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# SECURING SOCIAL MEDIA COMMUNICATIONS: A DEEP DIVE INTO MTPROTO, SIGNAL PROTOCOL, OSTN, AES-GCM, AND PROTEUS

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**Abstract** - Social media platforms have become integral to daily communication, necessitating robust security mechanisms to protect user data. This paper explores the key protocols used to ensure secure messaging within these platforms: MTProto, Signal Protocol, Open Secure Telephony Network (OSTN), AES-GCM, and Proteus. In this paper it analyses their approaches to key management, key exchange mechanisms, authentication and integrity verification, key verification mechanisms, and transparency and open-source contributions.

Keywords: Key Management,Social Media Security,Key Exchange Mechanisms,End-to-End Encryption (E2EE),Secure Messaging Protocols

## 1. Introduction

With the rapid expansion of social media platforms, the need for secure communication has never been more critical. Social media applications have become essential tools for personal communication, professional networking, and information dissemination. However, this widespread use also makes them prime targets for various security threats, including eavesdropping, data breaches, and unauthorized access. Ensuring the privacy and security of user communications on these platforms is paramount to maintaining user trust and protecting sensitive information.

To address these challenges, several advanced cryptographic protocols have been developed and implemented across different social media platforms. These protocols aim to provide end-to-end encryption (E2EE), which ensures that only the communicating users can read the messages, effectively preventing intermediaries, including service providers, from accessing the content.

This paper focuses on a comparative analysis of five prominent secure messaging protocols used in social media: MTProto, Signal Protocol, Open Secure Telephony Network (OSTN), AES-GCM, and Proteus. Each of these protocols has been designed with specific security goals in mind and employs unique methodologies to achieve them. By exploring these protocols, we can understand the different approaches to key management, key exchange mechanisms, authentication and integrity verification, key verification mechanisms, and transparency and open-source contributions.

### 1.1 Technical Overview:

### 1.1.1 MTProto:

[12] MTProto is a messaging protocol developed by Telegram to facilitate secure and efficient communication within its messaging platform. It employs a combination of encryption algorithms and techniques to ensure the confidentiality and integrity of messages exchanged between users.

One of the key features of MTProto is its emphasis on speed, making it ideal for real-time messaging applications. The protocol utilizes a combination of symmetric and asymmetric encryption to secure messages, with each message uniquely encrypted using session keys. This approach enhances security while maintaining high performance levels.

Working:

- Client-Server Communication: The MTProto protocol involves communication between the client (user's device) and the Telegram server. When a user sends a message, the client encrypts the message using session keys and sends it to the server.
- End-to-End Encryption: Messages are encrypted on the client-side and decrypted on the server-side, ensuring end-to-end encryption. The encryption keys are constantly changing to enhance security.
- Security Features: MTProto employs a combination of symmetric and asymmetric encryption, ensuring that messages are securely transmitted and protected from unauthorized access.

### 1.1.2 Signal Protocol:

Signal Protocol is an open-source encryption protocol widely adopted by messaging applications like Signal, WhatsApp, and Facebook Messenger to provide end-to-end encryption for messages, voice calls, and other forms of communication. The protocol is designed to offer strong security guarantees, protecting user data from interception and unauthorized access.[13] Signal Protocol utilizes a double ratchet algorithm to generate and refresh encryption keys dynamically during a conversation, further enhancing security by constantly updating cryptographic keys. Additionally, the protocol supports features such as forward secrecy and deniability, ensuring that past communications remain secure even if current keys are compromised.

Working:

- Double Ratchet Algorithm: Signal Protocol utilizes the double ratchet algorithm to provide forward secrecy and deniability. Each message exchange generates new encryption keys for enhanced security.
- End-to-End Encryption: Messages and calls are end-to-end encrypted, meaning only the sender and receiver can access the content. Keys are negotiated dynamically during conversations.
- Security Enhancements: Signal Protocol offers features like message integrity checks, verification codes, and secure key exchange mechanisms to prevent eavesdropping and ensure message authenticity.

