Cross border FX transaction using Finternet

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Abstract

Cross-border foreign exchange (FX) transactions have long been hindered by inefficiencies including high costs, lengthy processing times, and limited transparency due to their reliance on traditional banking infrastructure and multiple intermediaries. This paper presents a novel approach to FX transfers through the integration of Finternet ecosystem and unified ledger technology. Our solution introduces a decentralized architecture that enables peer-to-peer transfers with instant settlement capabilities, operating continuously while maintaining regulatory compliance. We demonstrate how this system reduces intermediaries through unified ledger implementation, provides real-time liquidity information, and leverages smart contracts for automated pathfinding. The paper details the technical components including decentralized identifiers (DIDs), verifiable credentials, and currency tokenization processes that enable secure, efficient cross-border transactions. Our findings suggest that this approach significantly improves upon traditional network transfers by reducing settlement times from days to seconds, lowering transaction costs, and enhancing transparency through immutable transaction records. This work contributes to the evolving landscape of global financial infrastructure by presenting a scalable, interoperable solution that balances innovation with regulatory requirements.

1 Introduction

In an increasingly globalized economy, the need for efficient, secure, and cost-effective foreign exchange transfers has never been more critical. Traditional FX transfer methods often involve multiple intermediaries, leading to high costs, lengthy processing times, and lack of transparency. This paper examines how the integration of Finternet and unified ledger systems can revolutionize FX transfers.

2 Current State of International FX Transfers

In the modern banking system, foreign exchange transfers involving different currencies are facilitated through specialized interbank accounts called Nostro and Vostro accounts. These are dedicated accounts that banks maintain with each other to handle foreign currency transactions. For example, when User 1 in the US wants to send USD to User 2 in Singapore (who will receive Singapore Dollars (SGD)), the transaction flows through this interbank account network.

3 Comparative study of different transfer networks

The Table 1, explores some of the current transfer networks along with the time taken, cost of the transaction and some of the regulatory considerations. As is evident from some of the transfer networks, are not ubiquitous and they will work seamlessly from some of the countries but not in others due to regulation restrictions. The aim of the Finternet is to work in collaboration with the regulators, financial institutions and best technologies that are available to ensure the cross border FX can be done from anywhere, anytime and to anyone.

As is evident from the different networks, the time taken to transfer can vary from a few seconds to a few days. Although some of the providers have a very smooth experience in a particular region with low cost and with near instant transfer, it is not always possible in other regions. The same services aren't ubiquitous and hence a user will have to find an alternative service provider. This will mean that the user will have to undergo KYC again on the other service provider adding to the time delays and is subjected to the inherent limitations of that network such as liquidity, fees, time taken to transfer and so on.

4 Finternet: Bridging Financial Networks

Finternet [2], represents a new paradigm in financial connectivity. It creates a decentralized network that allows for seamless interaction between different financial institutions and systems.

Traditional networks have several limitations as mentioned in Table 2. If a user chooses a bank to transfer FX, then he or she is also choosing the correspondent banks, transaction fees, regulations within it, settlement times and so on. To overcome such limitations, this paper proposes some of the solutions for some of the problems observed in the current traditional networks. For example, using Finternet a user can do a peer-to-peer transfer using instant settlement times 24 hours and 7 days a week from anywhere in the world within the framework of the regulations of the respective countries.

4.1 Key Features of Finternet

- **Interoperability:** Enables communication between diverse financial systems
- **Decentralization:** Reduces reliance on central authorities
- **Real-time processing:** Facilitates instant transactions
- **Enhanced security:** Utilizes advanced cryptographic techniques

Transfer network	**Time taken**	**Cost**	**Regulatory considerations**
SWIFT [14]	1-5 business days [1]	$20-$50 per transaction + exchange rate markup [17]	Highly regulated, subject to international banking laws [7]
TransferWise (Wise)	0-2 business days [16]	0.4-1.5% of transfer amount	Regulated as a financial institution in multiple countries
PayPal	Instant to 1 business day [9]	2.9% + fixed fee for domestic, 4.4% + fixed fee for international	Regulated as a money transmitter in many jurisdictions
Western Union	Minutes to 5 business days [15]	Varies, can be high for cash pickup	Heavily regulated, subject to strict AML/KYC requirements
Ripple (XRP)	3-5 seconds [10]	Very low, typically less than $0.01	Regulatory status varies by country, SEC lawsuit in US [11]
Solana (SOL)	400ms - 1 seconds [13]	Very low, typically less than $0.001	Tokens can be fully compliant with regulations using Token Extns.
Ethereum	15 seconds to minutes [5]	Variable, can be high during network congestion [13]	Similar regulatory challenges as Bitcoin
SEPA (EU only)	1 business day [6]	Usually free or very low cost	Heavily regulated within the EU

