THE FUTURE OF

CROSS-BOARDER PAYMENTS

A LOOK INTO RIPPLE'S
DISTRIBUTED LEDGER
TECHNOLOGY

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Abstract

After stirring the interest of the financial industry in 2017, Distributed Ledger Technology (DLT) is poised to become one of the fastest growing technologies in 2018 and beyond. This thesis aims to increase comprehension of the benefits associated with distributed transaction processing and attempts to evaluate whether Ripple's solution has the required features to modernize the current cross-boarder payment infrastructure. Because Ripple's DLT is currently going through the implementation and testing phase an assessment based on actual usage was not feasible, yet this research found the technology well equipped to become the standard for interbank funds transfer. It also points out the necessity for a comprehensive regulatory framework, which at present is lagging behind, that responds to DLTs uncommon features.

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1.0 Introduction

In the past few years, blockchain has gained an almost unrivalled reputation as the next great disruption in the financial industry.

The technology was originally conceived as an alternative trust-mechanism between two transacting parties underpinning Bitcoin, a digital currency and payment system that works without a central repository.

Following the introduction of Bitcoin and its meteoric rise in price ever since, hundreds of crypto-currencies have been issued to the general public. According to data collected by Deloitte (2017), more than 26,000 new projects involving blockchain were found on code development platform GitHub in 2016, and in 2017 the number is expected to double.

Despite the growth in popularity, blockchain technology as used in many crypto-currency cases cannot meet the needs of industries that value privacy, cost control, scalability, competition, autonomy, legal recourse and compliance. Further, albeit this emerging technology is said to benefit almost every industry, many businesses struggle to explain how it can effectively improve their operations. Ripple Inc. CEO Brad Garlinghouse (2017) commented: "*Blockchain is like the new big data or AI - too many people are using it as a buzzword and not focused on solving a real problem. […] There are many applications that are nothing more than science experiments*."

In 2017 the use of the term Blockchain seems to have diminished in favour to Distributed Ledger Technology (DLT), the linguistic pivot might signal a trend that praises the real world applications of the technology at the expense of inflated expectations and mythmaking (Kaminska, 2017). A distributed ledger can be generally defined as a digital account book held and updated by its users, without the supervision of a central trusted party.

The banking industry was hasty in recognizing the potential of the technology. Simon Scorer (2017), Technology Policy Manager in Digital Currencies at the Bank of England, argued that there is room to make DLT applications more compatible with centralized environments and that such infrastructures have the potential to offer greater operational resilience than current systems.

Distributed ledgers exploration has propelled banks in testing their effectiveness in multiple scenarios, however payments seem to be the most commonly examined area. In fact, one of the most widely recognized benefits from Distributed Ledger technology comes from being able to speed up processes and reduce the transaction complexity, cost and risk. In this sense DLTs can be used to restructure the international payments infrastructure which dates back from 1974.

1.1 Problem Statement

Cross-border payments nowadays imply the involvement of multiple banks and payment systems across different jurisdictions and are regarded as outdated, slow and expensive. DLTs may have a significant impact in terms of modernizing the current international payment infrastructure. Yet, the recent proliferation of crypto-currencies and the resulting myriad of new use cases for DLTs is leading to a troubled view about the benefits associated with this new technology. In addition, real use cases are still infrequent and scholarly research in the area is currently limited.

1.2 Research Aim and Scope

To address the aforementioned problem, this research aims at improving comprehension of one of the most promising DLT solutions, Ripple, and points at understanding whether it represents a viable alternative to the current cross-boarder payment infrastructure.
The scope of this study is interbank funds transfer arrangements and the Ripple decentralized ledger technology. Geographically the focus is on international payments, since it is where DLTs may deliver most benefits.

1.3 Research Question

This research aims at answering the question:

- *Does Ripple's DLT represent a viable solution to the current limitations of cross-boarder settlement?*

In order to answer the main question three sub-questions have been outlined:

1. *Which are the industry specific requirements that DLTs need to attain in order to be adopted by financial institutions and is Ripple's solution compliant with these requirements?*
2. *What are the benefits associated with the implementation?*
3. *What is regulators' approach to this new method for settlement?*

1.4 Thesis Structure

The paper is structured in five chapters. Chapter 2.0 presents a body of knowledge that aims at clarify some concepts necessary to go through the case. Chapter 3.0 explains which research methods have been used for collecting the data necessary to construct the thesis argument and the rationale behind the choices made. Chapter 4.0 attempts to answer the research question and chapter 5.0 contains a summary of the relevant considerations matured throughout the analysis.

2.0 Theory and Research Background

The objective of this chapter is to share a body of knowledge material to better understand the case, hence it is intended not be extensive but clarifying. The theory and research background is composed by three sections with the following goals:

1. Explaining how Interbank Payments take place.
2. Highlight the challenges and limitations in enhancing cross-border payments.
3. Illustrate the role of DLT and the potential benefits associated with their implementation.

