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Fortifying Critical Infrastructures: Secure Data Management with Edge Computing

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Abstract: *Critical infrastructures (CIs), including energy, healthcare, and transportation, are vital to societal functions, making their security paramount. The emergence of edge computing as a means of safe data management is a direct result of the growing dependence of these infrastructures on real-time data and networked devices. Computing at the edge, or near the source of data, improves efficiency, simplifies data processing, and enables better real-time judgements by decentralising data processing. However, this distributed architecture introduces new security challenges, such as managing a broader attack surface and ensuring data integrity. This paper reviews the role of edge computing in securing critical infrastructures and discusses advanced security measures like encryption, access control, AI-driven anomaly detection, and blockchain. It also outlines future research directions, emphasizing the need for scalable, interoperable edge systems, AI-enhanced security models, quantum-safe encryption, and privacy-preserving techniques. Global standardization is highlighted as essential for consistent, reliable integration. Ultimately, edge computing offers a promising pathway to fortify critical infrastructures against evolving cyber threats, ensuring their continued, resilient operation in an increasingly connected and digital world.*

Keywords: Critical infrastructures, Edge computing, secure data management, real-time decision-making, data integrity, AI-driven security, privacy-preserving techniques, cyber threats