Ripple Solutions Guide

Ripple Solution 3.0

January 2017

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Introduction

Ripple's distributed financial technology allows banks to efficiently transact with other banks to settle transactions in real time. An alternative to today's global payment infrastructure, Ripple eliminates time delays and ensures certainty of settlement, resulting in lower transaction costs for banks and their customers and unlocking new revenue opportunities.

Ripple Overview

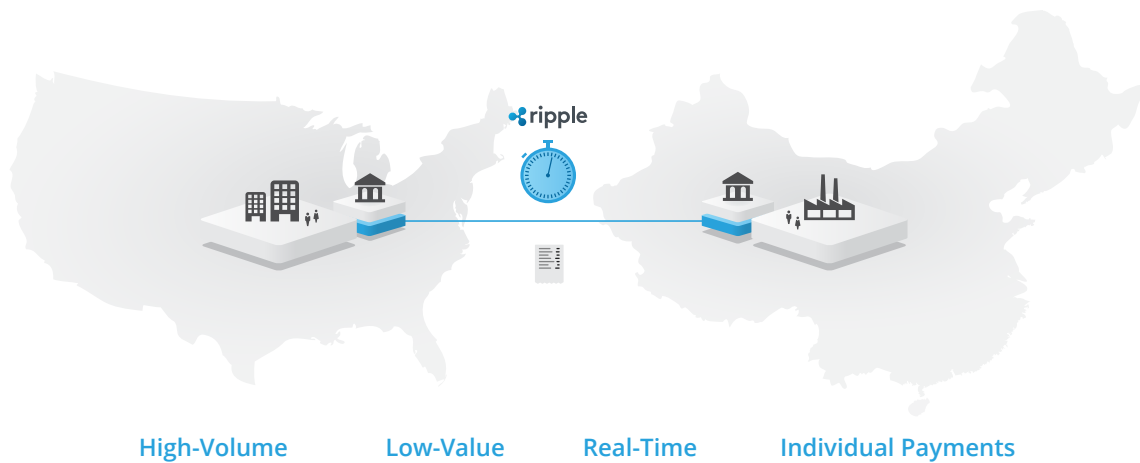## Today: Inefficient, Batch Payment Infrastructure

The needs of today's transaction banking customers - corporate and retail - have evolved significantly. They need the ability to send international low-value payments on demand, in real time across not just banking networks but also emerging financial networks (e.g., mobile wallets). However, cross-border payment networks today are fragmented and siloed, due to a diverse set of messaging and settlement protocols. These limitations in today's infrastructure force banks to process payments in batch, resulting in high processing costs, lengthy settlement times, and a poor customer experience. These inefficiencies not only result in an enormous cost (an estimated $1.6T* per year for all participants in the ecosystem), but also fail to meet the needs of today's banking customer.

Low-Volume   **High-Value**   **Slow**   **Batch Payments**

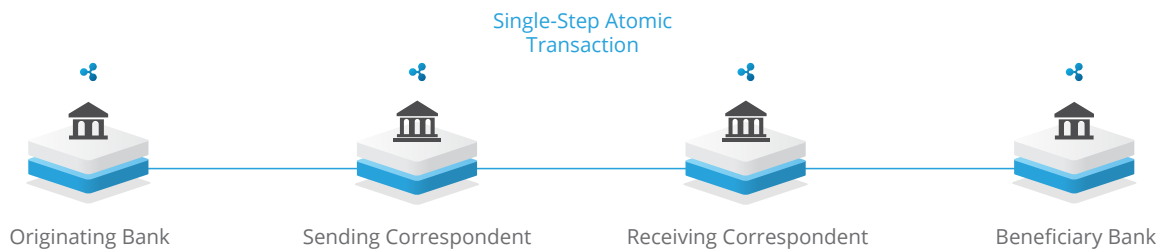## Ripple: Efficient, On-Demand Payment Infrastructure

Ripple connects these siloed networks through an open, neutral protocol (Interledger Protocol or ILP) that brings new efficiency to financial settlement by enabling real-time settlement, ensuring transaction certainty and removing settlement risk. It enables banks to differentiate and offer new cross-border payment services while lowering their total cost of settlement. It is designed specifically to meet the needs of financial institutions by fitting within their existing risk, compliance, and information security frameworks. Ripple's solution is built to interface with the bank's systems using an API interface or through a translation layer that can consume traditional payment message formats to compress the integration timeframe into weeks.

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*   Ripple analysis across: World Trade Organization, *International Trade Statistics 2014;* Institute of International Finance, *Aggregate Capital Flows 2014;* Federal Reserve Financial Services, *Cross Border Payments, 2015*

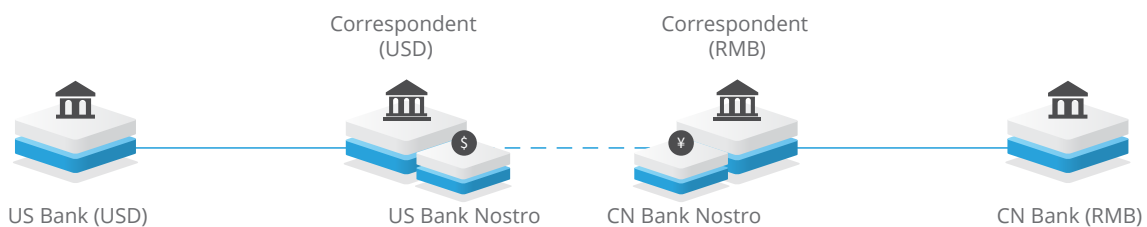High-Volume   Low-Value   Real-Time   Individual Payments

Benefits for Banks

Real-Time Payments with No Settlement Risk

Single-Step Atomic Transaction

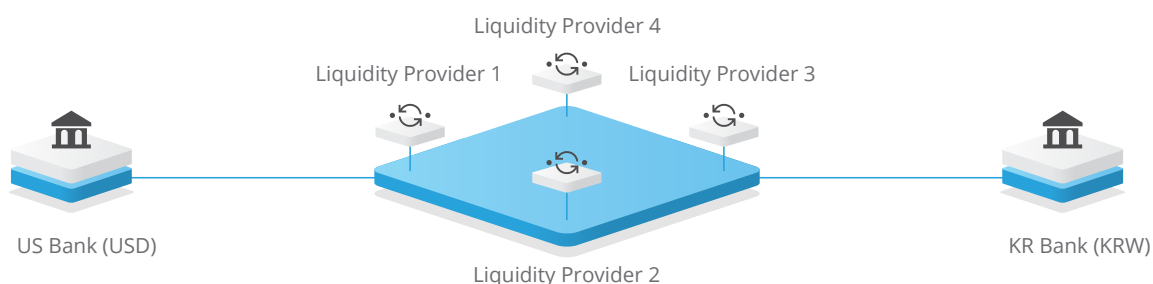Originating Bank   Sending Correspondent   Receiving Correspondent   Beneficiary Bank

Ripple enables transactions with no settlement risk, even with multiple intermediaries. Ripple's ILP-based solution coordinates fund movement across multiple ledgers to remove all settlement risk and minimize delays in the payment process. This means that banks no longer have to have direct reach (nostro accounts) across all corridors to efficiently process payments. Banks can consolidate their nostro accounts without affecting their quality of service or reach.

