

Research on The Mechanisms of Blockchain Cross border Payment System

Liang-Xin Li

Business School, Chongqing College of Humanities, Science & Technology
256 Xueyuan Street, Caojie Town, Hechuan District , Chongqing 401524, China

Lingling Jiang

Economics School, People's University, Beijing 100872
China

Abstract

Blockchain is a decentralized and point to point communication technology which is a key potential candidate for next generation global direct fast cross border payment system. This paper is taking Ripple net work as a example to study the practical way to realize traditional all purposes payment instruments. It is shown all traditional payment instruments can be realized through Blockchain technology, especially Ripple system. The details of cash flow of the efficient Ripple cross border payment are designed and analyzed thoroughly. The paper is also studying the obstacles, advantages and disadvantages of the Blockchain system and its development over traditional cross border global payment system.

Keywords: Blockchain;cross border payment;Ripple; digital Check

1 Introduction

Since the advent of blockchain technology, a large number of blockchain payment systems have emerged, such as bitcoin, Ripple, litecoin, Libra, etc. world famous traditional financial institutions and industry giants have also begun to study blockchain technology to promote their cross-border payment business[1,2,3]. Among many blockchain cross-border payment systems, Ripple, as the earliest blockchain cross-border payment enterprise, is representative of its cross-border payment system in terms of technology scalability, compatibility and business processing mode. It is the benchmark of cross-border payment systems, and its business model has been applied in a large range[4]. For the above considerations, this paper selects Ripple as the case study object to elaborate and explore the application characteristics and internal mechanism of blockchain in the field of cross-border payment[5,6,7].

Ripple, founded in 2012, is an American company focusing on blockchain technology and digital cryptocurrency. Headquartered in San Francisco, it is a private financial technology company. Ripple cross border payment system is an open-source payment agreement developed by Ripple company[2,3,4]. Its goal is to establish a fast, effective and low-cost global payment system to help customers of banks and other financial institutions make global payments faster, more reliable and cheaper. Ripple cross-border payment system has a large market share in the field of blockchain payment. As of May 2023, more than 200 financial institutions around the world have established cooperative relations with Ripple. Banking institutions and remittance institutions such as Bank of America (BOA), Santander Bank of Spain, Standard Chartered Bank, SCB, express fund are all major customers of Ripple. In June, 2023, Ripple recently reached a cooperation with Banco de la República, the Central Bank of Colombia, to jointly explore the use cases of blockchain technology. As the leader of enterprise blockchain and digital cryptocurrency solutions, Ripple has a good development prospect in the field of blockchain payment[8,9].

In Forbes' 2022 selection of the most valuable private financial technology companies in the United States, Ripple ranked fifth with a valuation of \$15 billion, and 2023 Ripple was selected into the 2023 Hurun global Unicorn list with a valuation of 105 billion yuan, ranking 23rd.

1) Main features of Ripple

First, uniqueness. In each transaction, a unique time stamp will be generated to record the transaction log information, and this time stamp is open and transparent, and will be deleted only at the end of the transaction day. Without a timestamp, it is not possible to determine whether the transaction has been completed.

Second, security. Since each node stores the ledger copies of all transaction data, even if a node fails or is damaged, the entire ledger will not be affected. At the same time, each time a transaction is made, the user needs to send a request to the server and verify his identity to ensure that the transaction process is not interfered by external factors such as hackers. In addition, Ripple also uses smart contracts to automatically perform certain operations to ensure the absolute security of users' funds and personal privacy[10].

Third, finiteness. XRP in Ripple cross-border payment system is a digital cryptocurrency that cannot be mined. Its quantity is controlled by Ripple company. The total amount is constant and will only gradually decrease. Each transaction will consume a certain amount of XRP, but the amount is very low, about 1/1000 cents. The XRP required by this transaction will not be paid to anyone, but will disappear after the transaction is completed[11].

2) Ripple's consensus mechanism

The Ripple cross-border payment system uses the RPCA (Ripple protocol consensus algorithm) consensus mechanism. The mainstream consensus mechanism of blockchain (pow\pos\dpos, etc.) needs to be synchronized among various nodes, which has the problems of high communication cost and low consensus efficiency. In order to improve the consensus efficiency, Ripple has innovated and improved the consensus mechanism. In the RPCA consensus mechanism, in order to reduce the cost of node synchronization, the method of electing trust nodes and voting by trust nodes is adopted to maintain a high consensus efficiency and efficiency. Ripple's consensus is reached between the verification nodes. Each verification node is pre configured with a list of trusted nodes. The transaction recognized by the vast majority of trusted nodes is the final effective transaction, and the final consensus can be reached only when all nodes apply the same transaction to the ledger. The RPCA consensus algorithm adopted by Ripple does not require all nodes to participate in the decision-making, and the identities of the voting nodes are known in advance and the number is small, so the decision-making time efficiency is high, and the consensus verification can be realized in seconds[12].