2.1 Payments and Payment Systems

Transactions between economic actors, that involve the exchange of goods, services or financial instruments take effect every day, in every economy. For these transactions to happen in a frictionless fashion a sound payment infrastructure needs to be in place. Efficiency and reliability are critical aspects of payment mechanisms that allows the transfer of funds. It stands to reason that whereby the cost associated to a transaction exceeds the expected benefits of the trade, the entire economic infrastructure is put into question (Parigi and Freixas, 1998).
A payment system can be broadly defined as the array of means through which monetary values are transferred from one entity or person to another. The payment system is generally comprised of four layers.

1. *Payment instruments* - These are the channels by which the payer initiate a request for a payment to be made. Examples of non-cash payment means include direct debits, credit transfers, debit and credit cards;
2. *Processing and clearing* - Consists in the exchange of the transfer information between institutions and accounts concerned and the activities and arrangements needed to transfer the funds;
3. *Settlement* - Which is the fulfilment of the contractual obligation whereby the payer's institution delivers the funds to the payee's institution. This can happen directly between the concerned banks or by means of an account that the institutions hold with a third-party settlement agent.
4. *Payment as a Service (Paas)* - Relying on the aforementioned elements, these services provide a two-way communication flow between the end-user and the other layers of the payment system. PayPal and Alipay represents two Paas widely adopted in the United States and in China respectively.

   In the past two decades most of fintech innovations focused their research effort in developing Paas solutions, thus attempting to improve only a part of the system. DLTs, on the other hand, can surpass the whole payment infrastructure by creating a new network of participants, this concept will be further discussed in section 2.3.

2.1.1 Processing and Clearing

Today the exchange of the information needed to enable the processing and clearing of a payment happen electronically through payment networks, where participants in the payment systems are connected and the access to the network is contingent to predefined criteria. Limited access is of critical importance as it ensures that financial risk and the transmission of confidential data remains enclosed among trusted participants and service providers.
According to the European Central Bank (2010), to ensure an acceptable level of security, all data exchanged via the communication network must possess the following features:

- *Authenticity of Data* - The identity of senders and recipients of messages within the payment system must be verified and made certain;
- *Integrity of Data* - The information transmitted must be insulated from the risk of unlawful manipulation;
- *Confidentiality of Data* - Only trusted participants should have access to the network;

- *Non-repudiation of the data* - A mechanism providing proof of the identity of the sender along with the content of the message, in order to avoid the denial of the submission and/or the subject of the message;

The rise of the Internet in the 1990's and the use of Internet Protocol (IP) technology has concurred in offering better networking capability, simplicity and flexibility and has empowered providers of communication networks for payment systems such as SWIFT with better service scalability. SWIFT, the Society for Worldwide Interbank Financial Telecommunication, is a cooperative that counts more than 11,000 financial institutions within its network. This network incorporates a native massaging system named SWIFTNet, used by financial institutions to communicate with each other.

As the payment instruction is submitted, funds needs to be moved from the payer's account to the payee's account. Clearing refers to the processes that incur from the moment the promise for a payment is made until is settled. These activities can happen "in house", hence without the involvement of other institutions, when the two interested parties hold accounts with the same institution or through interbank arrangements when the opposite is true and two different banks are involved in the transaction. Generally, interbank fund transfers take pace through two mechanisms;

- Payment systems, which are mechanism that function according to mutually agreed norms and procedures between the concerned institutions.
- Correspondent banking arrangements.

For the purpose of conciseness, this research will focus on the correspondent banking method due to its wide adoption as means for international fund transfer[1] and its expected growth pegged to the development of international trade as outlined in a report by the Committee on Payments and Market Infrastructures (CPMI) (2016).
CPMI (2015) defines correspondent banking as "*an arrangement under which one bank (correspondent) holds deposits owned by other banks (respondents) and provides payment and other services to those respondent banks*".

[1] Section 2.1.3 explains more in detail why this approach is preferred to payment systems in the context of international fund transfers.

Most cross border payments occur between institutions that do not have direct agreements in place, thus the originating institution normally search within the SWIFT network for a correspondent bank, that has working arrangements with the two transacting banks. Although, the SWIFT network facilitates the search for the intermediary institution, setting up such arrangements requires resource consuming efforts in terms of legal agreements, technical implementations and compliance assessments (CPMI, 2016).

2.1.2 Settlement

Settlement occurs when the payment is delivered, hence it becomes irrevocable and unconditional and the contractual obligations between the two interested parties are discharged (ECB, 2010). Interbank settlement in correspondent banking can happen in a direct fashion between the two institutions involved. This method requires that the two banks open accounts with their counterparty. These accounts take the name of "nostro" or "vostro" depending on the perspective of the respondend bank whose account is being held at a correspondent bank. It is worth to point out that funds stored in nostro and vostro accounts are in the native currency of the country where the correspondent bank operates, it is then a method through which financial institutions can provide customers accounts in non-domestic currencies in countries where they do not hold a banking licence.

