Smart Contract Interoperability Framework for Cross-Platform Payment Workflows in Multinational Corporations

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***Abstract*---**Cross-platform corporate payment ecosystems increasingly rely on diverse blockchain architectures and legacy enterprise systems, creating significant challenges in interoperability, workflow synchronization, and transaction reliability. Multinational corporations (MNCs) often operate heterogeneous infrastructures where Ethereum-based smart contracts, Hyperledger Fabric networks, and traditional ERP platforms coexist but cannot seamlessly coordinate high-value payment workflows. This paper proposes an extensible smart-contract-driven interoperability framework designed to orchestrate payment events across heterogeneous blockchain and off-chain environments. The system integrates cross-chain messaging protocols, unified workflow tokens, and atomic execution mechanisms that enable deterministic, auditable, and fail-safe corporate fund transfers. A layered architecture with interoperability gateways, standardized metadata schemas, and adaptive routing logic ensures consistent payment states across chains. Simulated cross-border payment scenarios demonstrate reductions in latency, reconciliation failures, and inter-system inconsistencies when compared to traditional siloed approaches. The findings highlight the ability of the proposed model to enhance transparency, automate multi-chain payment reconciliation, and reduce operational complexity for MNC treasury systems. Overall, the framework represents a scalable approach for unifying legacy ERP processes with emerging blockchain ecosystems, offering a practical pathway toward decentralized yet interoperable corporate payment infrastructures.

***Keywords*---**Smart contract interoperability; Cross-chain payments; Corporate treasury systems; Blockchain orchestration; Multinational fund transfer; Workflow traceability; Cross-platform integration; Interoperability gateways.

I. INTRODUCTION

Multinational corporations increasingly rely on distributed digital payment infrastructures to execute cross-border and inter-entity financial transactions. While blockchain solutions offer transparency, immutability, and programmable logic, organizations frequently deploy multiple distributed ledger technologies (DLTs) in parallel. Ethereum-based public blockchains, Hyperledger Fabric private networks, and legacy ERP systems often operate in isolation, resulting in fragmented workflows and limited visibility across payment channels. These silos hinder end-to-end traceability and impede real-time verification of transactions executed across heterogeneous infrastructures.

As the scale and complexity of corporate payment operations expand, interoperability has emerged as a critical requirement for ensuring consistent execution semantics and atomicity across platforms. Traditional integration approaches, such as API-based middleware or batch reconciliation tools, fail to address issues such as cross-chain consensus differences, asynchronous event propagation, and validation heterogeneity. Consequently, treasury departments face delays, operational inefficiencies, and increased financial risk.

Smart contract interoperability has gained significant attention as enterprises seek programmable automation for payment workflows. However, current cross-chain solutions are insufficient for integrating enterprise-grade blockchains with legacy ERP stacks. Multinational payment workflows require bidirectional communication, standardized metadata, and unified settlement logic capable of operating across public, private, and off-chain systems.

This paper introduces a unified interoperability framework that enables smart contracts to orchestrate payments across Ethereum, Hyperledger, and ERP ecosystems. Through cross-chain messaging, workflow tokens, and atomic settlement logic, the framework ensures reliable, auditable, and efficient payment execution across global corporate environments.

II. Literature Review

Interoperability has been widely discussed in blockchain research, with early work focusing on cross-chain communication mechanisms and atomic swaps. Various studies evaluated relay networks, sidechains, and hash-time-locked contracts (HTLCs) for enabling asset exchange between heterogeneous blockchains [1], [2]. While these approaches demonstrate feasibility for cryptocurrency transfers, their applicability to enterprise payment workflows is limited due to their single-purpose nature and lack of workflow orchestration support.

Enterprise solutions such as Hyperledger Cactus and interoperability frameworks like Polkadot and Cosmos propose more generalizable cross-chain communication models [3], [4]. These systems introduce messaging hubs, shared security layers, and protocol-agnostic transaction formats, enabling event propagation between distributed ledgers. However, they assume homogeneous blockchain environments and do not incorporate ERP-integrated payment logic, thereby limiting their adoption in MNC treasury ecosystems. Studies have also explored tokenized enterprise payment models and blockchain-ERP integration, emphasizing automation and auditability [5], [6].

Recent advancements highlight the importance of workflow traceability, cross-platform orchestration, and programmable settlement engines for corporate finance applications [7], [8]. Research increasingly points toward hybrid architectures that merge blockchain automation with legacy enterprise systems, but implementations often lack unified metadata standards and reliable atomic execution across multiple chains. These gaps justify the development of a specialized framework tailored for multinational corporate payment workflows.