### 1.1.3 Open Secure Telephony Network (OSTN):

Open Secure Telephony Network (OSTN) is a protocol designed for secure voice communication over the internet. It focuses on enabling end-to-end encryption for voice calls, ensuring that conversations remain private and protected from eavesdropping.[14] OSTN incorporates strong

cryptographic mechanisms to secure voice data transmission, including key exchange protocols and secure authentication methods. By implementing encryption at different layers of the communication stack, OSTN enhances the confidentiality and integrity of voice calls, making it suitable for use in sensitive scenarios where privacy is paramount.
Working:

- ○ Voice Call Encryption: OSTN focuses on securing voice calls over the internet through end-to-end encryption. Voice data is encrypted at the sender's end and decrypted at the receiver's end.
- ○ Key Exchange and Authentication: OSTN employs secure key exchange protocols and authentication mechanisms to verify the identity of users and protect call data from interception.
- ○ Confidentiality: By incorporating encryption at various communication layers, OSTN ensures the confidentiality of voice conversations and mitigates the risk of unauthorized access.

### 1.1.4 Advanced Encryption Standard - Galois/Counter Mode (AES-GCM):

AES-GCM is a symmetric encryption algorithm widely used to provide confidentiality and integrity protection for data transmission. It combines the Advanced Encryption Standard (AES) block cipher with Galois/Counter Mode (GCM) for efficient and secure encryption. AES-GCM operates by encrypting data in blocks and generating authentication tags to verify data integrity during decryption[15]. The algorithm is known for its strong security properties, high performance, and low computational overhead, making it a popular choice for securing sensitive information in various applications.

Working:

- Block Cipher Encryption: AES-GCM operates as a block cipher encryption algorithm, dividing data into blocks for processing and applying encryption/decryption operations.
- Data Integrity Protection: GCM mode generates authentication tags to verify the integrity of encrypted data, protecting against tampering and ensuring data authenticity.
- Efficiency and Security: AES-GCM is known for its fast encryption/decryption speeds, minimal computational overhead, and robust security features, making it suitable for securing sensitive information.

### 1.1.5 Proteus:

Proteus is a secure communication protocol designed for peer-to-peer messaging, voice calls, and video calls. It emphasizes end-to-end encryption and privacy protection, ensuring that communications remain confidential and secure from external threats. Proteus employs robust cryptographic techniques to secure data exchange between users, including key agreement protocols, encryption algorithms, and message authentication mechanisms [16]. By prioritizing security and privacy, Proteus enables users to communicate securely over untrusted networks while safeguarding their sensitive information from unauthorized access.

Working:

- Peer-to-Peer Communication: Proteus enables secure peer-to-peer messaging, voice calls, and video calls by establishing direct encrypted channels between users.
- Encryption and Privacy: Proteus emphasizes end-to-end encryption, ensuring that communications are confidential and protected from external surveillance.
- Cryptographic Mechanisms: Proteus incorporates advanced cryptographic protocols, key agreement techniques, and authentication mechanisms to safeguard user data and privacy during communication.

## 2. Literature Review

Secure messaging protocols have garnered significant attention in both academic research and industry applications due to the increasing importance of privacy and security in digital communications. This literature review explores existing research and analysis related to the secure messaging protocols MTProto, Signal Protocol, Open Secure Telephony Network (OSTN), AES-GCM, and Proteus, highlighting their evolution, implementation, and impact on social media security.

MTProto is the cryptographic protocol developed by Telegram for secure messaging. In "A Technical Overview of MTProto" [1], the authors discuss the design principles and cryptographic primitives employed by MTProto, emphasizing its balance between performance and security. The protocol’s use of server-side keys and session keys is critiqued in "Security Analysis of MTProto" [2], which raises concerns about potential vulnerabilities related to server trust and key management. Despite these concerns, MTProto remains widely used due to its efficiency and relatively strong security guarantees.

Signal Protocol, originally known as the TextSecure Protocol, is renowned for its strong security properties. In "The Signal Protocol: Analysis and Implementation" [3], Marlinspike and Perrin outline the protocol's design, focusing on its use of the Double Ratchet algorithm for forward secrecy and post-compromise security. This protocol has been extensively analyzed in various studies, including "A Formal Security Analysis of the Signal Messaging Protocol" [4], which provides a formal verification of its cryptographic properties. The widespread adoption of Signal Protocol by applications like WhatsApp and Facebook Messenger underscores its effectiveness and trustworthiness.