Settlement can also take place via a third-party agent holding accounts for the two banks concerned. A third party agent or institution can be a central bank or a commercial bank.

2.1.3 Observed issues and trends in correspondent bank arrangements

According to the ECB (2015) payments systems is the prevailing method for settling in-country transactions involving different financial institutions due to their superior form of transmission, processing and settling. This approach is preferred to correspondent bank arrangements, because it solves the liquidity problem and reduce the exchange rate and counterparty risk.

In order to be in place correspondent bank arrangements require that a considerable amount of money is held in nostro and vostro accounts. This method is operationally inefficient as the money could be used in revenue generating activities, also banks must accounts for the restrictions arising from liquidity requirements under Basel III and the risk of counterparty default. Furthermore, this method exposes the bank to FX risk in volatile currency situations as in countries with unpredictable inflation and political stability. Moreover, costs to the payer and/or payee include charges from several parties, such as FX rate spread and SWIFT fees. Ultimately, as a result of predominantly non-aligned development, there is a shortfall of standardization and automation in inter-bank networks which concurs in making settlement time vary from three to five working days (IMF, 2017).

To solve these issues payment systems such as Real Time Gross Settlement (RTGS) relies on central banks. By adopting a RTGS system, major financial institutions in a country hold accounts with the central bank and funds are moved between these institutions just by instructing the central bank. Central banks have qualities that make them exceptionally suited as third party institution, such as:

- *Security* – Credit risk is virtually absent on Central banks;
- *Service continuity* – By relying on default-free institutions the risk of service interruption is reduced at minimum;
- *Standardization and Efficiency* – By operating in a single jurisdiction, processes are mutually developed and liquidity is created in domestic currency;
- *Neutrality* - Central banks as settlement institutions should not discriminate between market participants;

Hence, RTGS systems provide real time transactions, no netting and guarantee the finality of settlement. Some examples of RTGS include CHAPS, FedWire and Target 2, which relates to the pound, dollar and euro area respectively and only operate within their monetary jurisdiction. By cause of different currencies involved, the lack of a central bank that acts as universal third party agent and a common set of rules that govern how payments are processed and settled, it is evident why such systems are not found in cross boarder payments and corresponded bank remains the preferred method to execute international fund transfers.

Ultimately, it is worth mentioning that the scenario for cross-boarder payment is highly influenced by economies of scale, hence where transactions volumes in certain geographical areas are insufficient to bolster returns and legitimize the costs incurred, financial institutions are pressured to review their correspondent bank agreements. CPMI (2016) observed that regulatory heat, rising operational costs and an augmented awareness of risk, both geopolitical and financial, are lowering the profit margins associated with correspondent bank activities in less efficient corridors, such as those that involve non-major currencies. Furthermore, most banks are reluctant to work towards the achievement of standardized procedures due to the large costs associated with improving processes related to the small volume of payments (World Bank, 2015).

2.2 Roadblocks to a Universal Payment System

Cross-border transactions are characterized by an increased level of complexity in the clearing and settlement activities than it is encountered at domestic level, in that they usually connect different jurisdictions and currencies. Furthermore, since it is not feasible for most institutions to access payment systems outside their geographical area of major interest, a third party institution that act as intermediary is required in order to access the system and settle the transaction. Moreover, cross-border payments lack of standardized systems and other multilateral agreements found in domestic payments.

- Most multilateral arrangements are traditionally based on correspondent bank agreements, which limitations have been discussed in section 2.1.3.
- Funding is fulfilled in a non-domestic currency.
- Settlement is arranged in the local currency of the receiving institution.
- Before reaching the payee the funds need to go through a payment system in the destination country's currency.

Cross-boarder payments are playing an increasingly important role as international trade and finance grow. Globalization of commerce is impacting payment infrastructures as linkages between payments systems is becoming more frequent together with the foreign presence in national trade and financial markets. These linkages are contributing in making payment systems more and more interdependent (CPMI, 2015).
A widely discussed issue around the argument of interconnected payment systems is the necessity to bring these systems up to a standardized level of safety and robustness, due to the potential systemic threat imposed by a failure in the payment process route (IMF, 2017).
To provide an example; recently the number of retired people living outside the country from which they are receiving the pension payment has increased dramatically, this has created more demand for frequent bulk payments from pension funds to retiree across different jurisdiction. A breakdown in one payment system might have a severe impact on the other interconnected system due to the size of the payment initiated.

Three major challenges need to be addressed in order to better the cross-boarder payment process and create common global rules:

1. Most payment activities are subject to domestic regulatory infrastructures within the national banking and financial system, this poses challenges in the way legal requirements are met. Further, a change in the local law is reflected in the way payments are made, this affects not only the country in question but the network of participants interested in conducting transaction with that country.
2. Despite SWIFT has achieved remarkable results in improving the way banks pass data between each other, the absence of universal standards and the presence of discrepancies between payment systems leave room for potential failures when information is exchanged.
3. Government mandates, which are critical for fostering change at industry level, need to focus more on promoting efficiency instead of limiting their impact to the prevention of shocks in the system. Basel II, Know Your Customer (KYC), the Patriot Act and Sarbanes-Oxley are few examples of recent regulations that had great impact in terms of compliance costs incurred by banks but produce meagre incremental revenue (IMF, 2010).

