

Analysis of Ripple Trust Network

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Abstract—Ripple is one of the most popular Blockchain-based technology that acts as both currency and digital payment network for financial transactions. Similar to other cryptocurrencies, while ownership of wallets is implicitly pseudonymous in Ripple, IOU credit links and transaction flows between wallets are publicly available in the online ledger. The factor that sets it apart from other Blockchain cryptocurrency networks such as Bitcoin, Ethereum, is its payment settlement asset exchange and remittance system for international money and security transfers used by many financial institutions such as banks and financial middlemen. The transactions in the Ripple Network can be direct XRP payments or Path-based settlement transactions which transfer any type of credit between two wallets having suitable trust/credit paths between them. In this paper, we present the first thorough study that analyzes the Ripple Trust Set/ Credit paths network. In particular, we visualize and analyze the Ripple Trust Set network graph for the past 2 years transactions that create new credit paths or removes the existing paths. Our analyzes also understand different patterns of trust set transactions between two wallets and finds the most-active currencies and wallets in the Ripple Blockchain.

I. INTRODUCTION

Ripple was released back in 2012 after being co-founded by Jed McCaleb and Chris Larsen of OpenCoin. By 2018, the company had experienced 36,000% growth and established a growing network of some major global banks. Ripple is categorized as a type of cryptocurrency or Blockchain-based platform but it is not either of these, however, it shares some similarities with cryptocurrency such as Bitcoin and Blockchain platform such as Ethereum, it has few distinct differences that set it apart. Firstly, it doesn't use blockchain to provide consensus. Instead, it summarizes data

using a HashTree and compares this data across its validating servers. Secondly, unlike most other cryptocurrencies, XRP can't be mined. All 100 billion XRP tokens were produced and distributed at its inception. The practical use cases of Ripple include allowing banks and payment providers to expand their reach into new markets, allowing corporates to improve capital efficiency, providing a way to source liquidity for payments, and many more.

Ripple has been adopted by many banks to avoid large transaction fees while performing worldwide transactions. The Kansas-based CBW Bank and Cross River Bank are the first American banks to adopt Ripple. Recently, the Royal Bank of Canada has decided to adopt Ripple after exploring numerous available Blockchain operations.[3]

II. BACKGROUND

In this section, we present a brief overview of Ripple and its Trust-Set Network. We discuss the structure of its graph and two available types of transactions.

A. Ledger

The ledger is a record of the amount of currency in each user's account and represents the "ground truth" of the network. The ledger is repeatedly updated with transactions that successfully pass through the consensus process.

B. Currency in Ripple

XRP is a digital asset built for payments in Ripple. XRP coins are not mined. Ripple minted the entire supply when the network was launched, and Ripple intermittently releases portions of the supply from an escrow and sells them on the open market. Out of the total 100,000,000,000 supply of XRP, over 45 billion is currently in circulation. A wallet is considered active only if it has a certain amount of XRP and also, XRP is used for

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paying transaction fees. Apart from XRP, Ripple also supports transactions of fiat currencies and user-defined currencies.

C. Ripple Protocol Consensus Algorithm

Unlike Bitcoin or Ethereum, Ripple doesn't have a blockchain, therefore it does not have proof of work or proof of stake. Ripple transactions rely on a consensus protocol to validate account balances and transactions on the system. The consensus works to improve the integrity of the system by preventing double-spending. Ripple keeps track of all credit lines in a given currency for any user or gateway. Credit lines and transaction flows that occur between Ripple wallets are publicly available on the Ripple consensus ledger.

D. Types of Transactions

Ripple Transactions can be direct XRP payments which allow the exchange of XRP between two wallets or Path-based settlement transaction which makes use of trust lines available between wallets which indicates the trust extended from one wallet to the another or the amount owed by one wallet to the another.

E. Ripple Trust-Set Network

A Graph G with the directed edge (p, q) is labeled with the scalar weight value w indicating the unconsumed credit that wallet p has extended to wallet q , in other words, p owes w amount to q . Figure 1 shows the toy example of Ripple Trust Network in which balance of Jenny is 300 and Alan is 345, Rahul owes \$1000 to Jenny and Aman owes \$80 to Jenny. Consider a scenario where u wants to pay x to v . To perform the transaction, the credit value on every edge in the path from u to v is updated depending on the direction of the edge as follows: edges in the direction from u to v are increased by x , while reverse edges are decreased by x . For the settlement transaction to be successful, edges weights must always remain non-negative and must not exceed the pre-defined upper bound of the edge.

