The Ripple Protocol:
A Deep Dive for Finance Professionals

ripple

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Overview

Ripple Protocol: The Internet for Value

Ripple is a universal protocol founded in 2012 to power the cheapest and fastest payment system for value transfer. Ripple's technology enables users to transfer funds (including fiat currencies, digital currencies and other forms of value) across national boundaries as seamlessly as sending an email.

Building Upon Other Digital Currencies

Like other digital currencies such as Bitcoin, the Ripple Protocol enables peer-to-peer transaction settlement across a decentralized network of computers. As a result, Ripple circumvents many of the fees and reduces many of the risks involved in interbank funds transfers, particularly in international transactions. Unlike other digital currency protocols, however, the Ripple Protocol is currency agnostic and users are not required to transact in the Protocol's native currency (XRP). In addition, the technology enables near real-time settlement (three to six seconds) and is built to route each international transaction to the cheapest FX bid/ask spread available in the network.

A Compelling Alternative to Correspondent Banking

As a result of its key features, the Ripple Protocol represents a compelling alternative to traditional interbank funds transfer systems. While this report walks through several potential applications of the protocol, the technology is perhaps most promising in international transactions. Given the absence of an international payment rail, international interbank funds transfers rely on a series of correspondent banking networks which introduce multiple layers of fees, counterparty risk and settlement delays. The Ripple Protocol eliminates the costs associated with correspondent banking as it enables two banks located anywhere in the world to transact directly on a real-time basis.

Partnerships are Key

Another key differentiator of Ripple is the network's reliance on partnerships with banks, payment processors, money transmitters, and other financial services institutions. This approach stands in contrast to other peer-to-peer networks, most of which seek to disintermediate existing players. The Ripple Protocol is not built to interface directly with consumers and does not govern retail prices. Thus, the Protocol provides financial institutions with the flexibility of passing on some of the cost savings to their end customers (consumers and businesses) while managing profit margins.

Regulation, Liquidity and Competition are Key Risks

Regulatory uncertainty remains the key hurdle for digital currencies, including Ripple. It is unclear how regulation will ultimately shape up and what costs this will add on the protocol or to its users. Additionally, much of the protocol's appeal, such as the ability to send funds abroad and leverage competitive FX rates, hinges on the network ability to scale volume. Finally, competition could intensify as some incumbents that feel threatened by the rise of digital currencies could enact policies to restrict adoption.

Table of Contents

The Ripple Protocol: A Deep Dive for Finance Professionals

Ripple Protocol: The Internet for Value

Ripple is a universal protocol founded in 2012 to power the cheapest and fastest payment system for value transfer with a global, post-Internet architecture. Ripple's innovative technology enables users to exchange money (including fiat currencies, digital currencies, gold, and other items of value) across national boundaries as seamlessly as sending an email.

At its core, Ripple is a physical network of computers running a common open-sourced software (known as rippled, pronounced: ripple-"d"), developed and maintained by Ripple Labs (more on Ripple Labs below). Users plugged into the rippled software transact according to rules set by the Ripple Protocol. Similar to other Internet protocols – e.g. SMTP for email and HTTP for websites – Ripple is a set of rules that govern how Internet-connected computers communicate with each other. As an Internet protocol, no one owns the Ripple network and the open-sourced software is completely free. Ripple Labs does not operate the network, collect fees, or limit access.

Understanding Ripple as a Protocol

Understanding Ripple as a protocol is critical in order to appreciate the potential of the technology and the appeal for prospective users/partners. Ripple protocol is a set of rules for transaction clearing and settlement: governing how two parties can transfer ownership of any currency or item of value. The protocol is not designed as a consumer or merchant interfacing payment service. This means banks, payment processors, money transmitters, and other providers of financial services can continue to control the entire customer experience (including interfacing with their end customer, determining pricing, and customer acquisition).

In addition, as a protocol, Ripple cannot dis-intermediate banks or its financial services users/partners. This is synonymous with other Internet protocols like HTTP (the protocol for the Internet) or SMTP (the protocol for email); no company can cut access to these public goods, because no company controls them. On the other hand, Ripple relies on financial institutions to serve as gateways providing access for funds to enter and exit Ripple and market makers to provide liquidity within the network.

Another important aspect of a protocol is that users don't have to know how it works- and in fact, users don't even know there is a protocol to begin with. Consumers don't have to understand how the Automated Clearing House (ACH) or Society for Worldwide Interbank Financial Telecommunication (SWIFT) work to send payments or understand how the HTTP or SMTP protocols to use the Internet. What's important is that the protocols ultimately enable a seamless and user-friendly experience.

Ripple is a Shared, Common Ledger

Every financial firm manages a ledger of accounts of some sort. In a digital world, payments are essentially just updates to the database. A bank can transfer funds between in-house accounts by effectively moving $1,000 from cell C1 to cell D1. The complexity arises from the fact that every firm has its own proprietary ledger, and

two firms running two different systems cannot easily communicate directly. On a high level, one can think of Ripple as a neutral, open-source ledger that connects financial institutions and networks, and on which developers can build innovative payment applications. If every firm's back end can communicate with Ripple, then the protocol can act as a universal link between institutions globally. Ripple offers an improvement to existing solutions because, like email, Ripple is totally neutral and free. It is not controlled by any country or region. And unlike centralized solutions, no company can impose future costs to use the network.

A Compelling Alternative for Interbank Transfer Systems

There are several features of the Ripple protocol that make Ripple a compelling alternative to the current interbank transfers systems. Currently, interbank funds transfers impose financial and operational costs on financial institutions, which help dictate the retail prices consumers and businesses pay. In addition, counterparty risk and settlement delays are factors that banks and their customers need to constantly manage.

These costs and risks are most pronounced in international transactions. Today, each country has its own domestic interbank transfer system, such as the ACH system in the U.S. or the Bankers' Automated Clearing Services (BACS) in the UK. These payment systems enable domestic bank-to-bank transfers, usually routing through the central bank as a clearing agent. These are typically low-cost transactions for banks, but they could take two to five days to settle.

For international transactions, however, there is no global equivalent of ACH. This is partially because there is no trusted, supra-national clearing agent to provide the settlement that central banks provide on a national level. Instead, money moves across borders through a patchwork of correspondent banking relationships, connecting one regional banking center to another.

Correspondent banks are typically large, multi-national banks that maintain accounts in several regional banking systems. These correspondent banks act as a domestic agent's bank in international markets and could process transactions, accept deposits or conduct other business activities on behalf of domestic banks. For example, a small or mid-sized U.S. bank could transact with a European bank through the services of a correspondent bank with a presence in the U.S. and in Europe. These correspondent relationships are governed by bilateral agreements between financial institutions. For a more detailed discussion on correspondent banking, see "A closer look at correspondent banking" on page 33.

For businesses, consumers, and banks, the costs of correspondent banking could add up over many transactions. First, each correspondent bank introduces a per-transaction cost known as a lifting fee. Second, businesses or consumers typically bear the cost of currency conversion (i.e. the FX spread), which is dictated by the correspondent. Third, small/mid-size banks are typically required to deposit funds as collateral in an account at their correspondent bank as part of the arrangement. This "liquidity" cost varies depending on each bilateral arrangement and the perceived risk of each bank.

Moreover, each correspondent banking relationship introduces settlement delays, and the more complicated a correspondent banking network gets for a particular funds transfer, the longer the businesses and consumers need to wait to access funds. This could place small and mid-size banks at a disadvantage competing with larger peers who can often provide a better customer experience for international transactions

Inefficiencies in International Funds Transfers

The following is a simple illustrative example of how an international payment from a U.S. account holder (say, a U.S. importing business) to a EU account holder (say, a German exporting business) is handled through correspondent banking channels. The example below illustrates how the funds move after the U.S. account holder initiates the payment.

If the U.S. Bank does not have an EU banking license, which is typical of most small and mid-sized banks, then the U.S. Bank first transfers the funds to a large U.S. bank, its domestic correspondent bank. However, given that these banks operate different core account ledgers, they are unable to transact directly. Thus, the U.S. Bank routes the funds through the Federal Reserve, which then relays the funds to the domestic correspondent bank. These funds are transferred via the ACH system.

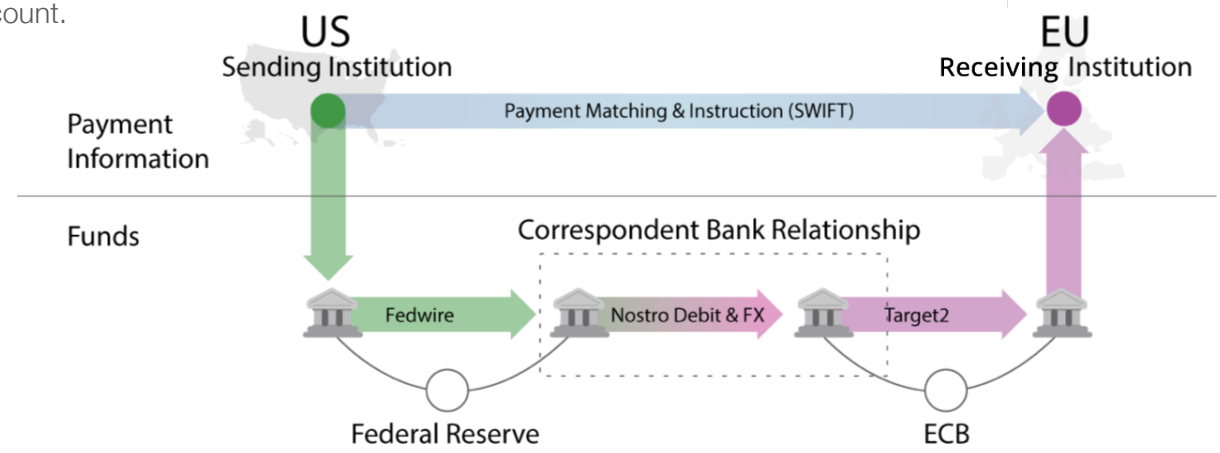
The correspondent bank maintains an account in the EU banking system, known as a nostro account, which is pre-funded with euros. After receiving USD funds via ACH, the domestic correspondent bank then initiates an offsetting EUR transfer from its nostro account to the beneficiary's bank in the EU banking system. Again, given that these EU banks also operate different account ledgers, the EU correspondent bank needs to route the funds via the European Central Bank, which acts as a clearing agent and finally relays the funds to the European bank where the German exporting business has an account.

SWIFT: Messaging vs. Funds Transfer

The Society for Worldwide Interbank Financial Telecommunication (SWIFT) provides a network that enables financial institutions worldwide to send and receive information about financial transactions in a secure, standardized and reliable environment.

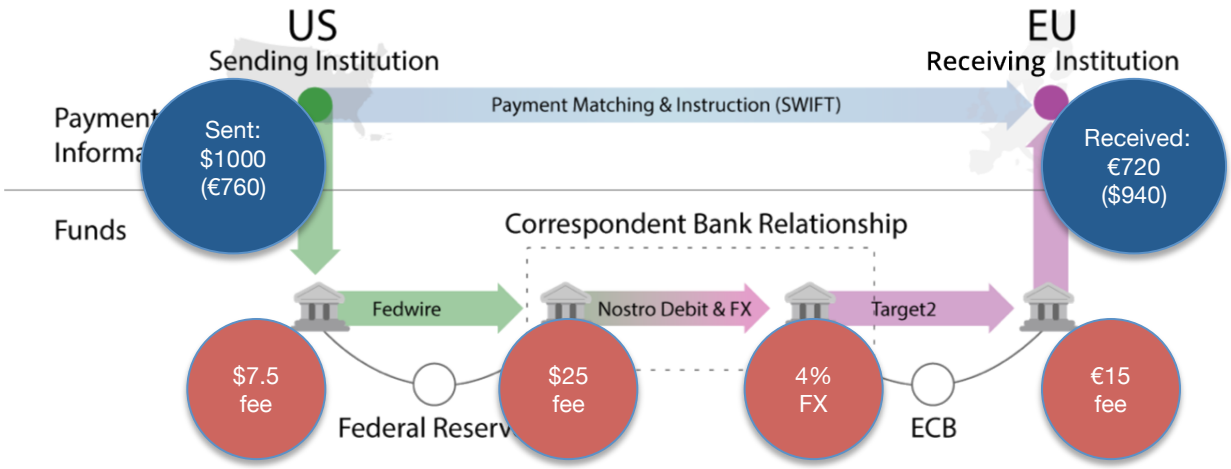
SWIFT is often colloquially thought of as "international wire." However, it only provides for messaging and *does not provide for funds settlement.*

Settlement still occurs through a patchwork of regional rails. Ripple can provide a free, international rail that can co-exist with SWIFT messages.



A key takeaway here is that there is no direct linkage between the U.S. and EU banking systems save for a handful of multi-national correspondent banks that maintain funded accounts in both regions and charge for the service of effecting funds transfer between them.

International transactions need to go through a series of hops between domestic banks, central banks and correspondent banks. Each hop represents an additional layer of cost (usually a per transaction fee), risk (settlement and counterparty risk), and delay. Additionally, international transactions introduce FX conversion fees (for businesses/consumers) and currency reserve management costs (for banks). The diagram below, for all its complexity, shows a relatively simply example between two heavily trafficked regions/currencies. The path between two developing market regions can be significantly more complex and costly, and in some cases, non-existent.



The Double-Spend Problem: Bitcoin's Breakthrough

Transaction settlement has historically been a tri-party arrangement between the sender, the beneficiary, and a trusted third party clearing agent. For example, in the U.S., the Federal Reserve is the trusted clearing agent that operates a ledger shared between banks. In retail payments, a player like PayPal is a clearing agent that operates a ledger shared by its retail users.

The need for a clearing agent stems from what technologists refer to as the double spending problem. A digital USD balance is just an entry in a ledger. It is the liability of its issuer – a promise to pay the bearer on demand – and it is underpinned by the assets held by a bank or custodian.

