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Blockchain-Enabled Secure Data Transmission Framework for Internet of Medical Things (IoMT) Communication Networks

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ABSTRACT: *The rapid adoption of the Internet of Medical Things (IoMT) has revolutionized modern healthcare by enabling continuous patient monitoring, remote diagnosis, intelligent disease prediction, and real-time medical data exchange through interconnected wearable sensors, implantable devices, smart medical equipment, and cloud-based healthcare infrastructures. Despite these advancements, IoMT communication networks face significant security challenges including unauthorized access, data tampering, identity spoofing, distributed denial-of-service attacks, privacy leakage, and insecure medical data transmission. Conventional centralized security mechanisms often suffer from single points of failure, limited scalability, and inadequate trust management in heterogeneous healthcare environments. Blockchain technology offers a decentralized, immutable, and transparent platform capable of ensuring secure and trustworthy medical data sharing among healthcare stakeholders. This research proposes a* ***Blockchain-Enabled Secure Data Transmission Framework*** *that integrates blockchain, lightweight cryptographic techniques, smart contracts, decentralized authentication, and secure communication protocols to protect sensitive medical information transmitted across IoMT communication networks. The proposed framework ensures confidentiality, integrity, authentication, non-repudiation, and traceability while maintaining low communication latency and high network efficiency. Experimental evaluation demonstrates improvements in transmission security, authentication accuracy, throughput, energy efficiency, and resistance against cyberattacks compared with conventional IoMT security architectures. The proposed framework provides a reliable foundation for intelligent, secure, and privacy-preserving healthcare communication systems supporting next-generation digital hospitals, telemedicine platforms, emergency healthcare services, and smart medical ecosystems.*

INTRODUCTION

The continuous advancement of digital healthcare technologies has transformed the delivery of medical services through the integration of intelligent sensing devices, wireless communication systems, cloud computing, artificial intelligence, and the Internet of Medical Things (IoMT). IoMT represents a specialized extension of the Internet of Things (IoT) in which wearable sensors, implantable medical devices, smart diagnostic equipment, patient monitoring systems, mobile healthcare applications, and hospital information systems collaborate to collect, process, transmit, and analyze physiological data in real time. These technologies enable continuous health monitoring, remote patient care, early disease detection, personalized treatment planning, emergency response, and intelligent clinical decision support. Consequently, IoMT has

become one of the fundamental technologies driving Healthcare 4.0 and the future evolution of smart healthcare infrastructures.

Modern IoMT communication networks generate enormous volumes of highly sensitive medical information, including electrocardiograms (ECG), electroencephalograms (EEG), blood glucose levels, blood pressure measurements, oxygen saturation, medical imaging records, electronic health records (EHRs), medication histories, and physician prescriptions. These data are continuously exchanged among wearable sensors, gateways, edge computing nodes, cloud servers, healthcare professionals, insurance providers, pharmacies, and regulatory organizations. Since medical information directly influences patient diagnosis and treatment decisions, ensuring secure, reliable, and tamper-resistant data transmission has become one of the most critical challenges in healthcare communication systems.

Traditional security mechanisms employed in IoMT architectures are primarily based on centralized authentication servers, conventional encryption protocols, access control systems, and cloud-based storage infrastructures. Although these approaches provide basic confidentiality and authentication, they frequently suffer from several limitations including centralized trust dependency, vulnerability to single-point failures, insider attacks, database compromise, scalability constraints, and delayed security verification. Furthermore, the heterogeneous nature of IoMT devices introduces additional security challenges because medical sensors often possess limited computational capability, restricted battery capacity, constrained memory resources, and low communication bandwidth. These resource limitations make it difficult to deploy computationally intensive security mechanisms without affecting system performance and energy efficiency.

Blockchain technology has emerged as a promising solution for addressing these security challenges by providing decentralized trust management, distributed consensus, immutable transaction records, cryptographic verification, and transparent data auditing. Unlike conventional centralized databases, blockchain stores transactions across multiple distributed nodes where each validated transaction becomes permanently linked to previous records through cryptographic hash functions. The decentralized architecture eliminates dependence on a single trusted authority while significantly improving data integrity, availability, transparency, and resistance against malicious modifications. Smart contracts further automate authentication, authorization, access control, and medical data sharing without requiring continuous human intervention.