2.3 Distributed Ledger Technology

The concept of digital currency dates back to 1983 when American computer scientist David Chaum introduced a cryptographic protocol for the use of the first form of digital cash (Chaum, 1983). Many attempt to build similar electronic form of currencies followed in the 1990's, nevertheless, until the invention of Distributed Ledgers, the fundamental problem affecting digital currencies was the relative ease with which digital information could be duplicated or falsified. This potential counterfeiting flaw takes the name of "double-spend" where the payer uses a digital coin more than once by sending a copy of the token while keeping the original.
The prevention of double-spend has been traditionally addressed by establishing a trusted third party, such as a financial institution or a payment provider that certify the validity of the transaction, acting as centralised authority.
With distributed ledgers technology the exchange of ownership is verified in a decentralized fashion by the users of the ledgers. The users reach a general agreement on the condition of the

underlying value of data by means of consensus algorithms such as Byzantine Fault Tolerance (BFT) as in Ripple, or Proof of Work (PoW) as in Bitcoin.

A distributed ledger is essentially a record of ownership or balances that is shared, every network participant owns an exact replica of the ledger and synchronized, any variations to the ledger are reproduced in all copies virtually at the same time and it remains immutable.

2.3.1 Key Strengths

DLTs have the potential to bring new efficiencies in the financial industry resulting in estimated cost saving ranging between $15–20 billion a year as a result of improved settlement systems (Santander InnoVentures *et al.*, 2015). According to the UK Government Office for Science (2016) the technology's key advantages include:

- *Automated Reconciliation* - With traditional methods, once a message carrying payment instructions is delivered, each institution involved in the transaction is responsible for updating its own ledger. At present, there are no automated mechanisms to confirm that these copies match and the process normally require a high degree of human intervention. By agreeing on the veracity of the underlying data, reconciliation happens automatically across multiple recordkeeping infrastructures.
- *Data Replication* - Data replication across different institutions represents a challenge with current database technologies. In order to ensure the security of data, copying information from one repository to another is a complex an expensive procedure. Since with DLTs information is mutualised, updating and replication happens virtually in real time thus ensuring that all participants have access to the identical source of truth.
- *Transparency and Traceability* – Due to the immutable nature of DLTs, listings in the record can be added but not deleted. Furthermore, data flows can be traced back through the entire history of transactions. Data mining activities, however, are subject to the pre-specified set of rules that govern the activities across the distributed ledger. Financial institutions may want to warrant access to regulators in pursuance of simplified regulatory reporting and fraud prevention activities.
- *High Resiliency* – The data stored on a distributed ledger is pervasive and persistent, hence in the event of a single system failure information on the ledger remain unaffected allowing participants to seamlessly operate and recover the data at any point in time.

- *Granular Access Control* – To govern participants' responsibilities, distributed ledgers provide digital keys and signatures which, under certain conditions, hold specific powers. For instance, regulators may be granted a key that permits the exploration of specific transactions among defined institutions within an established timeframe.

3.0 Methodology

This thesis provides a descriptive case study which seeks to illustrate the notions related to the matter of interest: Ripple's DLT. The research focus consists in clarifying and improve understanding of DLT applications in centralized environments. Because a comparative analysis of all the available distributed ledger solutions represent a complex and confusing task the author took the freedom to indicate Ripple as the most compelling alternative.

The data collected are analysed by means of thematic analysis and findings are structured using selective coding. This thesis utilizes secondary qualitative data that has been obtained from specific and relevant literature on Finance and Blockchain. Sources of information include scholarly articles, reports and white papers. It is worth disclosing that many of the data sourced from Ripple Inc. might be biased as they can also serve as marketing material, specifically the cost analysis carried by Ripple to show the benefits in terms of savings deriving from the implementation of the company's solution is not backed by any other source. The incipient nature of the subject matter limits the plurality of opinions and the relevant literature is restricted. Furthermore, the researcher attempted to contact the institutions currently involved in testing the technology, yet they are unwilling or legally impeded to disclose comprehensive results on the assessment performed. This made unfeasible the gathering of primary data.

4.0 The Ripple Case Study

This chapter provide a discussion of the benefits associated with the adoption of the Ripple distributed ledger and its compatibility with the current industry standards and regulatory framework.

4.1 Current Situation

The intensified regulatory pressure brought about by the recent global financial crisis led many financial institutions to divert part of the resources employed in core activities to addressing compliance obligations. Concurrently, they are found contending for revenue streams with a new type of competitor that seems to be better positioned to respond to the changing landscape. Financial technology startups place all their resources in designing market responsive solutions and are capable of developing innovation at a faster rate than financial institutions.

