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Blockchain Based Personal Health Record System

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Abstract : The rapid advancement of blockchain technology has opened up new possibilities for transformative applications across various sectors, including healthcare. This project introduces an innovative initiative leveraging blockchain's potential to redefine the management and sharing of personal health records (PHR). The primary goal is to establish a decentralised and secure PHR system that prioritises patient empowerment, data integrity, and privacy. Our strategy involves incorporating blockchain principles into the fundamental structure of the PHR system, ensuring a robust and tamper-resistant foundation. By decentralising the storage of health records, we mitigate the risks associated with centralised repositories, thus granting patients greater control over their sensitive information. To improve accessibility and convenience, each patient is provided with an NFC (Near Field Communication) card. This card acts as a secure authentication mechanism, enabling individuals to access their health records easily by tapping the card on designated readers. This innovative feature enhances the user experience, facilitating widespread adoption of the system. This project signifies a fundamental change in how individuals manage their health records, harnessing state-of-the-art technology to create a secure, transparent, and patient-centric ecosystem. As the healthcare landscape evolves, the integration of blockchain into PHR systems emerges as a critical driver for revolutionising healthcare data management. The inclusion of NFC card authentication further enhances the accessibility of this system, making it a comprehensive solution for secure and seamless personal health record management.

IndexTerms **- Personal Health Record, Blockchain Technology, Near Field Communication, Ethereum Virtual Machine.**

I. INTRODUCTION

Our project is motivated by the imperative need to revolutionise the management of personal health records (PHR) in healthcare. Traditional systems often fall short in ensuring data integrity, accessibility, and privacy, posing challenges for both patients and healthcare providers. Our commitment stems from the belief that individuals have the right to control their health data securely. By integrating blockchain into the core of the PHR system, we aim to empower patients, providing them with a decentralised, tamper-resistant, and transparent platform for managing their health records.

The motivation extends to addressing the broader challenges in healthcare data management. Through the innovative use of blockchain and Near Field Communication (NFC) cards, our project enhances accessibility while maintaining a secure authentication mechanism. We envision a future where patients actively engage in their healthcare, securely sharing their records with authorised entities to foster a collaborative and integrated approach to healthcare management. This project represents our dedication to innovating healthcare data systems, prioritising privacy, and placing individuals at the centre of their health journey.

II. LITERATURE REVIEW

The discourse begins with [1], introducing a groundbreaking blockchain-based access control model for personal health record systems. This model addresses limitations and offers enhanced privacy, security, and performance. Building upon this foundation, [2] contributes valuable design knowledge tailored for Personal Health Records, addressing security and privacy concerns while providing practical insights for future developments in healthcare data management. Moreover, [3] presents an innovative approach integrating blockchain, trust chain, and homomorphic encryption for secure and efficient healthcare data management, advancing privacy and communication channels within IoT networks.

Transitioning to related research, [4] proposes a patient healthcare framework leveraging permissioned blockchain technology to enhance efficiency and reliability for digital healthcare systems. Following this, [5] introduces a blockchain-based system for emergency healthcare, emphasising adaptability and real-time access control to improve patient-centric care and emergency healthcare data management. Additionally, [6] investigates blockchain's potential for managing personal health records, highlighting feasibility and challenges while suggesting solutions for optimising data management in public blockchain networks.

Continuing the review, [7] introduces a blockchain-based framework for secure EMR data sharing in cloud environments, emphasising lightweight and scalable solutions. Furthermore, [8] contributes by comparing Geth and Parity on a private blockchain, highlighting implications for Ethereum applications and the importance of performance metrics.

Transitioning to NFC technology, [9] explores its role in facilitating secure, short-range wireless communication between devices, emphasising the need for standardised protocols. Expanding on this, [10] discusses NFC sensors' applications in continuous monitoring across various fields, leveraging biodegradable materials and biosensors for diverse uses.

Moving forward, [11] delves into blockchain technology's role in enhancing IoT security, proposing axiomatic design theory for analysing integration and addressing challenges. Additionally, [12] proposes a patient identification system using NFC cards and blockchain in medicine, ensuring secure patient identification without exposing medical history.

Regarding Electronic Health Record systems, [13] proposes integrating blockchain for enhanced security, transparency, and patient control, utilising Ethereum, smart contracts, and encryption. [14] advances this further by proposing blockchain and Homomorphic Encryption integration to address healthcare data security challenges.