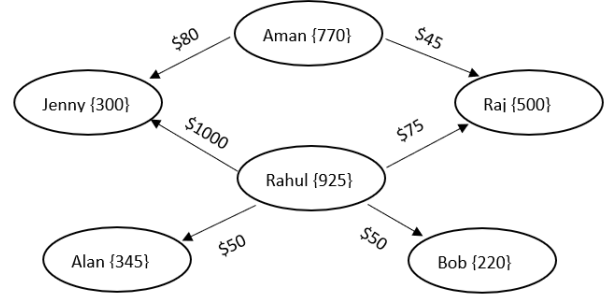


FIG 1: An illustrative example of Ripple Trust Network: Nodes represent wallets and balance in XRP currency, edges represent credit links between pair of nodes, weight on the edge represents the credit value that source node owes to the destination node.

F. Gateways

A new wallet willing to interact with others in the Ripple network, and not yet having any trusted wallet to interact with, needs to receive some trust amount on a credit link. The Ripple network solves this bootstrapping problem by introducing gateways. Ripple Gateways are businesses that provide an entry point into the Ripple Network. They enable customers to transfer funds – both fiat and cryptocurrency using the Ripple Network. Customers can use the Gateway to deposit funds in exchange for Ripple trust credits issued by the gateway, transfer their credits to another Ripple address, Withdraw funds by redeeming Ripple credits issued by the gateway.[7]

III. DATA COLLECTION

In this section, we describe the methods used in this study to collect Ripple trust set transactions data. We describe our data set in terms of number of transactions, number of wallets involved in those trust set transactions, currencies playing an active role in the Ripple Trust Network

A. DATA SOURCES

Ripple Data Server: The Ripple company maintains a set of public servers at api.ripple.com and history.ripple.com. We connected to them and crawled the Ripple trust set transactions, following the protocol defined in their corresponding API.[5]

API Method: Since our study focuses on the trust set network in the Ripple, we used the method

specifically to get the transactions related to creating, updating, or removing trust lines between the wallets. The method used in fetching data is `/v2/transactions/` and it accepts parameter such as `start` in form of timestamp string, which filter results to this time and later, `end` which filter results to this time and earlier, `type` which accepts string and filters the transactions to specific type(In our case it is *TrustSet*).

B. COLLECTED DATA

The study used the public API of Ripple public servers to fetch the transactions from the ledger. The collected data include transactions from January 2019 until November 2020. As of December 1, 2020, we collected a total of 2,39,355 trust set transactions.

Trust Transaction Format: Figure 2 shows an example of trust set transactions fetched from the data source mentioned in the above section.

- *LimitAmount*: Object defining the trust line to create or modify
- *LimitAmount.currency*: The currency to this trust line applies to, as a three-letter ISO 4217 Currency Code or a 160-bit hex value according to currency format. "XRP" is invalid.
- *LimitAmount.value*: Quoted decimal representation of the limit to set on this trust line.
- *Account*: The unique address of the account that initiated the transaction[9]
- *LimitAmount.issuer*: The address of the account to extend trust to.[8]

```
{
  "TransactionType": "TrustSet",
  "Account": "ra5nK24KXen9AHvsdFTKHSANinZseWnPcX",
  "Fee": "12",
  "Flags": 262144,
  "LastLedgerSequence": 8007750,
  "LimitAmount": {
    "currency": "USD",
    "issuer": "rsP3mgGb2toYUrx1LFiHJiQXhsziegtwBo",
    "value": "100"
  },
  "Sequence": 12
}
```

FIG 2: Example of Trust Transaction in JSON Format

Ripple Trust Network: The Ripple Trust Network was generated using the Pyvis library of Python which helps in forming the interactive

graphs as shown in Figure 3. The edge going from one wallet to another represents trust set transaction performed(source wallet owes to destination wallet). The interactive capability of the Pyvis Graph and NetworkX library of Python helped us analyzing the network.

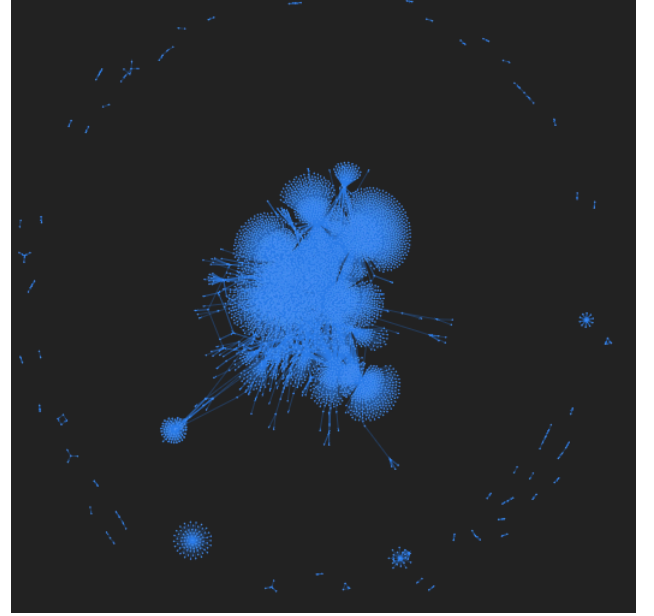


FIG 3: Visualisation of Ripple Trust Network from transactions between January 2019 until November 30, 2020