Table 1: Comparison of Transfer Networks

Factor	Description	Impact	Finternet Solution
Multiple Intermediary Banks	Each intermediary adds processing time and potential hold-ups	Very High	Direct peer-to-peer transfers on a unified ledger, eliminating intermediaries
Manual Processing and Verification	Human intervention for checks and processing	High	Automated smart contracts for processing and verification
Compliance and Regulatory Checks	Time-consuming AML and KYC checks, especially for high-risk transfers	High	Real-time automated compliance checks embedded in tokens and smart contracts
Time Zone Differences	Adds full days to cross-continental transfers	Medium-High	24/7 real-time processing, independent of time zones
Batch Processing	Transfers processed at set times rather than real-time	Medium	Instant, individual transaction processing
Outdated Technology	Legacy systems lacking real-time processing capabilities	Medium	Modern, blockchain-based technology enabling real-time transactions
Liquidity Management	Arranging for currency in specific markets	Medium-Low	Automated liquidity pools and instant currency conversion through tokenization

Table 2: Factors Affecting Settlement Time and Finternet Solutions

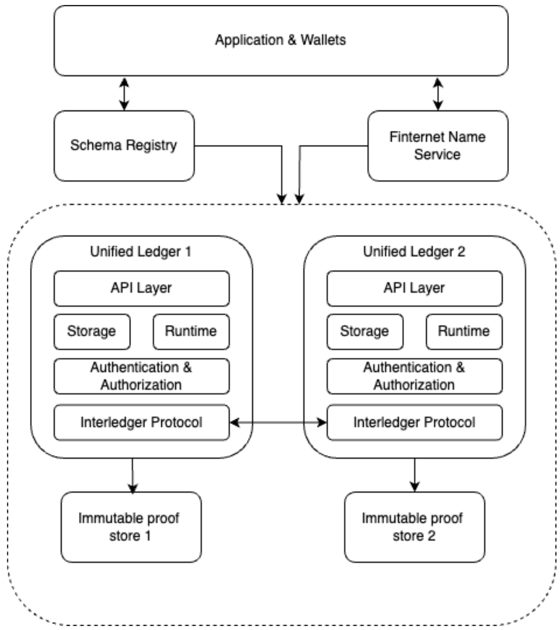

Figure 1: Unified Ledger

5 Unified Ledger

Unified ledger sits at the heart of the Finternet ecosystem with the following characteristics:

1. **User-centric:** The design places the user (individuals or organizations) at the center, allowing them to manage their assets, identities, and financial interactions easily.
2. **Interoperability:** The ledger must seamlessly interact with different financial systems, platforms, and protocols, creating a "network of networks."
3. **Composability:** Different types of transactions or operations can be combined and programmed within the system, enhancing flexibility.
4. **Immutability:** Once recorded, data or transactions cannot be altered, ensuring integrity and trustworthiness of the financial records.
5. **Compliance:** It must adhere to local and international regulations, including Know Your Customer (KYC), Anti-Money Laundering (AML), and tax laws while being adaptable to future regulatory needs

Unified ledger as illustrated in the Figure 1, shows that the unified ledger unifies all the blockchain networks using an inter ledger protocol which will seamlessly interoperate between the different networks and allows exchange of digital assets among them. A user can interact directly with a unified ledger without having to know which ledger technology the user is privy to. The digital wallet will hold all the digital assets of the user such as decentralized identifiers (DID), verifiable credentials (VC), tokenized assets, cryptographic keypairs and so on.

The Unified Ledger APIs abstract the complexity of the underlying ledger infrastructure, making it easier for services and applications to interact with the system.