Finally, [15] covers blockchain-based smart contract technology, discussing technical and legal challenges and proposing a methodology leveraging specific technologies. [16] concludes the discourse by highlighting NFC technology's role in enabling secure contactless payments, emphasising data transmission and transaction security.

III. PROPOSED SYSTEM

Our proposed system harnesses blockchain to transform healthcare data management, addressing EHR shortcomings. It offers enhanced security, privacy, patient control, and data accessibility. Patients can store data securely, control access, and verify their identity. Blockchain ensures encryption and transparency. Healthcare providers can access data securely from anywhere. The system prioritises patient-centric care, emphasising privacy and enhancing data management and security, resulting in a better patient experience.NFC-Enabled Access: NFC(Near Field Communication) technology allows quick and secure access to health records.

IV. METHODOLOGY

4.1 Blockchain technology

A decentralised, secure ledger system providing integrity and auditability through cryptographic links, each block containing a cryptographic hash of the previous block, a timestamp, and transaction data, ensuring tamper resistance. This privacy-preserving technology is implemented using a blockchain-based methodology, ensuring security for patient health records (PHR) in the Internet of Medical Things (IoMT). The proposed framework utilises a permissioned blockchain to share healthcare data, reducing security and privacy issues.

4.2 Metamask

MetaMask is a browser extension designed to facilitate interactions with the Ethereum blockchain. Beyond merely storing patient information, it acts as a digital wallet, enabling users to manage their cryptocurrency holdings and interact with decentralised applications (DApps). Its integration allows patients to retain control over their medical records, ensuring data sovereignty and enabling secure sharing with authorised healthcare providers. Through MetaMask, patients can authenticate transactions, sign digital agreements, and access blockchain-based services seamlessly within their web browsers. Its user-friendly interface and robust security features make it a crucial component for empowering individuals to manage their health data securely on the blockchain

4.3 NFC Setup

NFC handover facilitates information exchange between two NFC devices via tapping or proximity, enabling tasks like Wi-Fi setup. NFC setup configures and enables NFC on compatible devices for wireless data transfer and interaction with other NFC-enabled devices or tags, operating at 13.56 MHz radio frequency. NFC security involves implementing measures to prevent unauthorised access or data theft during transactions, ensuring data integrity.

4.5 Software-Hardware Integration

The NFC system comprises NFC cards with ample storage capacity and compatibility with scanners for data exchange. NFC card scanners/writers are essential for reading and writing NFC cards. The system operates on a chosen OS, such as Linux or Windows. The web application utilises MongoDB for medical data storage, Express.js for server-side functionality, React for the user interface, and Node.js as the runtime environment. Blockchain integration involves Ganache for Ethereum blockchain testing, Solidity for smart contract development, and Web3.js for web app-smart contract communication. IPFS is utilised as a decentralised file system for large file storage. Additionally, NFC reading and writing software requirements include NFC card SDK/drivers for interfacing with NFC cards.