Pattern of Transactions: We observe the pattern of trust set transactions from the data obtained. We observe the spike on January 10, 2020 as shown in Figure 4. The spike has not been documented as spam in the Ripple community.

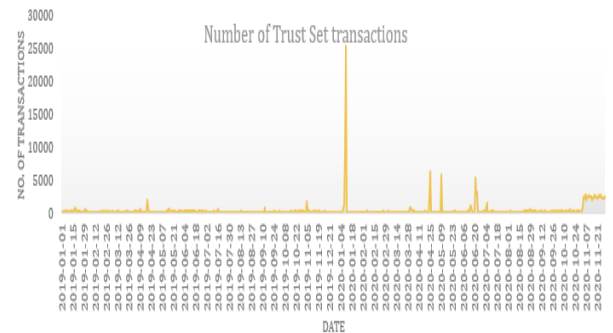


FIG 4: Pattern of Ripple Trust Set transactions between January 2019 until November 30, 2020

C. METRICS

Average Degree: The average degree is used to measure the number of edges compared to the

number of nodes. The average degree is simply the average number of edges per node in the graph. The average degree of the Ripple Trust Network is 3.1715.

Density of Graph: Density of Graph is the ratio of actual edges in the network to all possible edges in the network. The density of the Ripple Trust Network is $7.83e-05$.

Diameter: Diameter is the longest of all shortest paths. After calculating all shortest paths between every possible pair of nodes in the network, the diameter is the length of the path between the two nodes that are furthest apart. The measure gives the sense of the network's overall size, the distance from one end of the network to another. The diameter of the Ripple Trust Network is 12.

Clustering Coefficient: The clustering coefficient is a measure of the degree to which nodes in a graph tend to cluster together. The clustering coefficient of the Ripple trust network is 0.14807.

IV. ANALYSIS

In this section, we present the analysis of the network generated from the trust set transactions data. We observe the top trusted wallets and currencies used in the trust transactions between the wallets. We also study the pattern of trust between two wallets. We observe the pattern of transactions involved with top nodes.

A. Degree Centrality

Degree centrality is defined as the number of links incident upon a node (i.e., the number of ties that a node has). If the network is directed (meaning that ties have direction), then two separate measures of degree centrality are defined, namely, indegree and outdegree. Indegree is a count of the number of ties directed to the node (head endpoints) and outdegree is the number of ties that the node directs to others (tail endpoints). In such cases, the degree is the sum of indegree and outdegree[2]

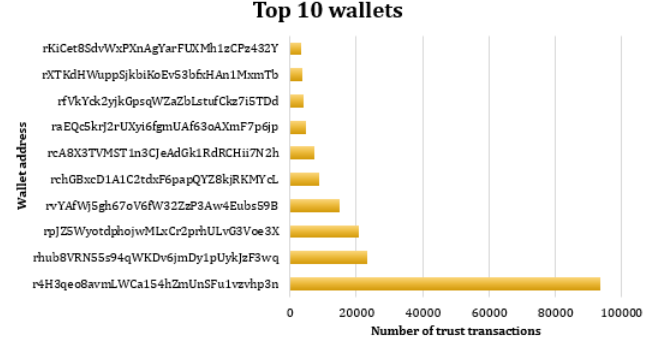


FIG 5: Top wallets based on degree centrality in the Ripple Trust Network

We observe the wallets with a high degree of centrality. Figure 5 shows the top 10 wallets involved in trust set transactions.

B. Most Active Currencies

All currencies other than XRP can be represented in the XRP Ledger as issued currencies. These digital assets (sometimes called "IOUs") are tracked in accounting relationships, called "trust lines," between addresses. Issued currencies are typically considered as liabilities from one perspective and assets from the other, so the balance of a trust line is negative or positive depending on which side you view it from. Any address may freely issue (non-XRP) currencies, limited only by how much other addresses are willing to hold. The issuer of the currency, called a gateway, handles deposits and withdrawals to exchange currency outside the XRP Ledger for equivalent balances of issued currency in the XRP Ledger. In this section, we observe the most-active currencies in trust set transactions.

