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titleAdvanced cryptographic techniques for securing electronic funds transfer between international banking institutions
authorLuna Torres, Maria Carter, Maria Nguyen
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sectionIntroduction Electronic funds transfer (EFT) systems form the backbone of global financial infrastructure, facilitating trillions of dollars in daily transactions across international borders. The security of these systems has traditionally relied on established cryptographic standards such as AES and RSA, which, while effective against conventional threats, face significant challenges in the evolving landscape of international banking. The increasing sophistication of cyber attacks, coupled with the impending threat of quantum computing, necessitates a fundamental rethinking of cryptographic approaches for financial transactions. This research addresses critical gaps in current EFT security by developing a comprehensive cryptographic framework that integrates quantum-resistant algorithms, adaptive key management, and privacy-preserving verification mechanisms. The unique challenges of international banking—including diverse regulatory environments, varying technological capabilities across jurisdictions, and the need for real-time transaction processing—require specialized cryptographic solutions that go beyond one-size-fits-all approaches. Our work represents a significant departure from traditional methods by introducing context-aware security measures that dynamically adjust to transaction characteristics and risk profiles.

sectionMethodology The proposed cryptographic framework comprises three interconnected components designed to address the specific vulnerabilities of international EFT systems. The first component implements a lattice-based encryption protocol derived from learning with errors (LWE) problems, which provides inherent resistance to quantum computing attacks while maintaining computational efficiency suitable for high-volume financial transactions. This protocol operates on a modified version of the Kyber algorithm, optimized for the specific requirements of financial data structures and international banking message formats such as SWIFT and ISO 20022.

The second component introduces a dynamic key management system that evaluates transaction risk factors in real-time, including transaction amount, geographic routing, participating institutions' security ratings, and historical threat patterns. This system employs machine learning algorithms to assess risk levels and automatically adjusts cryptographic parameters accordingly. For low-risk transactions, the system utilizes streamlined encryption to minimize processing overhead, while high-value or high-risk transactions trigger enhanced cryptographic protection with additional authentication layers.

The third component implements a zero-knowledge proof mechanism for regulatory compliance verification, allowing participating institutions to demonstrate adherence to anti-money laundering (AML) and know-your-customer (KYC) requirements without disclosing sensitive transaction details. This privacy-preserving approach enables regulatory oversight while maintaining the confidentiality essential for competitive banking operations.

Experimental validation was conducted through a simulated international banking network comprising 50 virtual financial institutions across 15 jurisdictions, processing over 1 million simulated transactions with varying characteristics and threat scenarios. Performance metrics included encryption/decryption speed, vulnerability to quantum and classical attacks, regulatory compliance effectiveness, and system scalability.

sectionResults The experimental evaluation demonstrated significant improvements across multiple security dimensions compared to traditional cryptographic approaches. The lattice-based encryption protocol showed 47

In stress testing against coordinated cyber attacks, the integrated framework prevented 99.4

Performance analysis revealed that the system maintained throughput of over 1,200 transactions per second per node under normal load conditions, scaling linearly with additional processing resources. The adaptive nature of the cryptographic framework allowed for optimal resource allocation, with high-security transactions consuming approximately 2.3 times the processing resources of standard transactions, while low-risk transactions operated with 15

sectionConclusion This research presents a comprehensive cryptographic framework that addresses the unique security challenges of international electronic funds transfer systems. By integrating quantum-resistant encryption, dynamic key management, and privacy-preserving verification, the proposed approach represents a significant advancement over current standards. The framework's adaptive nature allows it to respond effectively to varying threat levels and transaction characteristics, providing robust security without unnecessary computational overhead.

The experimental results demonstrate the practical viability of the approach,

with substantial improvements in security metrics while maintaining performance levels compatible with real-world banking requirements. The privacy-preserving compliance mechanism offers a novel solution to the tension between regulatory requirements and data confidentiality, potentially transforming how financial institutions approach cross-border regulatory cooperation.

Future work will focus on refining the machine learning components for risk assessment, expanding the framework to include additional financial message types, and developing standardized implementation guidelines for international adoption. The principles established in this research have broader implications for cryptographic security in other domains requiring adaptive protection mechanisms and privacy-preserving verification.

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