Enhancing Security in Real-Time Applications Using Blockchain Technology: A Survey

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Abstract. The increasing deployment of real-time applications in numerous domains like finance, healthcare and IoT sector, has exposed serious security challenges that traditional solutions struggle to address. Blockchain is a highly viable alternative for securing real-time IoT applications as it is both distributed and immutable in nature. This literature review identifies contributions from the existing literature, examines the trends in applying blockchain for real-time security, and provides proposed areas of research. In this paper, we present the innovative solutions to solve significant security-related concerns by integrating blockchain with modern technologies such as AI and IoT. A system that cannot delay data security in real-time applications is needed to be implemented for data integrity, confidentiality and availability. Now blockchain, with its decentralized and immutable security architecture, is being recognized as the potential solution for the security of real-time systems. A comprehensive review of blockchain applications in real-time scenarios such as energy management, healthcare system, and Internet of Things (IoT) have been presented in this paper. The paper then covers future strategies for real-time security applications, potential enhancements, and limitations of blockchain.

Keywords: Blockchain, IoT, Healthcare, Security, decentralized, real time.

1 Introduction

Real-time applications suffer from the risk of unauthorized access, DDoS, data leaks because of the requirement of data processing and data transmission are fast. Since the nature of the blockchain technology is distributed, it has been proven to be an innovative method of ensuring trust, audibility, and transparency. Real-time systems can be applied in various industries, including healthcare (e.g., tracking critical patient information), finance (e.g., process quick transactions), and IoT (e.g., create real-time connections between devices). The development of blockchain implementation in real-time is currently discussed in this study, and suggests its security enhancement results derived from new solutions. Safe and reliable exchange of information is increasingly important with the proliferation of real-time systems in applications such as Internet of Things, healthcare, finance, automotive networks, etc. Tradition security mechanisms do not necessarily satisfy such demands from these systems due to scalability, centralization and vulnerability issues. Blockchain offers a unique solution to those problems through a decentralized ledger and cryptographic security. This paper evaluates the recent progress done in integration of blockchain for realtime application security. The Blockchain is a distributed ledger technology, which provides secure and tamper-proof data storage using cryptographic methods. Decentralization, transparency and immutability are significant features. The transactions are verified through consensus rather central authority as under a blockchain. Consensus mechanisms are integral to keeping

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blockchain systems intact and virtually include Delegated Proof-of-Stake (DPoS) which we built, Proof of Work (PoW), and Proof of Stake (PoS) among others. There is a need to account for delays of typical security systems in order to attain stringent time constraints of live operations. Examples of such capabilities are distributed identity control, automated smart contract execution, and indestructible data sharing, through the use of blockchain. Blockchain tackles two main risks in real-time systems, looking for dependability and transparency by decentralizing trust and providing an immutable audit trail.

2 Literature Survey

Vehicle Networking Integration with Blockchain – In their work of 2024, Ashna et al. explored how blockchain can be used to realize secure communication and governance in 5G based car network. To achieve safe and valued network design, their work highlights the significance of validation scenarios in applying blockchain technology in automotive scenarios. Blockchain in 6G V2X Systems – Rajalakshmi (2024) studied the usage of blockchain in 6G-enabled V2X communication systems. The research is concerned with secure data exchange and resource exchange on-the-fly. Wang and Saghiri (2024) demonstrated in their decentralized platoon management SWOT analysis the potential of blockchain for ensuring data integrity and safe decision-making. Secure blockchains models were also introduced recently by [8] Wang and [15] Saghiri for autonomous vehicle communication to make the privacy secure, ensuring the reliability of the provided data. IoV communications can be secured from cyberattacks using Blockchain to increase the security of data and transaction authenticity, as Aliesawi et al. (2024). Demand Response Management for Electric Vehicles using Blockchain Tanwar et al. (2024) by applying blockchain technology to meet the variances of energy demand and reinforcement learning to minimize energy dispatching of the EVs. For energy-consuming purposes, others, such as Tawalbeh and El-Latif (2024) have also developed Proof-of-Stake and other lightweight consensus methods to lessen the energy consumed by blockchain. Zaboli et al. studied the blockchain technology. (2024) serving as the model of energy resource management in EVs, we propose environmentally-consensusive approaches to minimize the impact on the environment. For securing data integrity and privacy in wearable health applications Zhou et al. (2024) studied blockchain-mediated systems for secure data exchange. The ability of blockchain to maintain security and integrity of medical records and reduce the vulnerabilities was pointed out by Liang et al. in 2024. Nguyen and Hwang (2024) have used blockchain with AI for the management of smart grid, ensuring secure and independent data transfer. According to Waghanna et al. (2024). Blockchain contributes to making automotive supply chains more transparent and traceable. In such ways the number of counterfeit parts decreases and better quality control is established. The potency of blockchain in managing resource distribution throughout 6G-based supply chain in real-time applications has been demonstrated by Rajalakshmi (2024).