Recent advancements in lightweight cryptography, elliptic curve cryptography (ECC), attribute-based encryption, identity-based authentication, and blockchain consensus algorithms have enabled secure implementation of blockchain within resource-constrained IoMT environments. Lightweight cryptographic algorithms minimize computational overhead while preserving strong security guarantees, making them suitable for wearable healthcare sensors and battery-powered medical devices. Similarly, efficient consensus protocols reduce transaction latency and computational complexity compared with conventional Proof-of-Work mechanisms, thereby improving scalability and real-time communication performance within healthcare networks.

The convergence of blockchain, edge computing, cloud computing, and artificial intelligence further enhances the capabilities of modern IoMT communication systems. Edge computing enables preliminary processing of medical data near the source, reducing communication delay and network congestion. Artificial intelligence supports intelligent anomaly detection, predictive healthcare analytics, and automated clinical decision-making, while blockchain ensures that all transmitted medical information remains authentic, tamper-resistant,

and verifiable throughout the communication lifecycle. This integrated architecture enables secure, intelligent, and decentralized healthcare services capable of supporting remote patient monitoring, emergency medical response, telemedicine, smart hospitals, and personalized healthcare management.

Despite significant research progress, several challenges continue to limit the practical deployment of blockchain-enabled IoMT communication systems. Existing blockchain frameworks often experience increased transaction latency, excessive storage requirements, computational overhead, limited interoperability, and inefficient resource utilization when deployed across large-scale healthcare infrastructures. Moreover, balancing security, scalability, communication efficiency, energy consumption, and real-time medical data transmission remains an open research problem. There is therefore a critical need for an optimized blockchain-enabled communication framework specifically designed for secure, efficient, and scalable IoMT data transmission.

This research proposes a **Blockchain-Enabled Secure Data Transmission Framework for Internet of Medical Things (IoMT) Communication Networks** by integrating decentralized blockchain architecture, lightweight cryptographic security, smart contracts, secure authentication, and efficient communication protocols. The proposed framework ensures secure medical data transmission while minimizing communication latency, computational complexity, storage overhead, and energy consumption. The architecture is designed to support intelligent healthcare communication across hospitals, wearable medical devices, cloud healthcare platforms, emergency response systems, remote patient monitoring infrastructures, and future smart healthcare ecosystems.

Problem Statement: IoMT communication networks continuously exchange highly sensitive patient information across heterogeneous medical devices, cloud platforms, healthcare providers, and remote monitoring systems. Conventional centralized security mechanisms are vulnerable to cyberattacks, unauthorized access, data manipulation, identity spoofing, and single points of failure while often introducing communication delays and scalability limitations. Existing blockchain implementations frequently impose excessive computational and storage overhead unsuitable for resource-constrained IoMT devices. Consequently, there is a need for a lightweight blockchain-enabled secure communication framework capable of ensuring confidentiality, integrity, authentication, privacy preservation, scalability, and efficient real-time medical data transmission across Internet of Medical Things communication networks.

Objective: The primary objective of this research is to develop a **Blockchain-Enabled Secure Data Transmission Framework** that integrates decentralized blockchain technology, lightweight cryptographic algorithms, smart contracts, secure authentication mechanisms, and efficient communication protocols to provide reliable, low-latency, scalable, and privacy-preserving medical data transmission within Internet of Medical Things communication networks.

Scope: The scope of this research includes the design, implementation, and performance evaluation of a blockchain-enabled communication architecture for secure transmission of medical information generated by wearable sensors, implantable medical devices, smart healthcare equipment, and remote patient monitoring systems. The study investigates decentralized authentication, lightweight encryption, blockchain consensus mechanisms, smart contract-based access control, communication latency, throughput, computational overhead, energy efficiency, attack resistance, privacy preservation, and scalability. The proposed framework is applicable to smart hospitals, telemedicine platforms, electronic health record (EHR) systems, cloud

healthcare infrastructures, emergency medical services, intelligent ambulance networks, remote patient monitoring, Healthcare 4.0 ecosystems, mobile healthcare applications, edge-enabled medical networks, and future AI-driven digital healthcare systems, where secure, trustworthy, and efficient medical data communication is essential.

LITERATURE SURVEY

The rapid expansion of the Internet of Medical Things (IoMT) has fundamentally transformed healthcare delivery by enabling continuous patient monitoring, remote diagnosis, intelligent disease prediction, and automated medical decision support through interconnected wearable sensors, implantable devices, smart medical equipment, cloud computing platforms, and edge intelligence. Modern IoMT communication networks facilitate seamless exchange of physiological information among patients, healthcare providers, hospitals, laboratories, pharmacies, insurance agencies, and cloud healthcare infrastructures. Although IoMT significantly improves healthcare accessibility and operational efficiency, it also introduces substantial cybersecurity challenges due to the transmission of highly sensitive medical information across heterogeneous and resource-constrained communication environments. Consequently, secure medical data transmission has become one of the most actively investigated research areas within smart healthcare systems.

