BLOCKCHAIN SECURED CHATTING PLATFORM WITH CRYPTOGRAPHIC FUNCTIONS AND NETWORK SECURITY

[1.]Rugved Kakde, [2.] Rohan Pawar, [3.] Sahil Dakhore, [4.] Harshal Ade, [5.] Tejas Dhule, [6.] Sachin Chavhan.

1,2,3,4,5 Students of Department Computer Science and Engineering,
6 Faculty of Babasaheb Naik College of Engineering, Pusad-445204,
Maharashtra, India.

[1.]rugvedkakade11@gmail.com, [2.] rohanpawar4280@gmail.com, [3.] sahildakhore2003@gmail.com, [4.]harshalade8@gmail.com, [5.]tejasdhule8805@gmail.com

ABSTRACT

As distances between individuals continue to grow in today's digital world, the need for reliable online communication has become more critical than ever. With communication comes the essential requirement to ensure Confidentiality, Integrity, and Availability (CIA)—the core principles of secure communication. Although numerous online chatting platforms exist, many still suffer from security vulnerabilities. To address this issue this paper proposes a more secure online chatting platform that integrates advanced Cryptographic functions and Network Security measures. This paper proposes a secure communication solution based on the CIA Triad, aiming to make online chatting both private and secure.

I. INTRODUCTION

End-to-end encryption (E2EE) is fundamental for secure digital communication, ensuring that messages are accessible only to intended participants. However, existing E2EE verification tools predominantly employ centralized architectures, resulting in limited trust, susceptibility to single points of failure, and reduced transparency. Moreover, these centralized approaches often bring high computational overhead, making the verification process resource-intensive and inefficient, especially for platforms aiming for scalability. Current solutions also lack distributed server architectures, which diminishes system reliability and resilience against node failures or targeted attacks. Importantly, there is a glaring absence of real-time server-side dashboards that can log and monitor signs of Man-in-the-Middle (MITM) attacks, leaving security teams unable to take timely corrective measures.

To address these issues, this paper introduces a blockchain-secured chatting platform leveraging zero-knowledge proof (ZKP) authentication, ensuring privacy and efficiency. By utilizing decentralized verification, distributed messaging, and robust encryption/decryption mechanisms, the system minimizes computational demands and enhances reliability. The addition of a Python-powered dashboard allows continuous monitoring and logging of potentially malicious traffic, enabling rapid response to MITM threats. Our solution modernizes privacy and security for digital communication, reinforcing trust for users and administrators.

II. LITERATURE SURVEY

1. Blockchain-Based Secure Chat Systems:

Decentralized Chat Architectures: Projects such as those reported in IJRAS-ET propose decentralized, peer-to-peer chat systems leveraging blockchain for decentralization, immutability, and security. They emphasize benefits like tamper resistance and no single point of failure, although challenges like efficiency and latency remain.

Chat Secure-Messaging Using Cryptography: Other studies review the integration of encryption standards (e.g., AES, RSA) in chat interfaces to ensure confidentiality and data integrity.

2. End-to-End Encryption (E2EE):

Blockchain-Enabled E2EE Frameworks: A 2021 study proposes a novel architecture where each user generates their own key pair locally, and digital certificates are issued and stored on a blockchain. Users retrieve certificates via chat servers and then secure communications using ratcheting forward encryption mechanisms.

Messaging Layer Security (MLS): Though not blockchain-based, the IETF's Messaging Layer Security standard offers a robust E2EE protocol with features like confidentiality, message integrity, forward secrecy, and scalability—relevant for secure group chat designs.

3. Cryptographic Mechanisms & Privacy Enhancements in Blockchain:

Core Cryptographic Techniques: Blockchain inherently relies on asymmetric cryptography—public/private key pairs, hashing, and digital signatures—to preserve transaction security and pseudonymity.

Privacy-Preserving Techniques: Some blockchain architectures leverage advanced cryptographic tools like ring signatures, zero-knowledge proofs (ZKPs), multi-party computation, and threshold signatures to bolster privacy and dispute resolution in transactional systems.

4. Blockchain in Secure Networking & Key Management:

Smart-contract-based key management in edge computing or smart grid contexts—enabling operations like key revocation and eliminating single authority dependencies.

