Blockchain benefits in the Healthcare domain

Parthit Patel, Ria Dhanani, Karan Bhandari, Rajat Kadam

Abstract—Blockchain technology enables innovations within a decentralized and distributed paradigm without the requirement of a centralized authority. Transactions done on the Blockchain network are secure, trustworthy and immutable because of the cryptographic principles used. Blockchain has found use in many domains, largely attributed to the popularity of cryptocurrencies. A patent area of expansion where this technology can be used is the HealthCare sector. Using Blockchain, a patient-centric solution can be developed to address issues of personalization, security and cohesiveness. A decentralized, immutable and comprehensive data sharing platform can be developed which is capable of handling sensitive data and maintains accountability. The participants can be incentivized to partake in the network while their data is anonymized addressing the privacy concerns that the industry requires to be met. The purpose of this paper is discussing the various areas in Healthcare that would benefit from using Blockchain.

Index Terms— Blockchain, Cloud storage, EHR, Ethereum, Healthcare

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1 INTRODUCTION

BLOCKCHAIN has the potential to solve many of the problems that the conventional approach taken by the Healthcare industry suffers from. It provides an opportunity to solve problems such as compatibility, security, accountability and universal access. Blockchain provides a solution through its decentralized nature by synchronizing disparate silos of information and ensuring patient data security and privacy. Blockchain presents numerous advantages in the maintenance of Electronic Health Records (EHR) and awarding the ownership of these records to the patients. Today, the EHRs are stored across multiple institutions throughout the patient's lifetime. Certain sections of the patient's medical records are held by doctors or physicians, which may consist of data regarding medication. The ownership of this data remains with the above-mentioned medical professionals. Using Blockchain to implement a system for the Healthcare sector would allow for a universally accessible database, that would allow authorized users to access the relevant medical records. The ownership of these records would be assigned to the patients with the help of 'Smart Contracts'.

Blockchain would also allow for management of healthcare data to be done efficiently. Storage and sharing of data to authorized user is an important aspect for the healthcare industry. If done correctly, it improves the outcomes by providing holistic views of the patient, efficient communication between medical professionals and personalized treatments. Using Blockchain technology, we can develop decentralized applications that address the sensitive nature of the healthcare system. Implementing such a system would help in the data to be shared instantly if authorized. This would prove beneficial in the insurance industry. The patient's medical records can be instantly matched with the relevant insurance coverage, thus reducing waiting time for the needed financial backing in times of distress. The present health care system is susceptible to threats like changing patient data that is very sensitive and a single manipulation can prove to be fatal for the patient. One of the drawbacks in the conventional system is the monitoring of vital signs of patients. The doctors have to persistently question the patient about their past medical history which leads to a time-consuming process of diagnosis and treatment of a common ailment or a chronic disease. Amidst this pro-cess of diagnosis and treatment, there can also be chances of human errors which may be undetected for example: recording an incorrect blood pressure reading. This can affect the type of treatment the patient might receive. Since the current system is untraceable one cannot determine when and where the data was altered. If we were to search for the time and place the alteration occurred, it would be very tiresome and time consuming. Conventional health care management system [1] lacks the ability to acquire, store and analyze the data that is concerned with privacy and security issues. Health care data should not be revealed to other parties since it can be used fraudulently by malicious users. It does not have a control mechanism [1] that would grant access to only authentic and authorized users. Proper handling of prescription [2] becomes a vital part in health care management to ensure efficient delivery of health care services.

2 PROCEDURE FOR PAPER SUBMISSION

Healthcare is inundated with data. It generates a colossal amount of data in terms of maintaining a record of patients, their respective treatments and undergoing tests, medical history and so on. Due to this increasing amount of data, conventional healthcare systems face problems such as data storage, sharing of data and accessing of records in addition to keeping them secure.

2.1 Security

Healthcare as an industry has specific requirements associated with security and privacy due to additional legal requirements which include protection of medical information. In today's age where sharing records in any form becomes more prevalent with cloud storage and mobile health services, so does the risk of malicious attacks and private data being compromised increases. As a great deal of data belonging to the healthcare domain can now be obtained through smart devices, sharing and maintaining the privacy of information is an important concern. The healthcare industry requires authentication, interoperabil-

ity, data sharing, transfer of medical records and information acquired from mobile health. From relative obscurity to mass popularity, blockchain has come a long way in providing solutions in various sectors. The potential of blockchain in healthcare has recently been realized and thus the healthcare industry is undergoing significant changes. Blockchain can enhance information security in a variety of ways.