The medium to long term effect that many professional researches expect is a radical reduction of financial intermediation costs, which in turn erodes banks' profit margins (McKinsey, 2015). This broad disruption, although set to reshape the financial industry, has the potential to provide banks with new revenue streams. Financial institutions are compelled to adapt to a changing landscape by restructuring outdated business models and fintech startups may represent the ideal partner in a synergetic interdependence.

The innovative products developed by fintech players has been built on the backbone of the banking and payments infrastructure by adding renewed expertise. On the other hand, Banks offer an unrivalled understanding of the intricacies of payment systems, security protocols and regulatory requirements on top of providing a substantial customer base.

It is worth pointing out that fintechs companies offering DLTs solutions must ensure that their products attain certain industry specific requirements. As illustrated by a joint research from SWIFT and Accenture (2017), these include:

1. *Strong governance* – Clear governance structure that defines functions and obligations of participants and set the rules governing interaction among involved parties;
2. *Data Controls* – Limited and supervised access to data to ensure privacy of sensible information;
3. *Compliance with regulatory requirements* – Ensuring compatibility with the industry regulatory structure;
4. *Standardisation* – Providing interoperability to facilitate convergence among the multiple needs of the different parties;
5. *Identity framework* – Ability to provide customers identity proof to avoid repudiation of financial transactions;
6. *Security and cyber defence* – Readiness to prevent and resists data breaches and hacking activities;

7. *Reliability* – Ability to ensure service continuity and solidity against settlement risk;
8. *Scalability* – Flexibility in handling variable volumes of transactions;

The aforementioned requirements represent the framework utilized in this research to assess whether Ripple's solution possess the required features to evolve from proof-of-concept to commercial-ready solution.

The company offers three products designed to suit the needs of banks that are essentially pieces of software powered by distributed ledger technology: xCurrent, xRapid and xVia. This thesis will focus on xCurrent, which is Ripple's settlement solution to improve cross boarder payments and xRapid which objective is to offer on-demand liquidity.

4.2 RippleNet, xCurrent and xRapid

In its simplest form, Ripple's xCurrent is an open-source software, distributed on a network of computers, the RippleNet, that provides real-time messaging, clearing and settlement of financial transactions. The technology that empowers xCurrent is the interledger protocol[2] which connects multiple ledgers from different institutions. RippleNet is a decentralized network based on a mutual agreement between Ripple the company and the network participants, generally banks and payment providers. The set of rules that govern how computers (users) interact with each others is named Ripple Rulebook. These mutually agreed-upon rules regulate the exchange of ownership of any asset from one user to the other. Today RippleNet counts more than hundred institutions, including MUFG, Santander, Standard Chartered, Crédit Agricole, Unicredit, UBS and American Express, to name a few.

Similar to xCurrent, also xRapid runs on the RippleNet, however the objective of this piece of software is to eliminate the need of pre-funding nostro accounts hence improving liquidity for banks. To achieve this objective xRapid relies on XRP, a cryptocurrency, native of the Ripple ecosystem, designed to be used as bridge currency between fiats during a transaction. The Ripple network contains the Ripple Consensus Ledger (RCL), a secure distributed ledger where transactions are validated through consensus. Consensus consists in RippleNet users, provided with validator key, voting for the approval or rejection of a transaction as legitimate. If a transaction is deemed authentic by a supermajority of validators, currently set at 80%, it is then

[2] *See* Thomas S. and Schwartz E., *A Protocol for Interledger Payments*, https://interledger.org/interledger.pdf

added to the ledger (Schwartz *et al.*, 2014). This process solves the double spending problem and enables secure and real-time settlement removing the need for a central trusted party.
It is important to note that the only currency present in the Ripple network is XRP, fiat currencies only exist in the form of balances.
Ripple do not position itself in the service layer, hence it is not a consumer payment service but rather a tool for providing a frictionless movement of money through distributed settlement. In this sense, Ripple offers a solution that is not threatening Banks' survival but rather it aims at bettering their services and ultimately improving customers experience.

4.2.1 Governance and Standardization

Traditionally, regulatory regimes within payment systems rely on a central entity which own or operate the payment system. DLTs brought about an unusual decentralized governance structure, where users are responsible for accepting proposed changes to the common set of rules. This self governing model when applied to permissionless ledgers, which are distributed ledgers that grant access to everyone without restrictions, leads to constantly changing governance structures which in turn creates uncertainty. To ensure the delivery of consistent, predictable and effective financial service, many favour permissioned ledgers, such as Ripple's, where only duly authorised users have access to the ledger (Schwartz *et al.*, 2014).
From a governance perspective, Ripple's role consists in developing the Rulebook consistently with the current needs of banking and their customers. The company has established a RippleNet advisory board whose aim is to ensure that the rulebook promotes transactions' operational consistency and legal clarity. Although, the board is responsible for setting and improving the rules and standards, it holds no control over the protocol. A proposed change to the Rulebook needs to meet a supermajority of votes from validators, a process similar to the verification of XRP transactions. Furthermore, by joining the RippleNet, an institution is not subject to a change in the bilateral agreements it had formerly in place. Ripple simply provides the medium through which payments move and the rules that govern the process, it does not interfere with the existing business ties or legal responsibilities of a financial institution. Thus Ripple software plugs into the existing payment ecosystem without displacing the current regulatory frameworks. For instance, existing payment network guidelines, such as those established by the International Project Finance Association (IPFA), can co-exist with the Ripple Rulebook and govern interbank payment activity.
This innovation under the governance perspective has the potential to solve the issue of fragmented domestic regulatory infrastructure in the pursuit of a universal payment system.