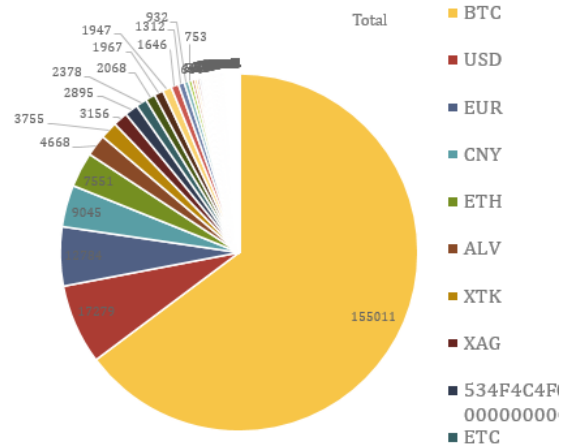


FIG 6: Currencies with the highest number of transactions in the Ripple Trust Network.

As shown in Figure 6, the highest number of trust transactions involved Bitcoin currency, followed by US Dollars and Euro.

C. Trust Pattern between two Wallets

In this section, we observe the pattern of trust extended from one wallet to the another. Figure 7(top) shows the trust pattern between the account and issuer *rBHWm3dzrSm8uuyTrTTj5T4UgYXqwUwRY* and *rXTKdHWuppSjkbikoEv53bfxHAn1MxmTb* respectively. The trust pattern between *r9xYSiMrPinU9k5sAK9YgZhKiwgHP7Cvd3* account and *rXTKdHWuppSjkbikoEv53bfxHAn1MxmTb* issuer is shown in figure 7(bottom).

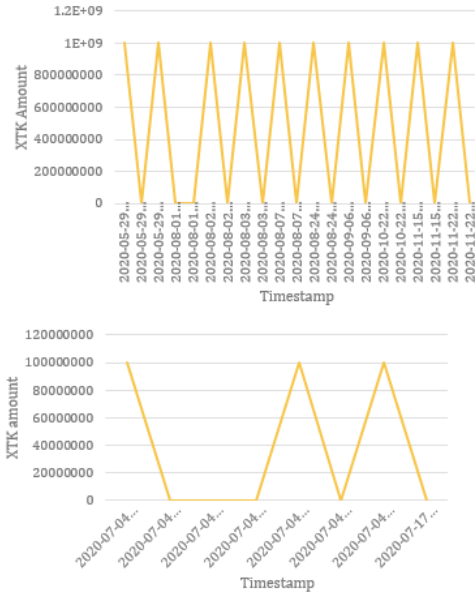


FIG 7: Trust pattern of issuer *rXTKdHWuppSjkbikoEv53bfxHAn1MxmTb* with an account *rBHWm3dzrSm8uuyTrTTj5T4UgYXqwUwRY* (top) and *r9xYSiMrPinU9k5sAK9YgZhKiwgHP7Cvd3* (bottom).

The graphs clearly show the oscillating pattern of the trusted amount between two wallets. The credit line extended from one wallet to another wallet oscillates between 0 and some positive value. We assume from the pattern that some trusts are extended only for the purpose of creating the path between the wallets, to perform the transaction. Once the transaction is successfully performed, the trust is broken(the amount of trust line becomes 0) and recreated for the next trans-

action(amount of trust line becomes some positive value).

D. Transaction Pattern of Top Wallets

In this section, we observe the evolution of number of transactions and average time gap between the transactions for the most active wallets in Ripple Trust Set Network.