- Blockchain provides the facility of who can access the data. In a private and permissioned blockchain, once a majority agrees only then a member can be added. This ensures that only verified, trusted members can access patient data. It can provide different levels of access to information based on their roles.

- In a blockchain, for even the slightest change of information, a different hash is generated. A dedicated hacker may try to recalculate the hash to make sure the chain remains intact. However, when this modified chain is shared with the network, it is not verified by the other nodes as they have a different copy of data. Thus, no changes can be made to the data until the network reaches a consensus and this makes hacking almost impossible.

- Every action and transaction are traceable, malicious actors can easily be identified. Additionally, blockchain uses hashes and consensus protocols which enhances security.

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2.2 Privacy

Healthcare data contains personal and sensitive information which is susceptible to cybercrime attacks. Cyber criminals can benefit financially from the theft of this data by selling to a third-party provider who may perform data analysis to identify individuals who are uninsurable. The privacy and integrity of healthcare data must be protected not only from external attackers but also from unauthorized access within the system. Different approaches to ensure privacy include cryptographic primitives such as public key infrastructure and access control models to limit the access to data. Patients have complete control over their data. Modifications to existing data are easily detected and emitted across the network thus boosting security.

• *Parthit Patel, Ria Dhanani, Karan Bhandai and Rajat Kadam are currently pursuing bachelor's degree program in Computer engineering in AISSMS IOIT, Pune, PH-01123456789. E-mail: parthitpatel@gmail.com*

3 INTEGRATING BLOCKCHAIN IN HEALTHCARE

The primary focus for implementing healthcare systems using blockchain is to ameliorate the quality of treatment the patients receive [2]. This system also directs to mitigate the cost and fallacy associated with the currently present system. Interoperability and tractable capabilities of the system make it ideal and efficient for using it in day to day life. The components [3] that will be interacting with each other and in and out of the system are users, wearable devices, healthcare provider, health insurance company, Blockchain network, cloud database. System implementation will require 3 phases [3] personal health data collection, data protection and validation, collaboration of healthcare systems and data.

Data Collection

Data collection phase is the first phase where patients' medical history is gathered and combined into an electronic health record. This can be done with the help of wearable devices like smart watch and activity trackers and medical devices like a pacemaker. The user can upload data to cloud database by simple login credentials. This will ease the process of synchronization and accessibility for healthcare providers. This will improve the efficiency for healthcare providers so that they can medicate patients in a better and faster way.

Data Protection and validation

Data moves in the system from the user to the cloud database and then to the blockchain network. The blockchain will assign it a proof of work and hash value. This will ensure the integrity and security of the system. The data generated can vary depending upon the type of device from which it is collected. To ensure total uniformity across the system a globally accepted data standard shall be acquired by all healthcare systems distributed across the globe. Blockchain uses hashed tree data structure to assign a node a key-value pair that can be used by users to maintain their accounts private with the help of crypto-key. This will not only keep the records safe but also improve storage capacity and scalability of system. This will also require time-stamping of transactions happening on the database.

Collaboration of Healthcare systems and data

After the creation of user account data can be shared by the users with healthcare providers for research and analysis and health insurance companies to gain insurance policy. The recorded events are associated with attributes like time, location, id, owner, receiver, digital signature. There are different types of operations performed on the data by different parties. This record is then transferred over the blockchain network where it becomes a transaction and a series of such transactions will form a block over the network. After a series of processes, the node will be secure and the integrity of the record will be maintained. The records are very critical and sensitive with respect to users as a minimal change can affect the type of treatment the patient receives. To control and regulate the access to records a transaction manager is necessary that will issue enrolment certificates to ensure authenticity of the users in the network.
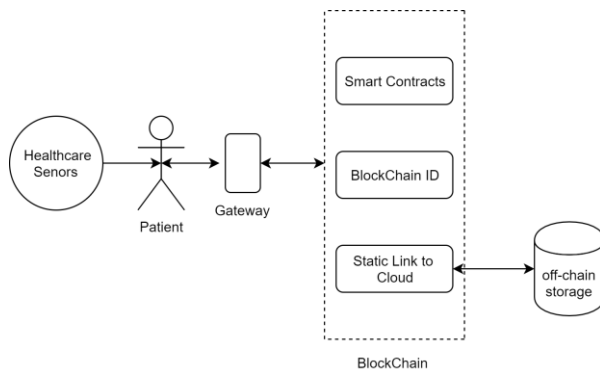
Fig. 1. Blockchain in Healthcare system architecture

