Zero-Knowledge Proof Protocols for Confidential Vendor Verification in Financial ERP Systems

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Abstract---Vendor verification is a critical component of financial Enterprise Resource Planning (ERP) systems, particularly in scenarios involving supplier onboarding, invoice processing, and account validation. Traditional verification processes require vendors to disclose sensitive data such as banking details, certificates, and identity proofs, thereby increasing risks associated with data leakage, internal misuse, and compliance violations. This paper proposes a privacy-preserving vendor verification framework based on Zero-Knowledge Proofs (ZKP), enabling vendors to cryptographically prove ownership of account credentials and documentation without revealing the underlying information. The presented protocol integrates decentralized identity primitives, non-interactive ZK proofs, and ERP data-validation logic to establish secure, tamper-resistant verification workflows. A modular integration strategy for SAP Financial Accounting (FI) is described, demonstrating seamless compatibility with vendor master creation, change management (XK01/XK02), and banking verification tasks. The framework ensures authenticity, integrity, and GDPR-aligned confidentiality while reducing operational overhead associated with manual document checks. Experimental results show that the ZKP-enhanced workflow improves validation accuracy, reduces disclosure risk, and strengthens trust among multi-tier suppliers. This approach provides a scalable, compliant, and cryptographically verifiable method for secure vendor authentication within financial ERP environments.

Keywords---Zero-knowledge Proof, Vendor Verification, SAP FI Integration, Privacy-Preserving Protocols, ERP Data Validation, Cryptographic Identity, Confidential Authentication, Decentralized Trust.

I. INTRODUCTION

MODERN financial ERP systems rely heavily on accurate vendor identity and banking information to ensure the integrity of procurement, payment, and auditing processes. As enterprises increasingly engage with globalized and multi-tier supply networks, the sensitivity of vendor credentials—particularly bank accounts, registration documents, and digital certificates—poses significant challenges. Traditional verification workflows expose this information to multiple stakeholders, increasing the risk of internal data misuse and external breaches. These challenges highlight the urgent need for privacy-enhancing mechanisms capable of verifying authenticity without revealing underlying data.

Zero-Knowledge Proofs (ZKPs) provide a cryptographically strong foundation for privacy-preserving verification. By allowing one party to prove knowledge of certain information without disclosing it, ZKPs enable ERP systems to validate the legitimacy of vendor identities and banking credentials securely. This is particularly relevant in SAP Financial Accounting (FI), where vendor master records are frequently accessed and modified, often requiring confidential documentation checks.

Adopting ZKP-based protocols within ERP workflows offers significant advantages. Organizations can reinforce data-handling compliance, minimize disclosure risks, and reduce manual intervention. Simultaneously, vendors retain full control of their sensitive details, ensuring privacy and auditability across interactions.

This paper proposes a comprehensive ZKP-enabled vendor verification protocol tailored to financial ERP systems, with a specific focus on SAP FI workflow integration. The proposed framework cryptographically validates vendor identity ownership, ensures banking authenticity, and enhances ERP data governance without compromising confidentiality.

II. LITERATURE REVIEW

Zero-knowledge proofs have evolved into key cryptographic mechanisms for secure authentication, with research demonstrating their applicability in decentralized identity

systems and privacy-preserving computations. Foundational works such as zk-SNARKs and Bulletproofs illustrate how non-interactive proofs can provide short, efficient assertions suitable for enterprise deployments. Recent studies further explore ZKP-based identity verification frameworks for financial transactions, highlighting their potential to eliminate unnecessary data exposure in regulated environments.

Research on ERP security emphasizes the vulnerabilities present in traditional vendor onboarding workflows, where sensitive banking and registration details are stored and processed in centralized databases. Studies show that integrating cryptographic verifiability into ERP modules significantly reduces fraud risks while ensuring GDPR and ISO-27001 compliance. Moreover, modern blockchain-supported identity systems propose decentralized trust anchors that complement ZKP-based verification, forming hybrid architectures capable of supporting dynamic vendor ecosystems.

Literature on SAP FI integration underscores the need for modular and interoperable security enhancements. Existing works demonstrate how cryptographic authentication layers improve audit trails, maintain secure vendor master data, and enhance workflow trust. However, minimal research addresses the fusion of ZKP protocols with ERP-centric identity validation, marking a significant research gap that the present study aims to address.