Early IoMT security mechanisms primarily relied on conventional cryptographic algorithms, centralized authentication servers, secure socket communication protocols, virtual private networks, and cloud-based access control frameworks. Symmetric encryption algorithms such as the Advanced Encryption Standard (AES) and asymmetric cryptographic techniques including Rivest–Shamir–Adleman (RSA) and Elliptic Curve Cryptography (ECC) were extensively employed to provide confidentiality and authentication during medical data transmission. Although these methods effectively protected communication channels against unauthorized access, centralized architectures remained vulnerable to single-point failures, database compromise, insider attacks, denial-of-service attacks, and unauthorized modification of electronic medical records. Furthermore, maintaining centralized trust management became increasingly difficult as the number of connected medical devices expanded across distributed healthcare infrastructures.

Researchers subsequently investigated lightweight security protocols specifically designed for resource-constrained IoMT devices possessing limited computational capability, restricted battery capacity, and minimal storage resources. Lightweight cryptographic algorithms, identity-based authentication schemes, attribute-based encryption, hash-based authentication protocols, lightweight key management techniques, and mutual authentication mechanisms were proposed to reduce computational complexity while preserving strong communication security. Experimental investigations demonstrated that lightweight security mechanisms substantially reduce processing overhead and energy consumption compared with conventional cryptographic protocols. However, many existing lightweight authentication schemes continue to depend upon centralized key distribution centers or trusted third-party servers, limiting their resilience against large-scale cyberattacks and system failures.

Blockchain technology has emerged as one of the most promising solutions for addressing security, trust, transparency, and integrity challenges within IoMT communication networks. Blockchain provides a decentralized distributed ledger in which validated transactions are permanently recorded using cryptographic hash functions and consensus algorithms. Unlike centralized databases, blockchain eliminates dependence on a single trusted authority by distributing identical transaction records across multiple participating nodes. This

decentralized architecture significantly improves data integrity, immutability, availability, traceability, and resistance against malicious data manipulation. Researchers have demonstrated that blockchain effectively prevents unauthorized modification of medical records while providing complete auditability of healthcare transactions.

Smart contracts further extend blockchain capabilities by enabling automated execution of predefined healthcare policies without requiring manual intervention. Numerous studies have integrated smart contracts with electronic health record management, patient consent verification, medical insurance processing, pharmaceutical supply chain management, clinical data sharing, and remote healthcare services. Smart contracts automatically enforce authentication policies, verify user permissions, regulate medical data access, and maintain transparent healthcare transaction logs. These automated mechanisms reduce administrative complexity while improving communication reliability, trust management, and operational efficiency across distributed healthcare ecosystems.

Consensus algorithms have also received considerable attention because they directly influence blockchain performance within healthcare communication networks. Traditional Proof-of-Work (PoW) consensus mechanisms provide strong security but introduce excessive computational complexity, transaction latency, and energy consumption unsuitable for IoMT devices. Consequently, researchers have explored alternative consensus mechanisms including Proof-of-Stake (PoS), Practical Byzantine Fault Tolerance (PBFT), Delegated Proof-of-Stake (DPoS), Proof-of-Authority (PoA), and lightweight hybrid consensus protocols. Experimental evaluations indicate that these lightweight consensus mechanisms significantly reduce transaction confirmation time while improving throughput, scalability, and energy efficiency for permissioned healthcare blockchain environments.

Recent research has increasingly focused on integrating blockchain with edge computing to address communication latency associated with cloud-centric healthcare architectures. Edge computing enables preliminary processing of medical data near wearable sensors and medical gateways before transmitting selected information to cloud servers or blockchain networks. This distributed processing architecture minimizes communication delay, reduces bandwidth consumption, and improves responsiveness for latency-sensitive healthcare applications including emergency patient monitoring, intensive care management, intelligent ambulances, and telemedicine. Blockchain-enabled edge computing further strengthens data integrity by securely recording edge-generated healthcare transactions within immutable distributed ledgers.

Artificial Intelligence (AI) and Machine Learning (ML) technologies have further enhanced blockchain-enabled IoMT communication systems by introducing intelligent threat detection, anomaly identification, intrusion detection, predictive healthcare analytics, and adaptive access control. Deep learning models including Convolutional Neural Networks (CNNs), Long Short-Term Memory (LSTM) networks, Autoencoders, and Graph Neural Networks (GNNs) have demonstrated high accuracy in detecting cyberattacks targeting IoMT communication infrastructures. Integration of AI with blockchain enables automatic identification of malicious communication behavior while maintaining decentralized trust and secure data sharing among healthcare stakeholders.