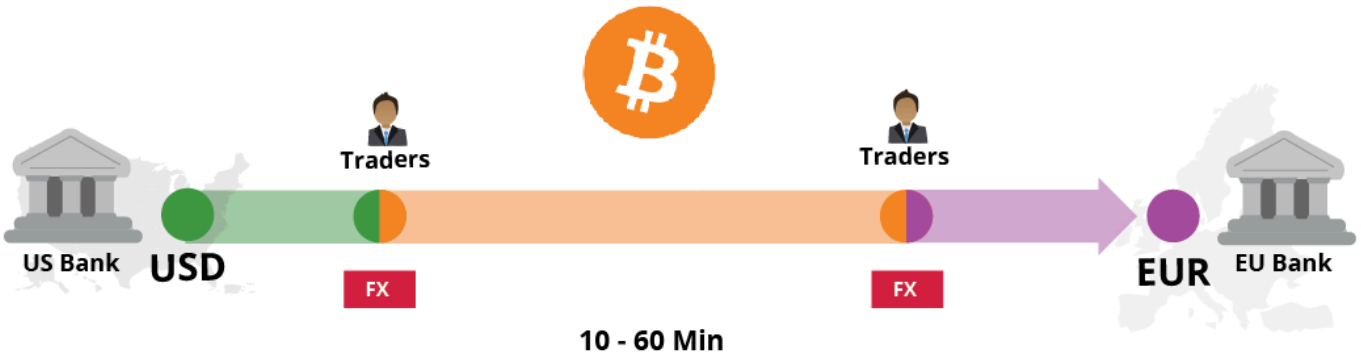
Without the Federal Reserve acting as a trusted clearing agent, a bank could conceivably "double spend" its assets and simultaneously send payments to multiple counterparties, which presents significant counterparty risk. Instead, banks deposit funds with the Federal Reserve, and the Fed can move assets between their accounts with enough visibility to ensure the solvency of payments. Or in the retail example, users deposit funds with Paypal, and Paypal can ensure that a user's assets are not double spent.

The Ripple Protocol

The Bitcoin protocol offered a novel solution to the double spend problem. In the Bitcoin protocol, a network of interconnected computers collectively managed a ledger which tracks ownership of digital assets (bitcoins). This eliminated the need for a clearing agent, thus enabling the peer-to-peer transfer of funds with no intermediaries. This theoretically eliminates many of the fees and underlying counterparty risk.

However, the Bitcoin protocol - like most other digital currency protocols - requires users to transact in the protocol's native digital currency (i.e. Bitcoin users must transact in bitcoins, or BTC).

The exhibit below illustrates how the same U.S. importer business can transfer funds to the German exporter business via the Bitcoin protocol. First, the U.S. business converts USD into BTC using a bitcoin service provider. BTC can then be transferred directly to the beneficiary's bitcoin account. Next, the German business service provider converts the BTC into Euros, and finally, the bitcoin service provider delivers Euros to the German business. The German business then deposits the amount into its EU Bank.



Bitcoin's technology is a conceptual improvement that removes much of the friction in the current process for interbank transfers. The protocol enables peer-to-peer transaction settlement and thus circumvents the complicated and costly correspondent banking framework. This has the potential to provide users with both cost savings and faster settlement. However, the fact that the Bitcoin protocol requires users to transact in BTC introduces some new frictions:

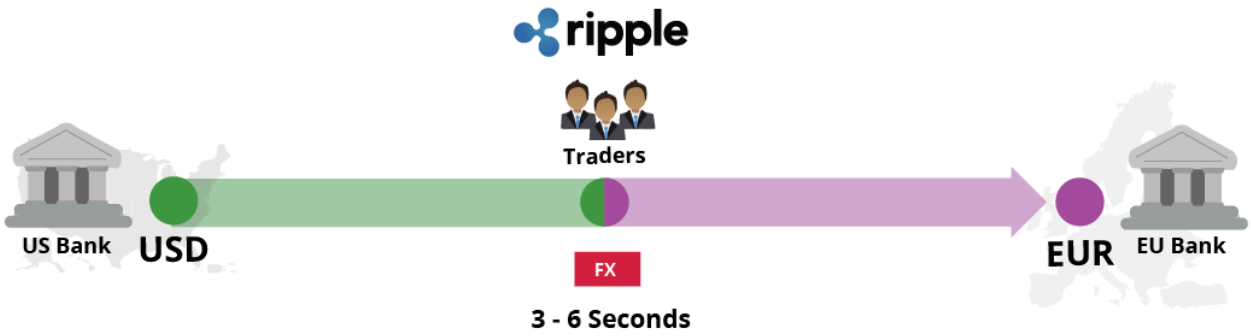
- Exchanges or bitcoin payment processors impose transaction fees to convert in and out of bitcoin.
- Liquidity to convert in and out of BTC may be limited or costly.
- Though many users immediately convert out of BTC upon receipt, there is still ten to sixty minutes of currency volatility that is unavoidable while the bitcoin network confirms transactions. YTD, the average hourly trading range for BTC/USD has been 1.5% with outlier moves as high as 20% over a sixty-minute window. This volatility can entirely consume the savings of using bitcoin, and then some.
- Even if the volatility of BTC is significantly reduced, there is no way to guarantee the fiat value that the beneficiary will receive (without a third party taking the price risk) which presents challenges for this schema to comply with Consumer Financial Protection Bureau mandates.

How Ripple Works

The Ripple protocol builds upon – and in some ways improves on – other digital currencies. Like other digital currencies, the Ripple protocol enables peer-to-peer transaction settlement through a decentralized network of interconnected computers. This eliminates several of the fees and counterparty risk involved in interbank fund transfers.

However, in contrast to other digital currencies, the Ripple protocol is completely currency agnostic and users are not required to convert local currency into Ripple's native currency (XRP or "ripples"). Additionally, rather than attempt to circumvent traditional financial institutions, Ripple relies on financial institutions to function as (1) gateways into and out of the Ripple network, and (2) market makers to provide liquidity for FX conversion by posting bids/asks for each currency pair. Ripple routes each transaction to the trader(s) with the best price in the network.

Thus, in the same transaction discussed above, the U.S. importer's bank would directly plug into Ripple and initiate a USD to EUR transaction. Market makers will compete for the transaction by posting bid/ask for EUR/USD. Ripple will ensure the market maker posting the cheapest offer fulfills the transaction. This market maker will thus, buy USD from U.S. Bank and sell Euros to the EU Bank.



The illustrative example points to several potential advantages of using the Ripple Protocol for interbank transfers.

- First, because, users are not required to convert to XRP in order to transact on the Protocol, the sender of the funds only needs to worry about one fee, which is the FX spread. This spread, moreover, is minimized given Ripple's algorithm to route transactions to the lowest spread on the network.
- Second, because Ripple is not intended to be directly customer interfacing, banks continue to control their customers' experience. Thus, banks could ultimately decide how much of the cost savings to pass on to their customers.
- Third, transactions on the Ripple network typically settle within a few seconds. This enables banks to grant their customers faster access to their funds, improving their overall customer experience, and improving working capital for businesses.

- Fourth, since customers continue to interface directly with their bank to access Ripple, KYC/AML and compliance requirements around customer interaction are already in place and can largely remain the same.

Summary table of different messaging and transaction settlement protocols

	SWIFT	Bitcoin	Ripple
Architecture	Centralized	Decentralized	Decentralized
Settlement Process	Batch clearing & settlement	Proof of Work	Consensus
Speed	2+ business days	10 - 60 minutes	3 - 6 seconds
Peak Volume	19mm Messages/Day [1]	600,000 Transactions/Day [2]	86mm Transactions/Day [RL Est.]
Currency	Fiat currencies	BTC only	Universal
Transaction Cost	Operator fees	Mining fee	Security Cost

Bilateral Settlement

Over the past few decades, best practices for funds settlement have trended towards tri-party settlement arrangements. In addition to the two counterparties who are transacting with one another, a third party settlement agent is often involved to mitigate settlement risk.

Staggered hours of operation across different time zones can make it difficult – or sometimes impossible – to settle both sides of a transaction simultaneously. For example, the banking hours of Japan and the U.S.A do not share any hours of overlap. To avoid Herstatt Risk (see inset) a settlement agent will typically receive payment from both counterparties and wait until both sides of the transaction settle before releasing funds. This serves to reduce the counterparty risk that arises from mismatched time zones and varying settlement times.

In contrast to the existing system, the Ripple ledger operates 24/7 and provides for real-time, bilateral settlement, eliminating the need for a third party clearing agent. Two counterparties who are integrated into Ripple can exchange funds or assets simultaneously.

Herstatt Risk

Herstatt Bank was a German bank that went bankrupt in 1974, highlighting to the world an example of settlement risk.

Per Wikipedia: "On June 26, 1974, German regulators forced the troubled Bank Herstatt into liquidation. That day, a number of banks had released payment of Deutsche Marks to Herstatt in Frankfurt in exchange for U.S. Dollars that were to be delivered in New York. Because of time-zone differences, Herstatt ceased operations between the times of the respective payments. The counterparty banks did not receive their USD payments."

This type of foreign exchange settlement risk is now known as Herstatt Risk. CLS Bank was founded in 2002 to mitigate this type of risk.

[1] http://www.swift.com/assets/swift_com/documents/about_swift/SIF_2013_01.pdf
[2] https://en.bitcoin.it/wiki/Scalability

Key Features of the Protocol

Below are key features of Ripple protocol, which further highlight how it differs from other interbank transfer systems and digital currency protocols:

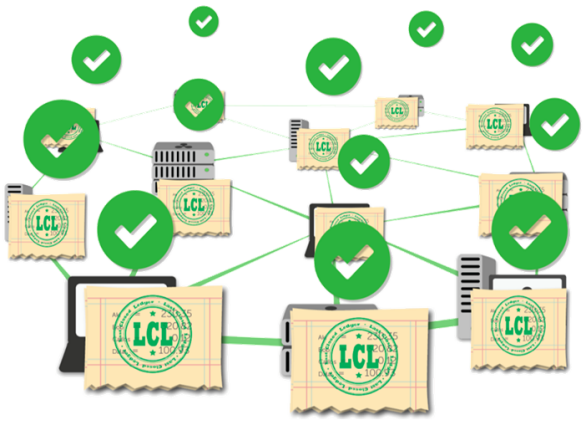
1. Consensus: the Driver of Real-Time Settlement

The Ripple network is a shared public ledger administered collectively by a network of servers. This ledger tracks the accounts and balances of Ripple users. Within the Ripple Network, all transactions are authorized and settled through a process called *consensus*. This process entails a supermajority of Ripple servers mutually agreeing that a transaction within the network is valid before updating the ledger.

Ripple servers use public/private key cryptography to verify whether transactions are valid or not. Each transaction that gets submitted is signed with a unique digital signature, analogous to how people sign paper checks with a unique signature in traditional banking. Ripple servers mathematically verify that the correct signature appears – the signature of the owner of the funds – before including transactions in a new ledger.

Consensus must be reached among a supermajority of connected computers in order to make changes to the ledger. *This is what is known as an atomic process – either a transaction is completely verified, or not.*

This process is what enables the Ripple Network to offer users real-time settlement (typically between 3 to 6 seconds) and bypass the need of a central operator, which as explained above, circumvents layers of fees that financial institutions, business and/or consumer bear for traditional payments. In other words, the process of consensus is what enables fast, secure and decentralized settlement on the Ripple network. This distinguishes Ripple from other digital currency protocols, such as Bitcoin, which rely on a process called proof of work (i.e. mining) to validate transactions on the block chain. Unlike Bitcoin, Ripple does not rely on mining to reach consensus, so it does not consume the large amounts of energy that Bitcoin does, nor is the network's security related to the amount of processing power devoted to it. For a more detailed explanation of the consensus mechanics, please refer to the Consensus white paper or the links to additional information in the appendix.



2. Currency-Agnostic: a Key Differentiator from Other Digital Currencies

The Ripple protocol also has a native currency called XRP (sometimes pronounced “ripples”) that exists within the network. This is similar to other digital currency protocols, which enable the creation and distribution of a native digital currency. Like other currencies, XRP is known as a crypto currency, or a currency that is verifiable using mathematical properties. These crypto currencies are digital assets, which can be transferred within the network.

Unlike other digital currency protocols, however, Ripple provides users complete currency choice and does not require users to transact in XRP. Instead, XRP is there to provide two key functions: to prevent abuse of the system and to act as a bridge currency for market makers providing liquidity within the network (more on both of these features below). Thus, users can hold balances in one currency and transact in another currency without converting to XRPs in the process.

3. FX In-Stream: Lowering the Cost of FX through Market Maker Competition

Cross currency payments have historically been an area with very healthy margins. The FX component of an international wire transfer can frequently bear a 2% - 4% fee to exchange even the most liquid G10 currencies. Retail remittance pricing is even higher, often at a 5% -10% spread to institutional foreign exchange market pricing.

Ripple has the potential to meaningfully bring down these costs by making payment FX rates competitive on a per transaction basis.

The Ripple network translates currencies by routing orders through market makers competing to earn bid/ask spread. These markets makers are important sources of liquidity within the network and are primarily financial institutions with a business in currency or securities market making (i.e. banks, hedge funds, quantitative trading shops). Market makers compete for business within the Ripple network, posting orders to buy and sell different currency pairs to facilitate payments.

The Ripple Protocol is designed to route every transaction to the cheapest price available in the market. Thus, the only way an order gets filled is if it is posting the best price for a specific currency pair at the particular time the transaction is executed. As a result, the protocol can lower one of the highest financial and operational costs for financial services companies moving funds across national boundaries.