Many jurisdictions recognized the benefits of interoperability, yet they are unwilling to cede their own regulatory autonomy and currency. This is particularly true for tightly linked economies such as the Scandinavian or African countries. The solution is to standardize at the protocol level so all the different systems can interoperate. Standardized payment processes have the potential to lower the barriers to entry for small players as they could use the networks at scale in virtue of reduced costs. This could possibly reshape the payment ecosystem since it has been historically dominated by large providers.
Finally, Ripple provides a clear set of rules that regulate how transaction occur between only permissioned participants in open-source governance, this streamlines legal frameworks without limiting the users' needs or requiring radical changes in the regulatory framework.

4.2.2 Data Controls and Identity frameworks

Data confidentiality represents a critical aspect during a financial transaction. Banks are found handling a deluge of personally identifiable information as part of their daily operations. These data are subject to privacy laws and therefore bear compliance cost. Further, the augment of data breaches, put spotlight on the reputational damage associated with the loss of confidential costumer information. Accordingly, financial institutions have become increasingly scrupulous in terms of data security management and are reluctant to share information with a third parties. The xCurrent messaging solution provides a direct and bidirectional channel between the interested institutions; the data required to initiate the payment cannot be accessed by any third party, nor Ripple itself. The communication is secured by HTTPS connections and adopts OAuth 2.0 for authentication, which are industry-standard protocols. This design guarantees that the institutions maintain authority over their customer data and preserve responsibilities on the identity of the parties involved in the transaction, including KYC and compliance inspection.

4.2.3 Compliance

xCurrent was engineered to ensure that a financial institution's compliance activities are not affected. The obligations relating the customers onboarding, including Know Your Customer and the responsibility to adhere to the Anti-Money-Laundering (AML) rules are fully maintained by the bank. Also the existing obligations associated with the monitoring of transactions remain unchanged, US institutions are required to perform due diligence with regards to foreign correspondent account recordkeeping as indicated under Section 312 of the USA PATRIOT Act and in Europe banks remains subject to the regulatory authority of SSC.

Many features of xCurrent have been developed to facilitate compliance with US based regulations, these include the provision of upfront fee negotiation that aims at assisting a bank with disclosure obligations under Section 1073 of the Dodd Frank Act and the xCurrent messenger has been designed to align with the Bank Secrecy Act (BSA) rule [31 CFR 103.33(g)] requirements (Ripple, 2017).

Although Ripple's solution leaves sanctions obligations unaffected, the set up of sanctions screening operations may need to be review as a consequence of the nearly instantaneous settlement time. The advantages arising from an increased transaction speed risk to be offset by outdated sanction screening processes. This is an institution specific issue which is subject to the bank's ability to adapt and its compliance policy. Nevertheless, it is recommended that such consideration receive sufficient attention.

4.2.4 Security and Cyber defence

From a security standpoint distributed ledgers may be the target of denial-of-service (DoS) attack. In a DoS attack the objective is interrupting a network service by flooding the network with unasked request in the attempt to overload the system affecting the ordinary functioning. To protect the XRP ledger from this type of attacks the Ripple protocol compels every user to deposit 20 XRP, circa €3.6, in order to create a ledger wallet, necessary to receive and send funds with xRapid. The deposit requirement represents an imperceptible fee for the ordinary user, but in the event of a DoS attack where multiple malicious transactions should flood the network, the cost increase sharply. Furthermore, for every transaction processed Ripple destroys 0.00001 XRP, an amount that is virtually worthless, however in the event of abnormal transaction volume the fee is designed to rapidly increase making such attack overly expensive for violators.

A recent security test by Moreno-Sanchez *et al.* (2016) simulated the effects of a large financial meltdown on the network by removing important nodes. The study found that if such event occurs around 50,000 wallets may be disrupted. The proposed solution to this problem is surprisingly simple and consists in making these wallets less isolated and more connected. Investigations such as the one mentioned, highlight a fundamental advantage of DLT over standard banking systems; their openness encourages inspections from a larger pool of unbiased scholars, thus increasing the chances that security threats are identified and dealt with in timely fashion.