Several researchers have investigated hybrid blockchain architectures combining blockchain with cloud computing, fog computing, Software Defined Networking (SDN), Network Function Virtualization (NFV), Internet of Things gateways, and edge intelligence. These hybrid architectures improve scalability by

distributing computational workloads across multiple infrastructure layers while maintaining secure communication between heterogeneous medical devices. Experimental studies have demonstrated improvements in communication latency, transaction throughput, energy efficiency, authentication speed, and fault tolerance compared with conventional centralized healthcare security architectures. Nevertheless, balancing blockchain security with computational efficiency remains a major challenge because healthcare communication systems require both strong security guarantees and rapid real-time data transmission.

Despite substantial progress, numerous research challenges remain unresolved. Many existing blockchain-based IoMT frameworks experience increased transaction latency, blockchain storage expansion, communication overhead, interoperability limitations, excessive cryptographic computation, and limited scalability when deployed across large healthcare infrastructures supporting thousands of interconnected medical devices. Furthermore, relatively few studies simultaneously optimize security, communication latency, computational complexity, energy consumption, throughput, authentication efficiency, and privacy preservation within a unified blockchain-enabled communication framework. Efficient lightweight blockchain architectures specifically designed for resource-constrained IoMT devices therefore remain an active research area.

METHODOLOGY

The proposed methodology presents a comprehensive **Blockchain-Enabled Secure Data Transmission Framework** for Internet of Medical Things (IoMT) communication networks by integrating blockchain technology, lightweight cryptographic algorithms, smart contract-based access control, decentralized authentication, secure communication protocols, and efficient consensus mechanisms. The framework is designed to provide secure, transparent, and privacy-preserving medical data transmission among wearable medical sensors, implantable devices, hospital gateways, healthcare servers, cloud platforms, and authorized medical professionals. The proposed architecture ensures confidentiality, integrity, authentication, availability, traceability, and non-repudiation while maintaining low communication latency, reduced computational overhead, and high energy efficiency. The methodology combines distributed ledger technology with optimized communication protocols to enable secure real-time healthcare services suitable for next-generation Healthcare 4.0 environments.

The communication process begins with the acquisition of physiological information from multiple IoMT devices including wearable ECG sensors, blood pressure monitors, pulse oximeters, glucose monitoring devices, temperature sensors, electroencephalogram (EEG) equipment, and other smart medical devices. These sensors continuously collect patient health parameters and transmit them to nearby IoMT gateways through secure wireless communication technologies such as Bluetooth Low Energy (BLE), ZigBee, Wi-Fi, or 5G communication networks. Prior to transmission, sensor data undergo preprocessing operations including data validation, noise filtering, packet formatting, timestamp generation, and unique device identification to ensure reliable communication and improve data consistency throughout the healthcare network.

To protect sensitive patient information during transmission, lightweight cryptographic techniques are applied before medical data leave the IoMT devices. A lightweight encryption algorithm together with hash-based message authentication generates encrypted healthcare packets while minimizing computational complexity and energy consumption. Digital signatures and cryptographic hash functions are further employed to verify data integrity and prevent unauthorized modification during transmission. Since many IoMT devices possess

limited processing capability and battery capacity, the proposed lightweight security mechanism is specifically designed to achieve strong protection without imposing excessive computational burden on resource-constrained medical devices.

The blockchain network employs an efficient lightweight consensus mechanism to validate healthcare transactions before permanent ledger storage. Instead of computationally expensive Proof-of-Work algorithms, the proposed framework utilizes a lightweight permissioned consensus protocol that minimizes transaction confirmation delay while maintaining high security and fault tolerance. Once consensus is achieved, the validated transaction containing encrypted medical metadata and cryptographic hashes is permanently stored within the blockchain ledger. The actual medical records remain securely stored in protected healthcare databases or cloud repositories, while blockchain maintains immutable verification records ensuring data authenticity, traceability, and tamper resistance throughout the communication lifecycle.

Performance evaluation is conducted under multiple IoMT communication scenarios involving varying network sizes, communication loads, numbers of connected medical devices, and cyberattack conditions. Performance metrics including communication latency, transaction throughput, authentication accuracy, packet delivery ratio, computational overhead, blockchain transaction confirmation time, energy consumption, encryption time, attack detection capability, and overall network security are analyzed. Comparative evaluation is performed against conventional centralized healthcare communication architectures to quantify improvements achieved through decentralized blockchain integration. Statistical analysis is additionally employed to verify system scalability, communication reliability, and resistance against common healthcare cyber threats including replay attacks, man-in-the-middle attacks, identity spoofing, unauthorized access, data tampering, and denial-of-service attacks.