2 classification of Ripple cross border payment operation mode

Ripple is a cross-border payment system. Its goal is to connect banks, payment service providers and digital asset transactions, so as to achieve faster and more economical global payments worldwide. Ripple has three solutions, Xcurrent, Xrapid and Xvia. Each solution has its own professional skill direction, which can help solve the difficulties faced by financial institutions and payment service providers in global payment transactions. For example, Xcurrent focuses on assisting large banks in handling cross-border payment business; Xrapid focuses on using XRP to solve liquidity problems; Xvia focuses on providing communication network integration services to non bank institutions and enterprises. From the perspective of whether to use XPR, Ripple cross-border payment solutions can be divided into two categories.

1) Solution based on non digital cryptocurrency

Xcurrent is a cross-border payment solution optimized by blockchain. It does not involve the use of encrypted digital currency XRP or the conversion with legal tender. It can be installed into the existing payment system of financial institutions in the form of external plug-ins, and will not interfere with the original rights and obligations of all parties in the system. The cost and scope of transformation are small. Therefore, Xcurrent is popular among financial institutions. Financial institutions can optimize the infrastructure of traditional payment system through this solution. At present, most of the financial institutions cooperating with Ripple use Xcurrent.

2) Solution based on digital cryptocurrency

Xrapid and Xvia solutions are based on digital cryptocurrency XRP to provide services. Among them, Xrapid is a solution to provide liquidity for payment service providers and build a global currency bridge for on-demand liquidity. Xrapid is based on the use of XRP digital cryptocurrency. Through XRP and XRP consistent ledger technology, transactions can be faster and cheaper. Xvia is a XRP digital cryptocurrency service based on Xrapid, which can better help ordinary companies access Ripple for payment. Xvia focuses more on an API standardized interface that allows banks and other financial service providers to interact within the same structure without relying on multi payment network integration. Its purpose is to promote integration and communication between Ripple participants, help financial service providers and ordinary enterprises, and help small and medium-sized business needs (such as invoices, delivery tracking and payment tracking). At present, the solution based on XRP digital cryptocurrency is rarely used in financial institutions cooperating with Ripple. On the one hand, financial institutions are still cautious about digital cryptocurrency. The main reason is that digital currency is still in the regulatory blind spot in many countries. On the other hand, the commercial implementation cost of this solution is huge.

3 Ripple analysis of cross-border payment operation mode based on non digital cryptocurrency

Ripple's Xcurrent solution uses the cross-border payment operation mode based on non digital cryptocurrency. Xcurrent does not rely on and use XRP digital cryptocurrency, but mainly improves the processing efficiency of traditional currency payment business by optimizing information sharing and transmission, and remains within financial institutions in terms of accounting processing. Ripple's cross-border payment mode based on non digital cryptocurrency is very similar to the traditional cross-border payment system swift.

3.1 composition of Ripple cross border payment system

Ripple cross border payment system is mainly composed of four key components:

(1) Messenger - Xcurrent messenger will realize information exchange for financial institutions connected to Ripple cross-border payment system, including but not limited to risk and compliance, fees, exchange rates, payment details and capital delivery time. Relevant transactions can only be carried out after all the information is confirmed to be correct.

(2) Validator - validator confirms transactions and coordinates the cross ledger flow of funds through encryption. For validators, financial institutions can use their own or third-party validators.

(3) ILP ledger - when ILP is implemented in the existing bank ledger, the ILP ledger is formed. The ILP ledger is mainly used for the tracking of working capital, credit and debit of transaction parties, and the ILP ledger uses atomic method to settle funds, which means that the transaction is either successful or terminated.

(4) FX ticker - FX ticker is mainly used to provide foreign exchange rates and track ILP ledgers. Generally speaking, foreign exchange liquidity can be provided by the paying bank or by a third party. The payment process of Xcurrent payment solution of Ripple cross border payment system is studied in detail in the following analysis.

3.2 Ripple cross border payment business analysis

Assuming that company A needs to remit 1000 euros from the United States to its customer company B in Europe, company A has a US dollar account in bank A in the United States, and company B has a euro account in bank B in Europe, the operation mode of Ripple cross-border payment business will be described in detail from the three stages of payment preparation, information verification and payment.

I) Payment preparation stage

First, the receiving and paying banks need to establish a Ripple suspend account, which is used to map the balance with the external Ripple ledger. The Ripple ledger is mainly used to track the liquidity of market makers. Changes in its capital situation will be mapped to the distributed ledger of the ledger through the external account. Once mapped to the ledger, the entire transaction will be conducted in the Ripple cross-border payment system. The steps in the payment preparation stage are as follows:

(1) Assuming that the liquidity of bank A is provided by the market maker, the market maker deposits 1000 US dollars in bank A and 1500 euros in bank B, company A has 1600 US dollars in bank A and company B has 100 euros in bank B.