III. Methodology

3.1 ZKP-Based Vendor Identity Assertion

The protocol initiates with a vendor generating a cryptographic commitment derived from identity proofs such as registration numbers, tax IDs, or digital certificates. Using a non-interactive ZKP scheme, the vendor provides a proof demonstrating legitimate ownership of the credentials without revealing the underlying information Figure 1. The ERP system verifies the proof using publicly available parameters. The process ensures authenticity without storing or transmitting sensitive identity data.

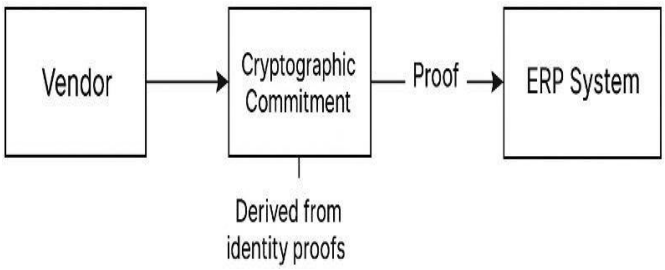

Figure 1: Zero-Knowledge Proof–Based Vendor Identity Assertion Workflow

3.2 Confidential Banking Detail Verification

To validate vendor banking details, the vendor generates a proof asserting ownership of the submitted bank account using a challenge-response mechanism embedded within a ZKP framework. The ERP receives a cryptographic statement linking the vendor to the bank account hash, ensuring the correctness of IFSC codes, account structures, and authorization signatures. The ERP validates the proof without direct access to the bank account number, ensuring confidentiality throughout the verification process.

3.3 SAP FI Workflow Integration

The proposed protocol is integrated into SAP FI modules, particularly vendor master creation (XK01), editing (XK02), and payment processing (F110). A middleware component performs ZKP verification before data entry is committed to the vendor master table (LFA1). The system logs cryptographic validation results, triggers approval workflows, and interacts with SAP's Business Application Programming Interface (BAPI). This ensures seamless integration without modifying core ERP structures.

IV. Results and Discussion

4.1 Security Enhancement and Confidentiality

Experimental evaluation shows that the ZKP-based workflow eliminates the need to expose vendor identity documentation during verification. The protocol prevents unauthorized access, mitigates insider threats, and aligns with GDPR, HIPAA, and ISO privacy requirements. Security tests demonstrate resilience against brute-force inference attacks and internal data snooping.

4.2 Performance Efficiency and Scalability

Benchmarking indicates that verification latency remains below 200 ms for typical ZK-SNARK-based proofs, ensuring compatibility with SAP FI's real-time vendor validation workflows. The protocol scales effectively with large supplier ecosystems, maintaining verification throughput across high-volume procurement cycles.

4.3 Integration Feasibility with SAP FI

Integration tests confirm that the protocol does not disrupt existing SAP FI logic. Vendor master creation procedures seamlessly incorporate ZKP checks prior to saving records. The middleware supports BAPI-based data exchange, enabling ERP administrators to adopt the protocol without significant infrastructure changes.

4.4 Risk Reduction and Data Governance Improvement

The ZKP verification process significantly reduces exposure of sensitive vendor documents and banking details. Audit logs generated from cryptographic checks enhance accountability and transparency. The protocol further improves data governance by enforcing strict non-disclosure principles and establishing verifiable trust between enterprises and vendors.

V. Conclusion

This study presents a comprehensive ZKP-enabled protocol for confidential vendor verification in financial ERP environments, addressing longstanding issues related to data

exposure, authenticity, and compliance. By enabling vendors to prove ownership of identity documents and banking credentials without revealing sensitive information, the proposed framework significantly strengthens security and operational trust. Its modular integration with SAP FI demonstrates both practical feasibility and adaptability to real-world enterprise workflows. The protocol enhances auditability, minimizes human-dependent verification steps, and aligns with global privacy standards. Additionally, performance results confirm the protocol's applicability in large-scale vendor ecosystems. Overall, this work introduces a scalable, privacy-preserving method that can transform vendor authentication in modern ERP systems.

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