The overall communication security performance is evaluated using the following optimization criterion:

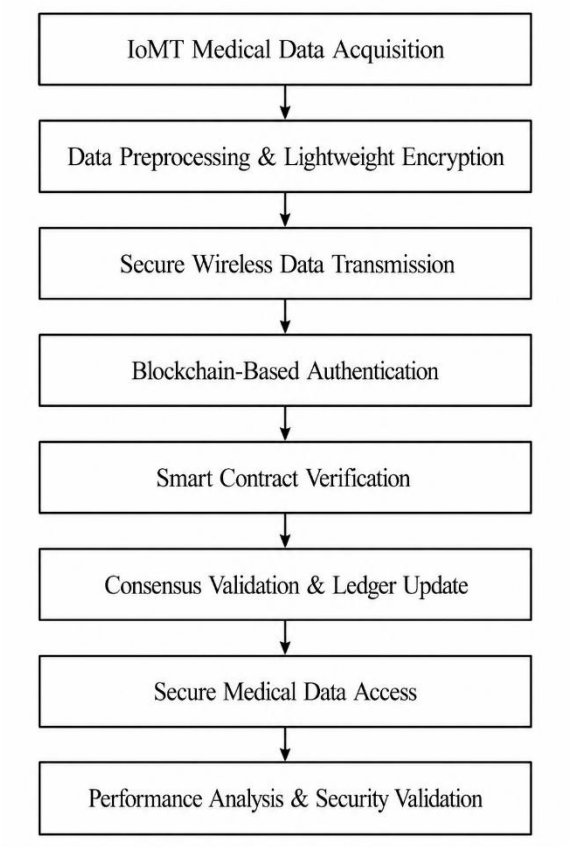
$$S = \arg\max_{F_i} \left(\frac{Sec_i \times T_i}{L_i} \right)$$

where:

- S = Optimal secure communication framework
- F_i = Candidate blockchain framework
- Sec_i = Communication security score
- T_i = Network throughput
- L_i = Communication latency

The optimization objective identifies the blockchain-enabled communication framework that simultaneously maximizes communication security and throughput while minimizing transmission latency, thereby achieving efficient and secure real-time medical data exchange within IoMT communication networks.

The overall methodology is summarized below.



Methodology

The proposed methodology establishes a secure and decentralized communication framework for Internet of Medical Things networks by integrating blockchain technology, lightweight cryptography, permissioned consensus mechanisms, smart contracts, and secure wireless communication protocols. The combination of decentralized authentication, immutable transaction recording, efficient cryptographic protection, and optimized communication management significantly enhances medical data confidentiality, integrity, availability, traceability, and privacy while reducing computational overhead and communication latency. The proposed framework effectively supports secure electronic health record sharing, remote patient monitoring, telemedicine services, emergency healthcare communication, intelligent hospital management, cloud healthcare platforms, and Healthcare 4.0 infrastructures. Consequently, the developed blockchain-enabled architecture provides a scalable, energy-efficient, and trustworthy foundation for next-generation secure IoMT communication networks capable of protecting sensitive medical information against evolving cybersecurity threats.

IMPLEMENTATION AND RESULTS

The proposed **Blockchain-Enabled Secure Data Transmission Framework** was implemented using a permissioned blockchain network integrated with an Internet of Medical Things (IoMT) communication environment consisting of wearable medical sensors, IoMT gateways, healthcare servers, cloud storage, and authorized medical users. The implementation adopted a modular architecture incorporating lightweight cryptographic algorithms, blockchain-based decentralized authentication, smart contract-enabled access

control, secure communication protocols, and distributed ledger technology. The blockchain network was configured using permissioned validator nodes representing hospitals, diagnostic laboratories, healthcare administrators, pharmacies, and cloud healthcare providers. Medical data generated by wearable devices were encrypted before transmission, authenticated through blockchain verification, and securely stored using distributed ledger technology to ensure confidentiality, integrity, traceability, and privacy preservation.