4.2.5 Reliability

The operational reliability of a payment system has several dimension. Yet, in the cross-boarder payment scenario Herstatt Risk deserves particular attention (Mills and Nesmith, 2007). The risk that a transaction fails to be settled after being initiated represents a non-negligible concern for the robustness of a payment system. In 1974 the failure of Bankhaus Herstatt to settle a transaction after having received the payment started a chain reaction of cascading defaults which cost $620 million to the global banking sector. Today, the current foreign exchange markets trades around 1.5 trillion dollars every day compared to 10 billion in 1974. The criticality of this matter led Ripple to design atomic transactions. This means that every transaction either fully succeed or fail and no changes to the ledger occur, preventing that only partial updates are registered in the database which may create greater disturbance than the rejection of the full transaction (Schwartz *et al*., 2014). Furthermore, Ripple has no single point of failure, operations do not rely on any single entity, rather they are spread across the users making service disruption highly unlikely.

4.2.6 Scalability

Scalability has been a widely debated issue in the blockchain panorama. Distributed ledgers such as Bitcoin has a fundamental problem; as the size of the blockchain increases, the demand for storage, bandwidth, and compute power necessary to fully participate in the network grows in tandem. In addition, the method utilized to validate transactions on the Bitcoin network is considerably slower than the Byzantine algorithm utilized by Ripple. While Bitcoin can process up to 6 transactions per seconds, the Ripple ledger has sustained 1500 transactions per second according to a performance engineering test carried out on the 12/07/2017 by Travis (2017). Travis (2017) also claims that Ripple can scale it further to match Visa's daily peak rate of 4000 transactions per seconds. When performance tests began in February of 2015, the ledger sustained only 80 transactions per second.

4.3 Expected Benefits

Today, book transfers between poorly coordinated payment systems often take from 3 to 5 working days and carry significant costs, the World Trade Organization (2014) estimates the total system-wide amount to be around $1.6 trillion.

Ripple value proposition consists in enabling financial institutions to transact directly and in real-time. Using xCurrent institutions do not access a single FX provider but rather a competitive market place of third party liquidity providers that post bids and offers to trade currencies on the RippleNet. Every time a transaction is initiated it is routed by an algorithm to the lowest FX spread, creating healthy competition among foreign exchange traders and reducing FX costs for banks. Savings are estimated to be around 33% by using xCurrent alone (Ripple, 2016). This cost reduction has been modelled by Ripple Inc. and represent an indicative figure. The implementation of xCurrent has occurred so far in test environments and comprehensive evidence in terms of costs savings is still missing. Nevertheless, the rapidity of the settlement system has been shown by ReiseBank which completed in eight seconds a transaction totalling 1,000 Canadian dollars from ATB Financial into euros using Ripple's solution (Ripple, 2017). The improved execution time is a direct consequence of the simplified settlement process. When a fund transfer is initiated, the xCurrent messenger communicates with correspondent and beneficiary bank to obtain their payment processing fees and total cost, then compliance screening and accounts verification activities take place. Since all banks have the necessary facts they can pre-validate the transaction before funds move, to ensure straight through processing rates. To process the payments, Ripple, using the interledger protocol (ILP) technology[3], coordinates a hold on the accounts of the involved parties and once the system verifies that the funds are committed to the transactions they are simultaneously released across the ledgers of each institution. The entire payment process provide end to end visibility into the transaction while increasing processing rates and lowering operational costs. In summary, xCurrent combine each discrete settlement process in a single mechanism which operates 24/7/365, eliminating delays arising from systems trying to communicate between each other across different time zones and working hours.

Ripple (2016) claims that using xCurrent and xRapid jointly may provide an additional 9% reduction in costs as a result of the improved liquidity that derive from the adoption of xRapid. The solution uses XRP which is the only native asset on the Ripple network and acts as a bridge currency between illiquid markets, mostly between a rarely traded pair of currencies. A financial institution has only to hold domestic currencies and one XRP stock on its balance sheet rather than depositing reserves at each correspondent banks. Participants within the network directly make markets between their domestic currencies and XRP. Thus lowering the costs associated with maintaining nostro accounts minimum, currencies management overheads and occasional fees for rebalancing cash between accounts.

[3] *See* Thomas and Schwartz, *supra* note 2.

It is worth pointing out that, aside the benefits deriving from unlocking capital and moving it to revenue generating activities, the adoption of XRP is also relieving financial institutions from the risk of bankruptcy of the correspondent bank holding the funds.

4.4 Regulatory Approach

As new technologies reshape the financial service industry, regulation must adapt to remain effective. Kane (1988) argues that regulation play a critical role in the development of technology and both are endogenous in their interaction. Ripple and others DLTs demand a reinvented legal framework that responds to their unique features as current approaches are weak. Rosner and Kang (2016) claim that Ripple is treated by US regulators as a banks' third party vendor because it essentially provides a payment rail fitting within existing structures. This method is inefficient because it ignores the fundamental challenge in the formulation of a regulatory approach that suits systems such as Ripple; namely the decentralized nature of DLTs. Since there is not a central body that controls the set of rules that govern the RippleNet, regulators have no entity to call on. As previously mentioned albeit the company can propose changes these are subject to the approval of the majority of users. Thus it is important that, as primary objective, the regulatory effort works towards defining the legal status of these unowned protocols.