Flexible Liquidity Provisioning

Model 1: For High-Volume Corridors

Correspondent (USD)   Correspondent (RMB)

US Bank (USD)   US Bank Nostro   CN Bank Nostro   CN Bank (RMB)

Model 2: For Low-Volume Corridors

Ripple allows banks to more efficiently allocate liquidity for payments. For high-volume corridors where they have the leverage to source FX at competitive rates, banks can continue using their nostro accounts to process payments. For low-volume corridors, banks can utilize a marketplace of third-party liquidity providers (bank or non-bank) to provide liquidity for processing payments. This enables banks to achieve higher balance sheet efficiency and expanding their reach to new corridors while improving the quality of service to their customers.

Lower Operational Costs
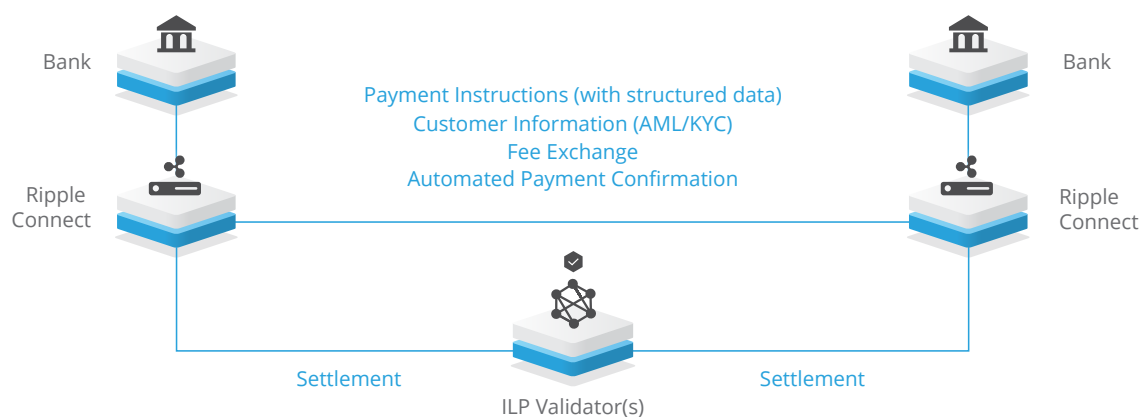
With bidirectional messaging in Ripple, banks can more efficiently exchange information about the sender, receiver, fees, rates, delivery estimate and payment status to lower their operational cost of processing international payments. With Ripple, banks get the flexibility to validate the transaction before the funds are transferred and confirm delivery of funds, ensuring high STP rates, low returns and negligible investigation and tracking effort.

Use Cases

Ripple provides a flexible payments solution for banks to modernize their clearing, settlement and reconciliation infrastructure. This gives banks the opportunity to optimize their network and increase efficiency in their existing processes. It also enables banks to innovate up the stack and create differentiated products and services for their retail, corporate and institutional customers.

CROSS-CURRENCY SETTLEMENT

Corporate Banking	Retail Banking

— Opportunity for Innovation

Correspondent Banking Interface

Clearing, Settlement and Reconciliation Infrastructure

Deposit Base
(Nostro Account Network/Third Party Liquidity Provider Network)

— Opportunity for Optimization
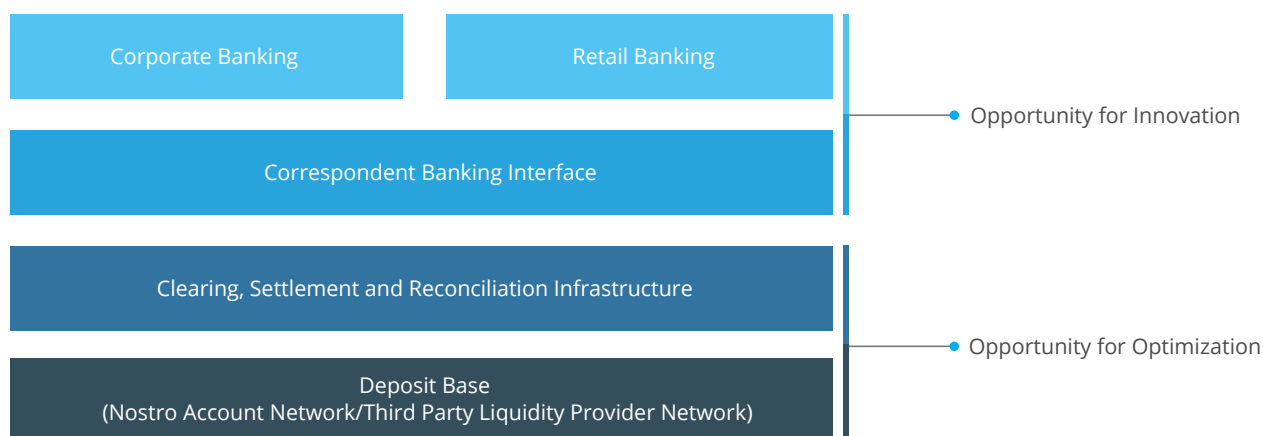
Remittance Service for Retail Customers:
Ripple's real-time settlement and complete transaction traceability lowers the total cost of settlement, enabling banks to profitably offer low-value international payments to their retail customers.

International Transaction Banking Service:
With the ability to settle funds internationally in real time, banks can repackage and provide this service to other regional banks to serve their customers. Banks can serve as a correspondent bank for Ripple transactions.

International Corporate Payments:
Banks can offer real-time, on-demand, completely traceable and data-rich international payment services to their corporate customers, allowing their corporate customers to achieve superior working capital management, and to automate reconciliation.

Cross-Border Intrabank Currency Transfers:
Banks with branches in different countries can use Ripple to transfer funds between their entities in different countries at a fraction of the time and cost today, allowing the bank's treasury to allocate capital more efficiently across international operations.