(2) To ensure liquidity, 1100 euros provided by the market maker will be transferred to the external account. Once the external account has funds, the market maker will provide the exchange rate of FX ticker to bank A, assuming that the exchange rate is eur/usd=1.1210

In this payment preparation stage, the account funds of companies A and B are reflected in their respective bank Books, while the liquidity capital investment of market makers is reflected in the Ripple ledger ILP ledger. The capital flow is shown in the following figure:

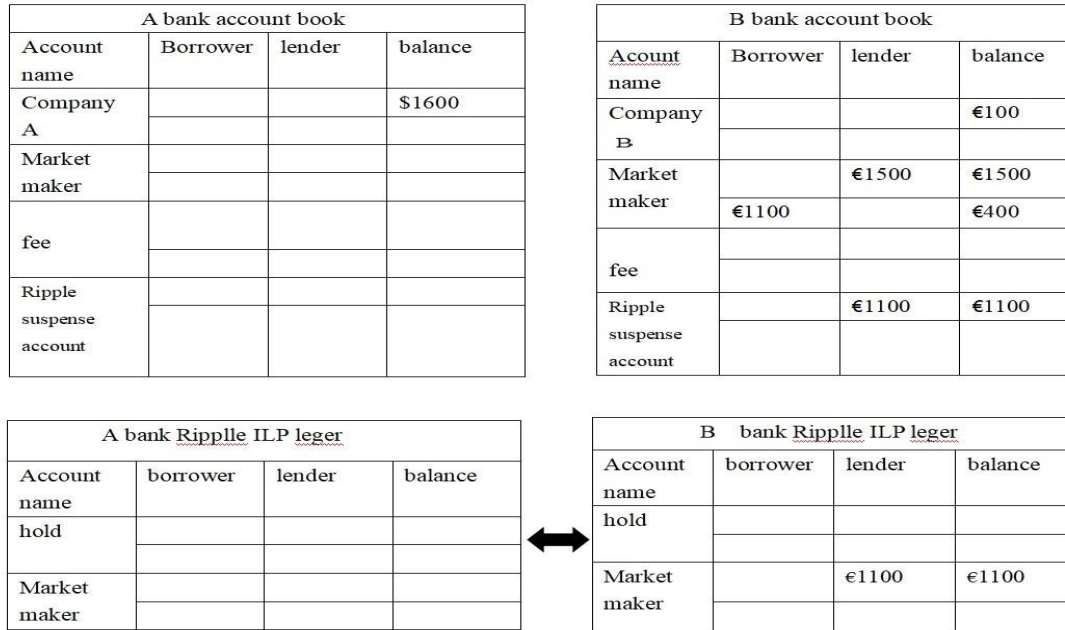


Figure 3-1 capital flow in payment preparation stage

II) Information validation phase

company A officially requests bank A to remit 1000 euros to company B of bank B. the specific steps are as follows:

- (1) After receiving the remittance request from company A, bank A enters the Ripple connect network channel through the system connection and sends an inquiry and remittance application to bank B.
- (2) After receiving the information of bank A in Ripple connect system, bank B began to review the kyc/aml and other related information of company A and company B. If the review fails, the transaction ends. If the review passes, the corresponding remittance service charge and the relevant information of company B will be returned to bank A for review. bank A and bank B both know the relevant information of companies A and B through Ripple, and bank A obtains the foreign exchange price through market makers at the same time.
- (3) According to the service charge obtained from bank B and the foreign exchange price obtained from the market maker, bank A plus the service charge of the paying bank, the total cost of the remittance is finally obtained. Assuming that the handling charge of bank A is USD 10, that of bank B is EUR 10, and the exchange rate is eur/usd=1.1210, the total cost of the remittance is about USD 1142 (1000 euros *1.1210+10 dollars+10 euros *1.1210).
- (4) bank A shall provide company A with the final total remittance fee, including the handling fee and exchange rate of bank A and bank B. company A shall confirm whether to accept the total remittance fee.
- (5) company A confirms the total cost of accepting the remittance.

At this stage, only the payment information is confirmed and verified, and the fund delivery is not involved.

III) Payment phase

company A accepts the fee and enters the payment phase. The banks of both parties transfer funds and record them in their respective accounts. The specific steps are as follows:

- (1) bank A makes an internal Book deduction, deducting 1142 dollars from the account of company A, of which 1132 dollars is the payment transfer amount, and 10 dollars is the payment transfer fee of bank A.

(2) The credit of USD 1132 is registered in the external account. When mapping the ledger, USD 1132 is first placed in the frozen account (hold), and is not directly credited to the account of the market maker. The corresponding processing will be carried out after the receiving bank provides sufficient proof. At this time, the capital flow is shown in the following figure:

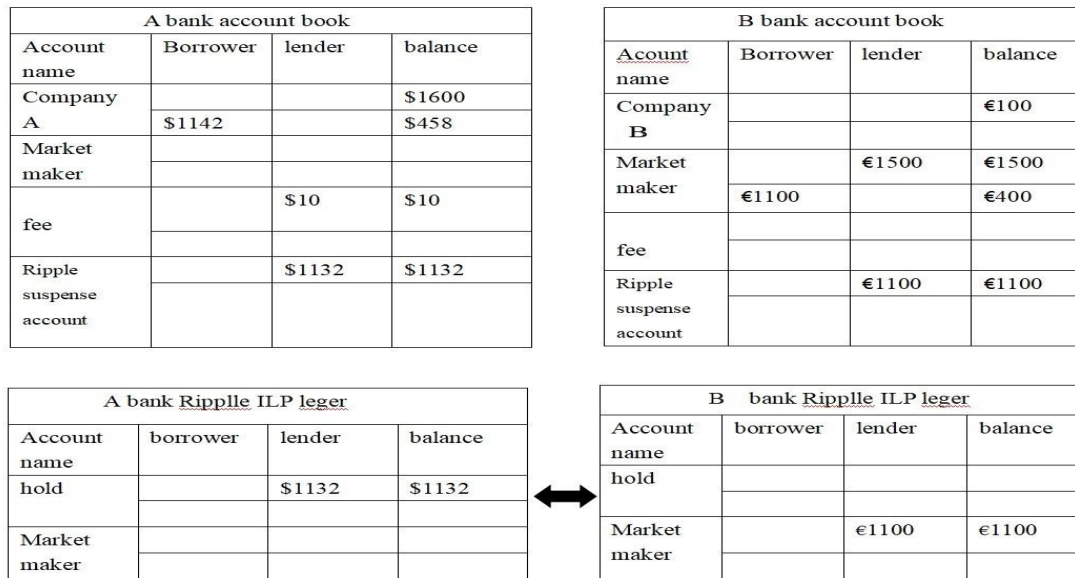


Figure 3-2 capital flow of bank A in payment stage

(3) bank B deposited 1010 euros in the frozen account (hold) from the market maker's working capital, and sent a receipt to the ILP validator containing only the certificate of deposit of encrypted funds, while other details such as bank A and payment were not reflected in the receipt. The capital flow at this time is shown in the following figure:

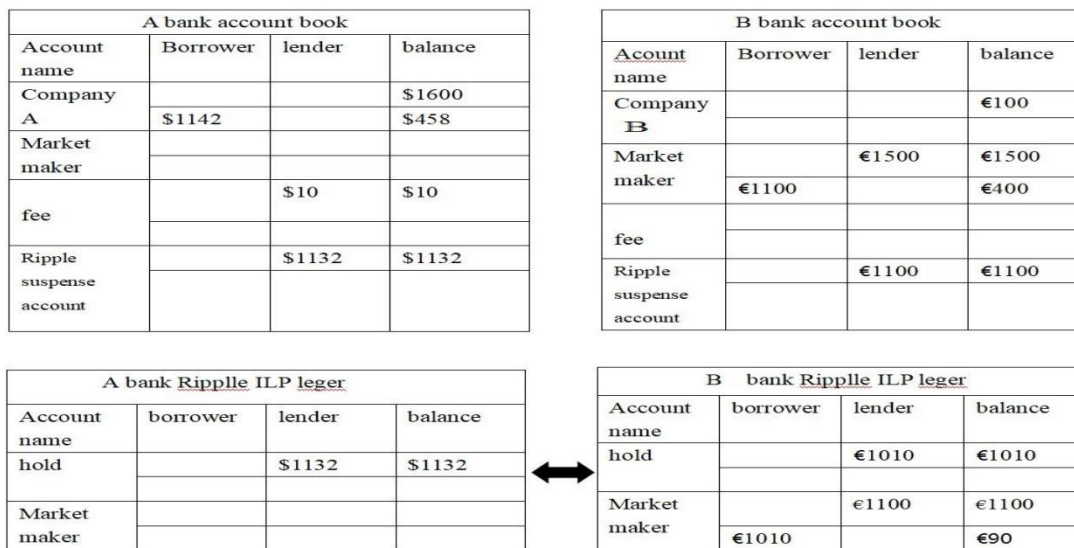


Figure 3-3 capital flow of bank B in payment stage

(4) After the ILP validator receives the full amount of funds from both parties, it will automatically trigger the fund clearing, record the account books of both parties, release the frozen funds, and complete the fund transfer. All processes are fully automated, and ensure that no wrong accounts will occur. The capital flow at this time is shown in the following figure:

A bank account book			
Account name	Borrower	lender	balance
Company A			\$1600
	\$1142		\$458
Market maker			
fee		\$10	\$10
Ripple suspense account		\$1132	\$1132

B bank account book			
Account name	Borrower	lender	balance
Company B			€100
		€1000	€1100
Market maker		€1500	€1500
	€1100		€400
fee		€10	€10
Ripple suspense account		€1100	€1100
	€1010		€90

A bank Ripple ILP ledger			
Account name	borrower	lender	balance
hold		\$1132	\$1132
	\$1132		0
Market maker		\$1132	\$1132

B bank Ripple ILP ledger			
Account name	borrower	lender	balance
hold		€1010	€1010
	€1010		0
Market maker		€1100	€1100
	€1010		€90

Figure 3-4 capital flow confirmed by both parties at the payment stage

3.3 innovation analysis of Ripple cross border payment mode

From the above Ripple cross-border payment operation mode, it can be found that the main role of Ripple's plug-in account is to reflect the liquidity of market makers. The plug-in account and ledger enter the Ripple cross-border payment system through the mapping relationship. After the banks of both sides access the Ripple system, they perform consistent bookkeeping on the unified distributed ledger. Based on the distributed ledger, both banks realized rapid information processing and capital clearing in Ripple, breaking the basic accounting mode of traditional banks.

