

## Transforming Healthcare Data Privacy: Integrating Blockchain with Zero-Knowledge Proofs and Cryptographic Security

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**Abstract :** Blockchain technology presents solutions for managing healthcare data, addressing critical challenges in privacy, integrity, and access. This paper explores how privacy-preserving technologies, such as zero-knowledge proofs (ZKPs) and homomorphic encryption (HE), enhance decentralized healthcare platforms by enabling secure computations and patient data protection. An examination of the mathematical foundations of these methods, their practical applications, and how they meet the evolving demands of healthcare data security is unveiled. Using real-world examples, this research highlights industry-leading implementations and offers a roadmap for future applications in secure, decentralized healthcare ecosystems.

**Keywords :** blockchain, cryptography, data privacy, decentralized data management, differential privacy, healthcare, healthcare data security, homomorphic encryption, privacy-preserving technologies, secure computations, zero-knowledge proofs

**Conference Title :** ICCIT 2024 : International Conference on Computing and Information Technology

**Conference Location :** San Francisco, United States

**Conference Dates :** November 04-05, 2024