Blockchain for Healthcare

An opportunity to address many complex challenges in healthcare

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OVERVIEW OF BLOCKCHAIN TECHNOLOGY

In today's digital world, different systems interact with each other for data and information exchange. We expect each interaction / transaction between the systems to be secure and reliable. Blockchain is a new technology that promises an efficient, cost-effective, reliable, and secure system for conducting and recording any transaction without the need of middleman.

A Blockchain database is a distributed database that records and stores transaction data in the form of time stamped "Blocks" linked to each other in such a way that no one can alter any transaction data. Members of the Blockchain network who validate the transactions are called nodes. Blockchain technology allows different types of nodes to enter Blockchain Network using specialized software such as Ethereum performing different functions [1] Mining nodes in the blockchain network will be assigned a secret private key and a public key pair. Public key acts as "Public Address" which is visible to all participants. Private and Public key pair is cryptographically linked such that identification is possible in only one direction using
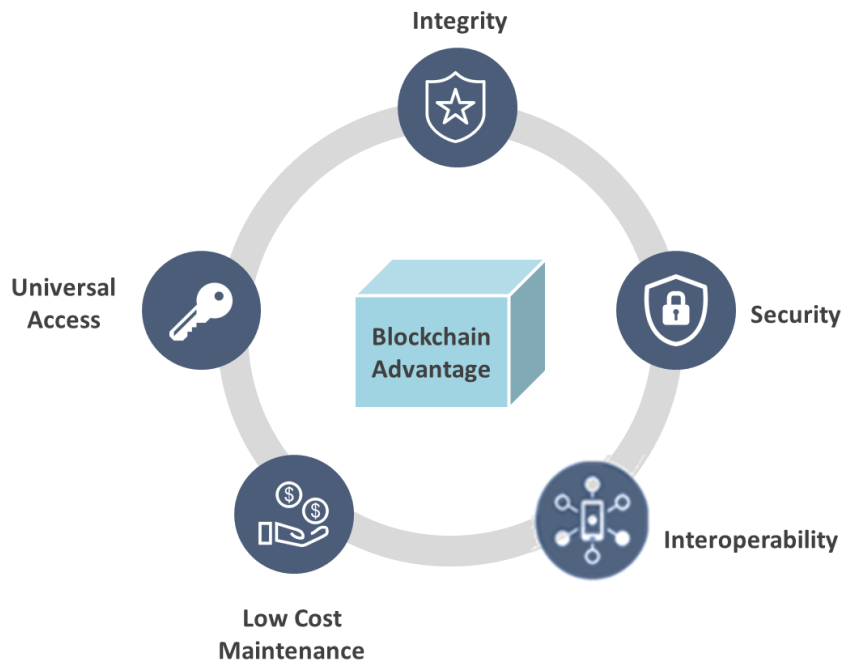
The private key. A message which is encrypted using a private key can only be read by any node with a public key which is linked to the private key, thus limiting the number of users to access or read an encrypted message or data.

Any action on blockchain is a function of network, so to alter any transaction data the hacker should modify the same data in all the nodes in the network. It basically means hacking into all the systems in the network at a time, which is practically impossible to do. Blockchain is consensus- based; every transaction needs approval from more than half of the participants or nodes before execution. Every transaction in blockchain is public but access to content of each transaction can be limited or restricted based on the sensitivity of the transaction. Today blockchain is finding applications in every field. like finance, healthcare, economics, legal, etc. Some examples from healthcare sector use cases where blockchain can be used are: EHRs, drug traceability from manufacturer to consumer, clinical trials to eliminate fraudulent data modifications and interoperability

HOW BLOCKCHAIN ADDRESSES CURRENT HEALTHCARE CHALLENGES

Blockchain provides us with a tremendous opportunity to overcome challenges that exist in the healthcare industry today, including interoperability, security, integrity, traceability and universal access.

Blockchain addresses current challenge for syncing patient data between multiple disparate HIS while ensuring patient data security and privacy by adopting a distributed framework for managing patient identity. Some of the healthcare challenges that blockchain

Interoperability

Today healthcare organizations are at different maturity levels as far as interoperability of healthcare data is concerned. There are some organizations who are exploring use of FHIR, while several organizations are using the CDA standard for data exchange and some share data using HL7 2.X standard Varying data standards across organizations is another challenge which reduces which hamper Quality scores interoperability Blockchain helps overcome this challenge by accessing data through APIs. With transfer of data through APIs, blockchain achieves standardization of data format, which is used to transmit data irrespective of the capabilities of EHRs to communicate different HL7 versions.

Security

Security in healthcare industry encompasses various aspects based on integrity of data maintained in an organization. Tampering and security breach of healthcare data is a growing concern for many healthcare organizations. It is difficult to tamper with data present in blockchain as it requires validation from different nodes in the chain. Blockchain offers inbuilt security features as the data in blockchain is encrypted with private key of the sender and only intended recipient can decrypt data using key from the sender.