3 Proposed Work

This section introduces a unique framework that improves real-time application security by combining blockchain with AI and IoT. Included in the framework are the following elements:

3.1 The Governance of DIDs

Traditional identity management has a single point of failure problem because it's very much centralized. For parties and peripheral client devices in real-time systems, it can employ blockchain-based authentication, which is a decentralized and tamper-proof method, and ultimately can ensure that the verification of identity is processed in a secure manner.

3.2 Real Time Robotics with Smart Contracts

Pre-determined rules can automatically be enforced via the smart contracts, no middlemen are required. Real-time applications - An example for this category is supply chain systems which pay out goods on delivery. This is a fast operation, which includes an acceptable number of human interactions with the processes, the user, etc and thus it is also a secure process.

3.3 Anomaly Detection by AI Support

Artificial-intelligence (AI) systems examine blockchain data to detect potential dangers and irregularities in real time. For instance, malicious activities in IoT networks and financial transactions in fraudulent financial domains can be identified through machine learning algorithms.

3.4 Security of IoT-Based Communication

Blockchain secures communication between Internet of Things by securing communication between Internet of Things. For applications such as smart cities, where real-time sharing of data between connected devices is of utmost importance, this part is important.

4 Block Diagram

As illustrated in Fig. 1, enhancing security in real-time applications involves integrating advanced technologies such as blockchain, IoT, and machine learning to ensure data protection, reliability, and operational efficiency.

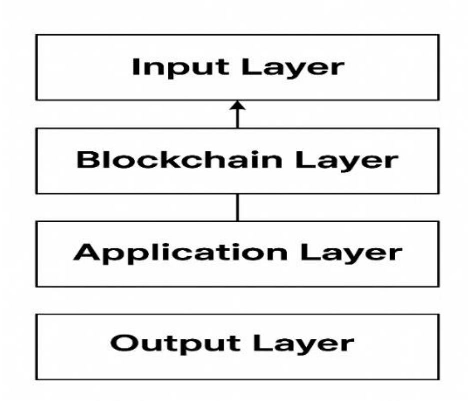

Fig.1. Enhancing Security In real Time Applications.

4.1 Input Layer

The input layer in real-time settings is the initial step aggregating the input from sensors, IoT devices and real-time systems, etc. Critical decisions and operating practices are based on the overwhelming volume of data produced by these devices. In health care, for instance, sensors incorporating the IoT monitor the health data of patients, and in vehicle networks they collect context information such as location of a vehicle, speed and surrounding circumstances. Blockchain technology itself is being utilized to secure and enable the fast accumulation of reliable, accurate data that real-time systems depend upon. Acting as the window of data into the blockchain based ecosystem, this layer is vital to bridge the gap between the real and virtual realms.

4.2 Blockchain Layer

The Blockchain Layer, which processes data in a decentralized and trustless fashion, is the essential element of the architecture. Its 3 pillars are the consensus mechanism, smart contract and the distributed ledger. Decentralized ledger offers transparency by making the data unalterable once it is validated. We do not need anyone to oversee the network in a trustless environment, as long as the participants of the network can come to an agreement in the validity of the transactions due to Consensus mechanisms like Proof of Stake (PoS) or Practical Byzantine Fault Tolerance (PBFT). Through facilitating the automated fulfilment of predefined contracts and rules, smart contracts enhance efficiency while reducing reliance on intermediaries. When considered together, these features define the Blockchain Layer as a mandatory element for ensuring integrity, trust, and secure data processing in real-time applications.