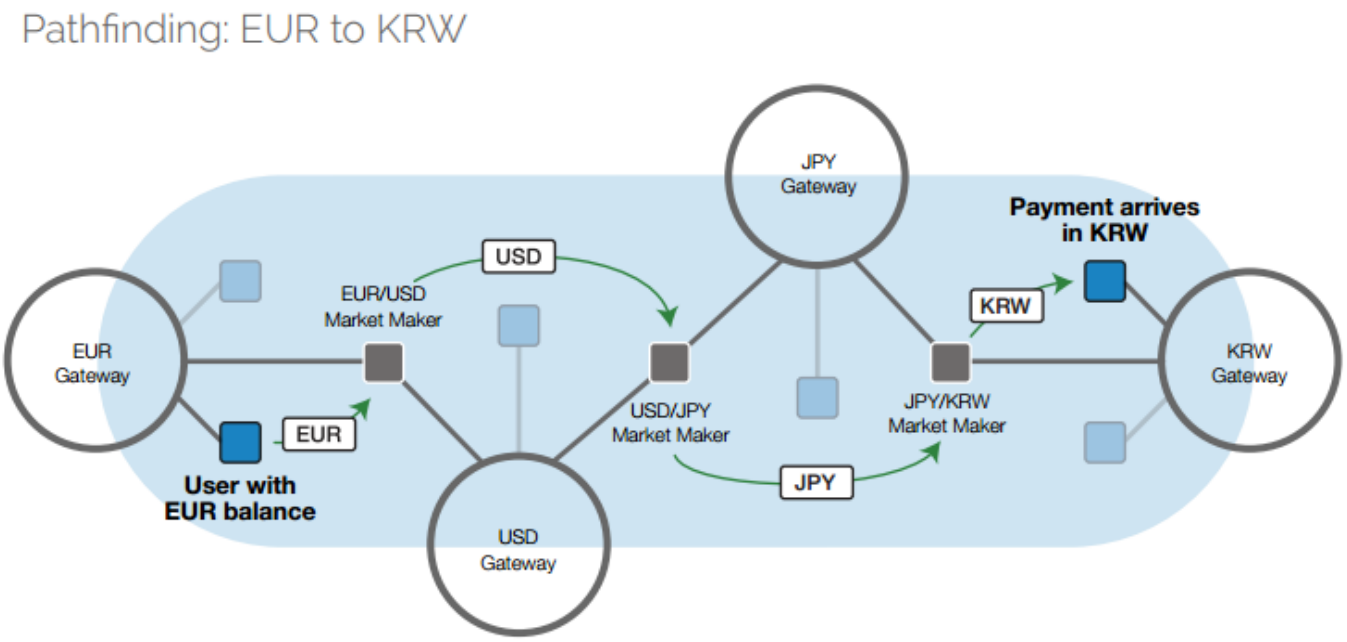
4. Pathfinding

Ripple’s Pathfinding Algorithm further improves on market maker pricing by searching for the cheapest path for payments to move across the network.

Key Features of the Ripple Protocol

In liquid currency crosses, the cheapest path will often be a direct "one hop" path through one market maker, for example directly from USD to EUR. However, the Ripple pathfinding feature will seek the cheapest path even if it is a more complex route through several intermediary currencies.

In the example below, the sender of a payment holds EUR, and the recipient wants to be paid in KRW. Since there may not be a tight market in EUR/KRW, the payment is routed through several order books to improve the price. Unlike in traditional markets, users are not exposed to legging risk. Ripple executes multi-hop paths as a single atomic transaction. The entire transaction either completes or it never happens – there is no way for a payment to get "stuck" en route. Since Ripple transactions are just updates to a distributed ledger, multiple legs can be executed at the same instant as they are all included in the same ledger update. There is no counterparty risk to intermediaries.



Summary of key features and benefits of the Ripple Protocol

Cost Factor	Ripple Solution		Funds Transfer
Settlement speed	Point-to-point	→	Real-time
Settlement risk	Atomic process	→	Straight-through processing[3]
FX rate	Marketplace for FX traders to compete	→	Least-cost FX

[3] Straight-through processing enables the entire payment lifecycle to be conducted electronically without the need for manual intervention or re-keying. Current international wires can have a failure rate of 2-10% depending on the institution, requiring human intervention to remedy.

Overview of the Ripple Currency (XRP)

Ripple Currency (XRP): Overview

The Ripple protocol has a native currency called XRP (sometimes referred to as "ripples"), which performs several key functions within the network. XRP, like other digital currencies, is a math-based currency (also known as cryptocurrency), which is a digital asset with verifiable mathematical properties. As a digital asset, ownership of XRP can be directly transferred peer-to-peer.

Just like bitcoin exists natively on the blockchain, XRP exists natively on the Ripple network as a counterparty-free currency. Unlike the Bitcoin Protocol, however, Ripple users can opt not to use XRP as a medium of exchange. Instead, XRP performs two key functions within the network: protect the network from abuse and provide a bridge currency for market makers. More on these functions below.

XRP: Protecting Against Network Abuse

Since the Ripple network is based around a shared ledger of accounts, a malicious attacker could create large amounts of "ledger spam" (i.e. fake accounts) and transaction spam (i.e. fake transactions) in an attempt to overload the network. This is commonly known as a denial-of-service (DoS) attack. In a DoS attack, perpetrators attempt to overwhelm a server with so many communication requests that the server is unable to respond to legitimate requests.
XRP's primary function is to provide a layer of security within the network to protect against these types of attacks.

To protect the network from abusive creation of excess ledger entries, each Ripple account is required to have a small reserve of XRP to create ledger entries. This reserve requirement is 20 XRP (or about $0.12 at the time of writing). This requirement is intended to be a negligible amount for normal users while preventing a potential attacker from amassing a large number of fraudulent accounts to "spam" the network.

As a second line of defense, with each transaction that is processed, 0.00001 XRP is destroyed (roughly $0.000000055 at the time of writing). This is not a fee that is collected by anyone – the XRP is destroyed and ceases to exist. This transaction fee is also designed to be negligible for users. But when the network is under heavy load, such as when it is attacked, this fee rapidly rises.

What is a Counterparty-Free Currency?

Traditional currencies like EUR and USD are not natively digital assets. When we send electronic payments, we obviously cannot transfer physical paper bills across the Internet. Instead, we exchange bank balances, which are effectively just IOUs that the bank has issued. A bank balance is a promise from the bank that you can redeem your money on demand. But it is nothing more than a promise to repay. All digital fiat money has counterparty risk.

XRP, unlike USD, is a natively digital asset. It can be transferred directly between two parties across the Internet. Sending XRP is akin to exchanging cash USD. There is no counterparty risk involved. You can digitally exchange the asset itself, as opposed to an IOU that represents the asset. Hence, XRP is a counterparty-free digital currency.

Overview of the Ripple Currency (XRP)

The goal of this design is to quickly bankrupt attackers and keep the network functioning smoothly. Attacking the Ripple network can get very expensive, very quickly, but for regular users, the cost effectively remains "free." In this context, XRP can be thought of as a postage stamp for transactions.

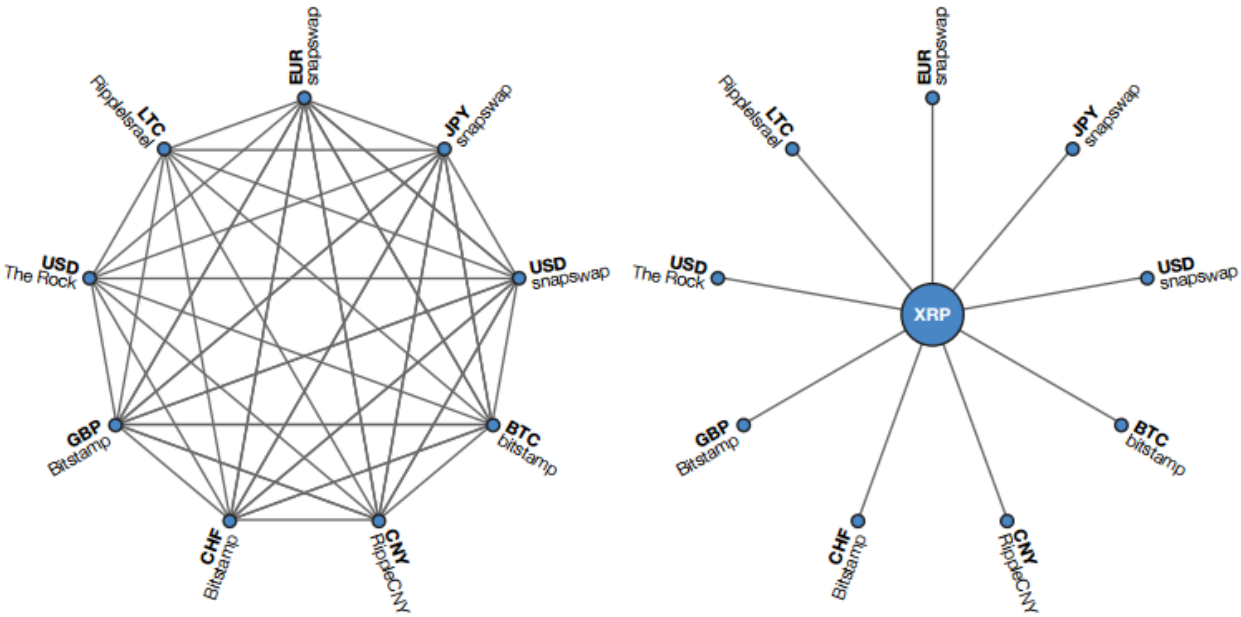
If the price of XRP were to appreciate significantly to the point where sending transactions becomes a non-negligible cost for normal users, there is a mechanism in place to lower (or raise) transaction fees by a supermajority vote of server operators.

XRP: A Bridge Currency for Liquidity

XRP can also serve as an ideal bridge for illiquid currency pairs. In theory, users of the Ripple Network could exchange anything of value. This could include fiat currencies, digital currencies, gold and even items like loyalty points, airline miles, or securities.

On a protocol level, Ripple makes a distinction between both the balance type (USD, EUR, XAU) and the issuing counterparty (Bank A, Bank B, etc.). This is important because USD balances issued by two different banks are technically liabilities of different institutions and have different counterparty risk profiles. From the perspective of the protocol, they are different financial instruments. As the number of assets and the number of counterparties in the network grows, the number of currency pairs can quickly become unmanageable for a market maker.

Instead of quoting every possible currency/gateway combination, XRP can serve as a useful bridging tool for market makers. If every currency is liquid to XRP, it is also liquid to other currencies.



Thus, while Ripple users have complete currency choice – meaning they can hold balances in one currency (such as USD) but transact in any other (such as JPY) – the market makers facilitating those transactions may see holding XRP as an ideal bridge currency.

The role of a "bridge currency" or "vehicle currency" is traditionally played by USD in financial markets. Within the Ripple network, there is a functional reason to prefer XRP. Because XRP is a natively digital asset (as opposed to a balance/liability), it is the only instrument within Ripple that has no counterparty risk, so it can be universally exchanged between market makers with no friction. Also, because it has no counterparty, XRP never has third party fees attached to it.

Ripple Labs believes that an increase in the number of counterparties and asset types in the network adds to the utility of XRP and creates demand for XRP in the long run.

An Overview of Ripple Labs

Ripple Labs is the creator of the Ripple Protocol and focuses on three primary areas.

First, as a software developing company, Ripple Labs provides the core technology for transaction settlement, developing and maintaining the code of the protocol. Second, Ripple Labs builds new tools to allow developers to build user-friendly applications, whether those end users are consumers, merchants or other institutions. Ripple Labs helps incubate these ideas but does not typically take a cut of ownership in order to maintain its neutrality. Third, Ripple Labs pursues partnerships to expand the Ripple network of financial institutions, users and market makers, providing APIs to access the protocol.

Ripple Labs has raised capital from some of the leading venture capital and technology firms, including Google Ventures, Andreessen Horowitz, LightSpeed Venture Partners, IDG Capital Partners, and Founders Fund. In addition, Ripple Labs continues to attract a diverse set of talented individuals with experience in relevant technology and financial services companies, including Apple, Google, Square, Twitter, e-Loan, Fiserv, Promontory Financial Group, Goldman Sachs, and the U.S. Federal Reserve.

Historically, information protocols, like HTTP and SMTP, were impossible to monetize directly. Ripple Labs is not a financial services provider and thus does not charge for using the network. The Ripple protocol, however, could in fact be monetized through its native currency, XRP. By design, 100 billion units of XRP were created at Ripple's inception, and per the protocol rules, no more XRP can ever be created.

Ripple Labs plans to retain 25% of all XRP issued to fund operations (and hopefully turn a profit) and distribute the rest to incent the participation of market makers, gateways, and consumers to utilize the protocol. Given that there is a finite number of XRP, as demand for XRP grows, the value of XRP should appreciate. In this manner, Ripple Labs believe that its incentives are aligned with those of protocol's users – both want the protocol to reach its full potential and scale.

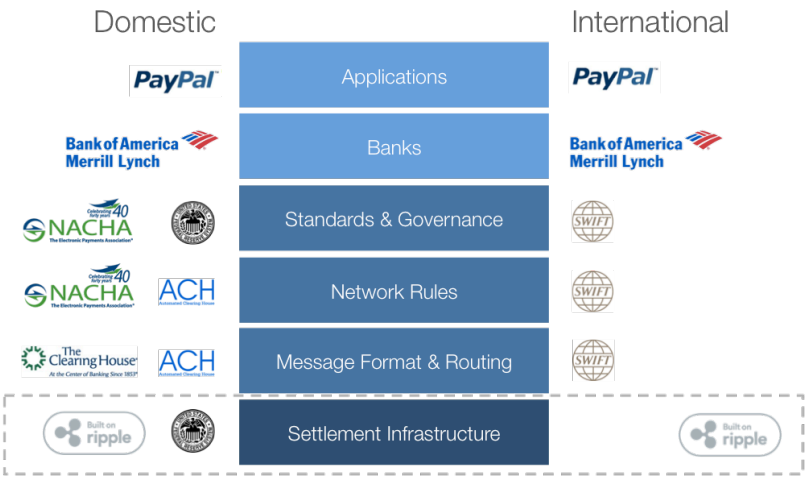
Potential Use Cases

Ripple: Focused on Transaction Clearance and Settlement

The following table is a simple look at the several layers in the payments ecosystem, with different financial services and payments companies specializing in certain segments.

The bulk of the innovation in payments is occurring at the top of the stack: companies like Square, Paypal, and Stripe are creating elegant user interfaces and user experiences, but these services are still riding on top of the old, antiquated infrastructure.

Ripple Labs is one of the few companies innovating at the very bottom of the payments stack, focused on providing a free, real-time settlement infrastructure for the world. Ripple Labs is not itself consumer facing and is not a provider of financial services or a custodian of funds. Instead, the technology provides an alternative rail for financial services, payments, and retail companies that build consumer/merchant interfacing applications. These companies can leverage Ripple's settlement system to provide customers with a better experience and reduce operational costs.