Integrity

Blockchain's distributed ledger and immutable transactions helps ensure data integrity while encryption of data enhances data security across the network. With the implementation of Blockchain technology, multiple instances of obsolete patient data with various stakeholders are replaced with single source of up-to-date information of patient information. Patient is the custodial owner of data controlling who has access to PHI information.

Universal Access

Managing access to patient data across healthcare entities is a challenge where Blockchain can help. Blockchain ensures that required data is present at every node and is available for use to the authorized entities based on the access rights provided through smart contracts or other mechanisms.

Cost of Maintenance

Maintenance of a typical healthcare information system involves various operations including but not limited to performing backup storage services, having recovery mechanisms in place and ensuring up to date fields. In case of blockchain, data is distributed across the network and there is no single point of failure leading to inherent backup mechanism.

Also, a single version of data is copied on every node of the blockchain. This reduces transaction volume that occurs between each information system reducing the burden on the healthcare ecosystem

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APPLICATIONS OF BLOCKCHAIN IN HEALTHCARE

Blockchain with its distributed ledger technology has captured the markets attention for its data handling capabilities with respect to decentralization and security. With its relatively successful implementation in the financial domain, various industries are now realizing its benefits and are exploring the potential of blockchain in their respective domains. Healthcare is one such industry looking at unlocking the benefits of blockchain. Several opportunities exist in healthcare wherein blockchain can help improve interoperability and privacy of patient health data. Some of the important healthcare applications are discussed in this article.

Blockchain for EHRs

The ideal scenario with EHRs is to maintain a life time medical record and be accessible to care team including physicians, lab technicians etc. at the point of care and on time. In current implementations of EHRs, patient data is stored across different organizations throughout the patient's lifetime. Few sections of a patient's medical record like medication

problems, diagnosis are recorded by the physicians and they continue to retain stewardship of those sections after a patient's treatment. In a blockchain implementation, a patient holds the stewardship of medical record and physicians will be given access on a need basis through "smart contracts".

One of the issues EHRs face currently is maintenance of records accurately involving correction of any erroneously recorded data. Apart from ensuring data integrity, different providers and hospitals system face interoperability challenges leading to ineffective data sharing, if any at all. The lack of coordination in data management and exchange leads to health records being fragmented.[2] Blockchain framework can help alleviate data fragmentation issues across healthcare entities. With blockchain implementations for EHRs, members of a private, peer-to peer network can share the block content with appropriate viewership permissions, while the original member maintains ownership of the data shared. In addition, blockchain supports "smart contracts which are basically self-executing contracts with the terms of agreement

coded in them. Smart contracts allow automation and tracking of state transitions like viewership rights or new record creation in a system. To guarantee data integrity, blockchain includes cryptographic hashing of records. The care team can add new records to a patient's profile, while the patient decides which provider views the information by authorizing them. This ensures patient and provider engagement and helps in the evolution of patient records. Blockchain architecture is built on principles of decentralization and cryptography, which could contribute to more secure and highly interoperable EHR systems.

Blockchain in Clinical Research

While there has been a considerable advancement in moving medical data from paper to digital records, healthcare industry is still working its way through issues regarding sharing of patient data across providers and organizations. Throughout their lives, patients may move cities, change health plans, switch their healthcare providers for their treatments. Most of their detailed medical records tend to remain in silo with the individual facility or provider. Furthermore, each medical entity would have saved patient data in

their own storage structure and semantics. This leads to hurdles when it comes to sharing of the data. These hurdles are partly due to nature of the data in question (Protected Health Information) or to prevent information blocking during exchange. This not only has an implication on treating patients efficiently across multiple organizations, but also hampers the field of clinical research, which requires real life medical data to conduct research and test their hypothesis in real world scenarios with real world data. Clinical trials need patient data which is de-identified. Consolidating and de-identifying patient data takes significant time and effort, which leads to a considerable cost.

A critical factor in attaining higher accuracy in outputs of clinical research and trials is the availability of large sets of real life de-identified raw data, analyzable datasets for secondary analysis and meta-analysis Polls show that majority of consumers are open to sharing their medical records for analysis and research on the assurance that their privacy is maintained, and the data is secured.

APPLICATIONS OF BLOCKCHAIN IN HEALTHCARE

With trust is built into Blockchain database, there is a high degree of transparency. Records are publicly writable by anyone and owned (stored) by no one, with security of data being provided through encryption. Using private and public key cryptography, a shared ledger can facilitate information sharing and community driven clinical study. Patients can directly control their medical data and rights to grant or withdraw data access to care givers and organizations. Such a platform would be a vital in helping research organizations get direct and secure access to a vast repository of holistic and accurate clinical data.