Solution Overview

Ripple's solution is built around an open, neutral protocol (ILP) to interoperate different ledgers and networks. It offers a cryptographically secure end-to-end payment flow with transaction immutability and information redundancy. It is designed to comply with your bank's risk, privacy and compliance requirements. It is architected to fit within your bank's existing infrastructure, resulting in minimal integration overhead and business disruption.
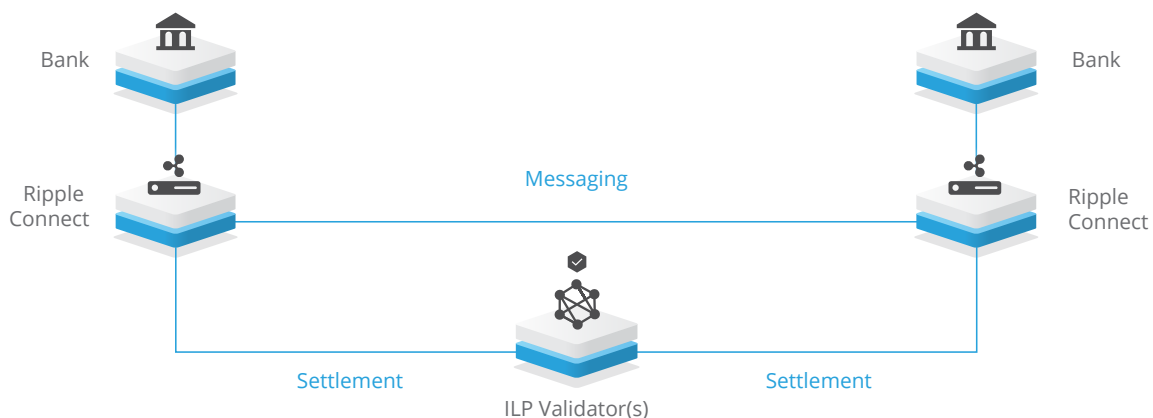
There are two key components to the Ripple solution for banks:

RIPPLE CONNECT

Ripple Connect is a plug-and-play module that processes international payments for banks. It connects to the beneficiary bank's Ripple Connect to exchange KYC and risk information, fees, FX rates (if applicable), payment details and expected time of funds delivery. It packages this information and presents the entire cost structure to the originating bank, providing unprecedented visibility into the total cost of the transaction. If information is incorrect or missing, transacting parties will find out before initiating the transaction, drastically increasing STP rates. Once the sender approves the transaction, Ripple Connect employs ILP to settle funds and notifies all parties of the transaction confirmation.

ILP VALIDATOR

The ILP Validator (a component that cryptographically confirms the success or failure of a payment) coordinates the funds movement across the ledgers of transacting parties in a way that removes all settlement risk and minimizes delays in settlement. The ILP Validator provides the single source of truth for the transacting counterparties on the success or the failure of the payment.

Ripple Connect

Ripple Connect is the messaging component of the Ripple solution that enables banks to exchange sender and recipient information, fees, and the estimated delivery time of the payment before the payment is initiated. The payment data exchanged through Ripple Connect can be used to meet jurisdiction-specific regulatory needs and other enhanced services. Ripple Connect also works in concert with the other components of the Ripple solution to settle funds using the Interledger Protocol (ILP) in a way that removes all settlement risk and preserves transaction privacy.

How It Works

To send an international payment with Ripple Connect, the originating bank makes a `Get Quote` request to its own Ripple Connect instance, which contacts the Ripple Connect instance at the beneficiary bank to get its fees. The originating bank's Ripple Connect instance queries the FX Connector (component that the liquidity provider uses to post FX rates) to get the FX cost for the payment. The originating bank receives a response to its `Get Quote` request and determines if the terms of the payment (which include the beneficiary bank's fees and the FX rate) are acceptable.

If the terms are acceptable, the originating bank makes an `Accept Quote` request. If the configuration of the beneficiary bank's Ripple Connect has requested additional information about the payment, the originating bank provides that information in the `Accept Quote` request. (Additional payment information is not technically required, but for regulatory reasons, institutions often require information similar to fields in pacs.008 or MT 103 messages to process payments).

The beneficiary bank then reviews the quote and performs compliance checks to ensure that:

- The payment terms are acceptable.
- The additional payment information requested from the originating bank is present and sufficient to process the payment.

If the terms and additional payment information are acceptable, the beneficiary bank locks the quote. A locked quote indicates that both parties intend to process the payment and deliver the funds as described in the contract fields of the payment object.

To execute the payment, the originating bank makes an internal book transfer to debit the funds from the sender's account by making a `Submit Sending Payment` request. This request triggers the settlement payment, which transfers the funds through the Interledger Protocol (ILP) from the originating bank's ILP Ledger (a subledger to track the state of the liquidity provider's funds) to the beneficiary bank's ILP Ledger.

When the beneficiary bank sees that the ILP transfers have been validated by the ILP Validator, the beneficiary bank makes an internal book transfer to deliver the funds to beneficiary's account. After executing the internal book transfer, the beneficiary bank makes a `Submit Receiving Payment` request to its Ripple Connect instance. This request notifies the originating bank's Ripple Connect instance that the funds have been delivered to the beneficiary. After receiving the notification, the originating bank's Ripple Connect instance changes the state of the payment to `succeeded`. At this point, the payment is considered complete by both parties.

Throughout the entire process, either bank can query the state of the payment at any time because each payment is assigned a unique payment ID and is fully automated.

Key Features

The key features of Ripple Connect include:

Pre-Transaction Communication:
Ripple enables information exchange between transacting banks that include transaction fees, delivery time, FX rate and additional payment information before executing the payment. This information can be used to pre-validate the transaction to increase STP rates.

Fee Transparency:
Ripple allows financial institutions to disclose the total cost of payment (including the processing fee charged by the originating and beneficiary banks and the FX rate for the payment) to the originator before executing the payment.

Funds Settlement with Unique Identifier:
Each end-to-end payment has a payment ID that can be used to query the status of the payment at any point during payment execution, including funds settlement, and thereafter.

Configurable Fees and FX Rates:
Financial institutions can set fees and the FX rate for payments made with Ripple Connect. FX rates are set in the FX Connector and queried by Ripple Connect during the quoting process.

Payment Delivery Confirmation:
Financial institutions receive notifications about each phase of the payment, including when the funds are delivered to the beneficiary's account.

Secure Communication:
Ripple Connect uses Transport Layer Security (TLS) v1.2 for secure communication with existing financial institution systems, partner Ripple Connect instances, and the ILP components of the Ripple solution.

End-to-End Transaction Visibility:
Both the originating and beneficiary banks have full visibility into the state of the payment, allowing them to troubleshoot failed or delayed payments.

ILP Validator

The ILP Validator performs the function of coordinating ledger updates across multiple financial institutions involved in a transaction. Financial institutions have the option of running their own ILP validator and using that validator for all their transactions, or (in future product releases) relying on the network of ILP validators reaching consensus through a byzantine-fault-tolerant (BFT) consensus algorithm.

ILP Validators provide a central source of truth for validating transactions while preserving transaction privacy. The transaction details remain private to only the transacting banks, while the ILP Validator is used to verify whether certain "crypto-conditions" have been fulfilled (i.e. whether the funds are available for delivery).

When banks are ready to settle funds, the originating bank sets the terms of the payment with the ILP Validator, requiring the beneficiary bank to provide proof of funds on hold ready to be posted to the beneficiary. The originating bank also puts the funds on hold from the sender and sends the ILP Validator a cryptographic receipt of the hold. When the beneficiary bank puts the funds on hold, it provides a cryptographic receipt to the ILP Validator proving the condition has been met. The ILP Validator verifies the time-stamp and the receipts, and instructs both banks to release the hold and transfer funds (for the originating bank, to the liquidity provider and for the beneficiary bank, to the beneficiary). For more information how ILP Validators work, see the ILP Whitepaper (interledger.org/interledger.pdf).