The optimization and innovation of Ripple cross-border payment mode is mainly based on the Rayleigh payment protocol (RTXP), distributed ledger and market makers. Through these three core elements, Ripple is different from the traditional cross-border payment mode. It can realize the connection and exchange between different networks and different financial resources, and realize low-cost cross-border payment business worldwide.

1) Rayleigh wave payment protocol (RTXP) opens the information channel.

Ripple opens up the information channel through the path and gateway on the basis of the Rayleigh wave payment protocol, so that financial institutions, individual customers and other participants can equally access to Ripple cross-border payment system through their own networks, and automatically verify their identity, so as to realize the transmission of instruction information and capital payment instructions. The Ruibo payment agreement breaks the information barrier in cross-border payment and is conducive to improving the efficiency of information transmission.

2) Distributed ledger realizes the consistency of ledger information.

Through the unique RPCA consensus mechanism algorithm of Ripple cross-border payment system, efficient information verification can be realized, and the verified transactions can be automatically added to the distributed ledger. All transaction information is distributed for bookkeeping and storage. Each node stores a copy of the ledger, which realizes the sharing of ledger information and ensures the consistency of ledger information in Ripple system.

3) The market maker mechanism provides sufficient liquidity.

Ripple cross-border payment system forms a unified digital market for multiple market makers by introducing intelligent market maker mechanism. In this market, transaction participants can select the best quotation for exchange according to the market bidding mechanism, so as to realize real-time currency exchange and account transfer. The application of this market maker system makes the circulation of money more flexible and efficient, improves the liquidity of the market, and reduces the transaction cost.

3.4 Ripple analysis of bill settlement operation mode based on digital cryptocurrency

The blockchain cross-border payment mode based on digital cryptocurrency makes the payment efficiency of the blockchain more efficient by using digital cryptocurrency as the transaction medium of different currencies, and truly realizes payment as settlement. Among the numerous financial institutions cooperating with Ripple, although most of them use the Xcurrent solution of non digital cryptocurrency and few partners use the digital cryptocurrency mode, XRP using Ripple digital cryptocurrency can better demonstrate the advantages of blockchain technology in cross-border payment. Taking Ripple's cheque, bill of exchange and promissory note business based on digital cryptocurrency XRP as an example, this paper expounds Ripple's bill settlement operation mode.

4 Ripple digital cryptocurrency XRP

XRP is a digital cryptocurrency issued by Ripple in March 2013, with a total issuance of 100billion. XRP is a transaction medium created based on the principle of encryption technology. It can convert with any legal tender and circulate freely in Ripple cross-border payment system. The main role of XRP is to protect network security and serve as a medium currency.

XRP protects the network security of Ripple cross-border payment system through its unique consumption mode. Each participating entity of Ripple needs to hold a small amount of XRP as the trading reserve (the general reserve requirement is 20 XRPs). For each transaction, the holder will consume only 0.00001 xrps, which is negligible for the transaction cost. However, if malicious attackers attempt to cause Ripple network paralysis, Ripple will increase the cost of each transaction exponentially, so as to prevent malicious attackers from trading again by rapidly exhausting their account xrps, so as to protect the security of the system. XRP plays the role of media currency by converting with any currency. When there is no suitable market maker, Ripple cross-border payment system can use XRP as a medium to realize currency conversion. For example, to realize the conversion between Euro and RMB, you can first convert Euro into XRP, and then convert XRP into RMB (xrp/eur, xrp/cny).

Since the total amount of XRP is fixed and will not be released later, and XRP will only be destroyed in Ripple operation mode, the number of XRP will only be less and less. Ripple realizes the appreciation of XRP through this deflation mode. Compared with bitcoin, XRP was launched later and its price is far lower than bitcoin, but the total market value of XRP can still rank the top among more than 100 digital cryptocurrencies.

4.1 Ripple digital cryptocurrency check, bill of exchange and promissory note business analysis

Ripple's bill business is based on XRPL, which is a distributed ledger. In addition to storing all the financial information of transaction participants, it also provides cross currency transaction services, and protects and verifies transactions through a consensus mechanism. Ripple's bill function is based on XRPL to realize payment settlement. It supports users to create deferred payments that can be canceled or cashed by the intended receiver. XRPbills start from the sender of funds and create a bill with a specified amount and payee. When the receiver cashes the bill, the funds are extracted from the sender's account to the payee's account. The entire process cannot move the funds until the receiver cashes the bill. Due to the nature of XRP bills, anyone may send XRP to the institutional account of XRP ledger. In order to comply with the regulations such as BSA, KYC, AML and CFT, financial institutions must provide documents on the source of funds they received, and processing these unnecessary payments will bring huge costs and time delay to the compliance department of these institutions, including possible fines or penalties. Ripple innovates to solve this problem by means of deposit authorization, that is, setting the deposit authorization flag in the transaction, and only the cheque authorized by deposit can accept funds. This function of XRP notes supports users to reject unwanted payments or accept only partial payments, which is very useful for institutions that need to be careful to accept payments due to compliance reasons.