Note: Corporate logos in graphic above are for illustrative purposes only

If widely adopted, Ripple's peer-to-peer, decentralized settlement infrastructure would replace the current settlement system for funds transfers. However, the other layers on the payments stack would be unchanged. Financial services institutions, developers, and payment processors would continue to focus on their strengths and directly integrate their services on top of a more efficient transaction settlement system.

Banks and payment processors will continue to acquire and interface with their end-customers (business and/or consumers). Regulatory bodies like the Federal Reserve will continue to set and enforce regulatory standards. Messaging standards like SWIFT can be easily integrated into Ripple as well.

Several "networks" or clubs of financial institutions may ultimately form on top of Ripple's common settlement protocol. For example, NACHA (the North American Clearing House Association that governs the ACH network in the U.S.) could create standard rules that allow for payment reversibility, compliance, dispute resolution, etc. between member banks on the Ripple network. The same can be true for SEPA region banks in Europe.

Potential Use Cases

This low cost, real-time settlement system can have numerous potential future applications. Ripple Labs business development efforts have been primarily focused on addressing two current pain points for financial institutions: intra-group transfers and inter-bank transfers.

Intra-Group Transfers

Large, diversified financial services institutions will often operate separate core ledger systems in different business lines. This is especially common among companies that were formed through multiple acquisitions over the years, where ledger system integrations can be challenging and costly.

For example, a financial conglomerate that operates a brokerage and a retail bank may never have integrated the brokerage and checking account ledger properties after an acquisition. In this case, if a bank's customer wanted to transfer cash from her brokerage account to her checking account maintained in the same financial institution, the financial services company needs to move the cash outside its system via ACH. As described above, the transfer could take up to 3 days to settle. Not having access to these funds results in a working capital challenge to the bank and the bank's customer. There are additional operating and compliance costs associated with expatriating and repatriating funds.

Ripple can provide a relatively turnkey solution to integrate ledger-based properties within an institution.

Inter-Bank Transfers

Domestically, inter-bank transfers appear similar to the intra-group transfers described above. In this case, a domestic financial institution would need to use the ACH system to transfer the cash to another domestic financial institution. Once again, the receiving bank (and the bank's customer) will not have access to the cash until the transaction settles in up to 3 days.

International inter-bank transfers, however, have many more pain points given the lack of a global payment rail. Instead, money moves from one regional bank system to another through a series of correspondent banking relationships. Correspondent banks are financial institutions that can conduct business transactions, such as process payments, accept deposits and transfer securities on behalf of other institutions. Correspondent banks help domestic banks conduct these business transactions in foreign jurisdictions.

As explained above, these international transactions need to go through a sequential process, where transactions take several hops. Each hop adds a layer of fees, counterparty risk and settlement delay. These fees and risks vary depending on how complex the correspondent network is. Some transactions (particularly for funds going to certain developing countries) navigating through an extensive correspondent bank network involving several hops could take up to 15 days to settle.

Potential Use Cases

What are the Advantages of Using Ripple?

The Ripple network relies on industry partnerships to reach its full potential. These partnerships include financial services institutions, including banks, payment processors and other money transmitters, which can integrate their services on top of Ripple's back-end settlement solution. The following are a few compelling reasons for potential partners to build on top of Ripple:

For Banks

Ripple's technology can enable banks to optimize internal payments operations (e.g. back-office) and provide new and enhanced external payments services to customers (e.g. retail, commercial and institutional clients). By reducing fees associated with correspondent banking and shortening the cash cycle, Ripple's distributed network eliminates many of the costs and risks involved in the current ecosystem for banks. In addition, banks can leverage market maker competition to lower their FX cost for international transactions. Importantly, Ripple also eliminates the need for banks to post reserves/collateral to their correspondent bank, improving working capital.

While financial service providers could lower wholesale costs of payments with Ripple, the protocol does not interfere with a bank's relationship with its end customers. This includes customer acquisition, service and pricing. Thus, the financial services business continues to determine retail prices of payment services for customers. As a result, Ripple allows banks to continue monetizing their most attractive asset – their account holders.

Banks are also best suited to act as gateways given their extensive experience in complying with financial services regulations, anti-money laundering (AML) and know your customer (KYC) rules. As a result, having well regulated entities, such as banks as gateways could help enhance the security of the network and increase confidence for all users, potentially leading to more payment volume.

For Payment Processors or Money Transfer Operators

Ripple can also enable payment processors and money transmitters to integrate into Ripple and offer their customers real-time settlement. Rather than replace existing systems, Ripple's open nature makes it easy to integrate into the Ripple network, enabling existing network rules and processes to remain in place.

Given the intensifying competition in payments and money transfer ecosystems, leveraging the Ripple Protocol could provide payment processors and money transfer networks a competitive advantage. These companies would benefit from a lower wholesale cost of payments and money transfers. However, the protocol does not set retail prices. As a result, payment processors and money transfer operators would have flexibility to compete on price while managing profit margins. For a more detailed discussion on the payments and money transfer ecosystems, see "A closer look at electronic payments" and "A closer look at international money transfers" on pages 37 and 40, respectively.

Potential Use Cases

Over time, Ripple is likely to erode the marginal cost of payments as companies compete on price. We believe that a meaningful increase in the volume of payments could serve as an offset to a decline in per-payment margins. The emergence of a "value web" could do for payments what the information web did for information sharing – when communications became fast and cheap, the volume of communications grew exponentially. Increased payment volume could come from more international transactions, higher penetration of B2B volumes or micro-transactions and increased inclusion of the 2 billion underbanked individuals. It is difficult to definitively say whether margin erosion or payment volume growth will ultimately drive the industry towards higher or lower profitability.

For example, it is currently not economically viable to send $200 internationally, because fees would typically account for such a large percentage of the total payment value. If the marginal cost per payment were lower, this and other new market segments could emerge.

For Regulators

Regulators could find it easier to monitor and enforce regulatory standards for transactions that occur on the Ripple network. Under the current interbank funds transfer systems, banks record transactions on separate ledgers. Thus, it could be difficult to follow the flows of funds, particularly in international transactions, which require the funds to go through multiple correspondent banking relationships. Flow of funds within Ripple are easily traced, as all transactions are posted on one giant ledger.

In addition, since regulated banks and other financial institutions integrate in the Ripple Network and provide liquidity, these financial services institutions will continue to comply with their existing regulations, such as anti-money laundering (AML) and know your customer (KYC) rules.

Ripple provides law enforcement and regulators with a single consolidated global ledger with which to monitor economic activity.

For Market Makers

Market makers play an important role within the Ripple network. These financial institutions provide liquidity by competing for FX trades. Market makers earn bid/ask spread on trades and will benefit as volume grows on the network.

The foreign exchange market is known to be among the most liquid markets in the world, yet retail and B2B payments have had persistently wide margins. This provides a strong incentive for market makers to participate in a space where many market making firms historically have not had a seat at the table.

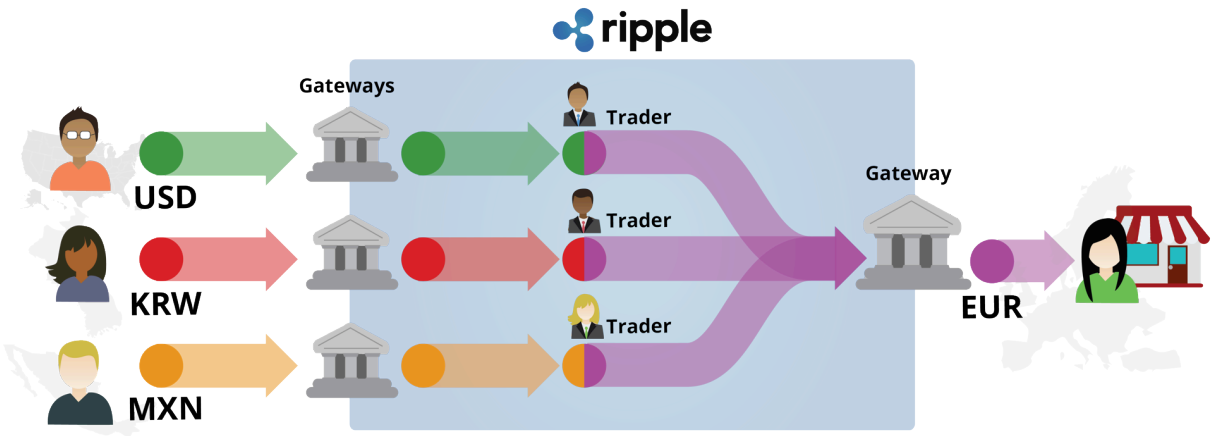
For Corporate Treasuries

Real time payments can provide working capital improvements in many capacities. For example, currently, in order to make payroll on the 30th of the month, a company will typically need to send funds 5 days before the

30th. This suggests that payroll costs are "in transit" for 1/6 of the year (5/30 days each month). Real time payments via Ripple can allow for "just in time" payments, submitted on the 30th to settle on the 30th, providing an improvement in working capital.

For Merchants

Ripple allows merchants to conduct business in several countries without exposing the merchant to foreign exchange risk. For example, a EU-based machinery exporter can sell to customers in the U.S., EU, and Japan. All of the customers can continue to pay for products in their local currencies, leveraging Ripple's foreign exchange network to ensure that the merchant seamlessly receives payment in EUR. In effect, Ripple allows for continuous rebalancing of foreign exchange, instead of waiting to accumulate blocks of foreign currency and converting at the end of the quarter or reporting period. Additionally, real-time settlement on Ripple means that funds are immediately available, improving working capital for the merchant.



For Prepaid Debit Programs

Ripple allows for the seamless translation of any store of value. Prepaid debit cards can be linked to a Ripple account to facilitate the spending of non-traditional stores of value at point of sale. For example, a cardholder could hold gold balances on Ripple that are backed by physical gold bullion at a Ripple gateway. The cardholder could spend gold at point of sale, and Ripple will seamlessly leverage market makers to exchange gold for USD in real-time, delivering USD to the issuing bank for settlement with the merchant via traditional methods.

The same logic can be applied to convert loyalty points or any other store of value into USD, as long as market makers can quote the price effectively. This requires no hardware upgrades or modification at the point of sale. From the merchant's perspective, it looks like a traditional debit transaction.

XRP Demand Examined

Sources of XRP Demand

As with most other digital currencies, there is a fixed supply of XRP, 100 billion units, and according to the protocol's rules, no more can ever be "printed" to debase the currency. Ripple Labs' business model is predicated on a belief that demand for XRP will increase (resulting in price appreciation) if the Ripple protocol becomes widely adopted. In this section, we discuss some potential demand drivers for XRP as the Ripple network grows.

In order for there to be long term "organic" demand (as opposed to purely speculative demand), XRP must provide some utility to its holders. XRP provides utility by fulfilling two functions: 1) security and 2) bridge currency.

XRP Secures the Network

The network charges tiny fees denominated in XRP to discourage network abuse. A malicious attacker could attempt to overwhelm Ripple servers by sending transaction spam (a flood of small transactions) or ledger spam (creating a flood of new orders or new accounts). These types of attacks, known as denial-of-service (DoS) attacks, can occupy a server with requests for information, creating a long queue to process information, rendering it unable to process legitimate transactions in a reasonable timeframe.

To prevent these types of SPAM abuses, the Ripple network requires every user to hold a small amount of XRP to meet network reserve requirements and to pay transaction fees. The table below breaks down reserve and transaction fee amounts. In each of these cases, the economic value is negligible for normal use – less than $1 worth of XRP is enough to send tens of thousands of payments across Ripple. The reserves exist to create an economic cost to sending an abusively high number of transactions.

XRP: Fast Facts

> 100 billion units of XRP were created at Ripple's inception

> Small amounts of XRP are destroyed with each transaction (i.e. deleted from the database).

> 99,999,980,473 XRP currently exist – July 23, 2014

> No more XRP can ever be created, per the protocol rules

> XRP is currently subdivisible to 6 figures (0.000001)

Action	XRP Reserve Amount	Explanation
Account Reserve	20 XRP	Each account must hold 20 XRP to be valid.
Transaction Fee	0.00001 XRP (variable based on server load)	This amount is destroyed with every transaction. This is designed to be negligible for normal users (rounds to zero). Under heavy server load, this fee scales higher to make it expensive to sustain a DDoS attack.
Trust Line Reserve	5 XRP	This amount is frozen as "margin" for each trust line that is in place.
Working Order Reserve	5 XRP	This amount is frozen for each working order that is in the order book. When an order is filled or cancelled, the reserve amount is released.

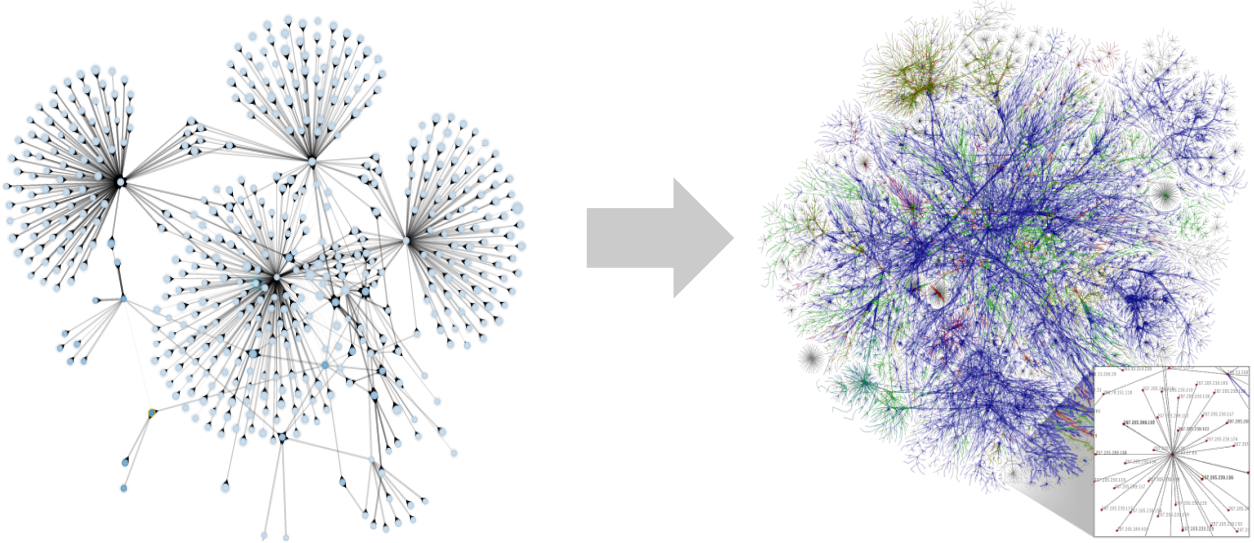
These reserve amounts are set by a supermajority of server nodes using a voting mechanism built into the protocol. So if the value of XRP rises (or falls), the reserve amounts can be lowered (or raised) to maintain the desired economic effect.