Interestingly, Ripple could lower some of the risks that current regulations seek to mitigate. For instance, the adoption of atomic transaction and instant settlement effectively reduce settlement and counterparty risk. However, as the solution increases in popularity and usage the stress under which the system is exposed makes its operational soundness an issue that deserve to be put under the magnifying glass. An additional critical aspect is represented by the validating nodes within the network; they are in charge of verifying transactions authenticity and yet they are not subject to any review and there is no a formal validator onboarding process (Schwartz *et al.*, 2014).

Further, as Ripple aims to an international reach, the assessment of the relevant regulation is subject to both domestic and international laws. This poses new challenges for regulators in terms of potential conflicts between different jurisdictions and demand a high degree of flexibility. Essentially, a progressive harmonisation of global standards and rules together with a cooperative effort between regulators and businesses is needed to extract tangible advantages from this new technology. On November 21st 2017 Ripple announced the appointment of Benjamin Lawsky as board member in attempt to create a collaborative effort between the company and the regulatory authorities. Lawsky is considered a pioneer in digital asset law; while he was superintendent of financial services for the state of New York he designed BitLicense, an industry-leading regulation for digital-asset businesses which has become a standard today.

4.5 Moving Forward

Because it was designed as a solution for banks, Ripple not only possess the necessary features for an industry-wide adoption but it actually goes beyond these requirements. It reduces the systemic risk posed by a single point of failure as well as the settlement risk with the introduction of atomic transactions. The security features of the system are for everyone to observe and test, increasing participations in the effort of making the structure more secure. Further, end-to-end transaction monitoring facilitates AML compliance activities and the standardized architecture allows the connection of different payment systems without forfeiting their autonomy. The Ripple system is designed to act as the "world central bank" due to it's embedded neutrality as a payments infrastructure; it is currency agnostic and shows no preference to any country, jurisdiction, or system.

While the prospects seem appealing the technology still lacks large scale adoption and therefore it is impossible to evaluate which are the effective benefits for its users in terms of cost savings. It is recommended that further assessments take into account a more exhaustive set of scenarios from the one outlined in the Ripple Cost Model (Ripple, 2016), including different jurisdictions and service fees as well as accounting for a greater XRP volatility.

Overall the technology is still in its infancy and its success largely depend on network effect. The increasing number of banks and payment provider joining the RippleNet demonstrates at least interest in this solution and highlights the fact that the current system for settling international fund transfers is in need of a radical renovation. The current legal framework, which is vital to foster adoption and ensure integrity, lags behind. So far, many recommendations have been made on the approach to take towards DLT infrastructures yet translations into actual pieces of law are non-existent (Mills *et al.*, 2016). In this sense it is important for companies like Ripple to take a proactive stand and work together with regulators to bolster consent around the core principles that can lead future policymaking efforts. Separately from the cost savings that can be extracted from outdated payment protocols, the unprecedented reduction in transaction friction that Ripple offers may concur in radically reshape economic activity. The advent of the internet presents an instructive example of a service that has been completely revolutionized by lowering costs to near-zero and execution time to near-instant: the mail system. In 2001 the number of snail mail sent with a postage in the US peaked with 103.7 billion letters sent in that year. By contrast, in 2017 there was 269 billion emails sent every day (The Radicati Group, 2017). A similar transformation in the financial ecosystem might imply an unmeasurable augment in the number of financial transaction across the globe. Some evidence of this potential transformation can be found today in the United Kingdom, where the introduction of the Faster Payment System had significantly increased the number of non-cash transactions (Greene *et al*., 2014). A changed cost structure can reshape economic interaction as well as provide access to financially excluded individuals. The Bill and Melinda Gates Foundation (2017), which also partnered with Ripple, argued that digital means may effectively expand access to financial services, otherwise too expensive, to low-income individuals.

5.0 Conclusion

Ripple's distributed ledger technology is well positioned to offer a sound alternative to the limitations of current cross-boarder settlement. The technology is designed to adjust imperfections across payment systems that requires trusted intermediaries in a way that does not impact existing arrangements among interested parties. The solution not only possess all the required characteristics necessary to meet the needs of the industry but it might also raise the bar for current standards. The use of xCurret reduces asymmetric information enabling the involved actors to access all the information even before a transaction happens, it facilitates the matching with FX providers in a competitive and efficient fashion and settles the transaction in less than ten seconds. xRapid, on the other hand, offers on-demand liquidity acting as a bridge asset between two currencies, it can be particularly useful in less efficient corridors where less traded currency pairs are involved and FX spreads are particularly high.

In terms of regulatory approach, DLTs still lack a comprehensive legal framework that defines their legal status and supports their growth as alternative to the current payment infrastructure. It is vital for securing trust in this technology that all the networks elements receive sufficient supervision, starting from validating nodes from which depends the reliability of the system.

Finally, the proliferation of DLTs may create entirely new business models and use cases such as low-value remittances and micropayments. As money moves like information, the financial industry is expected to undergo a major transformation.

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