5.1 Key components of Unified Ledger

- **Schema registry:** Contains schema that define the structure and properties of objects within the system
- **Finternet Name Service (FNS):** FNS provides a seamless and user-friendly way to identify and resolve users across the entire Finternet ecosystem similar to Domain Name System (DNS)
- **Interledger protocol:** Interledger protocol facilitates seamless communication and interoperability between diverse ledgers, settlement rails, and financial systems within the unified ledger infrastructure
- **Immutable proof store:** The Immutable Proof Store maintains encrypted proof of all transactions and state changes, ensuring verifiability and auditability for all participants in the unified ledger infrastructure

6 Cross border FX meets Finternet

In the traditional system of cross border FX, we can model the network as a graph:

- **Nodes:** Banks and financial institutions
- **Edges:** Relationships and agreements between these institutions
- **Edge Weights:** Available liquidity for transfers

The role of intermediaries in this system is crucial. They act as trust brokers and attempt to find the optimal path for money transfers, considering multiple factors:

- **Liquidity:** Ensuring sufficient funds are available along the transfer route
- **Fees:** Minimizing costs for the transfer
- **Speed:** Finding the quickest route for the transfer
- **Compliance:** Ensuring all regulatory requirements are met along the way

However, this process is complicated by several factors:

- **Incomplete network visibility:** Intermediaries don't have full information about all possible routes and their current states
- **Rapidly changing conditions:** Liquidity, fees, and other factors can change quickly
- **Complex multi-objective optimization:** Balancing all these factors simultaneously is a challenging problem

Now, let's examine how the Finternet approach addresses these challenges:

- **Creating a unified ledger (reducing nodes):** The unified ledger essentially consolidates multiple financial institutions into a single, shared ledger system. This dramatically simplifies the network graph by reducing the number of nodes. Instead of having to navigate through multiple separate banking systems, all participants operate on the same ledger.

- **Providing real-time liquidity information (accurate weights):** In the unified ledger system, liquidity information is updated in real-time and visible to all participants. This solves the problem of incomplete network visibility and rapidly changing conditions. The "edge weights" in our graph analogy are now accurate and up-to-date at all times.
- **Using smart contracts (automated pathfinding):** Smart contracts can automate the process of finding the optimal path for transfers. These contracts can be programmed to consider all relevant factors (liquidity, fees, speed, compliance) and make decisions based on predefined rules. This addresses the complex multi-objective optimization problem by leveraging computational power to find optimal solutions quickly.
- **Tokenizing assets (standardizing edges):** By tokenizing assets, the Finternet approach standardizes the "edges" in our graph. Instead of dealing with multiple types of assets and currencies, each with its own transfer rules and requirements, tokenization creates a common format for value transfer. This further simplifies the pathfinding problem and makes it easier to compare different routes directly.

7 Secure and Fast Privacy Preserving Compliance Checks in FX

Cross-border foreign exchange (FX) transactions are subject to increased scrutiny due to concerns related to money laundering, terrorism financing, and adherence to international sanctions. Financial institutions are traditionally required to screen payments against various sanctions lists—governmental and international databases identifying individuals, organizations, or countries that are prohibited from receiving financial services.

While this screening is crucial for compliance, it introduces significant challenges regarding privacy and data security. Existing cross-border payment systems often necessitate that financial institutions share sensitive information, including sender and receiver details, transaction amounts, and purposes. This data is typically exposed to multiple intermediaries, such as correspondent banks and payment processors, thereby heightening the risk of privacy breaches, data leaks, and unauthorized access. The difficulty becomes especially pronounced when attempting to verify transactions against sanctions lists without inadvertently disclosing personal information of individuals not on these lists.

Privacy-preserving technologies address these challenges by allowing institutions to verify transactions against sanctions lists securely, without revealing sensitive payment details to intermediaries or compromising data privacy. Using advanced cryptographic methods such as Multi-Party Computation (MPC) and Zero-Knowledge Proofs (ZKP), these technologies support compliant cross-border payments, safeguarding the confidentiality of financial data throughout the transaction process. Secure Multi-Party Computation (MPC) allows a group of independent data owners, who neither trust each other nor a common third party, to collaboratively compute a function based on their private inputs without revealing them. They ensure privacy protection by keeping transaction data confidential, reducing risks of data breaches. They also enhance compliance by allowing institutions to meet sanctions and AML regulations without exposing customer data. Additionally, these technologies foster efficiency and trust by revealing information only when necessary to authorized parties. Lastly, they support cross-border integrity, helping institutions navigate diverse regulatory frameworks securely and compliantly.