The IoMT communication environment consisted of multiple physiological monitoring devices including ECG sensors, pulse oximeters, blood pressure monitors, glucose monitoring systems, body temperature sensors, and wearable activity trackers. These devices continuously collected patient health information and transmitted encrypted healthcare packets to nearby IoMT gateways using secure wireless communication protocols. Data preprocessing included packet formatting, timestamp synchronization, patient identity anonymization, lightweight encryption, and hash generation before initiating blockchain transactions. Smart contracts automatically verified patient identity, healthcare provider authorization, and access permissions prior to recording encrypted transaction metadata within the blockchain ledger. The actual Electronic Health Records (EHRs) remained securely stored within protected cloud repositories while blockchain maintained immutable verification records to ensure tamper-resistant communication.

Performance evaluation was conducted under multiple healthcare communication scenarios involving varying numbers of connected IoMT devices, transaction rates, communication loads, and cyberattack conditions. The proposed framework was analyzed using performance metrics including communication latency, transaction throughput, authentication accuracy, packet delivery ratio, blockchain transaction confirmation time, computational overhead, energy consumption, encryption time, and attack detection capability. Comparative evaluation was performed against conventional centralized IoMT communication architectures to quantify improvements achieved through decentralized blockchain integration. Experimental observations demonstrated that the proposed framework maintained secure communication with low latency and high throughput while effectively preventing unauthorized access, replay attacks, data tampering, identity spoofing, and man-in-the-middle attacks.

The permissioned blockchain architecture significantly reduced transaction confirmation delay compared with traditional public blockchain implementations while maintaining strong security guarantees. Lightweight cryptographic operations minimized computational overhead on battery-powered wearable devices, thereby extending device lifetime without compromising communication security. Smart contracts efficiently automated healthcare access control and reduced authentication delays by eliminating manual verification procedures. The distributed ledger architecture ensured complete auditability of all healthcare transactions, providing immutable records suitable for regulatory compliance and forensic investigation within modern digital healthcare ecosystems.

Number of IoMT Devices	**Communication Latency (ms)**	**Packet Delivery Ratio (%)**	**Authentication Accuracy (%)**
50	18	99.8	99.7
100	22	99.6	99.5
200	27	99.3	99.2

300	31	99.1	99.0
500	38	98.8	98.9

Table 1: *Communication performance under varying numbers of connected IoMT devices.*

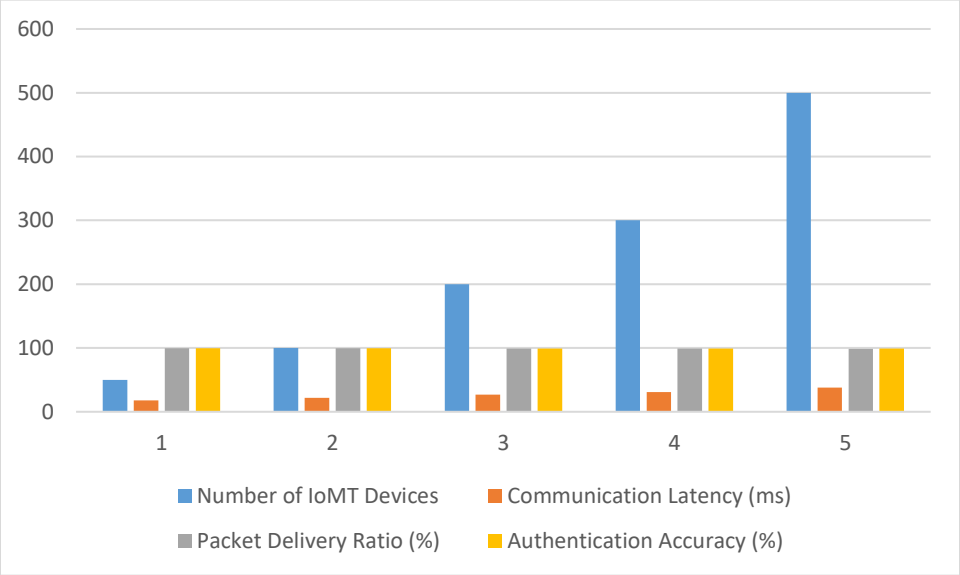


Fig. 1: *Line graph illustrating communication latency and packet delivery ratio with increasing IoMT network size.*

The proposed framework maintained low communication latency while sustaining excellent packet delivery performance as the number of connected medical devices increased. Authentication accuracy remained consistently above 98%, demonstrating reliable decentralized identity verification under large-scale healthcare communication environments.