As the number of accounts, the number of live orders, the number of trustlines, and the number of transactions on the network increase, there should be a very small increase in demand for XRP.

XRP as Bridge Currency

On a protocol level, Ripple makes a distinction between both the balance type (USD, EUR, XAU) and the issuing counterparty (Bank A, Bank B, etc.). This is important because USD balances issued by two different banks are technically liabilities of different institutions and have different counterparty risk profiles. As the number of assets and the number of counterparties in the network grows, the number of currency pairs can quickly become unmanageable for a market maker.

The diagram below shows the network evolving from a few gateways to several hundred thousand gateways.



Rather than quoting every possible currency/gateway combination, XRP can serve as a useful bridging tool for market makers. If every currency is liquid to XRP, it is also liquid to other currencies.

As the number of gateways grows, it becomes increasingly complex to find paths to resolve transactions. Long paths are inherently fragile. It takes long periods of time to scan for long paths, and since order books are subject to constant change, the longer it takes to calculate a path, the more likely it is that the path will have changed or disappeared by the time a transaction is attempted to be sent.

XRP Demand Examined

If all balances on Ripple are liquid to XRP, it significantly reduces the need for complex paths, making everything one hop away. Accordingly, XRP becomes more useful as a bridge currency as the Ripple network topology sprawls.

If XRP is increasingly used as an intermediary currency, users who are unsure of what currency they will need may choose to hold XRP, since it readily translates into all other assets on the network. Market makers are one type of user for which this could be the case, but one can easily think of others as well.

Demand for XRP as a Risk Asset

XRP shares the cash-like or gold-like characteristics that attract many speculators to Bitcoin and other digital currencies. Like gold, digital currencies have historically done well in times of increased banking system stress or bouts of sovereign risk, when investors seek to reduce counterparty risk. Apart from these isolated episodes, XRP and other digital currencies have not shown any meaningful correlation to other risk assets like equities or traditional commodities. Within the digital currency space itself, assets like XRP and BTC have shown a strong correlation to each other over longer periods of time.

Future Demand Potential

The Ripple network is still in its infancy and relatively unknown. Likewise, XRP is still fairly complicated for average users to acquire or even completely inaccessible in many parts of the world. Increased exposure and a more global network of Ripple gateways could result in increased speculative interest, which may have significant impacts on price. Speculative demand and bullish expectations for the future were enough to send XRP and BTC total market capitalizations to over $6 billion and $23 billion in Q4 2013, respectively.

If the Ripple protocol becomes the backbone for global value transfer, Ripple Labs expects the demand for XRP to be considerable.

Historical XRP Data

Ripplecharts.com provides historical price and volume data about XRP and other assets traded on the Ripple Network.

Benefits and Applications Beyond Traditional Payments

As with other digital currencies, the potential benefits of Ripple could extend much beyond traditional payments. The ability for parties to settle transactions in a decentralized network, in real-time, and at a low-cost could have implications for securities transactions, B2B payments, crowd-funding and escrow settlement. Broadly speaking, anywhere there's an Internet connection there is now an Internet-for-value exchange, which can bring untapped segments such as underserved/underbanked populations and micropayments into mainstream financial services.

Macroeconomic Benefits of Real-Time Payments

A number of central banks (including the U.S. Federal Reserve[4], Finland, and Australia) have been exploring and advocating a move to real-time payment systems. Currently, the pace of the payment system acts like a bottleneck on economic activity. To make an analogy to the pre-email days, it harkens back to when paper contracts were shipped back and forth between counterparties for physical signatures in order to get a deal done. Much like email sped up the pace of doing business, a jump to real-time payments can also accelerate economic activity and increase the velocity of money. By reducing the settlement time of payroll, accounts receivables, and other financial interactions, Ripple can speed up the cash conversion cycle of a company.

Increasing Velocity of Money

From a macroeconomic perspective, Ripple could increase the velocity of money, translating into greater economic activity. The velocity of money is the rate at which money flows from one transaction to another. As we have discussed throughout this report, banks and their customers typically need to wait several days to gain access to funds in cross-border transactions.

In some cases, counterparties essentially replicate a real-time payments system via the extension of credit. For example, the receiving bank in an international bank-to-bank funds transfer can access funds in real-time if large financial institutions extend credit to the receiving bank. Receiving banks can make those funds readily available to their end customers before the funds actually settle (in 5-7days). This is sometimes known as a "risk funds model".

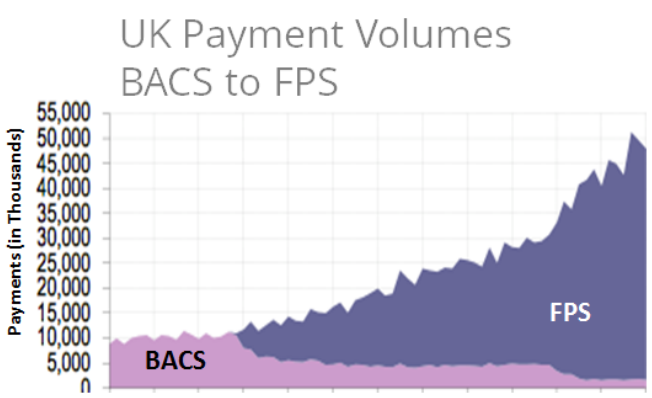
However, this introduces another layer of counterparty risk and cost into the system, which may not be the most efficient way of enabling real-time payments. With Ripple's technology, funds are fully settled in real-time without the need to extend credit. In this case, the funds are known as good funds and are not based on credit (i.e. a "goods funds model"). Receiving banks can then loan those funds back out to consumers or businesses, which then spend the money in the economy. This can greatly increase the velocity of money and have a positive impact in the overall economy, without increasing counterparty risk.

[4] http://fedpaymentsimprovement.org/

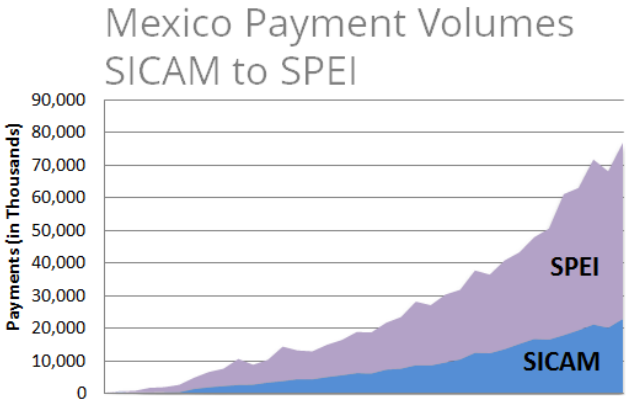
Benefits and Applications Beyond Traditional Payments

Faster Payments Means More Payments

There is some empirical evidence that faster payment network result in higher volume of payments. Below we show some historical data from both the UK and Mexico, illustrating the change in volumes after faster domestic payment systems were implemented. As mentioned earlier in the paper, while the marginal cost of sending payment can decrease, the payments industry may see an offset from a dramatic rise in the number of payments sent around the world.



2006 – 2012
Source: fasterpayments.org.uk



2004 – 2013
Source: Banco de Mexico

Providing Liquidity to a Wide Range of Value

Ripple's technology can also enable the exchange of varying forms of value, such as gold and loyalty points. For example, gateway providers can enable consumers to purchase, store and convert precious metals into any currency in the world using Ripple. This is exactly what Gold Bullion International, a well-known precious metals custodian, began doing earlier this year. In this manner, individuals can decide to hold their gold as a store of value or convert into other currencies in real-time in order to make transactions.

Another example might be loyalty points or gift cards, which represent a huge amount of stored value. According to a study by loyalty marketing information company Colloquy and SWIFT Exchange, approximately $16 billion in rewards points and miles go unredeemed each year (out of $48 billion total rewards miles and points issued annually). In addition, CEB TowerGroup estimates that more than $1 billion in gift cards go unredeemed each year.

Ripple can very easily provide loyalty program managers with tools to enable "out of network" spending of loyalty points by converting value into USD or other currencies. This increases utility for customers while giving points issuers granular control over how and where points can be spent.

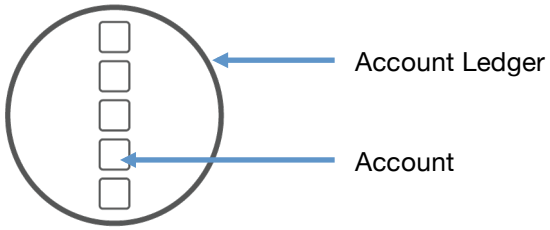
Walking Through the Mechanics of the Ripple Protocol

This section takes a deeper dive into the mechanics of the Ripple Protocol, highlighting the key features of the technology described above. The following series of illustrations depicts how a typical international transaction would flow through the network in three general steps.

Step 1. Before the Transaction

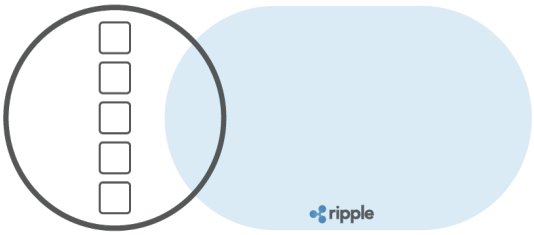
The hypothetical parties to this transaction include a U.S. Sender (consumer or business), European receiver (consumer or business), U.S. Bank (i.e. where the U.S. Sender has an account), Europe Bank (i.e. where the European Receiver has an account) and market makers (which provide liquidity for currency conversion, including EUR/USD).

The following diagram depicts an account ledger (i.e. the bank's core system), and each square represents an account within the bank's ledger (e.g. the checking account of U.S. Sender).



Each bank plugs into Ripple by downloading the open-source software and communicates balances to the network via an application-programming interface (API). In the illustrations below, the Ripple network is depicted by a blue oval. As the diagram shows, U.S. Bank's account ledger is integrated into the Ripple Network.

Integration involves synchronizing the two ledgers, so that the issuance of a balance in Ripple results in a debit in the core system, and vice versa, so that there is never a duplication of balances.

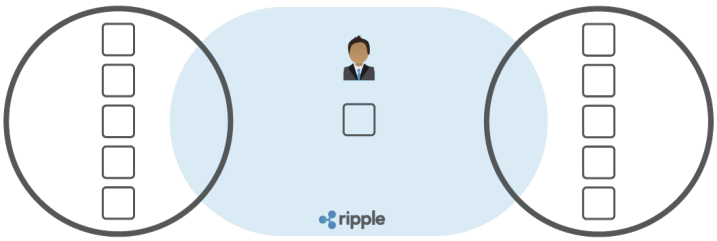


Multiple banks that are connected to Ripple then establish correspondent agreements either bilaterally or through clusters in order to transact on a peer-to-peer basis. The diagram on the following page shows that both U.S. Bank and European Bank are now integrated into Ripple and communicate balances into the network.

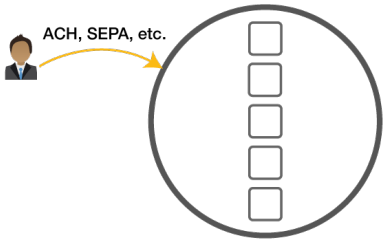
Mechanics of Settlement on Ripple: A Closer Look

A bilateral or group agreement is typically necessary to provide for KYC information sharing to comply with funds "Travel" regulations and to provide for things like reversibility in the event of an erroneous payment.

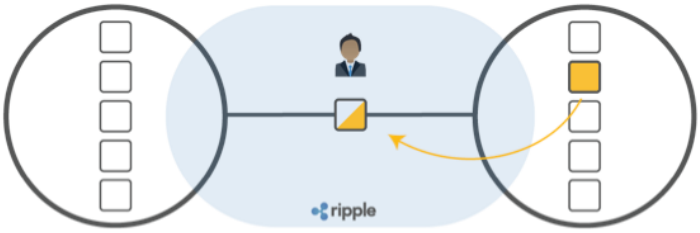
A market maker (typically a hedge fund or FX trading desk) sets up an account with both banks to provide liquidity in the system. Banks can vet, authorize, and in some cases, contract with the market maker directly.



Ripple is a pre-funded network. As shown in the diagram below, the market maker pre-funds his account by sending euros to the receiving bank (European Bank). This is done through the domestic payments systems (i.e. ACH, SEPA, etc…)

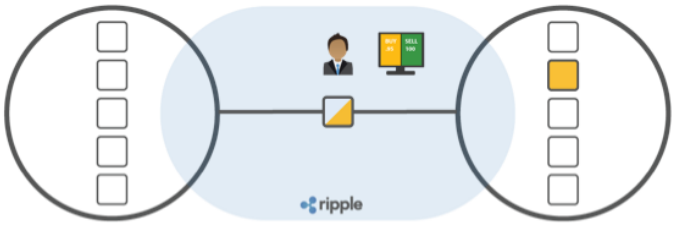


European Bank then immobilizes the cash and issues EUR to the market maker's account in Ripple. European Bank now has posted a liability (i.e. a balance) onto the Ripple ledger. This is depicted by the partially yellow shaded box within the Ripple Network below. This liability is backed by the EUR assets that the market maker pre-funded, which are now held by the bank in an immobilized account.