Among all, jurisdiction-specific regulatory requirements such as sanctions screening and capital flow management (CFM) are popular compliances to be met. Finternet aims to enable faster and efficient cross border FX. Finternet's FX module is designed to streamline large-value cross-border transactions by boosting efficiency, transparency, and speed, while maintaining rigorous regulatory standards. Privacy enhancing technologies (PETs) are used for automating compliance and clarifying country-specific policies- establish a system that empowers each transaction party to perform required checks seamlessly before releasing funds. [12] gives details on the multi-party computation based privacy compliance verification algorithms as adopted in Finternet. It outlines the protocols to be used for the Private Sanctions List check and CFM, offering security against malicious adversaries who may deviate from the protocol. This security is ensured within the standard real-ideal paradigm for MPC protocols.

8 On-boarding process and currency tokenization

8.1 User on-boarding process

The user onboarding process begins when a user downloads and installs the wallet application, where they first set up basic security measures like a PIN or biometrics. During initialization, the wallet automatically generates a Decentralized Identifier (DID), which serves as the user's unique digital identity. The user then moves to the identity registration phase, where they select a human-readable alias (similar to choosing a username) that gets verified and registered through the Decentralized Directory [4] (DeDi) – if their preferred alias is taken, they'll need to choose another.

Following successful alias registration, the user proceeds to KYC verification, where they submit required documentation (such as government ID and proof of address) through their wallet. The KYC service verifies these documents, and upon successful verification, issues a Verifiable Credential [18] (VC) that gets stored in the user's wallet.

This VC serves as their verified digital identity credential, completing the onboarding process and granting them full access to platform features. Throughout this process, users maintain control of their identity and credentials while establishing a verified presence on the decentralized platform.

8.2 Token manager on-boarding process

Token manager (such as a bank in FX flow) is responsible for the tokenization/detokenization of a currency and also does a lot of compliance checks required for the FX transaction to happen.

8.3 Currency tokenization

The bank money tokenization process implements a secure workflow for converting traditional bank currency into digital tokens. This system involves four key components: the User interface, Token Manager for processing and verification, Unified Ledger for