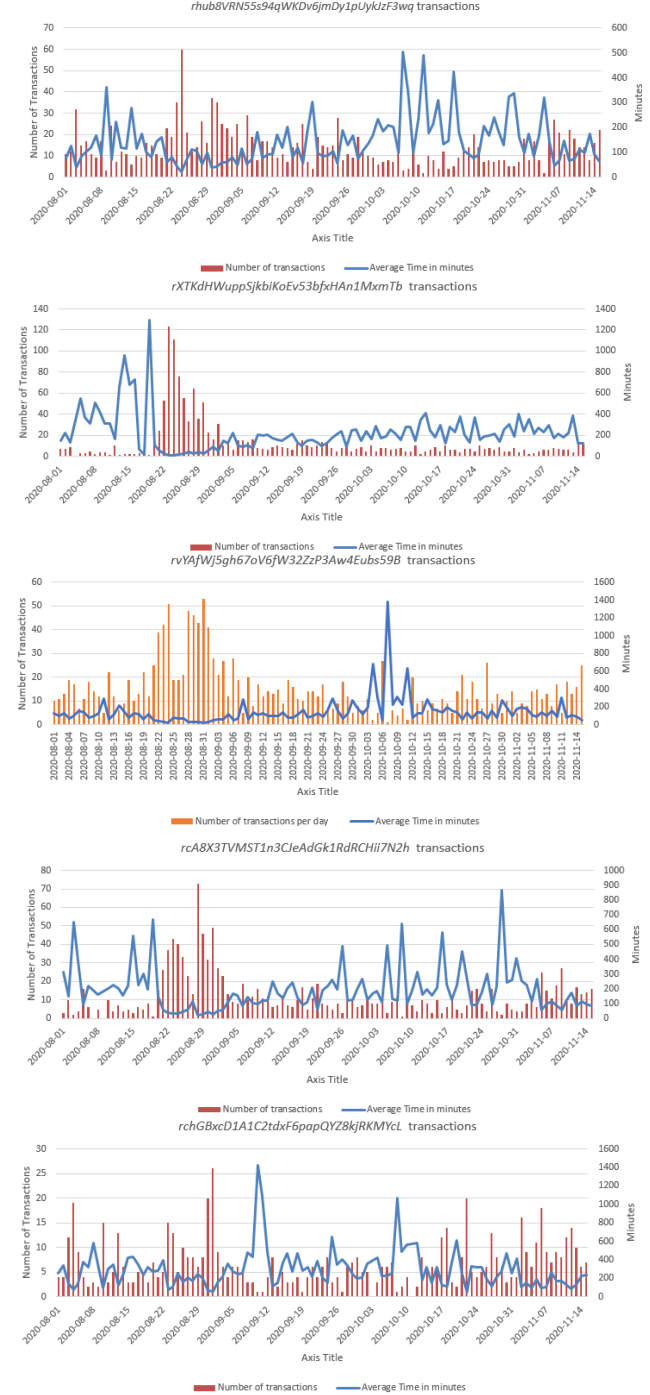


FIG 8: Trust transactions pattern and average time gap between transactions of most active wallets.

Analyzing the graphs of the top 5 wallets in Figure 8, we noticed that the average number of transactions lied in the range of 7 - 12 transactions per day with the average timespan of 100-200 minutes between two transactions. Noticing the trend in all the five graphs we noticed that there was a sudden spike in the transactions in the last week of August on further analysis for those dates it was found that there was a sudden spike in the price of XRP by \$0.10 reaching to slightly above \$0.30 from \$0.20. After that in the next few weeks, the price was dropped low so we perceived that can be the reason for very few transactions as people were holding onto their assets which can be seen in the graphs of all the top wallets. In November there a sudden price increase in the price of XRP which again can be related to a greater number of trust set transactions so people can trade more. In the overview, we can see the number of trust set transactions is derived by the price of XRP.

V. CONCLUSION

The study analyzed the Trust Network of two years trust set transactions fetched from the Ripple public data server. Additionally, we studied the important trust network metrics such as node degree, the diameter of the graph, density, and degree centrality. The research shed light on most used wallets in a trust set transactions and currencies that are mostly used in extending the credit line from one wallet to another. More interestingly, the study observed a pattern of trust between two wallets. We also observed the pattern of transactions of most active wallets. The study analyzed the average time gap between two transactions related to building or updating the trust. We were able to visualize the oscillating pattern of trust between two wallets.

Our analysis thereby opens the way for several interesting future works. More research may be realized by a machine learning approach and considering more amount of data to view the broader image of Trust Network. There is a need for a better understanding of the overall trust pattern between two wallets of the Ripple network since this study focused on the trust pattern of top wallets only.

VI. ACKNOWLEDGMENT

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REFERENCES

- [1] Becoming a Ripple Gateway. Ripple online documentation. <https://ripple.com/build/gateway-guide/becoming-a-ripple-gateway>
- [2] Ripple Website. <https://ripple.com/>.
- [3] Ripple Labs Signs First Two US Banks. Ripple Blog, Sep 2014. <https://ripple.com/blog/ripple-labs-signs-first-two-usbanks>
- [4] Hot and Cold Wallets. Ripple online documentation. <https://ripple.com/build/gateway-guide/hot-and-cold-wallets>.
- [5] XRP Online Ledger: <https://xrpl.org/>
- [6] <https://xrpscan.com/>
- [7] Ripple Gateway List. Ripple online documentation, Nov 2015. <https://ripple.com/knowledgecenter/gatewayinformation>
- [8] TrustSet Transaction : <https://xrpl.org/trustset.html>
- [9] TrustSet Common Fields : <https://xrpl.org/transaction-common-fields.html>