OSTN is less documented in the literature compared to MTProto and Signal Protocol but is recognized for its adaptation of secure messaging principles to telephony. "Secure VoIP: The Open Secure Telephony Network" [5] discusses OSTN’s integration of the Double Ratchet algorithm with telephony-specific features, highlighting its potential for securing voice and video calls. The hybrid approach combining Signal Protocol elements with additional telephony-focused mechanisms demonstrates its versatility in secure communications beyond text messaging.

AES-GCM is a widely used symmetric encryption algorithm known for its performance and security. "Efficient Implementations of the Galois/Counter Mode of Operation" [6] examines the computational efficiency of AES-GCM, making it suitable for high-throughput applications. The protocol's integration of encryption and authentication is detailed in "Authenticated Encryption with AES-GCM" [7], which explains how Galois/Counter Mode enhances security by providing integrity verification alongside confidentiality. Its application in secure messaging protocols is often in conjunction with other cryptographic mechanisms to provide comprehensive security.

Proteus, built on the Double Ratchet algorithm, extends the principles of Signal Protocol to offer continuous key updates and enhanced forward secrecy. In "Proteus: A Scalable Framework for Secure Messaging" [8], the authors describe the protocol's scalability and security features, emphasizing its suitability for dynamic and large-scale communication environments. The protocol's ability to maintain secure communication even after a key compromise is highlighted in "Post-Compromise Security in Secure Messaging Protocols" [9], demonstrating its robustness in various threat scenarios.

## 3 Related Works

### 3.1 Comparative Analysis of Secure Messaging Protocols

Several comparative studies provide insights into the relative strengths and weaknesses of these protocols. "Comparison of Secure Messaging Protocols: A Comprehensive Analysis" [10] evaluates MTProto, Signal Protocol, and AES-GCM, focusing on their cryptographic foundations and implementation challenges. The study highlights the superior security of Signal Protocol but acknowledges the performance advantages of MTProto and AES-GCM. Another comparative analysis, "Evaluating Secure Messaging Protocols for Social Media" [11], considers user experience and security trade-offs, emphasizing the need for a balanced approach in protocol design.

This comparative analysis examines the key features of MTProto, Signal Protocol, Signal Protocol with OSTN, AES-GCM, and Proteus in securing social media communications.

| Sl No | Application | Protocol Used for Secrete Chats |
|---|---|---|
| 1 | Telegram | MT Proto |
| 2 | WhatsApp | Signal Protocol |
| 3 | Viber | Combination of Signal Protocol and Open Source Telephony network |
| 4 | Zoom | AES – GCM |
| 5 | Wire | Proteus |

Fig 1

Fig 1. shows various messaging applications employ different secure protocols to ensure the privacy and confidentiality of user communications, especially in their "secret chats" feature. Telegram utilizes MTProto, a protocol developed in-house, known for its balance between speed and security. WhatsApp, on the other hand, relies on the Signal Protocol, renowned for its robust security features and end-to-end encryption. Viber combines elements of the Signal Protocol with the Open Secure Telephony Network (OSTN), providing a hybrid approach that extends secure messaging to voice and video communications. Zoom opts for AES-GCM, an efficient and standardized encryption algorithm, to secure its communications. Meanwhile, Wire utilizes Proteus, a protocol built on the Double Ratchet algorithm, offering continuous key updates and strong forward secrecy. Each application's choice of protocol reflects its priorities in terms of security, performance, and functionality, catering to the diverse needs of their user base.

| **Feature** | **MTProto** | **Signal Protocol** | **Signal Protocol + OSTN** | **AES-GCM** | **Proteus** |
|---|---|---|---|---|---|
| **Key Management** | Server-side master keys, session keys | Ephemeral session keys, root keys | Hybrid approach | Symmetric key management, session keys | Ephemeral session keys, root keys |
| **Key Exchange Mechanisms** | Diffie-Hellman | Double Ratchet, Diffie-Hellman | Double Ratchet + telephony-specific | Out-of-band key exchange, pre-shared keys | Double Ratchet, Diffie-Hellman |
| **Authentication and Integrity Verification** | MACs, encryption and signing, hashes | MACs, encryption and signing, hashes | MACs, encryption and signing, hashes | Authenticated encryption, MACs, tags | MACs, encryption and signing, hashes |
| **Key Verification Mechanisms** | Key fingerprints, QR code scanning | Safety numbers, QR code scanning | Safety numbers, QR codes | Pre-shared key verification | Safety numbers, QR codes |
| **Transparency and Open Source** | Protocol documentation, open source clients | Open source protocol, cryptographic analysis, | Open source components | Standardized protocol, open source implementations | Open source protocol, community review |

| Feature | MTProto | Signal Protocol | Signal Protocol + OSTN | AES-GCM | Proteus |
|---|---|---|---|---|---|
|  |  | community review |  |  |  |

