Electronic Health Record System Using Hyperledger Fabric

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Abstract. The healthcare industry deals with highly sensitive data which must be managed in a secure way. Electronic Health Records hold sensitive data of patient which should store and shared securely. However, the public release of this highly sensitive personal data pose serious privacy and security threats to patients and healthcare service providers. Hence, we foresee the requirement of new technologies to address the privacy and security challenges for personal data in healthcare applications. Blockchain is one of the promising solutions, aimed to provide transparency, security, and privacy using consensus-driven decentralized data management on top of peer-to-peer distributed computing systems. Our solution explores the potential use of Hyperledger Fabric in healthcare industry. With such permissioned blockchain system solution for storing and sharing healthcare record, the patient will have full control on their health information and authorize the doctors that can view health records by grant and revoke access mechanism.

I. INTRODUCTION

The Electronic Health Record System Through Hyperledger Fabric is a groundbreaking project that aims to revolutionize the management and accessibility of electronic health records (EHRs). In today's healthcare landscape, the need for secure and efficient EHR systems has become increasingly important. Traditional paper-based systems have limitations in terms of security, interoperability, and ease of use. This project addresses these challenges by leveraging the power of Hyperledger Fabric, a blockchain framework, to create a secure and transparent platform for storing and accessing health records.

The context of this project lies in the current healthcare industry, where the effective management of EHRs plays a critical role in delivering quality care. The Electronic Health Record System Through Hyperledger Fabric aims to overcome the limitations of traditional systems by providing a robust and user-friendly solution that ensures the privacy, integrity, and accessibility of health records.

The scope of this project involves the development of a frontend interface using HTML, CSS, and JavaScript. This interface will provide healthcare professionals and authorized staff with an intuitive and seamless experience for interacting with the EHR system. The backend will be powered by Hyperledger Fabric, enabling secure and transparent storage of health records.

The current state of EHR systems relies heavily on centralized databases and often faces challenges related to data security, privacy, and interoperability. The adoption of blockchain technology, specifically Hyperledger Fabric, in the healthcare sector has gained significant attention due to its decentralized nature, immutability, and cryptographic security features. By leveraging Hyperledger Fabric, this project aims to overcome the limitations of existing EHR systems and provide a more robust and trustworthy solution.

The contribution of this paper lies in the development of the Electronic Health Record System Through Hyperledger Fabric, which combines the benefits of blockchain technology with a user-friendly frontend interface. By utilizing Hyperledger Fabric, the system ensures secure and tamper-proof storage of health records, while the frontend interface provides a seamless experience for authorized users. This project significantly contributes to addressing the challenges of EHR management by enhancing data security, accessibility, and interoperability.

The Electronic Health Record System Through Hyperledger Fabric simplifies the management of health records by providing an intuitive user interface for healthcare professionals, administrators, and patients. The frontend, developed using HTML, CSS, and JavaScript, offers a familiar and user-friendly environment. The adoption

of Hyperledger Fabric ensures the integrity and privacy of the records, making it easier for authorized individuals to securely access and manage health-related information.

In summary, the Electronic Health Record System Through Hyperledger Fabric project introduces a revolutionary approach to EHR management by leveraging blockchain technology. With its frontend interface developed using HTML, CSS, and JavaScript, the system offers a user-friendly experience, while the utilization of Hyperledger Fabric ensures security and transparency. This project significantly contributes to addressing the challenges of traditional EHR systems and paves the way for a more efficient and secure healthcare ecosystem.

II. Types of Health Record

1.   PHR: A personal health record, or PHR, is an electronic application through which patients can maintain and manage their health information (and that of others for whom they are authorized) in a private, secure, and confidential environment.

2.   EMR: An electronic medical record (EMR) is a digital version of all the information you'd typically find in a provider's paper chart: medical history, diagnoses, medications, immunization dates, allergies, lab results and doctor's notes within one health care organization.

3.   EHR: An electronic health record (EHR) is a digital version of a patient's paper chart. EHRs are real-time, patient-centred records that make information available instantly and securely to authorized users.

III. Problems with current EHR systems

The healthcare industry still seems to be an easy target for hackers and this is due to the lack of technological understanding within the industry. The recent attacks on the healthcare industry are the evidence of data security challenges in this sector. The target attacks include, but not limited to, phishing attacks and ransomware which are successful in retrieving personal data. In fact, the high success rate of ransomware attacks has shown the lack of basic security measures such as backup and system updates. Healthcare applications like EHR are very sensitive as they directly involve personal and critical data, which must be secured from unauthorized access.

