



# Chapter 3

## VitaChain: An AI–Blockchain–Based EHR Management Framework With Zero–Knowledge Proofs for Enhanced Privacy

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### ABSTRACT

*As Electronic Health Records (EHRs) become integral to modern healthcare, concerns regarding security, privacy, and scalability have emerged. Conventional centralized systems face vulnerabilities and lack patient data control, necessitating innovative decentralized solutions. This research introduces a novel AI-blockchain-based architecture for permissioned health networks, leveraging zero-knowledge succinct, non-interactive arguments of knowledge (zkSNARKs). The framework integrates AI-blockchain, InterPlanetary File System (IPFS), and zkSNARKs to enhance EHR security, privacy, and scalability. IPFS is employed for off-chain storage, improving*

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*scalability alongside blockchain's tamper-proof logging. Encryption and smart contract-based access controls preserve privacy.*

## **1. INTRODUCTION**

The healthcare sector continuously evolves through Electronic Health Records (EHRs) digitalization. The adoption of Electronic Health Records (EHRs) has been recognized as a crucial step towards improving patient care (Ratwani, 2017), further emphasizing the need for secure and efficient management of such records. This paradigm shift offers unprecedented opportunities for increased efficiency, improved patient care, and data-driven insights (Ratwani, 2017). Nevertheless, this expansion is not devoid of its accompanying challenges, with significant apprehensions centering on interoperability, security, and privacy emerging as crucial focal areas. Conventional health data management systems, which are naturally centralized, deal with weaknesses associated with single points of failure, making patient data susceptible to potential cyber threats. Concurrently, the significant absence of patient autonomy about their medical data has raised substantial privacy concerns, necessitating a novel strategy to combine technological advancements with ethical obligations. According to recent allegations, more than 125 million healthcare records have been breached in the United States from 2019 to 2022. This breach has exposed highly confidential medical information such as diagnosis, treatments, prescriptions, and insurance details. The main challenge is the rapid growth of healthcare data, which also presents a significant scaling problem.

AI-Blockchain technology has found potential applications in various domains, including the Internet of Things (Basil, Ambe, Ekhaton, Fonkem, & Nduma, 2022), necessitating the exploration of its utility in the healthcare sector. It is renowned for its decentralized, transparent, and unchangeable characteristics and presents itself as a promising solution to redesign the structure of EHR systems (P. Sharma, Borah, & Namasudra, 2021).

Given this, the proposed architecture is seen as a unique approach to this challenge, intelligently blending AI-Blockchain with the Interplanetary File System and zero-knowledge proofs. This combination of advanced technologies creates a comprehensive solution that enhances security and privacy measures while also addressing the significant scalability issues that arise from the rapid expansion of healthcare data. The solutions should give patients more control over their medical data (Basil et al., 2022). Research pioneers a tailored AI-Blockchain solution for the complex landscape of modern healthcare systems, effectively addressing critical security and privacy challenges in permissioned EHR networks.

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