4.3 Application Layer

The application of blockchain technology in real world is Application Layer. It is at this level where validated and secure data can be processed into services and insights that can be applied in specific sectors. Use of blockchain in healthcare assures secure storage patient data, ensuring clear exchange of medical records sharing and 24/7 real-time health tracking. It benefits traffic control, the autonomous driving project and secure message exchange among vehicles in vehicular networks. And financial systems apply this in blockchain, to have secure transaction processing, fraud prevention, and real time payments. The Blockchain Layer has robust infrastructure, the Application Layer has innovative, practical and secure solutions for all types of real-time applications to meet customer needs and operational challenges.

4.4 Output Layer

The last layer of the system: output layer is in charge of providing secured and verified data to end users or external systems. This layer ensures that data used in real-time decision-making processes is accurate, cannot be tampered with, and is available. Whether exchanging money information in financial transactions, secure communication in the automotive communication, or exchanging critical patient health information in the healthcare domain, the Output Layer makes the flow of data reliable and trustworthy. This layer provides consumers with confidence that the data is true and trustworthy as it is based on the immutability and transparency of the blockchain. This forms the basis for actionable insights and real-time system-wide interoperability in real-time applications.

Table 1. Summary of Recent Blockchain and IoT-Based Solutions Across Various Application Domains.

Reference	Objective	Technology Used	Key Findings/Contributions
1, 16	Revolutionizing vehicle operations using blockchain	Blockchain	Improved governance and operational efficiency in vehicular networks.
3	Resource reservation for time-sensitive vehicular networks	Time-Sensitive Networking (TSN), ISAC	Proposes schemes for resource optimization in vehicular applications.
4	Trust-based incident and evidence management	IoT, Trust Models	Proposes models for reliable incident and evidence handling in IoV.
6	Enabling technologies for next-gen smart cities	IoT, Blockchain	Highlights blockchain and IoT applications in smart city development.
7	RFID and blockchain in medical big data	RFID, Blockchain	Combines technologies for efficient physiological signal processing.
8	Secure data offloading in healthcare	Blockchain, Deep Reinforcement Learning	Ensures secure and efficient healthcare data offloading.
9, 19	Security challenges in Smart Grid 2.0	Blockchain, Smart Grid	Explores threats and protection mechanisms for advanced grids.
10	Blockchain vulnerabilities and security challenges	Blockchain	Reviews blockchain security challenges and vulnerabilities.
11	Blockchain and IoT for secure transportation	Blockchain, IoT	Proposes frameworks for IoT-based secure transportation systems.
13	Effects of Industry 4.0 adoption in manufacturing	Industry 4.0, IoT	Highlights the impact of Industry 4.0 technologies.
14, 23	Decentralized platoon management using blockchain	Blockchain, SWOT Analysis	Analyzes decentralized platoon management systems using blockchain.

15	Federated framework for heart disease risk prediction	Blockchain, Edge-Cloud Computing	Proposes a federated edge-cloud framework for risk prediction.
17	Incentive mechanisms for supply chain data governance	Blockchain	Proposes blockchain-based designs for better data governance.
18, 20	Blockchain solutions to secure IoV communication	Blockchain	Reviews blockchain-based communication security in IoV.

5 Conclusions

The blockchain technology has been a disruptive technology for security enhancements in real-time applications such as IoTs, Car networks, Healthcare systems and energy management in different domains. It provides powerful solutions to critical issues such as data integrity, confidentiality and trust – due to its decentralized, tamper-proof and transparent nature. This survey demonstrates the creativity in which blockchain is being applied, for example, to address current problems, and to support effectiveness and resilience. Despite the significant advancement, the integration of blockchain in real-time systems is not free from challenges. For full utilisation, topics such as interoperability, scalability, and energy consumption need to be studied. New technologies such as AI (Artificial Intelligence)/6G networks/IOT and edge computing bring new hope for blockchain to underpin real-time and more dynamic and complex scenarios. Such uses of blockchain in real-time systems are expected to become important for the development of safe, effective, and sustainable technological ecosystems in the future. Yet there is a future that is secure and connected, and blockchain is poised to be an integral part of today's elementary real-time applications, breaking through current limitations using its benefits.

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