IV. WHAT IS BLOCKCHAIN

Blockchain is a system of recording information in a way that makes it difficult or impossible to change, hack, or cheat the system. A blockchain is essentially a digital ledger of transactions that is decentralized and distributed across the entire network of computer systems. Each block in the chain contains a cryptographic hash of pervious block, and every time a new transaction occurs on the blockchain, a record of that transaction is added to every participant's ledger.

V. Types of Blockchain

1. Public Blockchain
   Public blockchains are permissionless in nature, allow anyone to join, and are completely decentralized. Public blockchains allow all nodes of the blockchain to have equal rights to access the blockchain, create new blocks of data, and validate blocks of data.

2. Private Blockchain
   Private blockchains, which may also be referred to as managed blockchains, are permissioned blockchains controlled by a single organization. In a private blockchain, the central authority determines who can be a node.

3. Consortium Blockchain
   Consortium blockchains are permissioned blockchains governed by a group of organizations, rather than one entity, as in the case of the private blockchain. Consortium blockchains, therefore, enjoy more decentralization than private blockchains, resulting in higher levels of security.

4. Hybrid Blockchain
   Hybrid blockchains are blockchains that are controlled by a single organization, but with a level of oversight performed by the public blockchain, which is required to perform certain transaction validations.
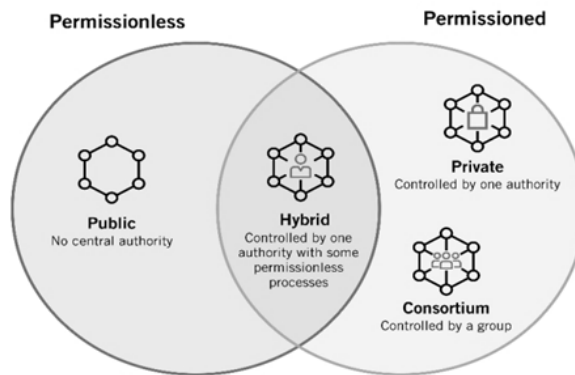

FIGURE 1: Types of Blockchain

VI. Hyperledger Architecture

Hyperledger Fabric is a modular blockchain framework that acts as a foundation for developing blockchain-based products, solutions, and applications using plug-and-play components that are aimed for use within private enterprises.

Where Hyperledger Fabric breaks from some other blockchain systems is that it is private and permissioned. Rather than an open permissionless system that allows unknown identities to participate in the network (requiring protocols like "proof of work" to validate transactions and secure the network), the members of a Hyperledger Fabric network enroll through a trusted Membership Service Provider (MSP).

The following are key design features woven into Hyperledger Fabric that fulfill its promise of a comprehensive, yet customizable, enterprise blockchain solution:

- Assets: Asset definitions enable the exchange of almost anything with monetary value over the network, from whole foods to antique cars to currency futures.

- Chaincode: Chaincode execution is partitioned from transaction ordering, limiting the required levels of trust and verification across node types, and optimizing network scalability and performance.

- Ledger Features: The immutable, shared ledger encodes the entire transaction history for each channel, and includes SQL-like query capability for efficient auditing and dispute resolution.

- Privacy: Channels and private data collections enable private and confidential multi-lateral transactions that are usually required by competing businesses and regulated industries that exchange assets on a common network.

- Security and Membership Services: Permissioned membership provides a trusted blockchain network, where participants know that all transactions can be detected and traced by authorized regulators and auditors.

- Consensus: A unique approach to consensus enables the flexibility and scalability needed for the enterprise.