Blockchain in Drug Supply Chain Management

One of the main challenges in the pharmaceutical industry is the transparency and security aspect of supply chain management. Pharma companies incur losses in millions annually due to counterfeit drugs. Pharma companies deal with products that directly impact the lives of their consumers,[3] which is why efficacy and safety of product is paramount. The journey of the product from manufacturer to consumer has multiple stages: transportation, handling, storage, redistribution, retail. Things can go wrong during these stages, from simple human error to malicious intent (fraud). In a conventional system, it can get difficult to identify the problem as participants in the supply chain may usually maintain their own records and may share their information usually just one level up and one level down the chain. Furthermore, if these records are paper-based, they are more prone to errors. These factors further delay investigations to identify the issues with drug supply chain.

Additionally, with governments and consumers demanding transparency in the supply chain for such products, companies have worked towards maintaining an open or transparent supply chain system. Depending on one organization to track irregularities still isn't fool proof.

Blockchain helps in addressing the supply chain issues by providing a distributed ledger which is shared among all the stakeholders within the supply chain. The records entered in the blockchain at each stage in the supply chain are immutable, permanent and decentralized. This in turn removes the vulnerability of introducing errors or fraud. Counterfeit drugs are reduced by maintaining a chain of custody log that lets organizations track each step of the supply chain at an individual drug or product level. With blockchain system in place, even the end consumer now has all the information regarding the product right from creation to consumption.

Blockchain in Claim and Billing Management

One of the losses in healthcare which needs to be eliminated and avoided is fraudulent claims and billing. Medical billing-related fraud is still very common in the healthcare space. Some of the very common healthcare frauds are providers claiming charges for the non-performed services, overcharging the actual services, performing unnecessary services for patient medical condition, misrepresenting non-covered medical services as services which are covered for obtaining claims money and covering financial loses.

There are many intermediaries involved to verify and adjudicate the claim information, to ensure there is very less time lag for claim processing and reduce the administrative cost for providers and payers. A typical process of claim adjudication involves lot of back and forth of communication between parties involved for claims processing. Blockchain system helps reduce most of these challenges faced during claim adjudication and payment processing activities. The blockchain solution can automate the required workflows and then all the parties involved can share single copy of the contracts and billing related information.

Blockchain Application in HIE

HIE's primary objective is to transmit healthcare data beyond geographical and institutional boundaries to provide an effective and secure delivery mechanism. With a universal sharing mechanism in place, lot of factors need to be considered, like:

- **Security**: Data privacy is of utmost importance, failure to secure patient data has financial as well as legal implications.

- **Infrastructure**: Sharing data traditionally requires a centralized data source which increases the security risk foot print and requires trust to a single centralized authority.

- **Interoperability:** Data should be shared in such a way that all the required parties can understand the structure and meaning

On a blockchain, all data is encrypted with the private key of participants in the network. Only few nodes or participants are given access to information by sharing the public key of a sending participant, thereby ensuring confidentiality and privacy.

In a traditional set up of HIE, data from different users in the network is stored in their personal storage systems as well as sent to HIEs on a periodic basis. It is a centralized storage system, where failing of the central storage would put the updates of several patient medical records at risk. With increase in data for each patient from various sources such as wearables, physicians, lab reports, HIEs are under pressure to scale the infrastructure and support variety 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.

Medical record access is permitted to only limited healthcare entities (people or organizations). Shared data across the blockchain network enables near real time updates across all healthcare entities. Secure access to patient 360 data is possible through the distributed ledger. Data duplicity is reduced as the same copy of data is available to all.

REGULATIONS AROUND BLOCKCHAIN

There are no regulations as of today around blockchain in the healthcare domain. The US healthcare department has started to take interest in understanding the use cases and applications of blockchain in healthcare. ONC is also actively considering the proposals submitted in a competition arranged by US government. Plan is to evaluate the proposals which include peer to peer network for analysis of patient health data with focus on security and privacy aspects, enhancing interoperability solutions for information exchange, patient tracking, improving healthcare claims processing and decentralized record management system for electronic health records. ONC plans to introduce a Blockchain-based infrastructure which healthcare companies in the US can leverage to create their unique private systems.

Challenges in Implementing Blockchain Technology

Blockchain technology has been widely adopted in the banking industry over the last decade. However, the awareness and adoption of this technology in healthcare domain is yet to materialize. Organizations face challenges in understanding how blockchain works and the benefits associated with it. Enterprise systems are still centralized, and organizations are not ready to adopt the new distributed data culture completely by implementing blockchain. Another challenge that the companies face in implementing blockchain is around investments. The cost of executing peer-to-peer transactions on blockchain network is huge for ensuring speed and effectiveness.

While 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.

CONCLUSION

Blockchain technology is an emerging technology and has a huge potential not just to impact few industries but it can change the way businesses are done. The adoption of blockchain technology in healthcare has started and we can expect to have commercial blockchain solutions in the market in near future. Most of the healthcare use cases for blockchain are intended to provide secure and integrated care to the patients

REFERENCES

- http://blog.appliedinformaticsinc.com/blockchain-transparency-integrity-and-clarity-to-the-healthcare-system/

- https://www.healthit.gov/sites/default/files/14-38-blockchain_medicaid_solution.8.8.15.pdf

- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4105729/

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