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BLOCKCHAIN DISTRIBUTED LEDGER FOR TRANSACTION CONSENSUS AND COMPLETION

[1]Prince Bhagat, [2]Abhinav Kumar Thakur, [3]Priyadarshan Todmal, [4]Omkar Dabir, [5]Prof. Tushar A. Rane

[1]Student, [2]Student, [3]Student, [4]Student, [5]Assistant Professor

[1]Department of Information Technology,

[1]Pune Institute of Computer Technology, Pune, India

Abstract : Nowadays, as per the rules and regulations of RBI, the cardholders can withdraw cash from any bank's ATM, he/she need not be restricted to the bank's ATM where the account is present. And as many people use a debit card, they frequently exercise this facility, due to financial or medical emergencies sometimes, location restrictions, bank limitations on the no. of transactions of one's debit card per month, etc. In financial terms, these types of transactions are called OFF-US transactions: where the issuing bank (the bank which has issued the card to the customer) and acquiring bank (the other bank whose ATM you intend to use) are different entities. The current system of handling such OFF-US transactions has a few drawbacks, firstly, the consensus is not achieved amongst the involved banks, and secondly, regarding discrepancy or mismatch of transaction status in case of failure during interbank transactions via NPCI, where the cardholder is unable to withdraw cash from ATM, yet money is deducted from his/her account. Due to these limitations, the reconciliation process becomes very time-consuming, and the card bearer suffers a lot due to delays in settlement for the amount deducted. To overcome the above-mentioned drawbacks is the purpose of this research undertaken. We intend to introduce distributed ledger technology based on Blockchain Hyperledger Fabric to achieve transaction consensus amongst the involved banks as well as NPCI, thus easing the reconciliation process and making the settlement process, to the debit card customer, efficient.

IndexTerms **- RBI, ATM, Blockchain, Distributed Ledger, OFF-US transactions, Hyperledger Fabric, NPCI, NFS, CBS, Consensus, Reconciliation, Settlement, RTGS.**

I. INTRODUCTION

1.1 Background

Failure of transactions in ATMs is a huge issue for debit cardholders in India because the reconciliation and settlement process are inefficient and non-transparent from the customer's viewpoint. The Reserve Bank keeps receiving many complaints from bank customers alleging that money from their accounts has been debited although ATMs have not dispensed cash for various reasons. More importantly, banks take a long time to reimburse cardholders for the sums involved in unsuccessful transactions. In many circumstances, the process can take up to 50 days. The above-mentioned delay is unjustified, as it leaves clients without funds for an extended period due to no fault of their own. Furthermore, clients may be discouraged from utilizing ATMs as a result of the wait [1].

Manual intervention from both the respective banks and the regulatory authority is required to verify, validate, and settle the complaint of each user. Thus, it makes the process tardy.

1.2 Relevance

This happens because no consensus is built right now. This is a significant pitfall of the currently existing process of reconciliation and settlement as there are tons of failed ATM transactions reported every year due to which thousands of cardholders suffer enormously. Even in situations of medical or financial emergency, they still have to comply with this exhausting and time-consuming process of reconciliation and money settlement.

Thus, to meet the challenge of customer dissatisfaction and specifically provide a sense of assurance and relief to ATM users in both metro and non-metro cities, we aim to introduce "blockchain" innovation which is capable of debottlenecking the current process of reconciliation and settlement of money in the banking industry, for all customers.

1.3 Research Purpose

The main idea of the research is to introduce distributed ledger technology i.e., Blockchain's Hyperledger Fabric to achieve transaction consensus amongst the involved banks in case of OFF-US transactions, so that in case of successful or unsuccessful OFF-US transactions in the real world, both reconciliation and settlement, can be facilitated in a very time-efficient manner.

II. BACKGROUND AND LITERATURE SURVEY

Before understanding the existing system of ATM transactions, we must get familiar with some government agencies involved in the sector.

National Payments Corporation of India (NPCI). The Reserve Bank of India's specialized section, the National Payments Corporation of India, is governed by the Ministry of Finance of the Government of India. It was established by the Reserve Bank of India to manage India's retail payment and settlement systems [2]. The National Financial Switch (NFS) is one of its ATM-related services. In India, there is a network of shared automated teller machines. The NFS network is the country's largest domestic ATM network.

