PureChain for Healthcare Data Sovereignty: Managing Patient Consent with Smart Contracts

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***Abstract*—In healthcare, managing patient consent and ensuring data privacy remain significant challenges in centralized systems. This paper proposes a PureChain-based healthcare data sovereignty system that leverages smart contracts to automate and secure consent management. Using the proof of authority and association (PoA^2) consensus mechanism and interplanetary file system (IPFS) for off-chain data storage, the system provides a decentralized and transparent solution, giving patients complete control over their health data. The smart contracts ensure that only authorized healthcare providers can access patient data with granted consent. This system enhances data security, patient privacy, and system efficiency, addressing the limitations of traditional healthcare data management systems.**

***Index Terms*—Data Security, Healthcare Data Management, IPFS, PoA^2, PureChain, Smart Contracts.**

I. Introduction

Healthcare data management in centralized systems presents significant challenges, including issues with data security, patient control, and unauthorized access [1]. Centralized databases store sensitive patient information, creating single points of failure and increasing the risk of data breaches [2]. Furthermore, patients often have limited control over their data, with unclear visibility into who accesses it and for what purposes.

PureChain, a decentralized and permissioned blockchain, ensures security, transparency, and immutability by leveraging PoA^2 consensus mechanism [3]. This consensus mechanism enables fast and efficient transaction processing while maintaining a high level of security [4]. Smart contracts are self-executing programs on a blockchain network that automatically perform actions when predefined conditions are met [5]. IPFS enables the decentralized storage of large files, like medical records, while alleviating the storage load on the blockchain.

This paper proposes a PureChain-based healthcare data sovereignty system that uses smart contracts to give patients complete control over their data. It enables easy consent management, allowing patients to grant or revoke access to healthcare providers, protecting privacy and preventing unauthorized access. The system aims to enhance data security, provide greater patient control, and ensure transparency, addressing issues in centralized healthcare data systems.

II. Component of the Framework

A. User Interface

The user interface (UI) is designed for simplicity and ease of use for patients and healthcare providers. Patients use a web or mobile app to grant or revoke consent for data access, while healthcare providers use a dedicated app to request access.

B. PureChain Network

The system uses PureChain, a permissioned blockchain with PoA^2 for efficient transactions and data integrity. PoA^2 relies on trusted validators for secure consensus, reducing energy consumption compared to traditional blockchains, while ensuring transparent and immutable records.

C. Smart Contract Layer

Smart contracts automate the consent process, allowing only authorized providers access to patient data. They log all actions related to consent, creating immutable records on the blockchain, ensuring transparency and preventing unauthorized access.

D. IPFS for Off-Chain Data Storage

Patient data is stored off-chain using IPFS to reduce the blockchain's storage load. Only an IPFS hash is stored on-chain, ensuring privacy and efficient data retrieval. Healthcare providers with consent can access the IPFS link, maintaining patient control over their data.

III. Proposed System

This paper proposes a PureChain-based healthcare data sovereignty system, as shown in Figure 1, that leverages PureChain with the PoA^2 consensus mechanism to enhance patient data security and streamline consent management in healthcare. The smart contracts allow patients to grant and revoke consent for healthcare providers to access their data, ensuring full patient control while maintaining data privacy.

Patient data is stored off-chain on IPFS, with links recorded on the blockchain to ensure immutability and transparency. This setup guarantees that consent actions, such as granting or revoking access, are permanently logged on the blockchain. Healthcare providers can request access to patient data, and patients can grant or revoke consent via a simple user interface. This system ensures that all data access actions are

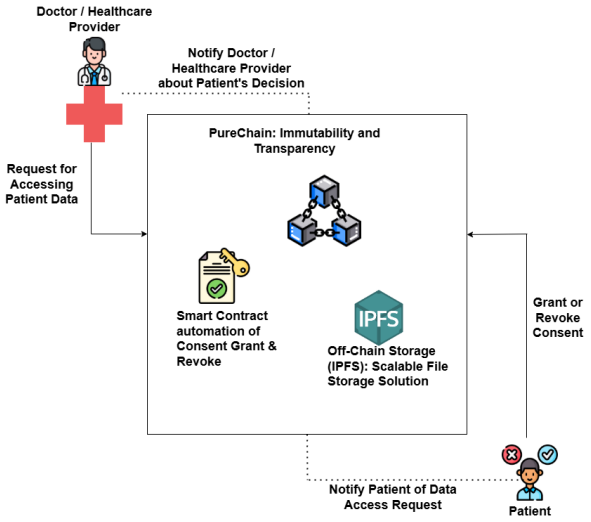


Fig. 1: Proposed System for PureChain-based Healthcare Data Sovereignty

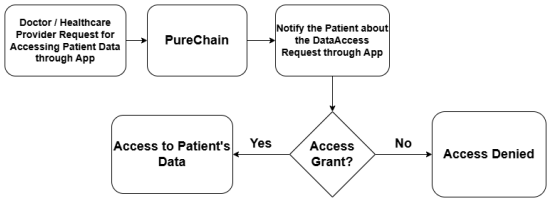


Fig. 2: Workflow of PureChain-based Healthcare Data Sovereignty

automated, secure, and transparent, each being auditable on the blockchain. Figure 2 illustrates the workflow of the proposed concept.

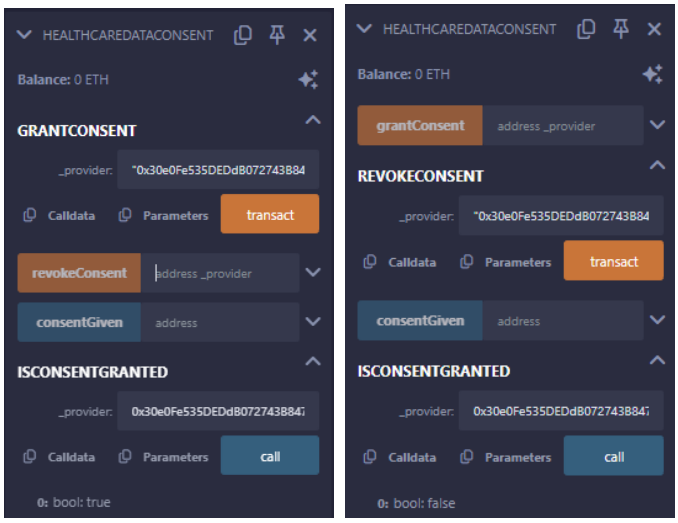
IV. Testing and Validation

The `HealthcareDataConsent` smart contract was tested using the Remix IDE on the PureChain testnet. In Figure 3(a), the patient grants consent to the provider by entering the provider's address. After the transaction is confirmed, the `isConsentGranted` function correctly returns true, indicating that consent has been successfully granted.

Next, Figure 3(b) shows the patient revoke consent for the same provider. Upon checking the consent status again, the function returns false, confirming that consent was properly revoked. These tests validate that the contract allows the patient to grant, revoke, and check consent accurately, providing a transparent and secure method for managing healthcare data.

V. Conclusion

The PureChain-based healthcare data sovereignty system offers a secure, decentralized solution for patient consent management, providing a patient-centric and transparent approach. PoA^2 consensus ensures efficient and secure data handling, overcoming limitations of centralized systems. Future work



(a) Granting Consent to a Healthcare Provider

(b) Revoking Consent to a Healthcare Provider

Fig. 3: Consent Status Check

will enhance user experience, explore cross-chain interoperability, and optimize AI-based smart contracts for better data processing and consent management.

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