4 DECENTRALISING ELECTRONIC HEALTH RECORDS

Medical records are critical but have highly sensitive private information of the patients used for diagnosis and treatment in healthcare. This information needs to be frequently distributed and shared with different people from healthcare to personal spheres of a patient. As this information is shared with a large number of individuals, a major challenge arises regarding the consistency of the medical information of the patient [4]. Cloud computing is being incorporated within the healthcare industry due to its low cost and highly scalable solutions, and the facility of automating the processes of health information manipulation. Yet cloud solutions still face the major issue of privacy of the medical records in this sector due to participation of third-party cloud solution providers. A blockchain based access control method for sharing the Electronic Medical Records will not only help in access control of the medical data, but also enable secure and efficient data sharing. Blockchain offers secure cryptographic techniques that can be used to authenticate and identify the systems and the users. This distributed approach will improve access control in a distributed, scalable and secure manner. With Blockchain creation of patient centric EMRs is possible. The data can be stored separately in from of clinical data and personal sensitive data. This degree of personalization can be set by the patients themselves. The patient will have complete authority on their medical data, and can authorize part of the data according to their need. This data will be secure, encrypted and time stamped, preventing any unwanted iterations by the owner or third-party. Any transaction carried out on the EHR will be reflected on the Blockchain, thus maintaining accountability.

Using blockchain in health industry will allow the patients, researchers and other communities access one shared data source which will be accurate, comprehensive and updated timely. Patients data authenticity will be easily proved through EMRs and a complete record will be visible to the doctors without anything hidden from them by the patients. This will improve the accuracy of diagnosis by the doctors. Patients will be able to visit multiple institutions without worrying about bringing all the previous data with them. The doctors can access the medical records simply by using the public key of the respective patients.

5 POTENTIAL HURDLES IN IMPLEMENTATION

While blockchain offers enhanced security and distributed storage, the same features pose certain challenges which must be overcome.

- The data on the blockchain is immutable and when it comes to healthcare data, such data comes under protection and privacy laws, many of them would not permit personal data to be recorded permanently.
- Blockchain are traditionally designed to handle transactional data which is relatively small in size and linear. The data obtained from the healthcare domain comes in multifarious forms such as images, patterns, scans. It is a matter of concern as to how a blockchain will cope with these requirements.
- In healthcare, interoperability is the ability of systems to communicate efficiently and exchange data. Data exchange standards should permit data sharing across labs, hospitals, pharmacies. Achieving interoperability depends on how the patients control their data and how they want it to be used. Blockchain technology is still in its infancy and needs to be standardized. Numerous authenticated and certified standards will be required from international standardization organizations.
- Along with technical impediments, blockchain also faces social challenges like cultural shift. Accepting a technology which is completely different from its traditional working will be challenge for the industry.
- Although the medical industry is trudging its way to digitization since the blockchain has not been validated in clinical aspects, there is a long way for the complete transformation of health records being stored and maintained in a blockchain and additional steps towards further development are required.

Despite the above-mentioned challenges, the advantages of blockchain clearly outweigh its weaknesses. It provides speedy access to medical data. It is autonomous and provides tamper proof information sharing. Additionally, there is a lower fraud risk in medical supply chain and beneficiaries get more control over their data. It also proves to be cost-efficient as it will significantly reduce the cost of monitoring data and managing a central server. Employing blockchains in medical contexts will drastically decrease processing time because as soon as a patient enrolls themselves, all the data will be available at once as it is on a distributed ledger. Moreover, doctors will not have to worry about the patient giving them an honest medical history since they can view original, authentic, and quality source-documented data in real time thus reducing probable history errors. The patients too won't have to worry about taking a second opinion from another doctor. Having patient records on a blockchain network will lead to people

knowing and connecting with many other people around the world with similar medical conditions. This will not only benefit their health, but will also result in the patients feeling accepted, supported, and they will have strengthened will-power to fight the disease.

Blockchain based healthcare framework will engage individuals in taking better care of their health, which will ultimately improve the quality of life.

6 COMPONENTS OF THE SYSTEM

- *User*: The user data is collected from different smart health trackers. This data can include number of steps, heart rate and blood pressure. This data is uploaded to the cloud database. The user has complete authority over their personal heath data and can grant, deny or revoke access to their health data anytime. The user is also able to share their data to doctors when they visit for a check-up or treatment. A cryptographic hash of the uploaded data is saved on the Blockchain. This provides the faculty of ensuring that the data uploaded to the cloud has not been tampered with.