National Financial Switch (NFS). NFS has been at the forefront of providing interbank ATM services to the greatest number of consumers [3]. The NFS network initially supported the following basic transactions: Cash Withdrawal, Balance Enquiry, PIN Change, and Mini Statement.

Core Banking Solution (CBS). Customers may monitor their accounts and use numerous banking services from anywhere in the world thanks to the Core Banking Solution (CBS), which connects bank branches. To put it another way, you don't need to go to your local branch to conduct banking transactions. You can do it at any time and from any location. The customer of a bank that uses CBS becomes the bank's customer rather than the customer of a specific branch.

To understand the existing system of ATM network let us consider a sample case of both successful and failed transactions and figure out the drawbacks. Consider the diagram (refer Fig.1) consisting of three banks (Green, Red, and Blue) and NPCI.

2.1 Successful and Failed Transactions

Consider a cardholder of the green bank, who wants to withdraw cash from the ATM of the Red bank. As the card is inserted into the ATM and the cash amount is requested for withdrawal, the red bank evaluates whether the card inserted is of the same or different bank. After it detects that the card belongs to the green bank, the request is forwarded to NPCI and further forwarded to the green bank. The CBS of Green bank verifies the account details of the cardholder and deducts the requested amount, if it is well within the available balance, from the customer's bank account, and a successful transaction record is generated for the green bank. Now, this success message is forwarded to NPCI where again a success transaction record is generated and lastly the message reaches red bank, only after which, does it allow the ATM to dispense the cash. After the cardholder successfully withdraws the cash amount, finally, a "successful transaction" is recorded for the red bank as well. This was a simple scenario of a successful OFF-US transaction.

The OFF-US transaction is the transaction where the issuing bank (the bank which has issued the card to the customer) and acquiring bank (the other bank whose ATM you intend to use) are different entities.

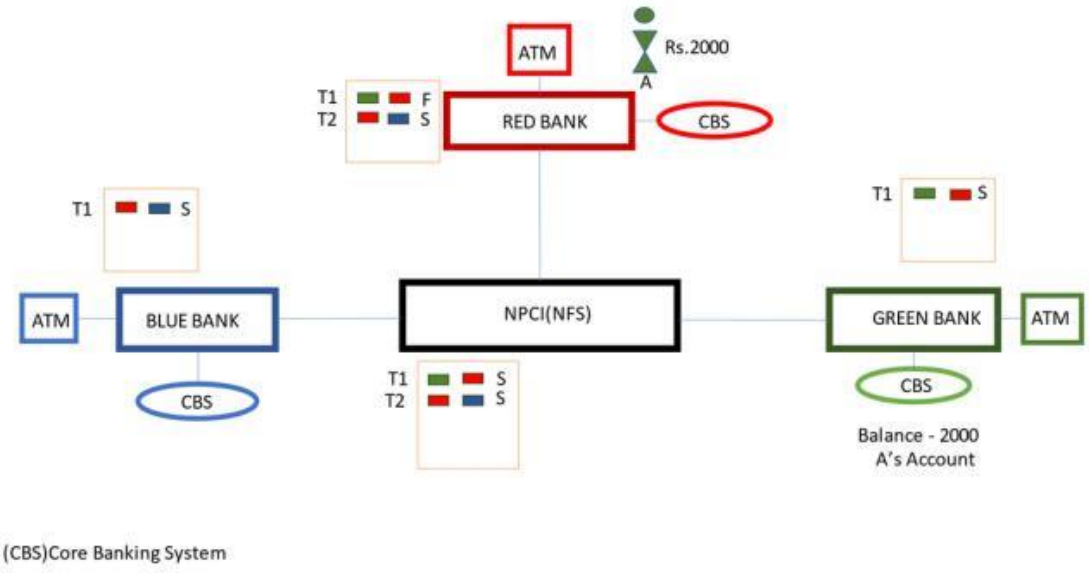

Fig.1: Interbank ATM network Transaction.

