BLOCKCHAIN IN HEALTHCARE

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1. INTRODUCTION

Blockchain is one of the most disruptive technologies in the world. Many companies across the globe are trying to adopt blockchain to innovate the way they function. One such industry that is of importance is the healthcare sector. Over the past few decades, the healthcare industry has seen very limited growth in terms of technological advancements. However, with the help of blockchain we can revolutionize the way healthcare industry manages data. In this paper, we will discuss the current issues related to healthcare industry and how blockchain can help solve those problems.

2. WHAT IS BLOCKCHAIN?

Blockchain is basically a time-stamped series of immutable record of data that is managed by a cluster of computers not owned or operated by a single person or entity [1]. The reason why blockchain has gained so much attention over any other database is as follows:

1) Decentralized network: the database is stored on a decentralized peer-to-peer (P2P) network that consists of network participants, each storing an identical copy of the blockchain. Each node is authorized to validate all incoming digital transaction from the network. Once majority of members validate the transaction, it is added to the shared ledger.
2) Digital transaction: consists of any information or digital asset that could be stored in a blockchain. Each transaction is added to a ‘block’ and each block contains a cryptographic hash to add the transactions in a linear and chronological order.
3) Immutable: no one can change or alter the data that exists inside the blockchain.
4) Transparency/Privacy: The data is stored cryptographically on a blockchain, which means that every user can view the transaction, but only those possessing the public key can decipher that transaction.

3. HEALTHCARE AND BLOCKCHAIN

The way medical records are currently stored is fundamentally broken. Patients' medical data is stored in an unorganized way across multiple organizations and multiple databases. As people switch healthcare providers, they lose their access to previous health records as the provider and not the patient owns the data.

Another major challenge in the healthcare industry is the lack of interoperability. Interoperability is the ability of information systems and databases to connect in a way that allows easy access to information amongst stakeholders. Two major reasons of interoperability include trouble identifying patients and information blocking. The root cause of trouble identifying patient is the fact that there is no universally recognized patient identifier. This issues had led to several errors in patient care and claimed numerous lives. The other issue causing interoperability is the practice of information blocking. Although, deemed illegal, information blocking still exist in today's healthcare industry. Basically, hospitals don't want to lose out patients and want to make it as difficult as possible for them to want to move to another hospital. Hospitals may also choose different databases to store patient's records so as not to be compatible with other databases, thus further preventing information sharing.

3.1 TYPES OF BLOCKCHAIN

There are two distinct types of blockchain; Public and Private. Public blockchains are open ecosystems where anyone can participate, and their participation is incentivized using a built-in rewards system. However, public blockchains like Bitcoin are not suitable for healthcare due to the following reasons.

- Low throughput: Bitcoin, a successful public blockchain implementation processes 7-8 transactions per second (TPS), while healthcare industry requires a system that can handle significantly more transactions.
- High latency: Bitcoin has a block confirmation time of 10 mins. This delay in propagation of information adds to the latency of the network, which in case of healthcare could prove life-threatening and should be close to 0.
- Low storage: Bitcoin currently stores approximately 1mb of data per block. This is simply not adequate to hold the medical records that comprises of high-resolution scans and x-rays.
- Lack of privacy: Public blockchains are open for any individual to look at. Therefore, storing highly sensitive data pertaining to patients publicly would lead to lack of privacy.
- Lack of resources: Public blockchain such as those that employ proof-of-work requires significant computation to compute hash. Therefore, it is impractical for these healthcare institutes or patients to spend so much resources on consensus protocols, unless there were some added benefits.

Private blockchains (also called permissioned blockchains) are accessible to only those individuals who have gained permission to be a part of the network. Benefits of using private blockchain over public blockchains includes faster transactions, data privacy and scalability.

4. DESIGN AND IMPLEMENTATION

The blockchain implementation proposed in this paper addresses the following issues: lack of patient's control over their medical records; fragmented or unorganized medical data; and interoperability. The proposed design implements a permissioned (private) blockchain using smart contracts on Ethereum.

Ethereum is an open source software platform based on blockchain technology that allows developers to build and deploy decentralized applications (DApps). While smart contracts allow the automation and tracking of state transitions (such as creation of new records and change is data viewership).

4.1 Universal Identification Number

A global participant identification number must be created for each patients that is linked to their Ethereum address. Registering new identities must be restricted to certified institution to prevent creation of multiple IDs for one patient. This identification number will be unique to every patient and would help prevent the issues related to mismatch of patient's health records, which in the past has led to several errors in patient care and increased likelihood of patient harm.

4.2 Smart Contract and Ethereum

Each transaction within the blockchain will consist of a cryptographic hash of the medical record to prevent alteration and ensure privacy. The smart contract enables logging patient-provider relationships with each medical record with information on which participants can view that information. Healthcare providers can add a new medical record related to a patient, and patients can validate that record and authorize sharing of that data between multiple healthcare providers. This automates the process of receiving new information and users can thus verify the data before accepting it. This keeps the participants (both patients and providers) informed and engaged in the evolution of any medical records.

4.3 Mining and Reward

In order to incentivize mining, we need to create a reward mechanism that encourages miners to contribute their computational resources in making the blockchain more secure and trustworthy. Healthcare stake holders such as researchers, pharmaceutical companies and healthcare providers are always in search for more medical data. We can incentive these stakeholders to mine the

blockchain by granting them access to a pool of aggregate and anonymized medical records as a reward for mining.

5. BENEFITS OF USING BLOCKCHAIN IN HEALTHCARE INDUSTRY

Blockchain can evolve as the master ledger for patient records. A single database would eliminate the issue of medical data and records being mismatched or duplicated. All healthcare data including previous medical conditions, lab results, medications and data generated by wearable devices can easily be achieved through blockchain, which can assist healthcare providers in diagnosing medical conditions and in coming up with improved ways of delivering healthcare.

Blockchain can also assist healthcare industry with supply chain management. Since blockchain works on a validation-based exchange, the insurance claims can be automatically verified where the network agrees upon the way medical services are provided to patients. Also, blockchain enables pharmaceutical companies to closely track their supply chain because of the kind of products they produce. Pharmaceutical companies lose a lot of money due to counterfeit drugs and due to their drugs being stolen and sold illegally. A transparent blockchain will enable these companies to closely track their drugs from point of origin (factories) to the point of consumption (patients), thus helping in eliminating falsified medication [3]. Also, the absence of a central authority would lead to fewer errors and frauds.

6. CONCLUSION

This paper provides a proof-of-concept that demonstrates how a decentralized database using blockchain can form a comprehensive medical record. Using smart contracts we allow patients not only access to their information, but also complete control over how that data is shared and used, thus maintaining complete autonomy over personal data.

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