- *Cloud Database*: The database will store the user's health data, all the requests made to access the medical data by various institutions, and data access parameters set by the user.

- *Blockchain Network*: Every request to view the medical data is present on the Cloud Database is routed through the Blockchain. The network stores the static link to the users Cloud storage. Every access requested the storage will be written the Blockchain and any upload made will be hashed, stored on the Blockchain and then pushed to the cloud. The network will have the following functions: Collect the users health data and store it in the block, process all the access requests by the user, insurance companies, medical institutions, and control access to who can access the data from the block.

- *Insurance Providers*: These companies can provide policies that suit the user better by requesting and analyzing their health data. This will include the previous medical treatments and the current state of the user's health. As the cryptographic hash of all the user's medical history is stored on the blockchain network, one cannot make false insurance claims. All the previous insurance claims will also be recorded on the block.

7 CONCLUSION

In this paper we discussed the potential uses of Blockchain in the Healthcare industry and the areas that it would disrupt. We discussed how the different domains within the Healthcare sector would benefit from decentralized applications developed using Blockchain. We confer that with the usage of Blockchain, health sensors, cloud technology and further innovation in s the sector, solutions to the problems that the current system faces can be solved.

REFERENCES

[1] B. A. Tama, B. J. Kweka, Y. Park, and K.-H. Rhee, "A critical review of blockchain and its current applications," in 2017 International Conference on Electrical Engineering and Computer Science (ICECOS), pp.109–113,IEEE, 2017.

[2] G. J. Katuwal, S. Pandey, M. Hennessey, and B. Lamichhane, "Applications of blockchain in healthcare: Current landscape & challenges," arXiv preprint arXiv:1812.02776, 2018.

[3] Z. Alhadhrami, S. Alghfeli, M. Alghfeli, J. A. Abedlla, and K. Shuaib, "Introducing blockchains for healthcare," in 2017 International Conference on Electrical and Computing Technologies and Applications (ICECTA), pp. 1–4, Nov 2017.

[4] A. Dubovitskaya, Z. Xu, S. Ryu, M. Schumacher, and F. Wang, "Secure

and trustable electronic medical records sharing using blockchain," in

AMIA Annual Symposium Proceedings, vol. 2017, p. 650, American Medical Informatics Association, 2017.

[5] E. Meinert, A. Alturkistani, K. A. Foley, T. Osama, J. Car, A. Majeed, M. Van Velthoven, G. Wells, and D. Brindley, "Blockchain implementation in health care: Protocol for a systematic review," JMIR research protocols, vol. 8, no. 2, p. e10994, 2019.

[6] [6] X. Liang, J. Zhao, S. Shetty, J. Liu, and D. Li, "Integrating blockchain for data sharing and collaboration in mobile healthcare applications," in 2017 IEEE 28th Annual International Symposium on Personal, Indoor, and Mobile Radio Communications (PIMRC), pp. 1–5, Oct 2017.

[7] Guo, R.; Shi, H.; Zhao, Q.; Zheng, D. Secure Attribute-Based Signature Scheme with Multiple Authorities for Blockchain in Electronic Health Records Systems. IEEE Access 2018, 6, 11676–11686

[8] Wong, M.C.; Yee, K.C.; Nøhr, C. Socio-Technical Considerations for the Use of Blockchain Technology in Healthcare. Stud. Health Technol. Inform. 2018, 247, 636–640

[9] Roehrs, A.; Da Costa, C.A.; Righi, R.D.R. OmniPHR: A distributed architecture model to integrate personal health records. J. Biomed. Inform. 2017, 71, 70–81.

[10] Zhao, H.; Zhang, Y.; Peng, Y.; Xu, R. Lightweight Backup and Efficient Recovery Scheme for Health Blockchain Keys. In Proceedings of the 2017 IEEE 13th International Symposium on Autonomous Decentralized System (ISADS), Bangkok, Thailand, 22–24 March 2017; pp. 229–234

[11] Griggs, K.N.; Ossipova, O.; Kohlios, C.P.; Baccarini, A.N.; Howson, E.A.; Hayajneh, T. Healthcare Blockchain System Using Smart Contracts for Secure Automated Remote Patient Monitoring. J. Med. Syst. 2018, 42, 130.