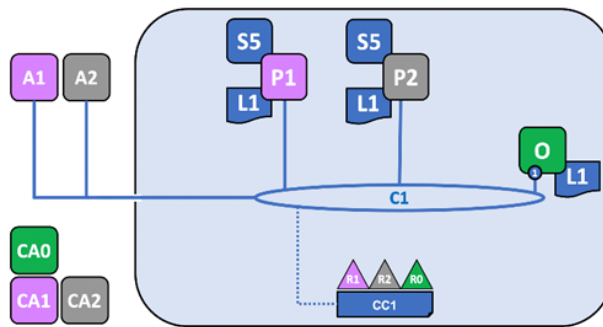FIGURE 2: Simple Hyperledger Fabric Network

VII. LITERATURE SURVEY

Mcseth Antwi in 2021 talks about "The Case of Hyperledger Fabric as a Blockchain Solution for Healthcare Applications." He proposed solutions that comply with GDPR/HIPAA. However, the solution is not fully implemented, and Hyperledger Composer is now deprecated, making the technology outdated, less scalable, and less flexible. Hyperledger Fabric was used in the project.

Ayesha Shehnaz in 2020 introduced blockchain for electronic health records. She employed a chain scaling solution that is scalable and includes a role-based access mechanism. However, the execution time increases with the increase in transactions. Ethereum was used in this project.

Anushree Tandon in 2018 conducted a systematic literature review on the use of blockchain in healthcare, providing a framework and future agenda. She emphasized the strategic perspective and cost-efficiency. It should be noted that the framework focused solely on selected databases, and she used Hyperledger Fabric in her solution.

VIII. PROPOSED METHODOLOGY

In this section, we elaborate on the Blockchain evaluation approach undertaken in this study. We start by identifying key requirements of healthcare applications, and then we present the testing data in the form of scenarios which are implemented to test the identified requirements. Finally, we present the details of the tools used to develop the proposed blockchain environment.

It is important to note that the purpose of this paper is to perform essential tests that we consider critical before the development of the full application (the full application is not developed in this context).

1. Requirements for the healthcare applications : Here, we outline the requirements of the proposed business network and identify what must be done in order to accurately replicate the healthcare applications. In order to investigate how blockchain can be leveraged, it must solve the key issues related to security, regulation compliance, scalability, and flexibility.

• Security The blockchain platform must ensure the basic aspects of security: availability, integrity and confidentiality, to be beneficial for the healthcare industry.

• Confidentiality can be achieved by making sure that the application is on a private blockchain and have restricted access for users. This will mimic the certification required in the healthcare industry, i.e., to become a doctor, the right qualifications are needed. Similarly, in the business network, doctors' accounts must be created by health institution. Further to this, the blockchain network should be permissioned to preserve data privacy. Furthermore, the participants will have different roles and privileges. Additionally, encryption must be used to make sure that data in-transit between the user and the blockchain is secure. Confidentiality is also imperative in this business network because it directly combats phishing attacks and data breaches (the most common attack on the healthcare industry)

• Integrity: Integrity means to make sure that the information is trustworthy and accurate. The blockchain must achieve this through two different ways: 1) hashing, and 2) shared distributed ledger. A strong collision resistant and secure hashing algorithm must be used to ensure integrity. Similarly, confidentiality and access control also make sure that the data is trustworthy by limiting the number of people who can tamper with the information.

• Availability: It is important that there is a reliable and easy access to information on the blockchain. By ensuring that the blockchain network is fault-tolerant, it reduces the number of failed connections to data on the blockchain. Additionally, information on a blockchain is a shared ledger, so there are various copies of the data making sure information will not disappear. The blockchain network must also run on the latest version of HyperLedger to make sure any bugs do not affect the availability of the system

IX. CONCLUSION AND FUTURE SCOPE

Hyperledger fabric is a promising blockchain framework that has some concepts of policies, smart contracts, and provision of secure identities which make the records secure and controlled. It enables the EHR systems to interoperable among multiple hospital organizations. Doctor can track history easily. Patients do not need to carry health history files and will be significant improvements in digital records.

An EHR scenario comes under the private and closed blockchain category and this solution can successfully conclude that it is an encouraging framework of this kind of blockchain. It provides a reliable and secure solution in managing health field record.

Many improvements and advancement can be done to improve solution. Nowadays, data is very crucial for advancement in any technology. Machine learning models which require lots of data which should be again valid and authenticate. By using this solution, the health data of the patients can be studied securely without knowing the patient's identity. This can improve accuracy machine of learning model and healthcare sector will greatly improve.

We have used text-based prescription i.e., doctor have to type prescription into patient's EHR taking lots of precious time of doctor. Hence this can be done by adding voice prescription. A voice-to-text implementation will save hard work to write prescription

X. ACKNOWLEDGMENTS

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