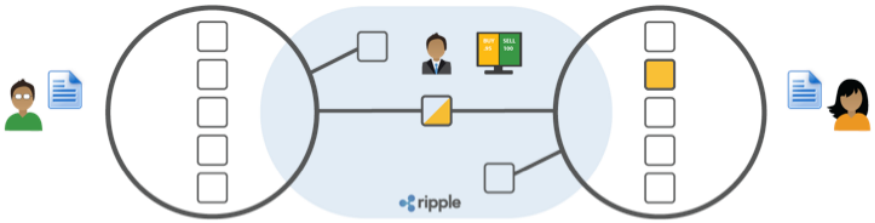
Mechanics of Settlement on Ripple: A Closer Look

The market maker can now post an offer to Ripple's order book, signaling to the market the rate where he is willing to sell his claim on Euros in order to buy U.S. Dollars.



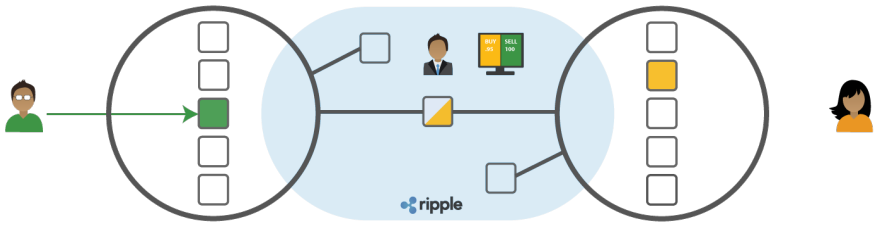
Now we introduce two customers who wish to transact. As illustrated below, the U.S. Sender and European Receiver are customers of U.S. Bank and Europe Bank, respectively. Each customer is subject to their banks' know-your-customer (KYC) rules, transaction rules, etc.

Each bank, further, has a single house account within Ripple which its customers access by proxy. This is analogous to how a customer would access ACH/SWIFT by proxy through his bank.

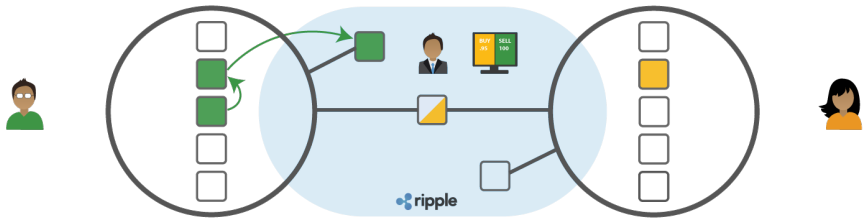


Step 2: The Transaction Flow

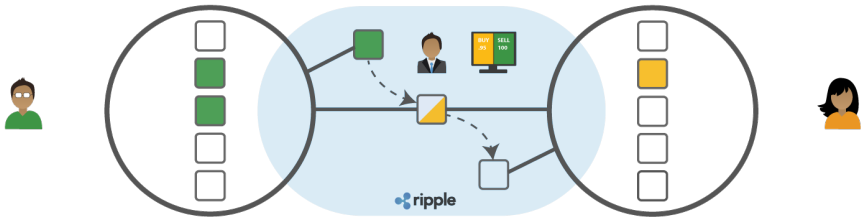
The U.S. Sender initiates the transaction by notifying his bank (U.S. Bank) that he would like to send cash to European Receiver. In the diagram below, the U.S. Sender's account is denoted by the green square and the European Receiver's account is depicted by the blank square in the center of EU Bank's ledger.



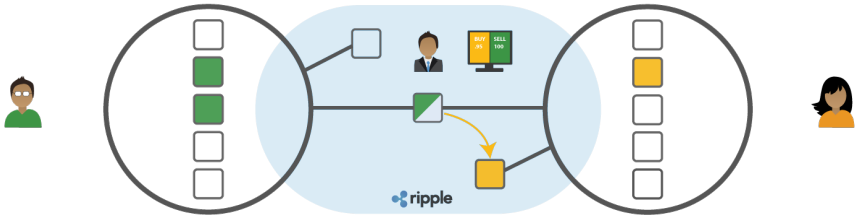
In the diagram below, U.S. Bank immobilizes the USD funds by transferring them to a house account and issues a USD balance into its Ripple account. This is illustrated in the diagram below by the green-shaded square interaction.



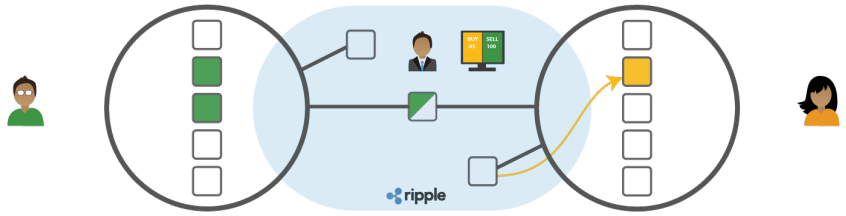
U.S. Bank can then query Ripple for the best rate to perform the transaction. Ripple automatically calculates the best execution path to trade between U.S. dollars and euros. The transaction is ultimately routed to the market maker with the most competitive offer in EUR/USD.



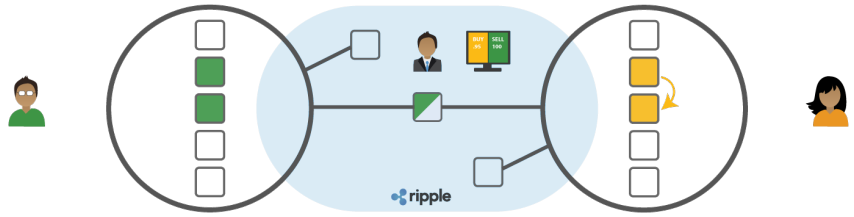
When the payment is sent, the market maker purchases USD from U.S. Bank, and Ripple simultaneously transfers EUR into Europe Bank's Ripple account. It is important to emphasize that neither bank has any counterparty risk to the market maker at any point in time, since both legs of the transaction are fulfilled simultaneously.



The European Bank debits this Ripple Balance to gain access to the funds. This is depicted by the yellow arrow and square in the diagram below.



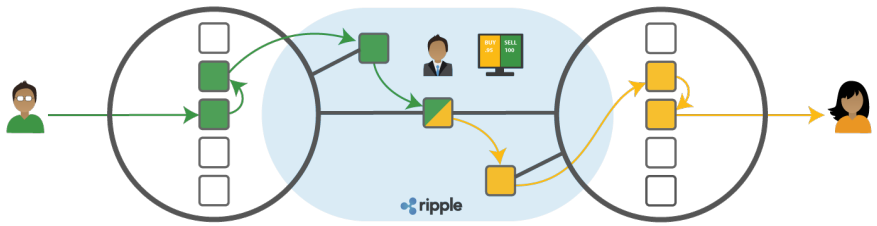
Finally, European Bank transfers EUR from the immobilized holding account into European Receiver's beneficiary account (i.e. the receiver's checking account) held in the institution.



All told, the process essentially boils down to two in-house transfers: 1) a transfer of USD from the sender to the market maker at U.S. Bank and 2) an offsetting transfer of EUR from the market maker to the recipient at Europe Bank.

Straight-through Transaction Settlement

The walkthrough above highlights how innovative the technology is for interbank transaction settlement. Once integrated into the protocol, any two banks located anywhere in the world can transact directly on a real-time basis. This entire process takes place in six seconds as the banks transact on a peer-to-peer basis rather than through several hops (as in correspondent banking) or through multiple currency conversions (as required by other digital currency protocols).



A Closer Look at Correspondent Banking

Today, each country has its own domestic interbank transfers system, such as the ACH System in the U.S. or the Bankers' Automated Clearing Services (BACS) in the UK. At the core, these payment systems enable domestic bank-to-bank transfers and are typically low-cost transactions for businesses and banks, but could take two to five days to settle. *For international transactions, however, there is no global ACH or payment rail.* Instead, money moves from bank to bank through a series of correspondent banking relationships, which act like a bridge from one regional banking center to another.

These correspondent banking relationships are bilateral agreements between financial institutions. Correspondent banking networks could become quite extensive, with larger financial institutions managing hundreds of bilateral arrangements. Correspondent banks act as a domestic agent's bank in international markets and could process transactions, accept deposits or conduct other business activities on behalf of domestic banks. For example, a small or mid-sized U.S. bank could transact with a European bank through a bilateral relationship with a large U.S. bank, which in turn could have a bilateral relationship with a large European bank.

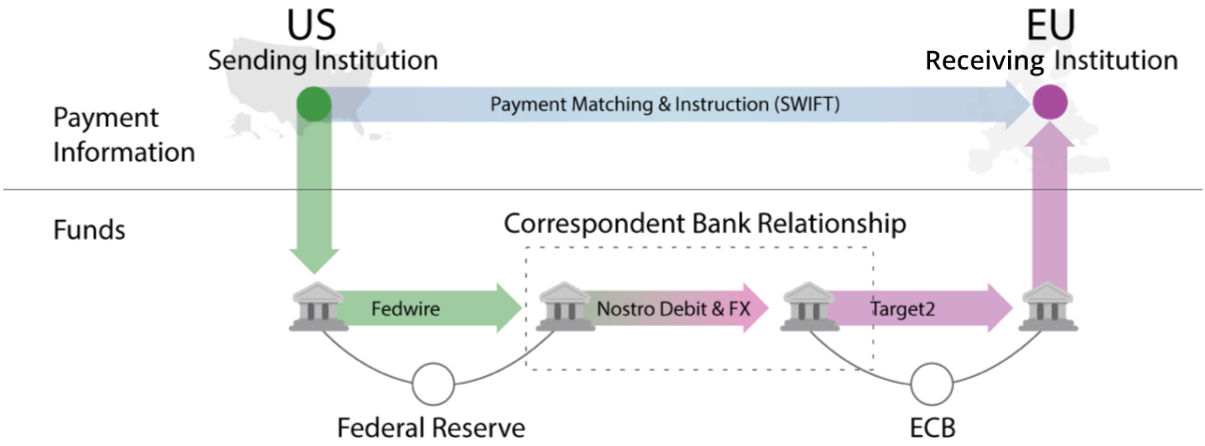
Correspondent banks typically have correspondent accounts (also known as nostro accounts) with foreign banks that have the ability to pay and receive in the domestic currency. For example, a large U.S. Bank might have a correspondent account with a large UK Bank, which can transact in British pounds. The correspondent account allows the U.S. bank to offer various services to domestic customers, including foreign exchange or foreign denominated deposits without a bank license in the foreign country.

These correspondent banks, moreover, decide on how and when to settle transactions between them using their correspondent accounts. For example, two correspondent banks with correspondent accounts could decide to settle transactions daily on a net basis. The banks simply deposit and withdraw funds from their correspondent accounts.

The exhibit on the next page walks through how a typical international transaction may look when funds need to move from a U.S.-based Bank (i.e. Alpha Bank in the illustration) to an India-based Bank (i.e. Beta Bank). In this example, Alpha Bank is a mid-size bank with no presence in international markets. However, the company sends the funds to HSBC, its domestic correspondent bank. The exhibit below assumes that HSBC, moreover, does not have a banking license in India and thus cannot operate in the market. Instead, HSBC transfers the funds to its correspondent bank in India, Citi. Citi withdraws funds from HSBC's correspondent account and routes the funds to Beta Bank, the India based bank.

Yet another bank – hypothetically Deutsche Bank – then handles the FX conversion between USD and INR as the examples assumes the bank is a big provider of liquidity in both currencies. Finally, banks send international interbank messages about the transaction (including settlement notification) using SWIFT codes (the Society for Worldwide Interbank Financial Telecommunication).

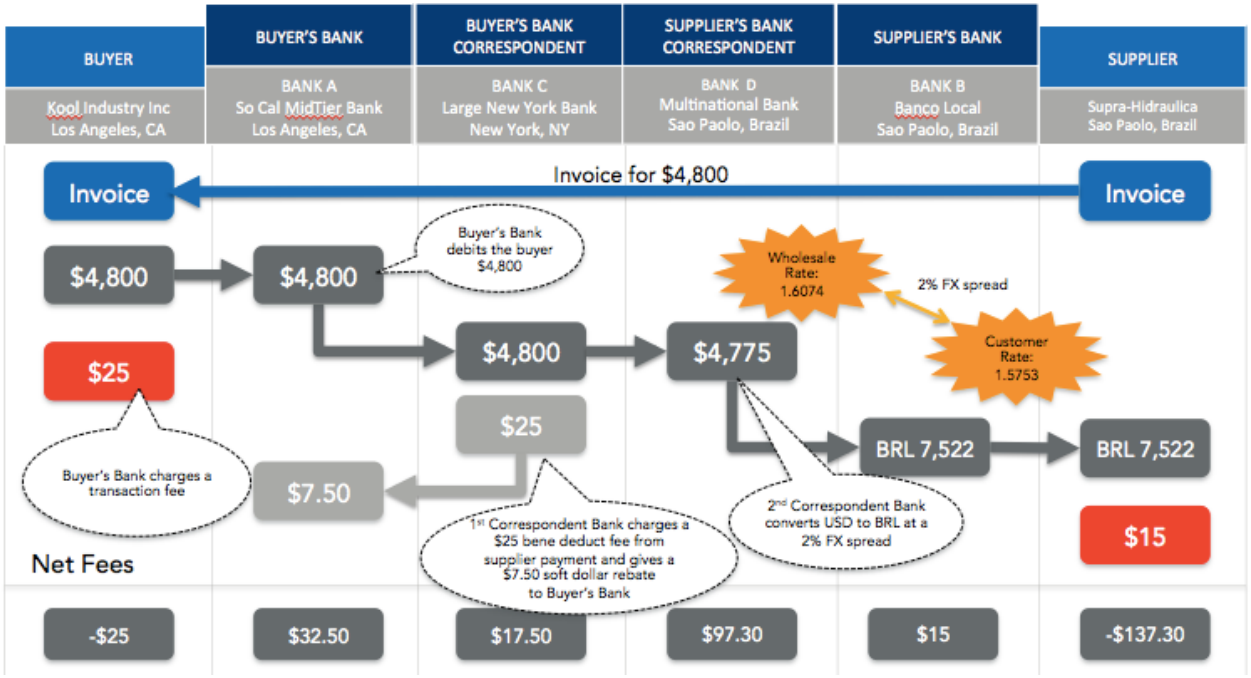
Correspondent Banking: a Closer Look



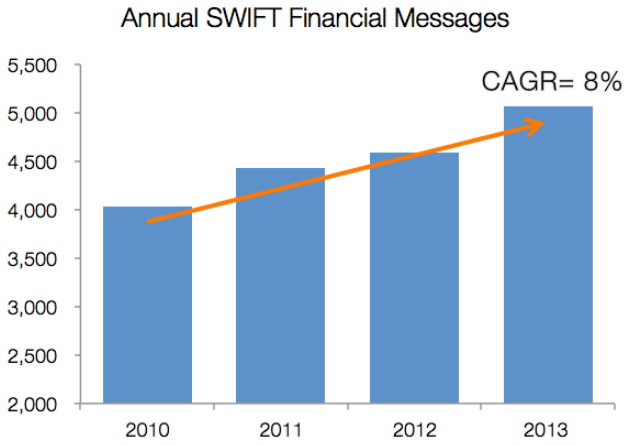
As discussed previously, this sequential process has significant costs to banks, which in turn helps set retail prices paid by bank customers (consumers and businesses). The funds can move through numerous hops, with each hop introducing a nominal fee per transaction, counterparty risk and settlement delays. Additionally, the FX conversion fees could be costly and operationally challenging. For example, HSBC needs to hold a significant amount of FX and has to rebalance in order to provide liquidity in multiple currencies. Additionally, each bank needs to have a certain amount of deposits in its correspondent banks as part of the arrangement. This "liquidity cost" varies widely depending on the bilateral arrangement and size of banks. These costs and reserve requirements add up across billions of transactions.

