

Aid of Blockchain Technology to Healthcare Systems and a BC Framework for Capsule Endoscopy Diagnosis

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Abstract

EHRs and healthcare applications are facing the great challenge of preserving data privacy and integrity while demanded to be shared worldwide with more stakeholders for various purposes. Blockchain, follows a consensus model, that makes it a promising solution to manage the transactions which is deemed suitable in the scope of healthcare. Blockchain technology has the potential of securely and comprehensively managing EHRs. In this paper, we discuss the need and suitability of Blockchain technology to healthcare systems and to evaluate, a framework of Blockchain in case of capsule endoscopy is discussed

Keywords

EHR, Blockchain Technology, Healthcare Systems, IoMT, Capsule Endoscopy

Introduction

The healthcare sector is under tremendous pressure and challenge to both reduce costs and to provide high quality service to its patients. As the industry evolves alongside emerging technologies, it also becomes progressively more difficult for them to keep costs down, being competitive at the same time. Medical devices were connected in view of providing thorough facilitation to patients in forms of digitising medical records, prescriptions, records of treatment, claim history and tracking etc [1]. This connected network of medical entities are termed as Internet of Medical Things (IoMT).

Such a rise poses exceptional demands for interoperability amongst all devices operating on them, medical data protection during use and exchange.

Expectations from IoMT

Patients expect their historical data in Electronic Health Records (EHR) to supplement their treatment thereafter. They wish EHR to help in efficient decision making on their treatment. They also demand protection from tampering or misuse of their medical data.

Physicians feel equipped with digital access to health records which enables enhanced quality of treatment [2]. Furthermore, EHR accounts improved disease management and better preventive care. In addition, the digital records provide efficient decision-support functions and upgraded collaboration amongst healthcare providers.

Healthcare providers look for systematic documentation and file organisation, adhering to regulatory requirements. Therefore, there is an appreciating role of EHR among the healthcare community.

Basic challenges in Healthcare data

Challenges posed to healthcare today are interoperability among all stakeholders and security of data in all aspects, which otherwise risks data sharing and curb patient-focused health care rendered by providers.[3]

Interoperability in healthcare can be categorised into three levels:

- Foundational – Enabling data exchange without need for data interpretation
- Structural – data exchange formats are defined
- Semantic – interpretation of exchanged data required

These three levels help to ensure that health applications and systems provide information with required quality assurance and integrity

How Blockchain technology helps

Blockchain is addressed as a public distributed ledger which is permanent and allows append-only transactions [4].

Basically, blockchains are made up of 3 underlying technologies: Private Key Cryptography, P2P Network, and blockchain protocol.[5]

Blockchain systems are of two types : public and private. They are also called permissioned and permissionless blockchains. The fundamental mechanism that holds a blockchain system is the consensus algorithm executed across the network that ensures validation of each transaction in the system.

Blockchain is gaining traction as a technology that could help solve healthcare industry's pressing problems and ensuring secured data sharing and access across stakeholder with defined access levels[6].

They foresee that blockchain will be the key that releases hurdles to healthcare data-sharing and ultimately enables a shift towards value-based care because of its features as below:

Transparency: Blockchain Technology offers the adequate transparency to the stakeholders by recording and verifying each transaction publicly.

Immutability: Prevents alteration to existing data and transaction by anyone.

Security: By being distributed, security is enhanced without binding to the threat on a centralised database.

Reduced expenses: Since transactions are peer-to-peer, without the interference of third parties, the costs are reduced to a greater extent.

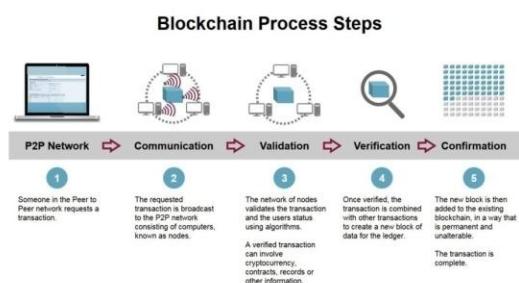


Figure 1: Courtesy :<https://www.msg-global.com/blog-item/blockchain-moving-beyond-bitcoin>

EHR blockchain is an accumulative collection of records, called blocks, which are linked with each

other using cryptography ensuring prevention of modifications [7] and promotes transparency and security. This technology can assist to improve offering of health services and quality of healthcare support by eliminating costs and security threats, widening coverage and enhancing quality, while enabling user provisions of healthcare [8]. Based on peer-to-peer networks, one of the advantages of using blockchain is, it apprises with realtime, leaving no option for intermediaries and associated costs. Being resistant to modifications, blockchain offers a transparent environment where organisations as well as patients can access their EHR apparently and without additional costs[9]. It also raisesintegrity of the system by eliminating chances of tampered or missing records and dataerrors.

Blockchain provides access to extensive,complete, and untamperedhealthcaredata which are contained in distributed systems in a secureand pseudo-anonymous way [4]

Typical Use cases

Below are a few usecases which may be addressed efficiently by implementation of Blockchain Technology in Healthcare Industry.

- ✓ Patient Prescription and medication history tracking
- ✓ Data sharing for telemedicine with due care and interoperability to patient, physician, hospital, drug store and insurance companies
- ✓ Diagnosis network and report with EHR
- ✓ Authorised access for research organisation with due anonymity
- ✓ Registry of medications for reference and decision making
- ✓ Interconnected network of medical devices enabling data sharing
- ✓ Drug traceability

Blockchain Framework for a case of Capsule Endoscopy

Basic transactions need to be done on EHR and other record blocks are as follows

1. Care provider traces Drug supply chain to get the capsule for diagnosis
2. Patient provides EHR Access to care provider. Care Provider appends diagnosis prescription to the patient history in EHR.
3. Notifications to provider on getting capsule
4. Diagnosis data in the form of optical and micro-ultra signals arecollected through recording devices
5. Recorded data are processed to create indicative reports by servers
6. Recorded data and indicative reports are added to patients EHR
7. Notification to Physician for analysis &prescription
8. Physician updates his notes in EHR
9. Notification of recorded data and report to Insurance providers
10. Bill are processed and added to Patient EHR



Figure 2: Transactions in Capsule Endoscopy Diagnosis with EHR system

In all the transactions above, access permission to EHR is provided by the patient and the data obtained at each stage are added up to his history without altering any of his early blocks. This ensures untampered history of blocks and access control to prevent unauthorised use or sharing of data. Since all devices involved and systems used are interconnected (IoMT), data gets transmitted among each other and appropriate blocks are created without hassles. Medical errors are absolutely eliminated without any delay in communication. This is a typical case study to understand the impact and effect of Blockchain in IoMT.[10]

Design concerns to be taken care are [4]

- Privacy: Balancing Data Accessibility with Privacy Concerns
- Scalability: Tracking Relevant Events Scalable Across Large Traffic

Conclusion

Blockchain vividly advocates its prominent and proven use cases in EHR management, drug supply-chain management, research and education of healthcare, health data analytics, remote patient monitoring, Insurance claims processing etc [6]. Though there are number of blockchain-based healthcare applications exist, there is still a huge scope for research to be conducted in unexplored services offered with emerging technologies in healthcare. Further research could also supplement efforts to mitigate the challenges of scalability, latency, interoperability, security and privacy to make this technology as a best fit for healthcare industry.

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