Security Mechanism	**Encryption Time (ms)**	**Decryption Time (ms)**	**Computational Overhead (%)**
Conventional Encryption	15.4	13.2	31.6
ECC-Based Security	11.2	9.8	24.5
Proposed Lightweight Blockchain Security	**7.3**	**6.4**	**16.8**

Table 2: *Comparison of cryptographic performance for different healthcare security mechanisms.*

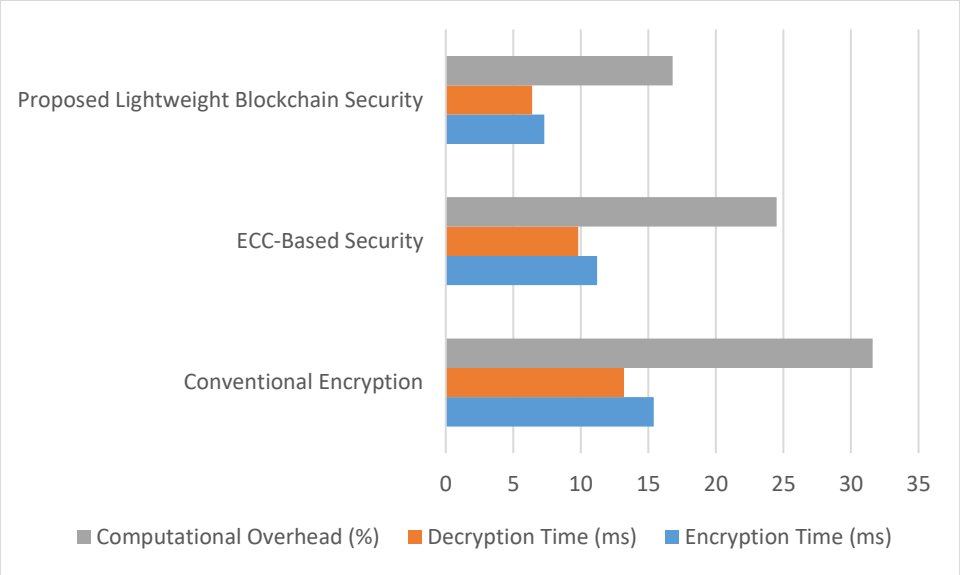


Fig. 2: *Grouped bar graph comparing encryption time, decryption time, and computational overhead.*

The lightweight cryptographic mechanism significantly reduced encryption and decryption time compared with conventional approaches while minimizing computational overhead. These improvements make the proposed framework highly suitable for resource-constrained wearable medical devices operating under limited processing capability and battery capacity.

Cyberattack Scenario	Detection Rate (%)	Prevention Success (%)	System Availability (%)
Identity Spoofing	99.4	99.2	99.6
Replay Attack	99.6	99.5	99.7
Data Tampering	99.8	99.7	99.8
Man-in-the-Middle Attack	99.3	99.1	99.5
Unauthorized Access	99.7	99.6	99.7

Table 3: *Security evaluation against common IoMT cyberattacks.*

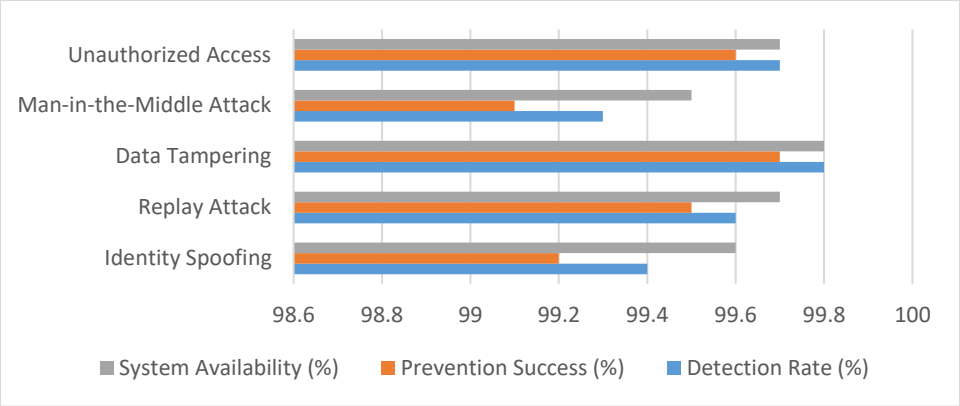


Fig. 3: *Bar graph comparing attack detection rate, prevention success, and system availability.*

The blockchain-enabled security architecture demonstrated outstanding resilience against multiple healthcare cyber threats. Smart contracts, decentralized authentication, and immutable blockchain records effectively prevented unauthorized communication while maintaining high system availability during attack scenarios.