As this model gets expanded to multiple intermediaries in the future, this model ensures that all legs of the payment process simultaneously or none of them do, removing settlement risk from the transaction. It also ensures that the transaction details are not shared with anyone other than the transacting banks. The ILP Validator does not see any payment details - rather it cryptographically verifies whether certain conditions are fulfilled.

Reference Architecture

The Ripple solution is typically installed on-premises behind the corporate firewall of a financial institution, with a load balancer handling inbound connections to Ripple Connect and a proxy server handling inbound and outbound connections to all Ripple solution components. As a financial institution, you can deploy multiple instances of the Ripple Connect behind the load balancer to scale to your volume of payments. A typical production deployment of the Ripple solution at a financial institution looks like the following example:
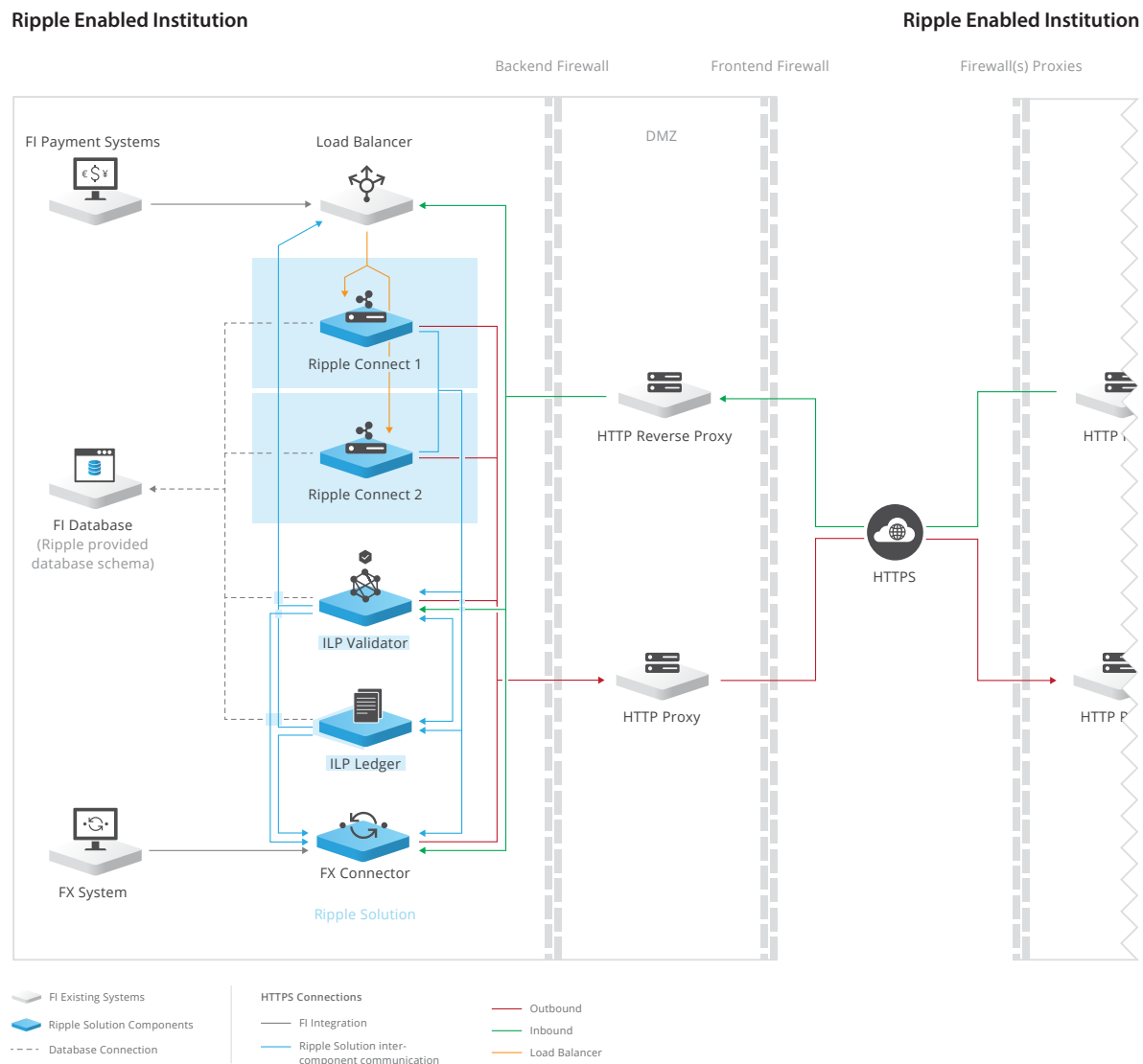
Note: If you are not providing liquidity, you only need to configure Ripple Connect and ILP Ledger.

This has the following features:

- Both Ripple-enabled institutions can send and receive payments through the Ripple solution.
- The originating or beneficiary institution can provide liquidity.
- The Ripple solution is deployed in a secure, trusted network zone, behind corporate firewalls and the DMZ. (The Ripple solution should not be deployed inside the DMZ.)
- All components of the Ripple solution are co-located on a single application server and communicate with each other over HTTPS and use TLS certificates for authentication.
- The Ripple solution deployment communicates with partner Ripple solution deployments over HTTPS and use TLS certificates for authentication.
- The databases for Ripple Connect, the ILP Validator, and the ILP Ledger are created with the provided database schemas and deployed on the same database server. (The FX Connector does not currently require a database.)