V. SYSTEM ARCHITECTURE

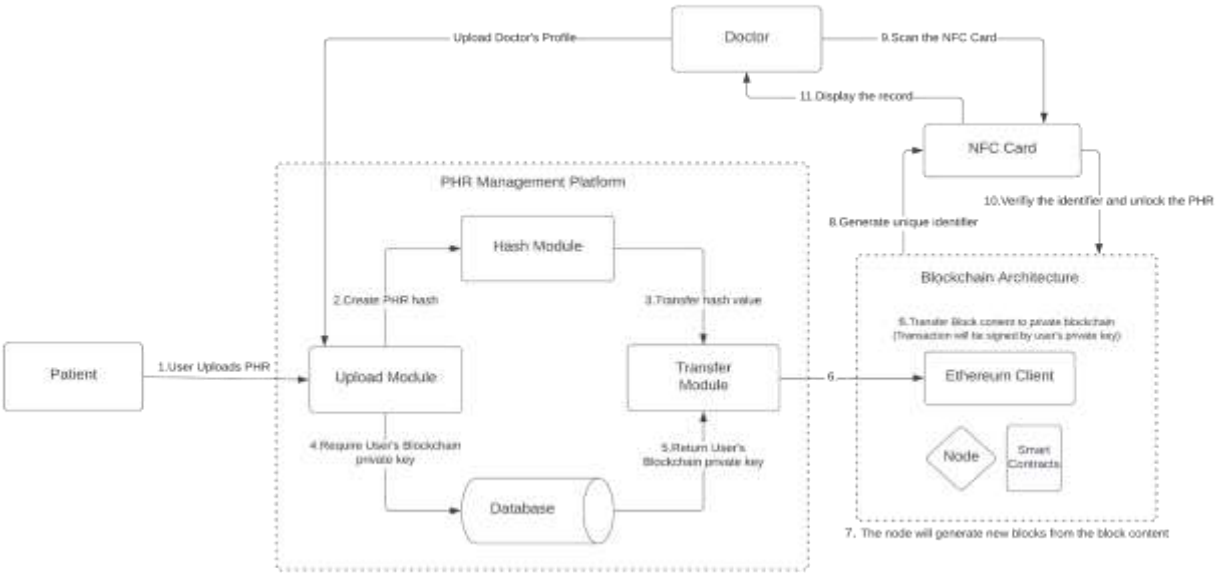

Figure 2 System Architecture

5.1 User Registration and Authentication

Managing user identity and access control involves implementing mechanisms to verify the identity of users accessing systems or data, and controlling their permissions based on their authenticated identity. This ensures that only authorised individuals can access the necessary resources while maintaining security and data integrity.

5.2 Upload Module

This module enables users to input and manage their health information, including medical history, allergies, medications, and test results, within their personal record. By centralising this data, individuals can conveniently track and share their health information with healthcare providers, facilitating comprehensive and personalised medical care.

5.3 Blockchain Storage

Health data stored on a blockchain operates similarly to entries in a digital ledger, providing a secure and immutable record of medical information. Utilising blockchain technology ensures data integrity by preventing unauthorised alterations or tampering, enhancing trust and reliability in healthcare data management.

5.4 NFC Card Registration

When a new card is registered for a medical record, a unique identifier is generated and linked to the corresponding record, stored securely within the NFC card. This identifier serves as a key for accessing the relevant data from the database, ensuring accurate retrieval and maintaining patient confidentiality and security.

5.5 NFC Card Verification

The system validates the unique identifier associated with each card to ensure its authenticity. If a match is found in the database, the data is retrieved, but if no match is found, an error is returned, indicating a potential tampering attempt and prompting further investigation to maintain data integrity and security.

VI. EXPERIMENTATION AND RESULTS

In our implementation, we deployed a blockchain-based health record management system integrated with NFC card authentication, leveraging Ganache IPFS and Ethereum Metamask. Through extensive testing, we observed significant enhancements in data security, accessibility, and patient empowerment. Users found the web application intuitive for registering and managing personal medical information. NFC technology facilitated swift and secure access to health records, enhancing user experience while maintaining robust security measures. Blockchain encryption ensured confidentiality and integrity, fostering trust among stakeholders. The decentralised nature of the system enabled global accessibility and granted patients control over their data without organisational barriers. A key feature was enabling doctors to access patients' health records, while patients could select specific doctors for consultation and add medical details to their records, thus ensuring a patient-centric approach and facilitating seamless communication between patients and healthcare providers.

VII. CONCLUSION

The proposed work introduces a novel approach to healthcare data management by integrating blockchain technology into the development of a decentralised Personal Health Record (PHR) system. This system addresses the limitations of traditional

Electronic Health Records (EHR) by ensuring enhanced security, privacy, and giving patients greater control over their health data. Utilising blockchain principles establishes a secure foundation, emphasising transparency and preserving the integrity of health records.

Our solution features patient-centric elements such as secure data control mechanisms and blockchain-based identity verification, empowering individuals to actively manage and safeguard their health information. The seamless integration of Near Field Communication (NFC) technology further enhances the user experience, providing swift and secure access to health records for both patients and healthcare providers.

In summary, this project represents a significant advancement in reshaping healthcare data management, focusing on privacy, security, and individual empowerment. As technology advances, our solution sets a new standard for the future of healthcare information systems—one that prioritises seamlessness, security, and patient-centricity. Our goal is to contribute to an improved healthcare ecosystem that values transparency, accessibility, and individual agency over personal health records.

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