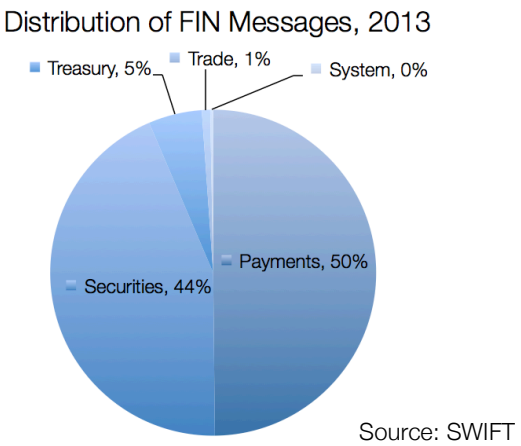
The exhibit below is a helpful illustrative example of how these costs could add up (developed by Glenbrook). The exhibit walks through how a U.S.-based business (Kool Industry) pays its Brazil-based supplier (Supra-Hidraulica) via a network of correspondent banks. As depicted on the diagram, this transaction could impose significant transaction fees and FX conversion fees (in this case the 2% FX spread) for business. This funds transfer system imposes significant costs over the billions of cross-border transactions. In 2013, for example, over 5 bn financial messages were sent over the SWIFT network (the leading provider of international interbank financial messages), with 50% of the messages representing cross-border payments.

Correspondent Banking: Example



Source: Glenbrook





Source: SWIFT

The costs of correspondent banking, moreover, are likely to rise given increased regulatory requirements. According to SWIFT, while correspondent banking and payments processing remains an attractive business, increased regulation and increased competition are putting pressure on industry profits. In a May 11, 2014 article, moreover, the Wall Street Journal (WSJ) reported that JP Morgan was reviewing many of its domestic correspondent-banking relationships. According to the WSJ, JP Morgan's review was prompted by heighted regulatory scrutiny, which has encouraged the bank to shore up its risk controls. While this review appeared specific to domestic correspondent bank relationships, the intense regulatory scrutiny could have important implications for riskier international correspondent banking networks.

Correspondent Banking: a Closer Look

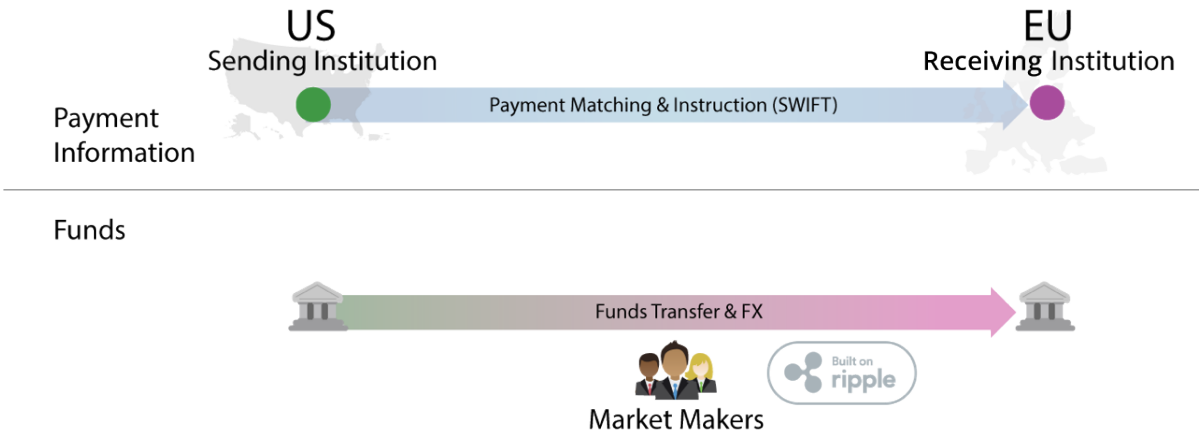
Correspondent banking also introduces numerous risks. While the examples above showed a simple illustration of two correspondent bank networks, some situations might be more complex. For example, an interbank transfer from mid-sized U.S. bank to a to India might involve three correspondent bank relationships. If one bank within the correspondent banking network were to delay a payment, it would be difficult for businesses and banks to track the funds.

When such payment delays occur, banks need to redirect staff and resources to solve these issues. As a result, financial institutions seek to minimize the rate of intervention and rate the efficiency of a payments system by a measure known as the straight through rate (i.e. the percentage of transactions that go through without intervention).

And of course, counterparty risk exists while transactions are in flight. While it is a remote possibility, it can be a big problem if a correspondent bank were to fail to make a payment. This is referred to as Herstatt Risk, coined after the German bank that failed in 1974 after it was unable to cover its liabilities.

Ripple addresses the inefficiencies in the interbank funds transfers as its decentralized network offers a low-cost, instant settlement system. There are several reasons driving financial institutions to use correspondent banking networks but one key factor is the difficulty in communicating between banks directly. Each bank has its own core account ledger, which cannot easily communicate with another bank's ledger.

In the Ripple Protocol, there is one shared ledger that other systems can plug into in order to communicate with each other. By handling transaction clearing and settlement through its decentralized network, Ripple's technology eliminates the need for multiple hops between regional bank systems. This enables settlement of transactions within 6 seconds.



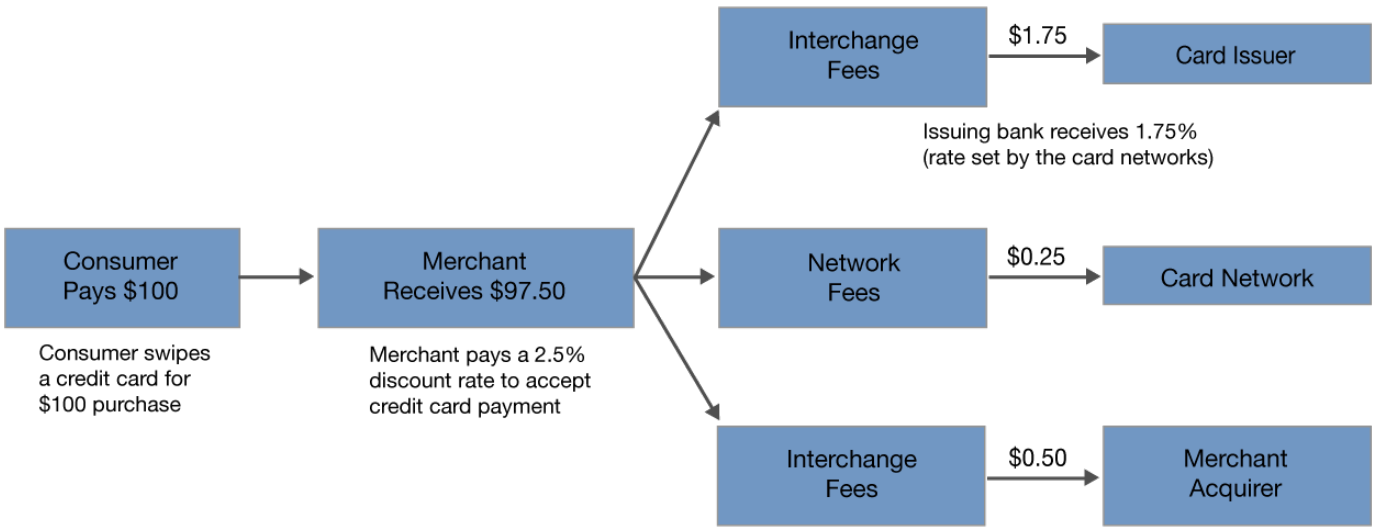
A Closer Look at Electronic Payments

Payments are perhaps the most widely used applications of interbank funds transfers. In a typical open-loop payments system (i.e. a Visa or MasterCard) funds move from a cardholder's bank (i.e. the card issuing bank) to merchant's bank (i.e. the acquiring bank). Visa and MasterCard (1) provide the rails for funds to move, clear and settle much faster than ACH, (2) set network rules that govern membership, security, and other practices, and (3) set fees for belonging to the network.

In the current payments ecosystem, merchants pay a fee for accepting electronic payments called the merchant discount rate (MDR). This MDR is typically expressed as a percentage of purchase volume and a per transaction fee. These fees vary widely depending on factors such as merchant size, type of merchant and risk of transaction (i.e. card not present are higher than card present transactions). However, in the U.S., merchants pay an average of 2.5% for physical retail payment and 3.0% or higher for online retail payments.

In an open-loop payment system, the MDR is composed of three major components: interchange (revenue for banks), network fees (revenue for payment networks) and merchant acquiring fees (revenue for payment processing intermediaries known as merchant acquirers). Merchant acquirers are responsible for charging merchants the MDR, routing the interchange component to issuing banks and paying some of network fees to payment networks (typically 60%-70% of network fees). Banks also pay network fees out of their interchange revenue (typically 30%-40% of network fees). The interchange fees and network fees are typically set by the payment networks, while the merchant acquiring fees are competitively set.

The following exhibit is a simplistic representation of how the payments economics of a typical credit card transaction are divided among key payments participants.

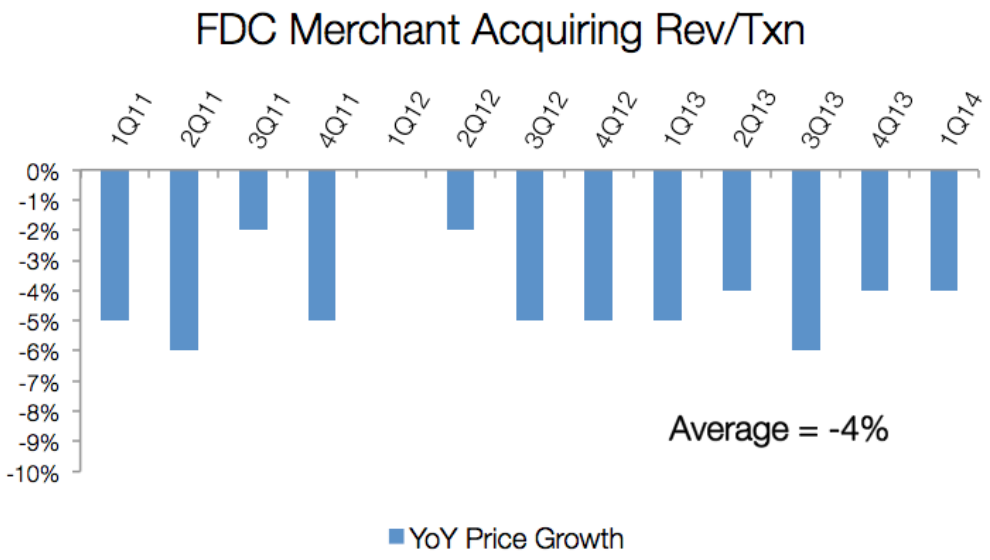


The Ripple Protocol could theoretically eliminate some of these fees, resulting in lower wholesale costs of payments for banks and payment processors. However, the protocol does not set retail payments prices nor determine how Ripple users interact with each other outside of the Ripple network. In addition, since users are not required to transact in XRP, consumers and merchants can continue transacting through their local currency. As a result, consumers and merchants do not need to change their behavior or preferred method of payment.

The payments ecosystem could theoretically continue to work with current payment network rules and existing pricing, though this would require payment networks, banks and merchant acquirers to integrate into the Ripple network.

Conversely, banks and payment processors could leverage Ripple's technology to lower their direct cost of payments (i.e. reducing 0.25% paid to network fees). This could add up to meaningful costs savings for banks and payment processors handling millions or billions of purchase volume. Companies would then have the option to hold onto the higher margins or pass on the cost savings to customers.

Payment processors, such as merchant acquirers, could gain an edge on pricing over the competition with Ripple. The merchant acquiring industry remains highly competitive, particularly in the mature and fragmented U.S. market. The industry's pricing outlook has turned increasingly as new entrants have introduced a wide range of new mobile payments/loyalty applications tied to simple pricing. The chart below looks at the normalized merchant acquiring revenue per transaction growth for First Data, the largest global merchant acquirer.