Technical Requirements

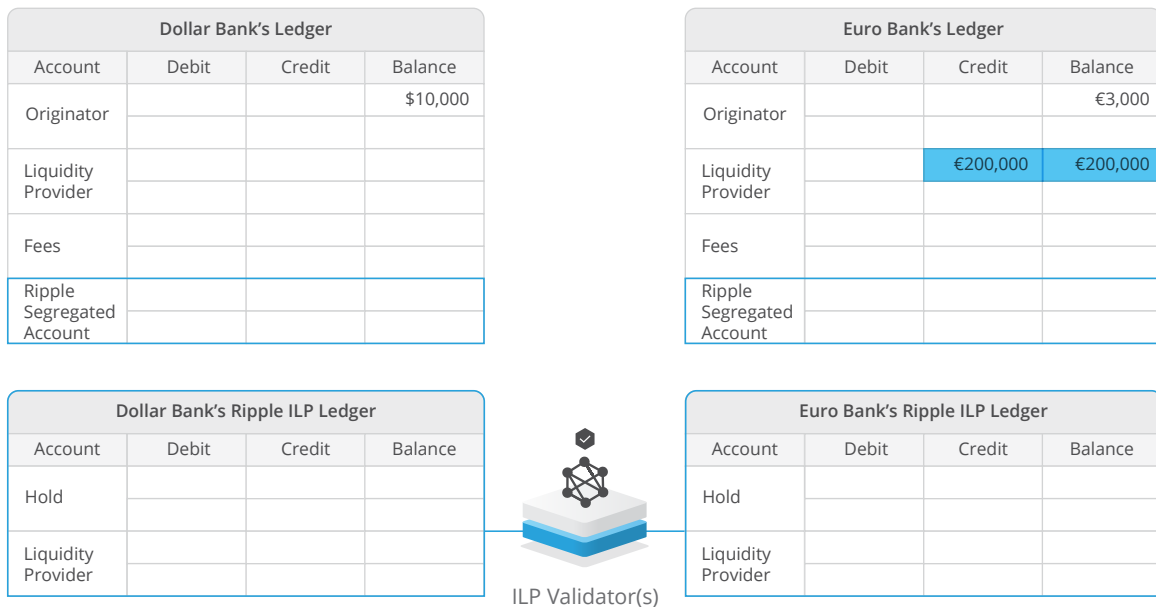|	
Operating System	Red Hat Enterprise Linux (RHEL) 6.7 and 7.2
Architecture	x86 (64-bit)
RAM	8 GB
CPU	4 Cores
Disk Storage	100 GB
Supported Database Connections	• PostgreSQL 9.4 • Microsoft® SQL Server® 2012
Deployment Options	RPM
RPM Dependencies	Node.js v6.9.0 or later

How It Works

Flow of Funds

This section will use an example payment to demonstrate the flow of funds through Ripple. In this example, Alpha Corp (in the U.S.) needs to pay Beta Corp (in the eurozone) a total of €100. Alpha Corp has an account with Dollar Bank in the U.S. and Beta Corp has an account with Euro Bank in the E.U. Both banks are integrated with Ripple.

Alpha Corp — Alpha Corp needs to pay Beta Corp €100 → Beta Corp
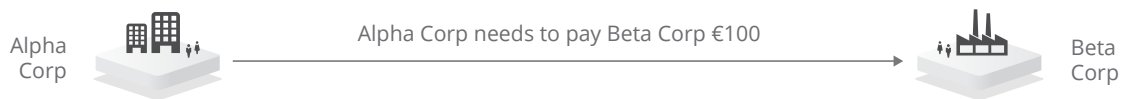
SETUP

To enable cross-currency flows on Ripple, banks can leverage their existing nostro/vostro relationships with other banks and provide liquidity through their FX trading desks, or can use external market makers to provide FX liquidity for exotic currency corridors. This example will refer to that function as the liquidity provider, whether it is the bank's FX organization or an external market maker.

As part of the setup process, the liquidity provider ensures that the beneficiary bank account is pre-funded with the local currency.

Dollar Bank's Ledger			
Account	Debit	Credit	Balance
Originator			$10,000
Liquidity Provider			
Fees			
Ripple Segregated Account			

Euro Bank's Ledger			
Account	Debit	Credit	Balance
Originator			€3,000
Liquidity Provider		€200,000	€200,000
Fees			
Ripple Segregated Account			

Dollar Bank's Ripple ILP Ledger			
Account	Debit	Credit	Balance
Hold			
Liquidity Provider			

Euro Bank's Ripple ILP Ledger			
Account	Debit	Credit	Balance
Hold			
Liquidity Provider			

ILP Validator(s)

Each bank sets up a segregated account, the balance of which is reflected on the ILP Ledger (a subledger to track the state of the liquidity provider's funds). Any contribution that a liquidity provider makes to the segregated account is reflected in the liquidity provider's account on the ILP ledger.

In this case, the liquidity provider makes €40,000 available for funding payouts of Ripple transactions. For a two-way flow, the liquidity provider would also pre-fund their dollar account and transfer some of the liquidity to the segregated account. For this example, we are just showing a payment going from the Dollar Bank to the Euro Bank.

Dollar Bank's Ledger			
Account	Debit	Credit	Balance
Originator			$10,000
Liquidity Provider			
Fees			
Ripple Segregated Account			

Euro Bank's Ledger			
Account	Debit	Credit	Balance
Originator			€3,000
Liquidity Provider		€200,000	€200,000
	€40,000		€160,000
Fees			
Ripple Segregated Account		€40,000	€40,000

Dollar Bank's Ripple ILP Ledger			
Account	Debit	Credit	Balance
Hold			
Liquidity Provider			

ILP Validator(s)

Euro Bank's Ripple ILP Ledger			
Account	Debit	Credit	Balance
Hold			
Liquidity Provider		€40,000	€40,000

Once the segregated accounts are funded, the liquidity provider posts an FX quote to the originating bank. In this case, let's assume the offer is EUR/USD at 1.1429.
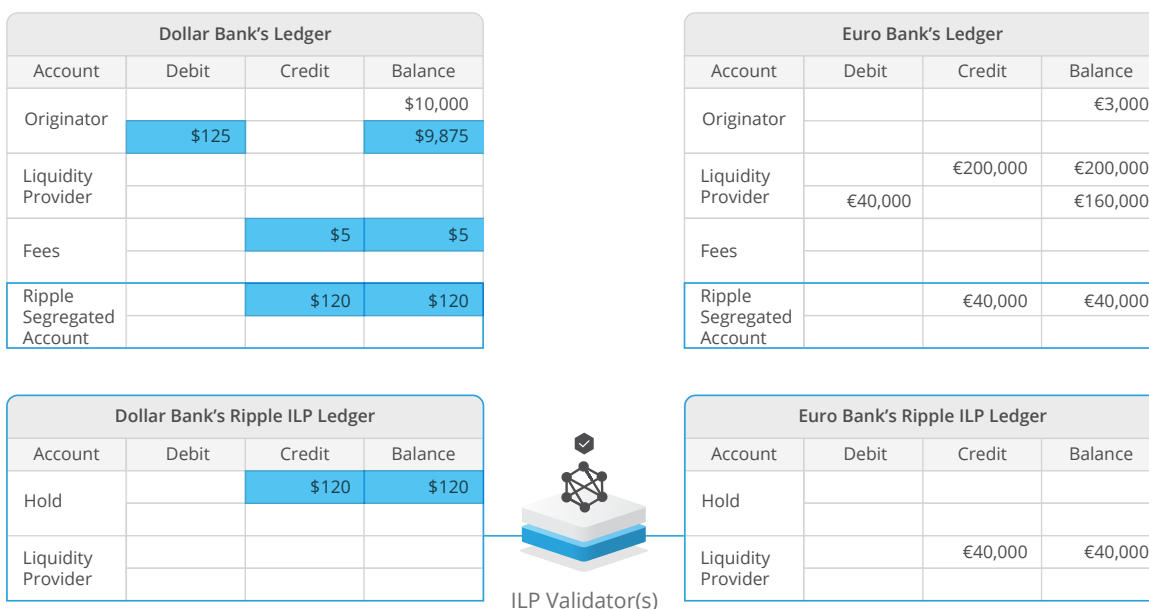
PAYMENT (INTEGRATED MESSAGING AND SETTLEMENT) FLOW