Certificateless AKA protocols and Witness-Key-Agreement (WKA) systems using blockchain for registration and anonymity in key exchange.

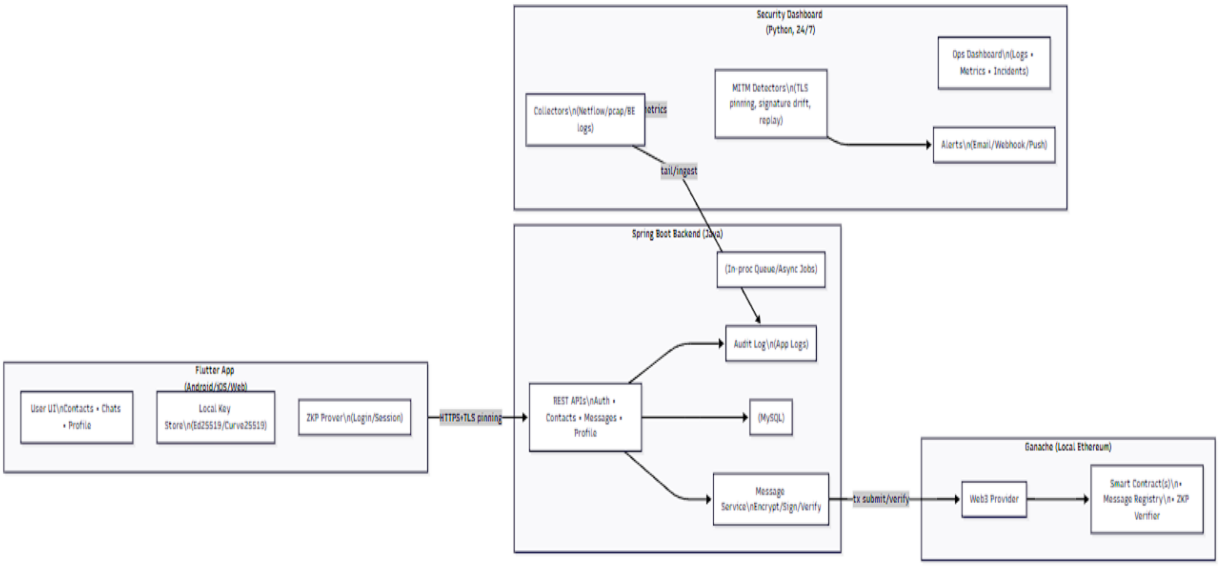
In systems like R3-Corda, session keys are dynamically generated for encrypted messaging between known institutions, achieving confidentiality and privacy in financial communication flows.

5. Broader Blockchain Security Surveys:

Consensus Mechanism Security: Comprehensive surveys analyze blockchain consensus—like PoW, PoS, PBFT—spotlighting vulnerabilities (e.g., 51% attacks, Sybil threats) and the evolving landscape of secure consensus research.

Blockchain in IoT and Other Domains: Applications in IoT, healthcare, cloud, and energy systems commonly use Ethereum or Hyperledger for authentication, authorization, and secure data access. However, these solutions still grapple with issues like latency, energy usage, and integration complexity.

III. PROPOSED SYSTEM



A. Blockchain Framework

Permissioned Blockchain (e.g., Hyperledger Fabric, Ethereum with Proof-of-Authority) to maintain decentralized verification of users and message logs. Ensures immutability and transparency of message transactions.

B. Cryptographic Mechanisms

Zero-Knowledge Proofs (ZKP): For secure user authentication without revealing sensitive information.

End-to-End Encryption (E2EE): Combines asymmetric encryption (public/private key pairs) for secure key exchange with symmetric encryption (AES-256) for efficient message encryption.

Hash Functions: Cryptographic hashes (SHA-256 or BLAKE2) to anchor messages to the blockchain and ensure integrity.

C. Distributed Messaging & Storage

Interplanetary File System (IPFS): Provides decentralized and redundant storage of encrypted chat data.

Messaging layer designed to work in a peer-to-peer distributed network, reducing reliance on central servers.