The multilateral switch is used in the case of OFF-US transactions to provide interoperability. It routes transactions from the acquiring bank to the issuing bank and routes the authorization, settlement, and reconciliation messages. An OFF-US transaction in the case of funds transfer may involve multiple banks, viz., the acquiring bank, the issuing bank, and the recipient's bank, and the process is put through by the multilateral switch. This multilateral switch is operated by NPCI and other interbank switch vendors [4].

Now, let us look into the scenario of an unsuccessful OFF-US transaction. If due to network delay or timeout, the NPCI success message is not received by the Red bank server or the NPCI message is received, but, the ATM does not function properly due to electricity issue/centralized server load and ultimately the cash is not dispensed by the ATM, in such a case,

though, the amount is deducted from the card holder's account in the Green Bank and a success record available at Green bank as well as the NPCI, the Red bank considers it as "failed transaction". Here, the main problem arises that, the records for the same transaction are not identical within the two involved banks and NPCI. There is a discrepancy in transaction status for this particular OFF-US transaction, across the involved banks.

2.2 Drawbacks in the Current System

In the current system of handling such OFF-US transactions, the consensus is not achieved amongst the involved banks due to which manual intervention of bank authorities is required, as a result of which, settlement process efficiency is compromised.

Regarding discrepancy or mismatch of transaction status in case of failure during interbank transactions via NPCI, where the cardholder is unable to withdraw cash from ATM, yet money is deducted from his/her account. In such cases, the reconciliation process is very time-consuming, and the card bearer suffers a lot due to delays in settlement for the amount deducted.

The reconciliation process is a significant pitfall of the current system, millions of failed ATM transactions reported every year due to which tons of both metropolitan and rural customers suffer enormously. There is an adverse impact on ATM users in small towns or villages like farmers or senior citizens who are unaware of the whole manual paperwork of banks. Already being financially deprived, they still have to comply with this exhausting and time-consuming process of reconciliation. The proposed system plans to overcome these drawbacks.

Also, in the case of a successful OFF-US transaction, where money is dispensed to the cardholder properly, NPCI has to regulate Interbank settlement, because the money the cardholder got was provided from the ATM of the other bank, and the card holder's issuing bank should compensate the second bank's ATM with that amount.

For this, the Real-Time Gross Settlement (RTGS) system is the current infrastructure service for inter-bank payment and settlement. But by using blockchain, we can increase the efficiency in terms of time utilization of the traditional RTGS system. Also, the traditional RTGS systems grant all privileges to central banks and operate on the unconditional trust of central banks. But this situation can be tackled as, in blockchain, a decentralized network of nodes is present.

So, to meet the challenges of customers and banks specifically, we aim to introduce "blockchain" which is capable of debottlenecking the current process of reconciliation and settlement of money in the banking industry and achieving uniform transaction status via distributed ledger consensus for all transactions in real-time.

III. BLOCKCHAIN HYPERLEDGER FABRIC

Hyperledger is a collaborative project to create an open-source, enterprise-level, distributed ledger [5]. It is a permissioned blockchain platform made up of peers who each have a specific function to play.

A ledger (a ledger represents the current state of a business as a log of transactions) in Hyperledger Fabric is made up of two independent but linked parts: a world state (refer Fig.2) and a blockchain. Each one represents a set of information about a set of business objects. There's a world state, which is a database that keeps track of the current values of a set of ledger states. Instead of needing to calculate the current value of a state by traversing the full transaction log, the world state allows a program to directly access it[6]. By default, ledger states are expressed as key-value pairs, and we'll see how Hyperledger Fabric offers flexibility in this regard later. States can be generated, changed, and destroyed; therefore, the world state can change constantly. Second, there's a blockchain, which is a public ledger of all transactions that have led to the current state of the world. Transactions are gathered in blocks that are appended to the blockchain, allowing you to see the history of changes that led to the current condition of the world. The blockchain data structure differs from the global state in that it cannot be changed once it has been written; it is immutable.