When a payment is initiated by Alpha Corp, the Ripple Connect instances at both banks exchange information about Alpha Corp and Beta Corp for KYC/AML checks and sanctions screening. These CIP/PII fields are entirely configurable by both banks. The sending Ripple Connect also queries the beneficiary bank for the processing fees that the beneficiary bank would charge to post the payment for Beta Corp. It also gets the exchange rate from the liquidity provider (could be the bank's FX desk). In this case, it is EUR/USD at 1.1429.
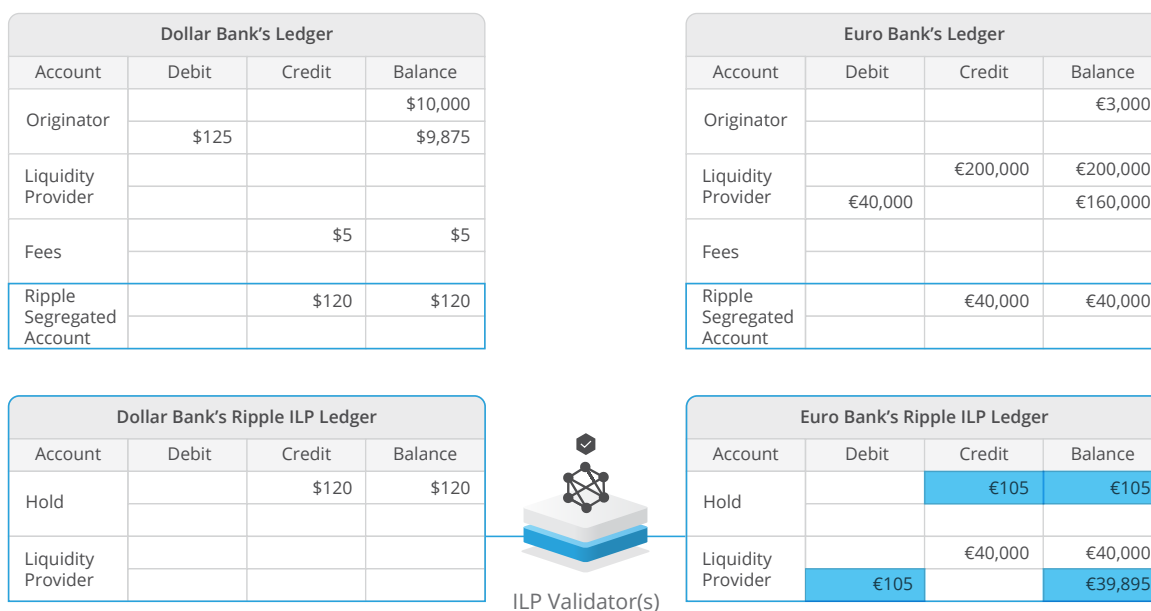
The originating bank's Ripple Connect compiles this information, adds the originating bank's processing fees and presents the bank with the "all-in cost" of the transaction. Assuming that the originating bank's fees are $5, the beneficiary bank's fees are €5, and the EUR/USD rate at 1.1429, the total cost of sending €100 to Beta Corp would be $125. Once Alpha Corp accepts the charge, the

payment is initiated. Dollar Bank debits Alpha Corp's account to the amount of $125, collects the $5 fee and credits the segregated account $120.

These funds are not yet credited to the liquidity provider - rather they are put on hold until the beneficiary bank also provides proof to the ILP Validator that they have also put on hold funds that can be posted to the beneficiary.

Dollar Bank's Ledger			
Account	Debit	Credit	Balance
Originator			$10,000
	$125		$9,875
Liquidity Provider			
Fees		$5	$5
Ripple Segregated Account		$120	$120

Euro Bank's Ledger			
Account	Debit	Credit	Balance
Originator			€3,000
Liquidity Provider		€200,000	€200,000
	€40,000		€160,000
Fees			
Ripple Segregated Account		€40,000	€40,000

Dollar Bank's Ripple ILP Ledger			
Account	Debit	Credit	Balance
Hold		$120	$120
Liquidity Provider			

ILP Validator(s)

Euro Bank's Ripple ILP Ledger			
Account	Debit	Credit	Balance
Hold			
Liquidity Provider		€40,000	€40,000

This triggers the ILP Validator to instruct the beneficiary bank to put funds on hold and provide the proof. The beneficiary bank puts on hold a total of €105 and sends a receipt to the ILP Validator. This receipt contains the cryptographic proof of the hold of funds, but does not contain any information about the banks, the transacting parties or the payment details.

Dollar Bank's Ledger			
Account	Debit	Credit	Balance
Originator			$10,000
	$125		$9,875
Liquidity Provider			
Fees		$5	$5
Ripple Segregated Account		$120	$120

Euro Bank's Ledger			
Account	Debit	Credit	Balance
Originator			€3,000
Liquidity Provider		€200,000	€200,000
	€40,000		€160,000
Fees			
Ripple Segregated Account		€40,000	€40,000

Dollar Bank's Ripple ILP Ledger			
Account	Debit	Credit	Balance
Hold		$120	$120
Liquidity Provider			

ILP Validator(s)

Euro Bank's Ripple ILP Ledger			
Account	Debit	Credit	Balance
Hold		€105	€105
Liquidity Provider		€40,000	€40,000
	€105		€39,895

Once the ILP Validator receives proof that both banks have funds on hold, it triggers the settlement of funds - instructing both ledgers to release the holds and transfer the funds. This is an atomic process, meaning that both intra-bank settlement legs of the transaction happen simultaneously, to eliminate the settlement leg risk.

Dollar Bank's Ledger			
Account	Debit	Credit	Balance
Originator			$10,000
	$125		$9,875
Liquidity Provider			
Fees		$5	$5
Ripple Segregated Account		$120	$120

Euro Bank's Ledger			
Account	Debit	Credit	Balance
Originator			€3,000
		€100	€3,100
Liquidity Provider		€200,000	€200,000
	€40,000		€160,000
Fees		€5	€5
Ripple Segregated Account		€40,000	€40,000
	€105		€39,895

Dollar Bank's Ripple ILP Ledger			
Account	Debit	Credit	Balance
Hold		$120	$120
	$120		$0
Liquidity Provider		$120	$120

Euro Bank's Ripple ILP Ledger			
Account	Debit	Credit	Balance
Hold		€105	€105
	€105		€0
Liquidity Provider		€40,000	€40,000
	€105		€39,895

ILP Validator(s)

Once the transaction settles on the ILP ledgers, Euro Bank collects the €5 fee and posts €100 to Beta Corp's account.

Once the funds post to the recipient's account, Dollar Bank is notified so that it can deliver a confirmation of beneficiary fund receipt to Alpha Corp.