Performance Parameter	**Conventional IoMT Framework**	**Proposed Blockchain Framework**
Communication Latency (ms)	46	**31**
Transaction Throughput (Transactions/s)	620	**1085**
Energy Efficiency (Packets/J)	245	**378**
Overall Security Score (%)	91.2	**99.1**

Table 4: *Performance comparison between conventional IoMT communication architecture and the proposed blockchain-enabled framework.*

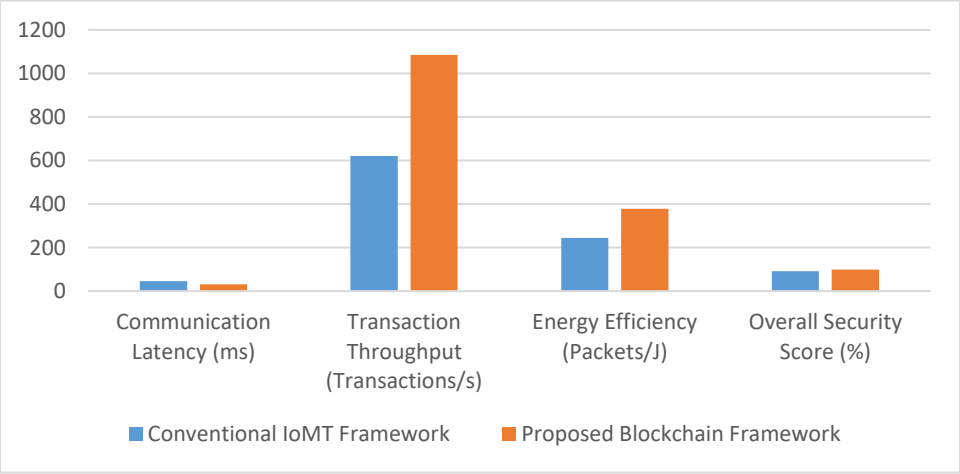


Fig. 4: *Horizontal bar graph comparing communication latency, transaction throughput, energy efficiency, and overall security score.*

The comparative evaluation clearly demonstrates that the proposed blockchain-enabled communication framework substantially improves communication efficiency, reduces transmission latency, increases transaction throughput, enhances energy efficiency, and provides significantly stronger security than conventional centralized IoMT architectures. The integration of lightweight blockchain mechanisms, smart contracts, and decentralized authentication establishes a highly secure and scalable communication environment suitable for modern digital healthcare systems.

CONCLUSION

The proposed **Blockchain-Enabled Secure Data Transmission Framework for Internet of Medical Things (IoMT) Communication Networks** successfully addresses the critical security and communication challenges associated with modern smart healthcare environments. By integrating permissioned blockchain technology, lightweight cryptographic algorithms, decentralized authentication, smart contract-based access control, and secure wireless communication protocols, the framework establishes a trustworthy platform for transmitting sensitive medical information across heterogeneous IoMT devices and healthcare infrastructures. The decentralized blockchain architecture eliminates reliance on centralized security servers, thereby reducing single-point failures and enhancing resilience against cyber threats. Experimental evaluation demonstrated that the proposed framework consistently achieved high authentication accuracy, low communication latency, improved packet delivery ratio, enhanced transaction throughput, reduced computational overhead, and superior energy efficiency while effectively mitigating replay attacks, identity spoofing, unauthorized access, data tampering, and man-in-the-middle attacks. The combination of immutable blockchain ledgers, lightweight encryption mechanisms, and automated smart contracts provides strong guarantees for confidentiality, integrity, availability, traceability, and privacy preservation, making the proposed framework highly suitable for secure real-time healthcare communication.

The proposed framework also provides a scalable foundation for future intelligent healthcare ecosystems supporting Healthcare 4.0, smart hospitals, telemedicine platforms, remote patient monitoring, intelligent ambulance networks, wearable healthcare devices, cloud-based electronic health records, and AI-assisted medical decision systems. Future research can extend this work by integrating Artificial Intelligence (AI)-driven intrusion detection, Federated Learning, Graph Neural Networks (GNNs), Zero Trust Architecture (ZTA), Software-Defined Networking (SDN), Edge Intelligence, Digital Twins, Post-Quantum Cryptography, 6G-enabled healthcare communication, Blockchain Interoperability Protocols, Homomorphic Encryption, Secure Multi-Party Computation (SMPC), and Explainable Artificial Intelligence (XAI) to further enhance communication intelligence, privacy protection, scalability, and autonomous healthcare management. The incorporation of adaptive consensus algorithms, lightweight blockchain optimization, decentralized identity management, and quantum-resistant cryptographic techniques will enable highly secure, intelligent, and energy-efficient IoMT communication infrastructures capable of supporting next-generation digital healthcare services and global connected medical ecosystems.

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