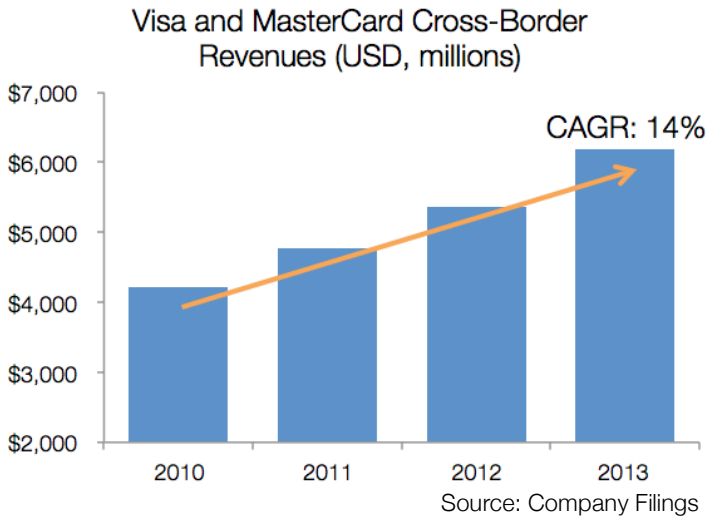
Source: First Data

This is in contrast to other digital currencies, such as Bitcoin, which require users to transact in BTC and thus circumvent the issuing and acquiring banks entirely. As a result, the Bitcoin protocol could theoretically eliminate the entire MDR for merchants, as there is no need for an issuer, payment network or traditional merchant acquirer (although in practice Bitcoin payment processors essentially replace the traditional merchant acquirer's role). However, this forces consumers to pay fees for currency conversion to and from BTC. In addition, the Bitcoin protocol potentially gives the pricing leverage to Bitcoin payment processors, which do not pay a MDR and decide how much of the cost savings to pass onto merchants.

The benefits of Ripple's clearing and settlement system are more pronounced for international transactions. Banks and payment processors would benefit from Ripple's competitive FX rates and real-time settlement. These benefits could also be passed down to end customers who often have to pay extra cross-border fees for international transactions. For example, merchants get charged an extra 40bps to 50bps on average for accepting cards issued by a foreign bank (i.e. an international transaction) and cardholders get hit with a currency conversion fee as well.

Cross-border fees are a lucrative business for payment networks. The exhibit below shows how cross-border revenues have been growing at a rapid clip since the downturn (at about a 14% CAGR[5] from 2010-2013) and account for nearly 25% of Visa and MasterCard's combined revenue. Given the high incremental margins of these transactions, moreover (likely in the 80%-90% range), cross-border volume likely makes up over 30% of combined profits for the payment networks. While this is already a significant cost for merchants, it likely will continue to grow as a function of international travel.

By reducing FX conversion fees and cross-border network fees, Ripple could deliver significant cost savings for banks, payment processors and merchants, while enabling real-time transaction settlement.



Source: Company Filings

[5] Compound Annual Growth Rate: The year-over-year growth rate of an investment over a specified period of time.

A Closer Look at International Money Transfers

International money transfer is another widely used application of interbank funds transfers. Money Transfer Operators (MTOs), such as Western Union or MoneyGram rely on a collection of correspondent banking networks to transfer payments abroad. In other words, when a consumer walks into an agent and sends money to her family in Ghana via a money transfer network, that cash is ultimately getting transferred through the money transfer network's correspondent banking relationships.

Money transfer systems thus bear similar costs, risks and settlement delays that exist in international bank fund transfers. As a result, the family receiving remittances have to wait several days to have access to the cash unless the sender is willing to pay a premium for faster settlement. In contrast to electronic payments (discussed above) where merchants bear the cost of payment acceptance, however, consumers are charged money transfer fees directly.

Nearly all money transfer systems could be broken out to six major components: payment gateways (i.e. cash-in and cash-out agents), Transaction Clearing and Settlement, FX Services (for international transactions), Transaction Communication, Messaging, and Dispute Resolution and Standards. As shown by the exhibit below, money transfer network operators bundle these services and charge a fee to consumers for facilitating money transfers. These fees incorporate the cost of interbank funds transfers.

The Ripple network unbundles these money transfer components and allows each function to compete on price. As discussed above, Ripple powers a quicker back-end settlement system than that offered by correspondent banking and allows FX traders (i.e. market makers) to compete for transactions (as shown in the exhibit below). This means that Ripple could lower some of the operational costs and FX spreads for money transfer networks as well as improve their consumer's experience by providing them with real-time settlement.

As a result, Ripple could drive down the wholesale cost of remittances for money transfer operators. Since Ripple does not govern retail prices, moreover, money transfer operators could have the flexibility to choose

how much of the cost savings to pass down to their consumers. This could be a significant competitive edge for money transfer networks, given how fragmented the remittance market is today.

In the current money transfer ecosystem, consumers pay MTOs a fee that varies widely by a number of factors including type of remittance, amount of face value and speed of settlement. Based on World Bank data, consumers pay roughly 8% of total amount transferred, on average. These fees are used to cover agent commissions, FX conversion fees, fees related to their correspondent banking relationships and other operational costs.

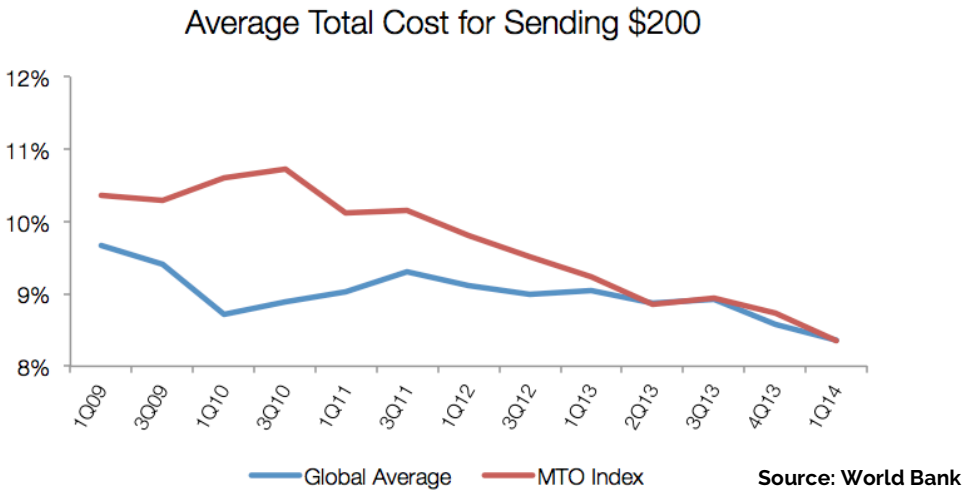
However, this fee has contracted significantly in the last five years, particularly for traditional MTOs. The exhibit below illustrates how the premium pricing charged by MTOs over the global average price of remittances has virtually eroded. In fact, the average price charged by MTOs reached the lowest level on record and finished slightly lower than the global average price in 1Q14.

While competition has been steadily intensifying between traditional MTOs, banks and non-traditional participants (such as retailers and telcos), the biggest change in the competitive landscape is the emergence of online and mobile money transfer companies.

These new providers leverage the Internet and have formed relationships with banks to enable bank-to-bank transfers and circumvent some of the fees involved in mobile money transfers, such as agent commissions.

As a result of this cost advantage, online and mobile money transmitters generally charge consumers a more competitive rate. In addition, rising regulatory requirements have increased operating costs for MTOs. Thus far, competitive pressure has prompted the leading MTO, Western Union, to lower prices significantly in select corridors. However, competition is likely to intensify and MTOs will continue to balance the need to offer more competitive pricing while maintaining healthy margins.

International Money Transfers: a Closer Look



Source: World Bank

Ripple's technology could help lower the cost of money transfer networks by removing the need to maintain an extensive correspondent banking network and offering competitive FX rates. As noted above, the Ripple protocol does not govern retail prices and thus money transmitters can choose how much of the potential cost savings to pass onto their end consumers. At the very least, however, the lower cost could provide MTOs with the flexibility to lower prices to compete with new entrants.

Potential Risks

What are the Risks to Ripple's Success?

Despite the key benefits of Ripple, there are also numerous risks that that potential users and potential XRP investors should consider.

Regulation Remains Unclear

As with other settlement protocols which involve a digital currency, regulatory uncertainty remains a big hurdle for wide adoption of Ripple. Regulators in the U.S. and abroad are increasingly taking steps to understand, contextualize and regulate digital currencies. As a result, it is still unclear how regulation will ultimately look and how burdensome it will be on digital currency protocols and users.

Though the Ripple protocol is very different from other digital currency protocols, it is unclear whether regulation will distinguish between protocols or regulate all digital currencies under one broad brush. On a similar note, Ripple could suffer from reputational damage if other digital currencies are used for illicit activities or operators/exchanges for other digital currency protocols are engaged in unlawful behavior.

Additionally, while Ripple makes it easier to track the flow of funds within the network, it is hard to identify individual account holders in isolation. While Ripple Labs is continuing to innovate and add features that could make it easier to identify account holders to help law enforcement, it will need to balance this with ensuring user privacy protection.

Ripple is a Nascent, Relatively Illiquid Network

Needless to say, the Ripple network is nascent and volume will gradually build as more banks, gateways and market makers integrate into the network. Much of the appeal of the network, including the ability to send money anywhere in the world and to leverage FX trading competition hinges on building out significant volume on the network. In addition, despite stress testing in "laboratory conditions", there is some uncertainty on how the network will perform when volume spikes in heavy traffic seasons. While these are issues that could get resolved over time, users must be aware of liquidity risk before transacting on the network today.

Competition Could Intensify

While Ripple focuses on forming industry partnerships with banks, payment processors and money transfer transmitters, it is possible that some incumbents could decide to compete with the protocol. Direct competition could entail incumbents creating their own digital currency protocol or deciding to integrate/partner with other existing digital currencies (i.e. Bitcoin, Litecoin, etc…).

Finally, while incumbents may not opt to either adopt other digital currencies or create their own, influential incumbents may enact policies that make it difficult for others in the ecosystem to use Ripple.

Potential Risks

Existing Networks Could Get Upgraded

The existing settlement architecture could be made faster. An upgrade to "same day ACH" in the U.S. could make more significant changes like Ripple appear less attractive. Likewise, some limited form of "global ACH" could get adopted to smooth pain points in international payments.

However, the Federal Reserve, in a series of recent Payments Town Halls, has indicated that it would prefer a more comprehensive solution to modernize the payments system. And any upgrade to ACH can be expected to take many years to implement, giving Ripple some time to gain traction.

Technological Flaws Could Exist

While the underlying source code has been public and available for public audit since September 2013, it is possible that technological flaws could be discovered in Ripple's consensus or other processes. While it may be possible to fix a bug, the reputational damage could still be significant.

It is difficult/impossible to definitely prove that something is fully secure. The absence of security breaches over a long period of time is usually the best evidence that a system is trustworthy. In this sense, trust in the Ripple protocol may partially be a function of time.

The Protocol Could Be Forked

Since the code for Ripple is totally open-source, a third party could clone and re-brand Ripple (i.e. "fork" the protocol), potentially garnering more adoption and the associated positive network effects. The Bitcoin protocol has seen a large number of clones (Litecoin, Dogecoin, etc.), all of which are essentially copies of the Bitcoin code base, with small changes that are often largely cosmetic in nature.

Because the Ripple protocol relies on integration with gateways and financial institutions, it is more complicated to effectively clone Ripple than it is to clone Bitcoin. Copying the code is easier than convincing third parties to integrate and support it.

Likewise, though Bitcoin has been extensively copied and rebranded, the original implementation continues to enjoy the most adoption and positive network effects.

A Superior Protocol Could Be Developed

It is possible that someone will develop a superior protocol for funds transfer and settlement, potentially offering faster settlement, better ease of use, or features that have yet-to-be considered.

Conclusion

Ripple Protocol: The Internet for Value

The Ripple protocol aims to link the financial world on a common system for transaction settlement. A global Internet for value transfer can create economic efficiencies that are as significant as those brought about by the Internet for information. Ripple's technology enables users to transfer funds (including fiat currencies, digital currencies and other forms of value) across national boundaries as seamlessly as sending an email.

A Compelling Alternative to Correspondent Banking

As a result of its key features, the Ripple Protocol presents a compelling alternative to traditional interbank funds transfer systems. Given the absence of an international payment rail, international interbank funds transfers rely on a series of correspondent banking networks which introduce multiple layers of fees, counterparty risk and settlement delays. The Ripple Protocol eliminates the costs associated with correspondent banking as it enables two banks located anywhere in the world to transact directly on a real-time basis. Market makers can compete on Ripple to provide liquidity for global payments. By introducing new market participants and making foreign exchange pricing a competitive process, the cost of sending payments can improve meaningfully.

Partnerships are Key

Ripple sits at the bottom of the payments stack, providing settlement functionality to banks, money transmitters, and other financial services institutions. This approach stands in contrast to other peer-to-peer networks, most of which seek to disintermediate existing players. The Ripple Protocol is not built to interface directly with consumers and businesses and does not govern retail prices. Thus, the Protocol provides financial institutions with the flexibility of passing on some of the cost savings to their end customers (consumers and businesses) while managing profit margins.

The Role of XRP

XRP is the native currency of the Ripple protocol. It is a digital asset, like Bitcoin, though most users of Ripple will continue to use their existing local currencies. XRP plays a security function and assists with liquidity providing on the network. Over time, if the Ripple protocol becomes widely adopted, demand for XRP may increase, leading to an increase in price. Unlike information protocols like HTTP or SMTP, investors can directly own a stake in Ripple, the value transport layer of the Internet.

Distributed Systems: The Future of Finance

Most of the world's payment systems still operate on infrastructure that was designed in the 1950s – 1970s. Recent technological innovations have made it possible to clear and settle transactions without involving a third party agent. This has opened the door to move finance to a post-Internet, distributed architecture. Incumbent players broadly acknowledge the inefficiencies in the current payments process and seek a solution. Ripple provides a free, neutral, and global solution to move payments into the Internet age.

Additional Resources

Ripple Homepage - https://ripple.com
Ripple Labs Homepage - https://www.ripplelabs.com
Ripple Primer (Market Making) - https://ripple.com/ripple_mm.pdf
Ripple Gateway Primer - https://ripple.com/ripple-gateways.pdf
Ripple Wiki - https://ripple.com/wiki
Create an Account on RippleTrade - https://www.rippletrade.com/#/register
Ripple GitHub Repository - https://github.com/ripple
Ripple Server Code - https://github.com/ripple/rippled
Ripple Developer Portal - https://dev.ripple.com
Consensus - https://ripple.com/wiki/Consensus

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