MTProto, Telegram's proprietary messaging protocol, distinguishes itself with its unique approach to key management. Utilizing server-side master keys and session keys, MTProto achieves a balance between operational efficiency and security [1]. This architecture allows for streamlined key management processes while ensuring cryptographic integrity. Furthermore, Telegram's commitment to transparency is evident through the provision of detailed protocol documentation and open-source client implementations, enabling community scrutiny and independent security audits [2].

Signal Protocol, the cornerstone of WhatsApp's security architecture, prioritizes robust key management and forward secrecy. By employing ephemeral session keys and root keys, Signal Protocol ensures that each communication session benefits from unique encryption keys, minimizing the impact of potential key compromises [3]. The protocol's open-source nature facilitates cryptographic analysis and community review, enhancing trust and confidence in its security guarantees [4].

Viber adopts a hybrid approach by integrating elements of the Signal Protocol with the Open Secure Telephony Network (OSTN), extending secure messaging capabilities to voice and video communications. This innovative strategy enhances the platform's security posture by leveraging the proven security features of the Signal Protocol while addressing telephony-specific requirements [5]. Open-source components within Viber's architecture foster transparency and community collaboration, strengthening its security foundation [6].

AES-GCM, the encryption algorithm of choice for Zoom, emphasizes efficiency and standardized communication security. With its symmetric key management approach and authenticated encryption mechanisms, AES-GCM ensures both confidentiality and integrity of user communications [7]. Although not inherently open-source, AES-GCM benefits from standardized protocols and open-source implementations, facilitating interoperability and third-party validation [8].

Wire relies on Proteus, a protocol built upon the Double Ratchet algorithm, to provide continuous key updates and strong forward secrecy. By incorporating ephemeral session keys and root keys, Proteus ensures that each communication session remains secure, even in the event of key compromise [9]. The protocol's open-source nature fosters community review and collaboration, enhancing its resilience against potential vulnerabilities [10].

## 4 Conclusion

The security, user verification methods, and transparency of the Signal Protocol, Proteus, MTProto, and AES-GCM are shown below based on the review from different articles.

1. Security and Robustness:
- Signal Protocol and Proteus are the most robust, employing advanced key management and exchange mechanisms like Double Ratchet and Diffie-Hellman, ensuring forward secrecy and frequent key changes.
- MTProto and AES-GCM provide solid security but may lack some advanced features found in newer protocols.

2. User Verification:
- Signal Protocol, Proteus, and MTProto offer user-friendly key verification methods like QR code scanning and safety numbers, enhancing usability and security.
- AES-GCM relies on pre-shared keys, which might not be as user-friendly but is effective in certain scenarios.

3. Transparency:
- Signal Protocol stands out for its complete openness and thorough community review.
- Proteus and AES-GCM also maintain high transparency with open source implementations.
- MTProto and Signal Protocol + OSTN have open source components but might not be as fully transparent as others.

The literature reveals that while each protocol has its unique strengths and limitations, Signal Protocol is often regarded as the most secure due to its comprehensive cryptographic design. MTProto offers a good balance of security and performance, making it suitable for mobile applications. OSTN and Proteus extend secure messaging principles to voice and video communications, while AES-GCM provides efficient and secure encryption suitable for high-throughput scenarios. This review highlights the importance of understanding the specific requirements and threat models of social media platforms when selecting or designing secure messaging protocols. For most secure communication needs, Signal Protocol or Proteus are the best choices due to their advanced security features, frequent key changes, and high transparency. MTProto can be considered if the integration with specific services is needed, while AES-GCM suits environments where standardized and straightforward symmetric key management is sufficient. Signal Protocol + OSTN is particularly useful for secure telephony applications.

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