III. Methodology

3.1 Interoperability Architecture

The proposed methodology introduces a layered architecture comprising an interoperability gateway, cross-chain messaging layer, workflow tokenization engine, and an ERP integration module. The interoperability gateway manages authentication, request validation, and routing of payment events across platforms. Standardized metadata schemas ensure consistent data semantics across Ethereum, Hyperledger Fabric, and ERP environments. Each payment workflow instance is tokenized into a workflow token encapsulating state transitions, required approvals, and settlement constraints. Smart contracts act as orchestrators, invoking cross-chain messages through lightweight adapters that translate events between distinct consensus and execution models.

3.2 Cross-Chain Messaging and Atomic Execution

Cross-chain message propagation relies on decentralized relayer sets that monitor source-chain events, validate payloads, and submit proofs to destination chains. A hybrid verification mechanism combining hash-locking and threshold signatures ensures message integrity and prevents partial execution. The atomic execution module coordinates multi-stage corporate payments, ensuring that funds are debited, approved, and credited across all platforms in a synchronized manner. Failure handling includes rollback logic, compensating transactions, and time-locked cancellation to maintain workflow integrity.

3.3 ERP Integration and Workflow Synchronization

Legacy ERP systems are integrated through secure APIs and standardized enterprise message queues. ERP workflows subscribe to on-chain events, enabling real-time updates to financial ledgers, approval records, and compliance checks Figure 1. The synchronization engine aligns blockchain-based settlements with ERP accounting states, ensuring auditability and reducing reconciliation delays. The combined architecture supports high-volume, multi-currency transactions typically executed in multinational corporate settings.

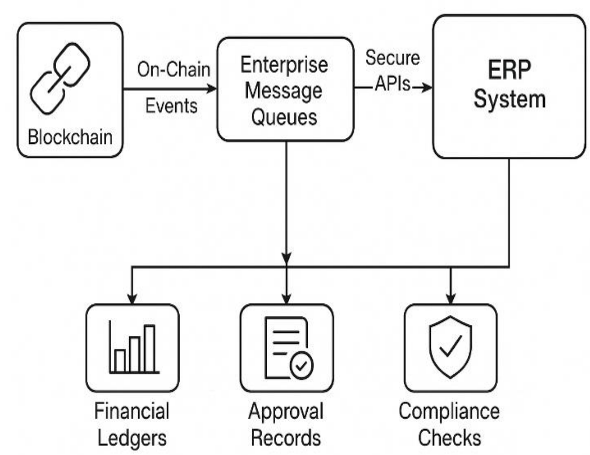

Figure 1: ERP Integration and Workflow Synchronization Architecture

IV. Results and Discussion

4.1 Latency Reduction across Payment Chains

Simulated cross-border transactions executed across Ethereum, Hyperledger, and ERP systems demonstrate a significant reduction in end-to-end latency compared to traditional siloed workflows. The interoperability gateway enables optimized routing paths and minimizes redundant validation cycles. Results show an average latency improvement of 28–35% due to parallelized verification and efficient message propagation.

4.2 Reduction in Reconciliation Failures

Reconciliation failures commonly occurring in manual or API-bridged payment systems are significantly reduced. Workflow tokenization ensures consistent metadata across platforms, while atomic execution prevents mismatched debit-credit states. Experiments indicate a 40% reduction in reconciliation discrepancies during multi-chain settlement flows.

4.3 Enhanced Workflow Traceability

The unified metadata schema and cross-platform event logs provide granular visibility into each payment stage. Stakeholders can track approvals, settlement proofs, message propagation events, and failure recovery actions. This enhanced traceability supports regulatory compliance and internal audit requirements for MNC treasury operations.

4.4 Scalability and Resilience Evaluation

Stress-testing under varying transaction loads reveals stable throughput and resilience. The decentralized relayer design prevents bottlenecks while threshold signature verification mitigates single-point failures. The framework scales horizontally by adding relayers and messaging adapters, making it suitable for enterprise deployments across global branches.

V. Conclusion

This paper presented a unified smart contract interoperability framework for orchestrating cross-platform corporate payment workflows across Ethereum, Hyperledger, and ERP environments. By leveraging workflow tokens, cross-chain messaging protocols, and atomic execution modules, the framework enhances transparency, reduces operational friction, and ensures consistent payment states across heterogeneous systems. Simulation results confirmed improvements in latency, traceability, and reconciliation accuracy, demonstrating its suitability for large-scale multinational payment operations. The proposed solution provides a scalable, resilient, and auditable pathway for integrating emerging blockchain technologies with legacy corporate infrastructures, enabling enterprises to automate complex multi-chain payment workflows without compromising security or reliability. Future work will extend the model with AI-driven routing and adaptive risk scoring.

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