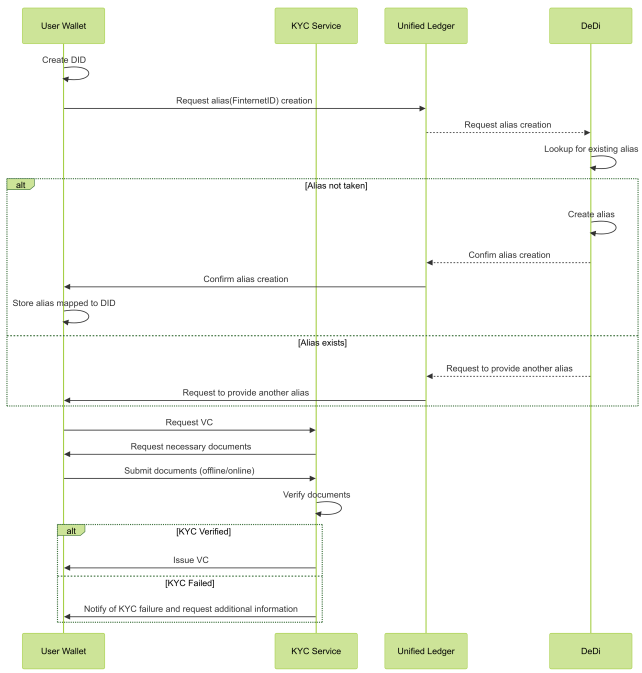

Figure 2: KYC Flow

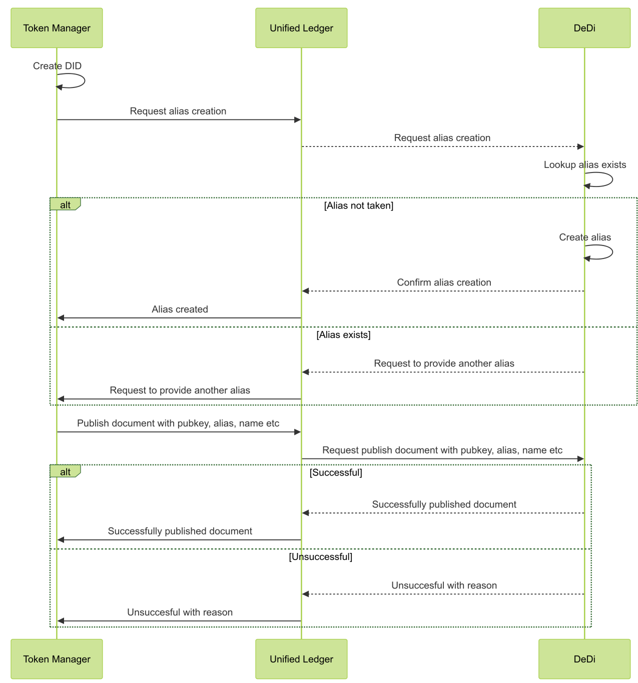

Figure 3: Token Manager on-boarding process

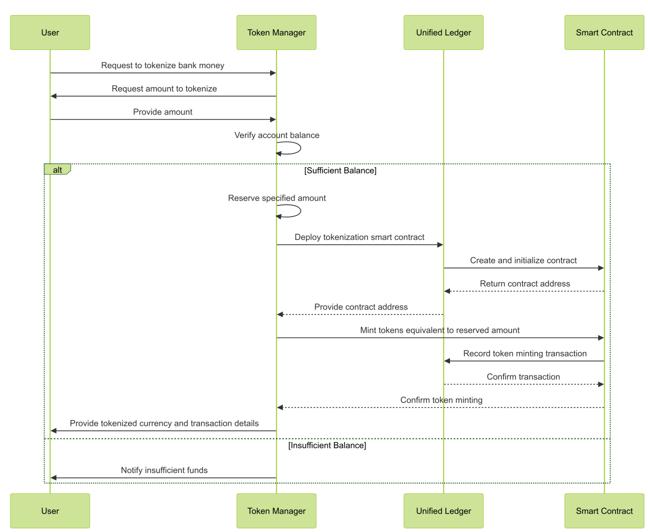

Figure 4: Currency tokenization

blockchain coordination, and Smart Contracts for token creation and management. The process ensures proper verification of funds, secure token minting, and accurate transaction recording.

8.4 Steps in the FX transfer process

1. User 1 in India domicile will sign up to Finternet using a unified ledger (UL) by creating a Finternet ID (john@solana). Similarly, User 2 will create a Finternet ID smith@cord.
2. Both user 1 and user 2 will undergo a KYC process as per the law of the land and their country of residence. For example, an India domicile might undergo KYC process by providing Aadhar using Digilocker. Similarly, a Singaporean domicile might undergo a KYC process by providing Singpass authentication. At this time both the users' wallets are also created with the wallet addresses stored on the unified ledger.
3. Once the KYC is done, they both link to a token manager (in this case a bank) who has the ability to tokenize the money in account to tokenized money.
4. Tokenization of money involves
   (a) User providing information of how much to tokenize from his existing bank account
   (b) User approval to tokenize the said amount in previous step
   (c) Token manager creating the tokens in unified ledger
5. After tokenization the user has the ability to spend or transfer the tokenized money. In the above example, user 1 (john@solana) chooses to transfer tokenized money to user 2 (smith@cord).
6. At this point, token managers can refer to "Black and Grey list" published by various authorities (such as FATF, Central Bank of the country, and relevant Govt ministries). These lists can be hosted on a public infrastructure enabled using protocols such as DeDi (Decentralized Directory). Token managers can access via the unified ledger APIs.
7. Since this is a cross border FX transfer involving two different currencies, the user can choose to use a liquidity provider service to transfer the money. Liquidity providers will provide a quote and the fees to be paid for the service.
8. Once the user 1 (john@solana) approves the transfer, liquidity providers will atomically swap the
9. Since the swap of currency happens on the blockchain, after the transaction confirmation, the user 2 wallet will have the tokenized SGD.

9 Finternet Solution: Transaction Flow

The Finternet ecosystem introduces a new paradigm for cross-border FX transfers. Let's explore the refined process of how a cross-border FX transfer works in this innovative system.