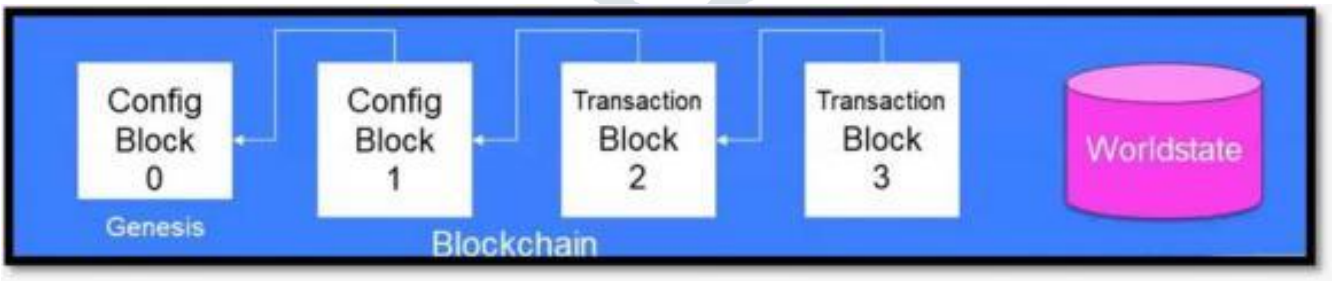

Fig.2: Blockchain Hyperledger Fabric World state.

3.1 Architecture Features

HF is a distributed system made up of nodes that may communicate with one another. A node is a fundamental logic entity. There are three different kinds of nodes. End-users' transaction suggestions are submitted by the client. A peer is a computer that commits transactions and keeps a copy of the ledger (refer Fig.3) [7].

The orderer ensures that messages provided to each node are delivered in the same order (i.e., consensus). Users write chain code to specify business logic and deploy it on the blockchain. Transactions are commands that are sent to the chain code. A transaction modifies the state of the blockchain, and all changes are recorded in chronological order in a ledger.

The current state of the ledger, also known as the world state, contains the most recent keys and values in the network. A channel enables a subset of peers to communicate to form private transactions. Only channel participants have access to the ledger

in this channel, which is shared among peers in the same channel. The structure of the blockchain network is determined by the channel, which is the cornerstone of data isolation and private transactions in HF.

3.2 Proposed Methodology

HF allows for sophisticated user privacy and data separation protection. We propose to develop a decentralized network topology in response to privacy concerns. We propose to build peer-to-peer links between every two commercial banks using channels, which is the key mechanism for data segmentation in HF, in contrast to standard RTGS systems.

This design assures that only those who need to know have access to shared ledgers; private data will be physically separated into different groups, each with its own set of access controls. Smart contracts define the business logic, with a pluggable consensus protocol ensuring consistency and finality. It's appropriate for high-value interbank payment solutions because of its modular architecture, flexible business logic, and mature access control mechanism. Hyperledger Fabric will be the foundation of our solution. The proposed system (refer Fig.4) consists of a channel created for permissioned members such as involved banks and central authorities. In Hyperledger Fabric, each channel has a completely separate ledger. This means a completely separate blockchain, and completely separate world states, including namespaces. It is possible for applications and smart contracts to communicate between channels so that ledger information can be accessed between them.