Next, the bill settlement business operation mode under the blockchain mode will be specifically described through the bill settlement business process of Ripple's check, bill of exchange and promissory note.

I) Cheque business

(1) Check creation phase

Assuming that Alice needs to remit money from the United States to Brab, a customer in Europe, Alice has an account in bank A in the United States, and Brab has an account in bank B in Europe, assuming that both parties have XRP digital cryptocurrency assets in their respective banks, both parties agree to pay and settle by cheque, and assuming that the banks of both parties do not charge any commission for cheque business. The specific business operation mode is as follows:

After bank A receives the demand that the sender Alice (sender) needs to issue a cheque, it creates a cheque in the Ripple system through the checkcreate transaction, designates the receiver (destination) as Brab, and sets the expiry date of the cheque and the maximum amount that may be deducted from the sender Alice account (sendmax), assuming that the maximum amount is 100XRP. No accounting processing is required at the check creation stage.

(2) Check processing stage

After the check is created, a check object will be created on the XRPlledger. The check object contains the related attributes of creating a check, and the check object can only be modified by Alice, the sender, through the transaction of canceling (checkcancel) or Brab, the receiver (through cancellation or cashing), and needs to be modified before the due date of the check. If the check expires, anyone can cancel the check. There is no accounting treatment when processing cheque transactions.

(3) Check cashing phase

After the check transaction is completed, the check receiver Brab proposes to cash the check to bank B. bank B submits a checkcash transaction in the system. At this time, the receiving party Brab has two options to cash a check:

Option 1: amount, which means that the receiver can use this option to specify an exact cash amount. Under this option, the sender should cover the possible transfer fees when filling in the check, and the receiver can only accept the invoice of the exact amount.

Option 2: minimum amount (delivermin), which means that the receiver can use this option to specify the minimum amount they are willing to receive from the check. If the receiver uses this option, Ripple will try to deliver as much as possible and at least this amount. If the amount that can be credited to the payee is less than this amount, the transaction fails.

Assuming that the receiving party Brab has chosen to determine the amount of 100XRP and that the sender has sufficient funds to pay, if the cheque is not expired, the funds will be directly deducted from the sender Alice's account and credited to the payee's account. The cheque object will be destroyed synchronously. The fund flow during the cheque cashing process is shown in the following figure:

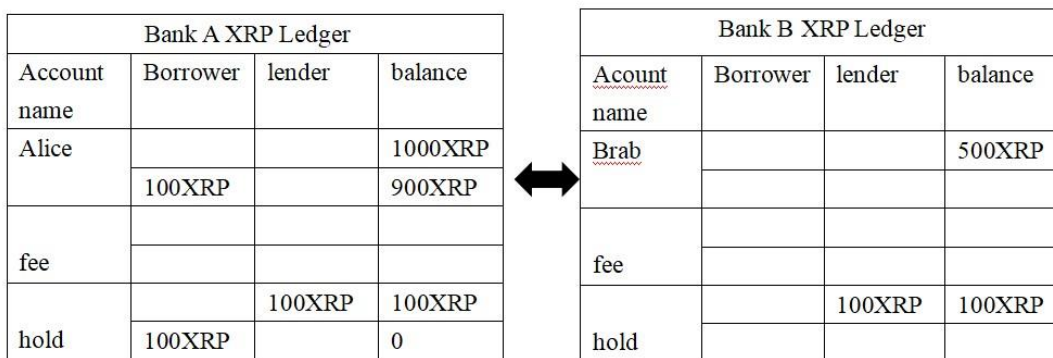


Figure 3-5 schematic diagram of cash flow in bank A

Bank A XRP Ledger			
Account name	Borrower	lender	balance
Alice			1000XRP
	100XRP		900XRP
fee			
		100XRP	100XRP
hold	100XRP		0

Bank B XRP Ledger			
Account name	Borrower	lender	balance
Brab			500XRP
		100XRP	600XRP
fee			
		100XRP	100XRP
hold	100XRP		0

Figure 3-6 schematic diagram of cash flow in bank B

The above processing steps are based on the fact that the cheque is not expired. If the cheque is expired, the cheque will expire before the payee can cash it. The cheque cannot be cashed again, but it can still be retained in the account book. After the check expires, anyone can cancel the check object by submitting a check cancel transaction, and then the check will be deleted from the ledger.

