Therefore, they don't have idea about the sharing of their health data among unknown parties. In such cases blockchain could be play crucial role for interaction and collaboration with the health care industry and securing a convenient sharing mechanism of electronic health data [9].

3.7 Data Management for healthcare:-

Different users have different roles for health data, and access to data by blockchain technology. MedRec is the main purpose of blockchain technology. Data permission and operation are recorded in the blockchain by EMR management system, and execution is completed by smart contracts. MedRec would have consolidated medical information for data authentication are benefit, auditing, and sharing, authority node to allow users to terminate and prevent any potentially malicious actions even in a majority of attack for trust. Healthcare system which mainly provides user to control the whole health record data by using blockchain [9].

3.8 Cloud-Based Applications:-

In blockchain technology every transaction of healthcare is stored in blocks on decentralized storage system. Security is the main concern for cloud storage that is connected all together for storage and accommodates a lot of Information Technology. Advantages of Cloud storage technology is fast transmission, good sharing, storage capacity, low cost, easy access, and dynamic association. Cloud challenges as how medical providers and organizations, public health agencies, healthcare service providers, and governments need to collaborate. Blockchain technology developed for secure, share, and store EHR data secure blockchain framework for medical data share by secure cloud storage for patients' sensitive medical record. To encrypt medical data, they used for identity-based encryption and identity-based signatures at the same time to implement digital signs. On top of that blockchain, other techniques are used to ensure the integrity and traceability [9].

3.9 Internet of Medical Things:-

IoMT systems are important in development of health and medical information systems. In IOMT Healthcare equipment such as heart monitor, body scanners, and wearable devices will be gather, process and share data over the Internet in real time. AI, healthcare providers, using the IoMT is an example, would capture an image, and identify malignant parts or even suspicious cells. And share such knowledge only those who have the right to access the information. The following area explores the idea in healthcare IoT and smart medical devices in the AI [9].

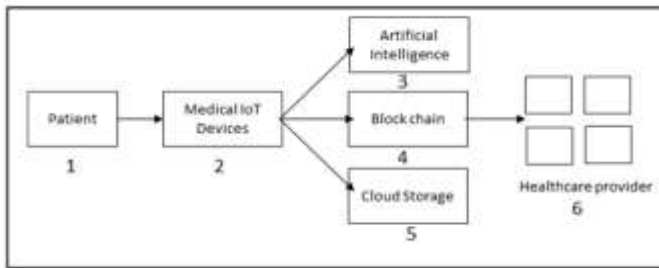


Figure 4. Internet of medical things (IoMT) in blockchain

Figure 4 is an illustration of IoMT in blockchain.

Step-1: In IoMT, the patient is the main source of all data.
 Step-2: Medical IoT devices are attached closely for monitoring patient's body, consequently, generating large volume of data.

Step-3: in step-2 data generate and stored on blocks or on the cloud storage. AI will help blockchain to create intelligent virtual agents, as well as create new ledgers automatically. Security is the prime priority when medical data will have sensitive, decentralized AI system can be help block chain to reach the highest security

Step-4: Healthcare providers are the end users who have access for a safe delivery which is authorized by the owner[9]

3.10 Blockchain Model for Health Care

A distributed blockchain that contains health records, documents would be storage, after the Bitcoin blockchain, every member in the distributed network of the health care blockchain would have a copy of every health record for every individual. Health data is dynamic and expansive, replicating all health [10]

records for every member in the network. Health data is dynamic and expansive, replicating all health records for every member in the network.

Data Lake is nothing but a data repository in which all medical data would be sorted off blockchain. Wide variety of images, documents can be stored in Data Lake. To do variety of analysis including mining for factors that impact outcomes, determining optimal treatment options based on genetic markers & identifying elements that influence preventive maintenance data lake is a very useful tool. Data lakes support interactive queries, text mining, text analytics and machine learning. To ensure privacy and authenticity of the information all information stored in the data lake would be encrypted and digitally signed [12].

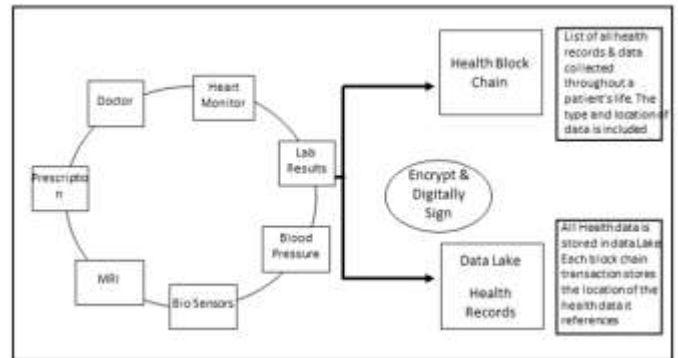


Figure 5: Health Information from provides and data from Personal devices and sensors

For reference above figure a digital signature would be created to verify authenticity of the document or image when a health care provider creates a medical record like prescription, lab test, pathology result, MRI. The health data would be encrypted and sent to the data lake for storage. The health record is registered in the blockchain along with the user's unique identifier when healthcare provider saves data to Data Lake. Notification will be sent to patient when data added to blockchain. By using mobile applications and wearable sensors a patient would be able to add health data with digital signatures and encryption [2].

4. BLOCKCHAIN APPLICATION IN HEALTH INFORMATION EXCHANGE

First objective is to transmit healthcare data and to provide an effective and secure delivery mechanism.

- 1) Security: Data privacy is also importance because secure patient data has financial as well as legal implications.
- 2) Infrastructure: Sharing data require a centralized data source which increases the security risk and requires trust to a single centralized authority.
- 3) Interoperability: Data should be shared that all the required parties can understand the structure blockchain, all data is encrypted with the private key of participants in the network. Only a few participants are given access to information by sharing the public key of a sending participant, thereby ensuring confidentiality and privacy [6].

These three main important terms used for health information Exchange, different user's data in the network is stored in their personal storage systems as well as sent to HIEs on a periodic basis. This is centralized storage system, where failing of the central storage would be put the updates of several patient medical records at risk. With increase in data for each patient from various sources such as wearable's, physicians, lab reports, HIEs are under pressure to scale the infrastructure and support vari-

ety of data sources. In a blockchain technology architecture, each patient controls ownership of the medical record, as against traditional architecture where a central authority controls accesses and distributes data across network [1].

5. CHALLENGES IN IMPLEMENTING BLOCKCHAIN TECHNOLOGY

How blockchain works and will be beneficial in healthcare technology it is a big challenge. Systems are centralized, and organizations are not ready to adopt the new distributed data culture completely by implementing blockchain. Companies face in implementing blockchain is around investments that are also a vast challenge. The cost of executing peer-to-peer transactions on blockchain network is huge for ensuring speed and effectiveness. Blockchain technology has its own set of challenges, it can play a significant role in addressing existing interoperability and security challenges of the healthcare industry [5]

6. CONCLUSION:-

In this paper discussed how blockchain technology can be useful for healthcare sector and how can it be used for electronic health records. Blockchain framework is a combination of secure record storage along with the granular access rules for those records. And framework proposes measures to ensure the system tackles the problem of data storage as it utilizes the off-chain storage Blockchain technology also the interoperability challenges within the health ecosystem. Health IT systems exchange data with the health blockchain. Blockchain technology also the interoperability challenges within the health ecosystem. It has been shown that EHR plays important roles in the healthcare system and its application. EHR in healthcare system include the need to improve efficiency in healthcare service delivery, patient safety, increase access to health care services, and more importantly, the need to reduce the costs of medical expenditures.

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