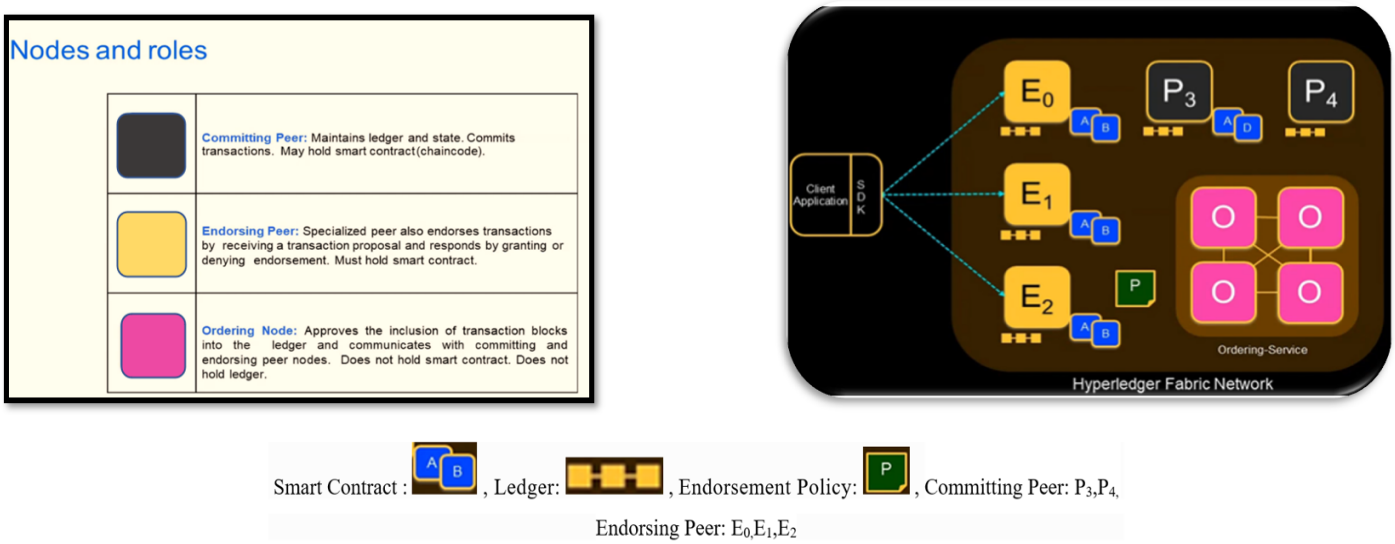

Fig.3: Hyperledger Fabric System Components and Network Architecture

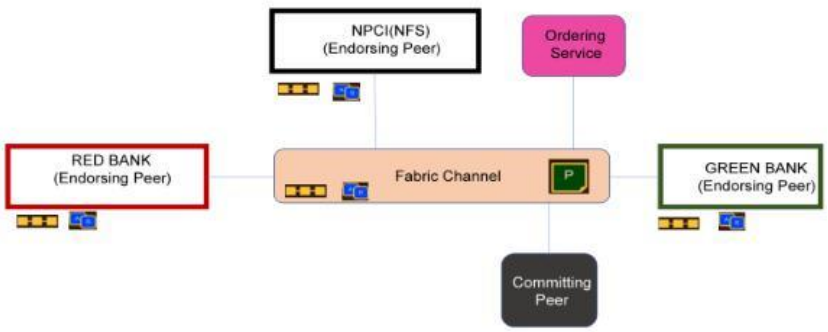

Fig.4: Proposed system model depicting channel between Red and Green bank.

3.3 Smart Contracts and Error Code Handling

Smart contracts are simply programs stored on a blockchain that run when predetermined conditions are met[8]. They typically are used to automate the execution of an agreement so that all participants can be immediately certain of the outcome, without an intermediary's involvement or time loss. When a transaction is finished, NPCI gets a response that contains the status code of the transaction. If the transaction is not successful for any reason, the appropriate error code will be received. The business logic written will handle the response and trigger certain smart contracts depending on the error code received. Smart contracts then will execute the required steps such as updating the consensus and sending alerts about transaction failure. Smart contracts can also be useful for settlements between banks and crediting money back to the user after the transaction failure.

IV. RESULTS AND DISCUSSION

Thus, the Hyperledger fabric platform of Blockchain can provide a decentralized trust network with a reliable consensus mechanism. Once a transaction happens in ATMs between banks, by application of Blockchain, we can build up a consensus between concerned banks within sometime of transactions, and the transaction status or return code of ATM across all the nodes in the network containing distributed ledger would be uniform.

So, the discrepancy of the mismatch in transaction status need not be resolved manually, thus overcoming the failure situation. Finally, by leveraging the immutability of the blockchain ledger, governing authorities can trace back the history of records and conduct reconciliation and settlement, both in case of successful or unsuccessful OFF-US transactions of real-world, in a very time-efficient manner.

V. CONCLUSION AND FUTURE WORK

Thus, a solution has been proposed for interbank transaction status consensus and completion based on permissioned Blockchain Hyperledger Fabric. The implementation helps achieve secure and early consensus along with settlement between banks and central authorities such as NPCI(NFS).

Channels can be created for the banks and involved authorities which are secure and cannot be accessed by other members on the network. This system would be able to implement a distributed ledger as well as handle interbank settlements through smart contracts to reduce work. We can further have additional banking facilities integrated into the system wherein messages can be generated to handle error codes.

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