API Process Flow

Executing the payment described in the "Flow of Funds" section involves the following API requests to Ripple Connect.

QUOTING PROCESS

1. The originator of the payment starts the process by providing information about the payment through an interface in the financial institution's client application (which could be part of an existing online banking system). At a minimum, this information must include the following:
   a. **Sender:** The originator of the payment.
   b. **Receiver:** The beneficiary of the payment.

c. The **amount** and **currency** of the payment, and whether this is a "sender" or "receiver" amount:

- **Sender Amount:** The specified amount is debited from the sender's account. Ripple Connect calculates the fees and FX cost and debits them from the sender's account. The receiver's account is credited with the remaining amount.

- **Receiver Amount:** The receiver's account is credited with the specified amount. The amount is debited from the sender's account in the sender's currency. Ripple Connect calculates the fees and FX cost and adds them to the amount debited from the sender's account. The originating bank uses the information provided by the originator to make a `Get Quote` request to its own Ripple Connect instance.

2. The originating bank's Ripple Connect instance makes a `Get Quote` request to the Ripple Connect instance at the beneficiary bank to get its portion of the payment, which includes its fees (€5 in the example above) and empty fields that indicate any additional information the beneficiary bank requires to process the payment.

3. The Ripple Connect instance at the originating bank gets the FX rate posted by the Liquidity Provider from the FX Connector.

4. The originating bank aggregates the fees for its portion of the payment, which includes its fees ($5 in the example above).

5. The originating bank receives a response to its `Get Quote` request and passes the quote to the initial sender to determine if the terms of the payment (which include the beneficiary and originating banks' fees and the FX rate) are acceptable. If the terms are acceptable, the originating bank makes an `Accept Quote` request. If the configuration of the beneficiary bank's

Ripple Connect has requested additional information about the payment, the originating bank provides that information in the `Accept Quote` request. (Additional payment information is not technically required, but for regulatory reasons institutions often require information similar to fields in pacs.008 or MT 103 messages to process payments.) Ripple Connect generates a payment ID, which is included in the `Accept Quote` response. The beneficiary bank reviews the quote and performs compliance checks to ensure that:

  a. The payment terms are acceptable.

  b. The additional payment information requested from the originating bank is present and sufficient to process the payment.

6. If the terms and additional payment information are acceptable, the beneficiary bank makes a `Lock Quote` request. A locked quote indicates that both parties intend to process the payment and deliver the funds as described in the contract fields of the payment. The contract fields cannot be changed after the quote is locked.

7. The Ripple Connect instance at the originating bank receives a notification that the payment is now locked, and updates the payment state in its own database to reflect the new state.

Both institutions now have an identical payment object in a locked state, with all the information that both institutions need to execute the payment.

PAYMENT PROCESS

After both banks accept the quote, the originating bank can initiate the end-to-end payment, which

is comprised of three sub-payments:

- **Sending payment:** The internal book transfer at the originating bank. The originating bank debits the originator's account and credits its own segregated account. Any fees charged by the originating bank are deducted from the originator's account in this transfer.
- **Settlement payment:** The transfers executed over the Interledger Protocol. The funds are transferred from the originating bank's transactional account (on its ILP Ledger) to the beneficiary bank's transactional account (on its ILP Ledger). This transfer is triggered automatically when the originating bank makes the `Submit Sub-Payment` request. Executing the settlement payment doesn't require any additional action on the part of the originating bank.
- **Receiving payment:** The internal book transfer at the beneficiary bank. The beneficiary bank debits its own segregated account and credits the beneficiary's account. Any fees charged by the beneficiary bank are deducted from the beneficiary's account in this transfer.

Executing the end-to-end payment involves the following steps:

1. The originating bank makes an internal book transfer debiting the funds from the sender's account. In the example above, $125 is deducted: $120 for the payment and $5 for the originating bank's fee.

2. The originating bank makes a `Submit Sending Payment` request to Ripple Connect to acknowledge that the funds have been debited from the sender's account in the bank's internal systems. The request to Ripple Connect does not affect the bank's internal systems. Typically, integration logic coordinates the transfer in the internal systems with executing the `Submit Sending Payment` request.

3. The originating bank's Ripple Connect instance notifies the beneficiary bank's Ripple Connect instance that the funds have been debited from the sender's account.

4. The `Submit Sending Payment` request triggers the settlement payment, which transfers the funds through the Interledger Protocol (ILP) from the originating bank's ILP Ledger to the beneficiary bank's ILP Ledger.

5. The originating bank's Ripple Connect instance notifies the beneficiary bank's Ripple Connect instance that the settlement payment has been sent.

6. The beneficiary bank sees that the ILP transfers have been validated by the ILP Validator and makes an internal book transfer to deliver the funds to the beneficiary's account.

7. The beneficiary bank makes a `Submit Receiving Payment` request to its Ripple Connect instance, which changes the state of the payment to `succeeded` in its database.

8. The beneficiary bank's instance notifies the originating bank's Ripple Connect instance that the funds have been delivered to the beneficiary's account.

9. After receiving the notification, the originating bank's Ripple Connect instance changes the state of the payment to `succeeded` in its database.

10. At this point, both parties consider the payment complete.
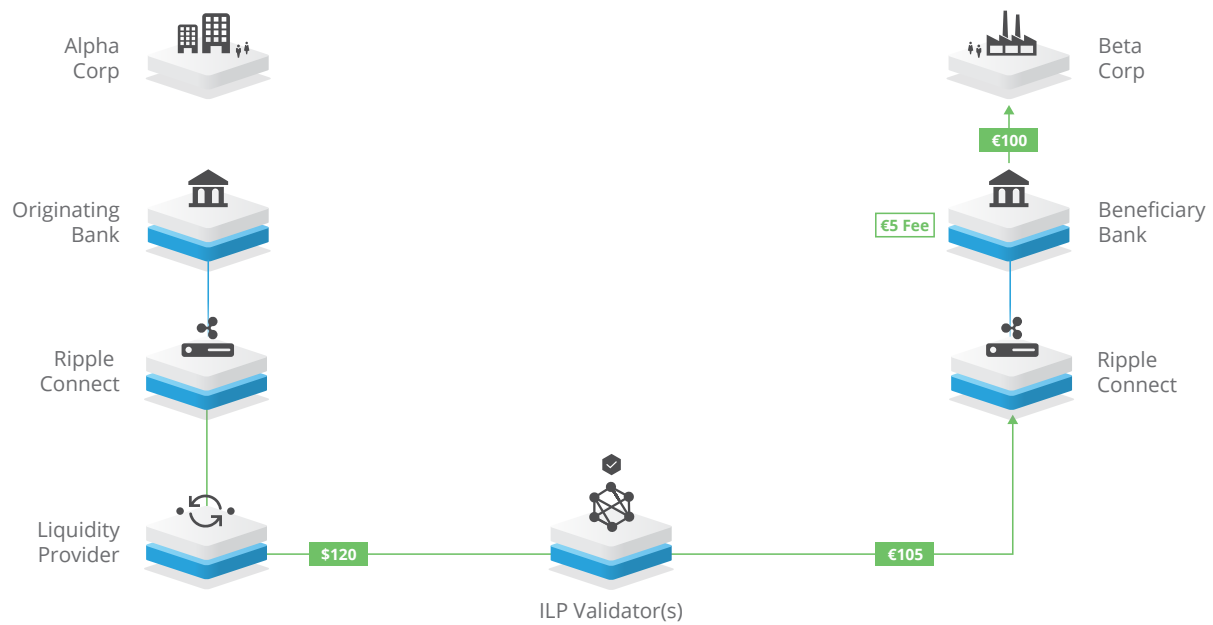
The payment is now complete. Alpha Corp. sent 125 USD and 100 EUR was delivered to Beta Corp's account.