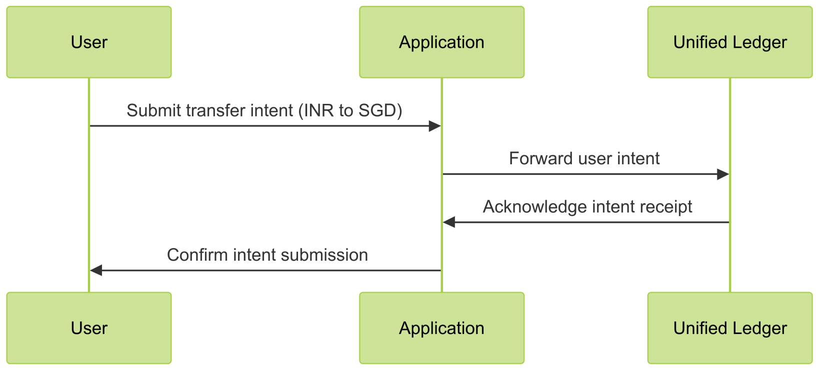

Figure 5: User Intent Submission Process

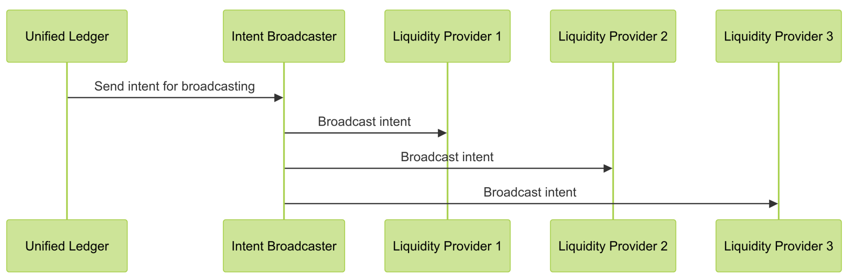

Figure 6: Intent Broadcasting Process

9.1 User Intent Submission

The process begins when a user submits their intent to the Unified Ledger via an application:

The Unified Ledger natively supports intents, allowing it to receive and process user intents distinct from transactions.

9.2 Intent Broadcasting

Once the Unified Ledger receives the intent, it broadcasts it to eligible participants:

9.3 Path Discovery and Aggregation

Eligible participants respond to the broadcasted intent with potential paths:

The Path Aggregator collects all proposed paths and hands them off to the Workflow Composer, which creates a Transaction Bundle [3] [8].

9.4 User Review and Signing

The application presents the proposed path and Transaction Bundle to the user:

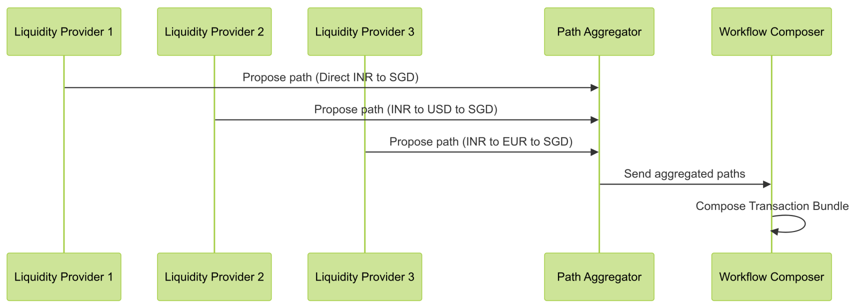

Figure 7: Path Discovery and Aggregation Process

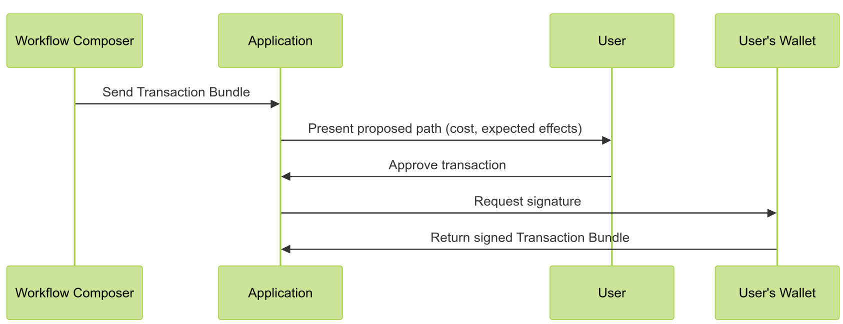

Figure 8: User Review and Signing Process

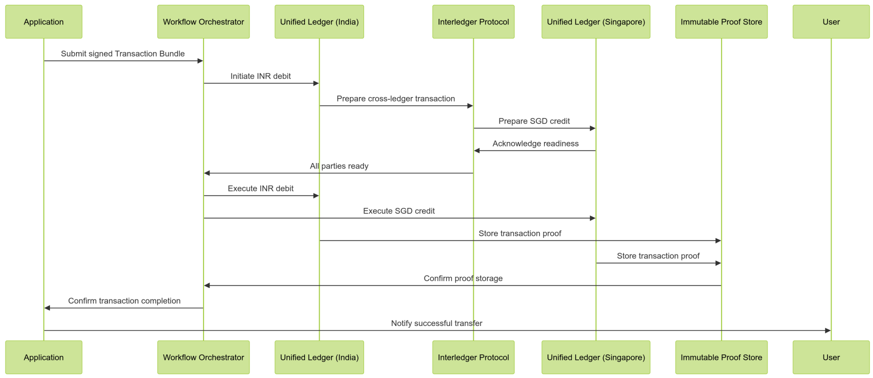

Figure 9: Workflow Orchestration and Execution Process

The user reviews the cost and expected side effects (credit/debit) before approving and signing the Transaction Bundle.

9.5 Workflow Orchestration and Execution

Once the Transaction Bundle is signed, the Workflow Orchestrator executes it atomically:

The Workflow Orchestrator ensures that all steps in the transaction are executed atomically, maintaining the integrity of the cross-border transfer.

This refined transaction flow highlights the native support for intents in the Unified Ledger, the role of the Intent Broadcaster in reaching eligible participants, and the process of path aggregation and workflow composition. It also emphasizes the user's involvement in reviewing and approving the proposed transaction before it's executed, enhancing transparency and user control in the Finternet ecosystem.

10 Key Benefits

- **Flexibility and Choice:** Users have multiple routing options, allowing them to choose based on cost, speed, or trusted intermediaries.
- **Enhanced Transparency :** Real-time visibility of all associated costs and fees with exchange rates clearly specified along with liquidity provider margins.
- **Operational Efficiency:** Reduction in settlement time from days to seconds while eliminating manual processing and reconcialation steps.
- **Financial Optimization:** Competitive rates through multiple liquidity provider options with lower transaction fees due to reduced intermediaries. Users can get better conversion rates through automated path finding.
- **Enhanced Security and Compliance:** Robust identity verification through DIDs and VCs with built-in AML and KYC verification processes. Security and compliance is further enhanced by cryptographically secured transactions with real-time monitoring and fraud detection detection capabilities.

11 Conclusion

The integration of Finternet ecosystem with unified ledger technology represents a transformative approach to cross-border FX transactions, offering solutions to long-standing challenges in the global financial system. Our analysis demonstrates that this architecture fundamentally reimagines how international money transfers can be conducted, moving away from the traditional correspondent banking model to a more efficient, transparent, and user-centric system.

The key innovations presented in this paper—including the unified ledger infrastructure, automated smart contracts, real-time liquidity information, and native support for intents—address critical inefficiencies in current FX transfer systems. By reducing the number of intermediaries, providing transparent pricing, enabling atomic settlements, and maintaining regulatory compliance, our solution offers significant advantages over traditional transfers.

Looking ahead, this approach has implications beyond just FX transfers. The architecture presented here could serve as a foundation for broader financial innovation, potentially transforming other aspects of international finance such as trade finance, securities settlement, and cross-border payments. As regulatory frameworks evolve and technology continues to advance, the Finternet ecosystem's modular and adaptable design ensures it can accommodate future requirements and innovations.

While challenges remain, particularly in terms of global regulatory harmonization and widespread adoption, the benefits of this system—reduced costs, increased speed, enhanced transparency, and improved user experience—make a compelling case for its implementation. As the financial industry continues its digital transformation, the Finternet ecosystem and unified ledger approach provides a robust framework for the future of cross-border financial transactions.

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