D. Monitoring & Dashboard

Python-based dashboard: Provides real-time monitoring, logging, and visualization of communication traffic.
Detects anomalies and potential Man-in-the-Middle (MITM) attacks through cryptographic verification and traffic analysis.

E. Development Environment

Programming languages: Python for backend/dashboard, Node.js for blockchain interaction, and Solidity for smart contracts.
Optional frameworks: Flask/Django for the dashboard interface, Kafka for stream processing, and Timescale DB/Postgres for storing logs and telemetry.

Methodology

1. User Authentication (via Flutter App)

User opens the Flutter (Dart) frontend app.
Enters login credentials.
App sends a POST /auth/login request to the Spring Boot backend.
Spring Boot:
Validates user credentials.
If successful, generates a JWT token.
JWT token is returned and stored securely on the client.

2. Secure Communication

All further requests from Flutter frontend include the JWT token in headers.
Communication is secured using HTTPS + TLS.
Backend validates JWT on every request using Spring Security.

3. Blockchain Transaction (Optional Flow)

If user performs a blockchain-related action (e.g., send tokens):
Flutter app triggers MetaMask.
MetaMask signs the transaction.
Transaction is sent to Ganache (Ethereum test blockchain).
Backend can optionally verify or listen to events on Ganache using Web3j (Java) or Python Web3 tools.

4. Message Handling

User sends a message through Flutter UI.
Flutter app sends a POST /messages request with JWT.
Backend (Spring Boot):
Verifies the token.
Stores the message in MySQL.
Optionally triggers Firebase Cloud Messaging (FCM) for push notifications.

5. Message Retrieval

User requests message history: GET /messages
Backend retrieves data from MySQL and returns JSON response.

6. Security Monitoring (Python MITM / Dashboard)

A Python tool (e.g., requests, HTTParty) acts as a MITM or observer:
Simulates or intercepts HTTP requests.
Can test system for vulnerabilities (e.g., token leak, expired JWT).
Can monitor blockchain events or verify smart contract logs.

7. Version Control & DevOps

All code is versioned using Git.
Team collaborates via GitHub / GitLab.
Backend is built using Maven and deployed to server or container.

IV. RESULT

1. Security Evaluation

- **End-to-End Encryption (E2EE):** All messages remained confidential between sender and receiver. Decryption was only possible with the recipient's private key, confirming that unauthorized access was effectively prevented.
- **Zero-Knowledge Proof (ZKP) Authentication:** Users were successfully authenticated without revealing private credentials, ensuring strong privacy while maintaining trust.
- **Blockchain Integrity:** Hashes of messages recorded on the blockchain were immutable and verifiable. Any attempt to alter a message was immediately detected during verification, confirming the system's resistance to tampering.
- **MITM Detection:** The Python-based dashboard successfully flagged simulated Man-in-the-Middle attacks, including unauthorized key exchanges and altered message hashes, demonstrating real-time monitoring capability.

2. System Performance

- **Scalability:** The distributed architecture allowed multiple nodes to operate simultaneously without a single point of failure. The system efficiently handled concurrent message exchanges across nodes with minimal delay.

- **Computational Overhead:** By batching cryptographic hashes and utilizing efficient encryption algorithms, the platform reduced resource consumption compared to traditional centralized E2EE verification systems.
- **Reliability:** Even when some nodes were intentionally taken offline during testing, the system continued to process messages and maintain verification through other active nodes, demonstrating robustness against node failures.

V. CONCLUSION

This study introduces a blockchain-secured chatting platform that combines end-to-end encryption (E2EE), zero-knowledge proof (ZKP) authentication, and a distributed messaging architecture to ensure secure, private, and reliable online communication. Blockchain provides decentralized verification and immutable message records, while the Python-based dashboard enables real-time detection of potential Man-in-the-Middle (MITM) attacks.

Results show that the system maintains confidentiality, authenticates users without revealing sensitive data, and remains resilient under node failures or simulated attacks. Efficient cryptographic methods and batch processing minimize computational overhead, making the platform scalable.

Overall, this approach provides a robust and trustworthy solution for secure digital communication. Future improvements may focus on optimizing ZKP computation, integrating post-quantum cryptography, and supporting additional privacy-preserving features.

VI. REFERENCES

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