II) Bill of exchange business

(1) Bill of exchange creation stage

Suppose Alice wants to purchase goods from Brab suppliers and needs to remit money from the United States to Brab, a customer in Europe. Alice has an account in bank A in the United States and Brab has an account in bank B in Europe. Assuming that both parties have XRPdigital cryptocurrency assets in their respective banks, both parties agree to pay and settle by bill of exchange, and assuming that the banks of both parties do not charge any service charge for bill of exchange business. The specific business operation mode is as follows:

After receiving the demand of the sender Alice (sender) to issue a bill of exchange, bank A creates a bill of exchange through the draft create transaction in the Ripple system, designates the receiver (destination) as Brab, sets the expiration time of the bill, and deducts the amount of 100XRP(sendamout) from the sender Alice account. At the bill creation stage, bank A needs to freeze Alice's (sender's) funds to ensure sufficient funds. The capital flow is shown in the following figure:

Bank A XRP Ledger			
Account name	Borrower	lender	balance
Alice			1000XRP
	100XRP		900XRP
fee			
		100XRP	100XRP
hold			

Bank B XRP Ledger			
Account name	Borrower	lender	balance
Brab			500XRP
fee			
hold			

Figure 3-7 schematic diagram of capital flow of bill issuance

(2) Bill processing stage

After the bill is created, a draft object will be created on the XRP ledger. The bill object contains the related attributes for creating bills, which cannot be modified by the receiving party Brab. If the bill expires, anyone can cancel the bill. When handling bill transactions, there is no accounting processing.

(3) Bill cashing stage

After the bill transaction is completed, Brab, the bill receiver, proposes to cash the bill and submit relevant business background materials to bank B. bank B submits the draft cash transaction in the system, and both parties synchronously verify the relevant business background and funds in the system.

As long as it is confirmed that the sender has enough funds to pay and the bill has not expired, the funds will be directly deducted from the sender Alice's account and credited to the payee's account after the relevant conditions are met through the settings of the smart contract. The bill object will be destroyed synchronously. The cash flow of the bill is shown in the following figure:

Bank A XRP Ledger			
Account name	Borrower	lender	balance
Alice			1000XRP
	100XRP		900XRP
fee			
hold		100XRP	100XRP
	100XRP		0

↔

Bank B XRP Ledger			
Account name	Borrower	lender	balance
Brab			500XRP
fee			
hold		100XRP	100XRP

Figure 3-8 schematic diagram of cash flow of bank A after Bill cashing

Bank A XRP Ledger			
Account name	Borrower	lender	balance
Alice			1000XRP
	100XRP		900XRP
fee			
hold		100XRP	100XRP
	100XRP		0

↔

Bank B XRP Ledger			
Account name	Borrower	lender	balance
Brab			500XRP
		100XRP	600XRP
fee			
hold		100XRP	100XRP
	100XRP		0

Figure 3-9 schematic diagram of cash flow of bank B after Bill cashing

The above processing steps are based on the fact that the bill is not expired. If the bill is expired, the bill will expire before the payee can cash it. The bill cannot be cashed again, but it can still be retained in the account book. After the bill expires, anyone can cancel the bill object by submitting the draft cancel transaction, and then the bill will be deleted from the ledger.

III) Promissory note business

(1) Promissory note creation stage

The settlement principle of promissory notes is the same as that of bills of exchange, except that bills of exchange are generally used for settlement in different places, while promissory notes are used for settlement in the same region. Suppose Alice wants to purchase goods from Brab suppliers, Alice and Brab's opening banks are in the same city, Alice has an account in bank A in the United States, Brab has an account in bank B in the United States, assuming that both parties have XRPdigital cryptocurrency assets in their respective banks, both parties agree to use promissory notes for payment and settlement, and assume that the banks of both parties do not charge any commission for this business. The specific business processing mode is as follows:

After receiving the demand that the sender Alice (sender) needs to issue a promissory note, bank A creates the promissory note in the Ripple system through the promise note create transaction, designates the receiver (destination) as Brab, sets the expiration time of the promissory note, and deducts 100XRP(sendamout) from the sender Alice account. At the creation stage of promissory note, bank A needs to freeze Alice (sender))'s funds to ensure sufficient funds. The capital flow is shown in the following figure:

Bank A XRP Ledger			
Account name	Borrower	lender	balance
Alice			1000XRP
	100XRP		900XRP
fee			
hold		100XRP	100XRP

Bank B XRP Ledger			
Account name	Borrower	lender	balance
Brab			500XRP
fee			
hold			

Figure 3-10 schematic diagram of cash flow of promissory note issuance

(2) Promissory note processing stage

After the promissory note is created, a promissory note object will be created on the XRP ledger. This promissory note object contains the relevant attributes for creating promissory notes, which cannot be modified by the receiving party Brab. If the promissory note expires, anyone can cancel the promissory note. When processing promissory note transactions, there is no accounting processing.