Impact on Compliance

Ripple as a Technology Service Provider

Ripple delivers licensed software and integration services that enable clients to facilitate real-time payments. In the scope of this activity, Ripple may be considered a vendor or third-party technology service provider; however, this categorization and any resulting regulatory requirements vary depending on the specific laws of each country.

Financial institutions often rely on third parties for technical services and may have internal programs to ensure the prudent management of these vendors. These programs and their due diligence standards are often unique to each institution, reflecting its operations, size, complexity and risk controls. Depending on the country, such programs are recommended or required by some regulators. Generally, as a third-party technology service provider, Ripple may be subject to these vendor management program requirements of its financial institution clients.

Aside from meeting the financial institution's vendor management requirements, Ripple may be subject to a regulator's oversight, approval and examination, depending on the rules of each country.

The regulatory treatment of Ripple is dependent on several factors, such as:

- The type of client being serviced (including its type of license, charter and designation)
- Country of integration and geographic scope of operations
- Volume and scope of activity enabled through the software provided
- Level of dependency on the software provided, and
- Other factors determined by the financial institution or regulator

Over the past two years, Ripple has engaged with central banks and regulators globally to educate them on distributed networks. As business engagements are formalized, Ripple works with each financial institution to identify and meet all relevant regulatory requirements ahead of integration.

KYC and AML Compliance Processes

Use of Ripple for payments does not impact a financial institution's compliance responsibilities. Recognizing this, Ripple's products are designed to complement a financial institution's existing customer onboarding, due diligence and transaction monitoring programs.

When using Ripple, a financial institution's customer onboarding and Know Your Customer (KYC) processes remain unchanged. The financial institution maintains full responsibility for ongoing

compliance with Anti-Money Laundering (AML) and Office of Foreign Assets Control (OFAC or, more broadly, "sanctions") legislation and regulations. Financial institutions are also responsible for ongoing monitoring of transactions conducted through Ripple in accordance with their existing transaction monitoring program requirements. U.S. financial institutions also maintain responsibility for compliance with foreign correspondent account recordkeeping and due diligence requirements specified under Section 312 of the USA PATRIOT Act. Use of Ripple does not alter these obligations of the financial institution.

The messaging capability within Ripple Connect enables financial institutions to comply with U.S. Travel Rule requirements. It also enables upfront fee negotiation to assist with Regulation E pre-payment disclosure obligations (Section 1073 of the Dodd Frank Act). The direct, bidirectional messaging between originating and beneficiary financial institutions allows for the secure transfer of additional data about the payment, its sender and its recipient.

While the financial institution's compliance with AML and sanctions obligations remains unchanged, the timing of its sanctions screening activities may need to be altered given the real-time nature of Ripple transactions. To capitalize on the speed at which transactions are conducted over Ripple, financial institutions may wish to augment their sanctions screening processes to pass this benefit on to their customers. This consideration is institution-specific, dependent on the capabilities, speed and compliance policy of the financial institution.

Fee Pre-Disclosure

Ripple enables financial institutions to have complete clarity into the fees and FX cost of the payment before initiating the transaction. This transparency allows the financial institution to accurately quote the total cost of sending the payment to the consumer before sending the funds.

Fee transparency on Ripple is a significant advantage over payment systems today, which do not provide visibility into the total cost before sending the payment. Ripple's ability to pre-disclose all fees prior to sending the payment not only improves the customer experience, but also enables compliance with laws in some countries, specifically the United States.

Security on Ripple

Using Ripple, your customers' data remains private and secure, behind your bank's firewalls. Financial transaction history is stored in the databases for the ILP Ledger and Ripple Connect. The ILP Validator database only stores the cryptographic cases and conditions required to validate and coordinate payments.

CRYPTOGRAPHIC SECURITY

Financial transactions on Ripple are signed using industry-standard cryptographic algorithms including Ed25519. Only your financial institution can cryptographically sign for your transactions — no other institution or individual can do it on your behalf. ILP Validators use public/private key cryptography to verify whether the conditions required to execute payments have been met using digital signatures analogous to signatures on paper checks in traditional banking. ILP Validators mathematically verify that the correct signature appears – the signature of the owner of the funds – before allowing the payment to execute.

PAYMENT DATA SEPARATION

Implementing a payment system on Ripple provides a layer of separation and security between payment data and settlement data for financial transactions that are executed over the Interledger Protocol. The ILP Validator only sees the cryptographic cases that it uses to mathematically verify that each institution has fulfilled the conditions required to execute the payment. The actual payment data is encrypted and shared only between the two institutions making payments to each other. The following types of payment data are stored and maintained in internal databases that are only accessible by each financial institution:

• Identifiers for originators and beneficiaries
• Required PII/CIP information for originators and beneficiaries
• Additional payment information such as invoice numbers
• Additional metadata

SECURE COMMUNICATION

Financial institutions' internal systems communicate with Ripple Solution over secure HTTPS connections and use OAuth 2.0 for authentication. The ILP components of Ripple Solution use HTTPS for secure communication with each other and Ripple Connect and use CA certificates for authentication.

HTTPS is also used for:

- Pre-transaction communication between Ripple Connect instances at corresponding partner institutions
- Communication between Ripple Connect, the ILP Validator, the ILP Ledger, and the FX Connector

About Ripple

Ripple provides global financial settlement solutions to ultimately enable the world to exchange value like it already exchanges information – giving rise to an Internet of Value (IoV). Ripple solutions lower the total cost of settlement by enabling banks to transact directly, without correspondent banks, and with real-time certainty of settlement. Banks around the world are partnering with Ripple to improve their cross-border payment offerings, and to join the growing, global network of financial institutions and liquidity providers laying the foundation for the Internet of Value.

Ripple is a venture-backed startup with offices in San Francisco, New York, London, Luxembourg and Sydney. As an industry advocate for the Internet of Value, Ripple sits on the Federal Reserve's Faster Payments Task Force Steering Committee and co-chairs the W3C's Web Payments Working Group.

Contact Us

To learn more about how your financial institution can adopt Ripple, please contact us at ripple.com/contact

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