(3) Promissory note cashing stage

After the promissory note transaction is completed, Brab, the promissory note receiver, proposes to cash the promissory note and submit relevant business background materials to bank B. bank B submits the promissory note cash transaction in the system, and both parties synchronously verify the relevant business background and capital situation in the system. As long as it is confirmed that the sender has enough funds to pay and the promissory note has not expired, the funds will be directly deducted from the sender Alice's account and credited to the payee's account after the relevant conditions are met through the settings of the smart contract. The promissory note object will be destroyed synchronously. The cash flow of the promissory note is shown in the following figure:

Bank A XRP Ledger			
Account name	Borrower	lender	balance
Alice			1000XRP
	100XRP		900XRP
fee			
hold		100XRP	100XRP
	100XRP		0

Bank B XRP Ledger			
Account name	Borrower	lender	balance
Brab			500XRP
fee			
hold		100XRP	100XRP

Figure 3-11 schematic diagram of cash flow of bank A after cashing promissory notes

Bank A XRP Ledger			
Account name	Borrower	lender	balance
Alice			1000XRP
	100XRP		900XRP
fee			
hold		100XRP	100XRP
	100XRP		0

Bank B XRP Ledger			
Account name	Borrower	lender	balance
Brab			500XRP
fee			
hold		100XRP	100XRP
	100XRP		0

Figure 3-12 schematic diagram of cash flow of bank B after cashing promissory notes

The above processing steps are based on the fact that the promissory note has not expired. If the promissory note has expired, the promissory note will expire before the payee can cash it. The promissory note can no longer be cashed, but it can still be retained in the ledger. After the bill expires, anyone can cancel the promissory note object by submitting the promissory note cancel transaction, and then the promissory note will be deleted from the ledger.

5 Conclusions

From Ripple's business processing of cheques, bills of exchange and promissory notes, it can be found that based on Ripple's XRP account book, participants in bill business can freely query and share the accounting information and customer information in the system. All information is open, transparent and tamper free, ensuring the consistency of information. At the same time, the use of XRP, a digital cryptocurrency, allows business participants to achieve payment settlement without the need for central settlement or other third-party agents, eliminating the process of fund settlement and reconciliation. Both banks realized rapid information processing and capital clearing in Ripple, breaking the traditional bill settlement mode of banks.

The basis of the operation mode of the digital cryptocurrency bill business is similar to the operation mode of cross-border payment in non digital cryptocurrency. The main difference is that the bill business uses XRP. The use of XRP can speed up cross-border payment, reduce payment costs and improve credibility. In the cross-border payment mode of non digital cryptocurrency, the traditional cross-border payment can be greatly optimized, and the addition of digital cryptocurrency XRP makes the blockchain payment system more efficient. However, because financial institutions are still cautious about digital cryptocurrency, and digital currency is still in the regulatory blind spot in many countries, as well as the huge cost of commercial implementation of the digital cryptocurrency model, and enormous consumption of computing and storage space for the decentralized distributed system which needs next generation quantum computing and storage technology, non digital cryptocurrency cross-border payment is less used among Ripple's partners.

References

1. Baseera A., Alsadhan A.A.. Enhancing Blockchain Security Using Ripple Consensus Algorithm[J]. Computers, materials & continua , 2022, (1) : 4713-4726
2. Martijn van Meerten; Burcu Kulahcioglu Ozkan. Evolutionary Approach for Concurrency Testing of Ripple Blockchain Consensus Algorithm. **2023 IEEE/ACM 45th International Conference on Software Engineering: Software Engineering in Practice (ICSE-SEIP)** DOI: [10.1109/ICSE-SEIP58684.2023](https://doi.org/10.1109/ICSE-SEIP58684.2023) 14-20 May 2023
3. Qiu,T.,Zhang,R.,and GaoY. "*Ripple vs. SWIFT: Transforming Cross Border Remittance Using Blockchain* Technology. *Procedia Computer Science*, No. 147, 2019, pp 428-434
4. Liang-Xin Li, Lingling Jiang. Chinese strategies for Blockchain Cross-Border Payment System Development[J].*International Journal of Business and social science*, 2023, 14(6):72-81.
5. Neyer G, Geva B. Blockchain and payment systems: What are the benefits and costs?[J]. *Journal of Payments Strategy & Systems*,2017,11(3):215-225.
6. Narayanaswami C, Nooyi R, Govindaswamy S R,Viswanathan R. Blockchain anchored supply chain automation[J]. *IBM Journal of Research and Development*, 2019,63(2/3):7:1-7:11.
7. Scott R R, Ben K, Arkady Y, et al. Blockchain Technology: What Is It Good for?[J]. *Queue*,2019,17(5):41-68.
8. Morkunas V J, Paschen J, Boon E. How blockchain technologies impact your business model[J]. *Business Horizon*,2019,62(3):295-306.
9. Yli-Huumo J, Ko D, Choi S, et al. Where is current research on blockchain technology?—A systematic review[J]. *PloS one*,2016,11(10):163-477.
10. Trivedi S, Mehta K, Sharma R, et al. Systematic literature review on application of blockchain technology in E-finance and financial services[J]. *Journal of technology management & innovation*,2021,16(3):89-102.
11. Joss P M, Omri R. KYC optimization using distributed ledger technology[J]. *Business & Information Systems Engineering*,2017,59(6):411-423.
12. Halilbegovic S, Arapovic A, Celebic N, Atovic T. Exploratory analysis of blockchain application in trade finance[J]. *European Journal of Economic Studies*, 2019,2(8):110-119.