

Instant Payment Framework Based on Blockchain Technology and Open API Architecture to Improve the E-Payment System of The Local Banks in Egypt

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**The Paper extracted from the Dissertation under the Title:
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مستخلص: تبحث هذه الدراسة في كيفية استخدام تقنية سلسلة الكتل في تحسين المدفوعات والمعاملات بين البنوك المحلية من خلال تقديم إطار عمل قائم على سلسلة الكتل واستخدامه من أجل إجراء الدفع الفوري والمعاملات المالية بين البنوك المحلية حيث تعتبر تقنية سلسلة الكتل تقنيه واعدته وسيكون لها تأثيرات كبيرة على الصناعة المصرفية نظرًا لإمكانياتها وقدرتها على تمكين طرق جديدة لتنظيم ومعالجة أنشطة الصناعة المصرفية ، وتقليل التكاليف والوقت المرتبط بالوسطاء ، وتحسين الثقة والأمن. وتظهر النتائج أن خصائص تقنية سلسلة الكتل (تعزيز الأمان والشفافية وثبات المعلومات والتسوية اللحظية للمعاملات) واستخدام بنية واجهة التطبيقات المفتوحة سيكون له تأثير إيجابي كبير على نمو المدفوعات الإلكترونية والمعاملات المالية بين البنوك في مصر. سيوفر الإطار المقترح الذي يستخدم سلسلة الكتل وبنية واجهة برمجة التطبيقات المصرفية المفتوحة في تحويل الأموال بين البنوك المحلية فرصة كبيرة للبنوك وتأثير إيجابي على استراتيجية التحول الرقمي ، والشمول المالي ، ورقمنة المدفوعات ، وتمويل الشركات الصغيرة والمتوسطة ، وزيادة الشراكات مع شركات التكنولوجيا المالية واستخدام التقنيات المبتكرة بشكل أكبر لتحقيق الكفاءة في الخدمات المصرفية والمدفوعات.

Abstract: This study investigates how the use of blockchain technology can improve the payments and transactions between local banks by introducing blockchain based framework and using it in order to make instant payment and financial transactions between local banks. Blockchain technology is considered to have high impacts on banking industry because its potential and the ability to enables new ways of organizing and handling the banking industry activities, reduces costs and time associated with intermediaries, and improve the trust and the security. The findings show that the blockchain technology characteristics (Enhanced Security, transparency, information immutability, and faster settlement) and using open API (Application Programming Interface) architecture will give us seamless integration of financial services and application and using this approach will have significant positive impact on e-payments growth and the financial transaction between banks in Egypt. The proposed framework which uses the blockchain and open banking API architecture in fund transfer between local banks will provide great opportunity and space to banks to improve and positively impact for digital transformation strategy, financial inclusion, digitization of payments, SME finance, Increasing access points, partnerships with FinTechs and using innovative technologies further to bring efficiency in banking and payments.

Keywords: Blockchain Technology, Information Technology, E-Payment, E-Banking, Banking Integration, Open APIs

1 Introduction:

Over the last few years, a major (Information Technology) IT innovation known as blockchain technology has emerged as a potentially disruptive technology. The idea of a global consensus ledger, which is kept and maintained on a distributed network of computers, is the main concept of this technology. Blockchain technology has become popular since the introduction of bitcoin as digital currency. The bitcoin mechanism was introduced by Satoshi Nakamoto in 2008 in a paper entitled Bitcoin: A Peer-To-Peer Electronic Cash System (Nakamoto,2008). This paper introduces a new approach of electronic payments that allows the funds to be sent directly from one party to another without going through a financial institution (Crosby,2016). Blockchain is the name of the technology behind this.

Blockchain, is a type of Distributed Ledger Technology that has been defined as “an incorruptible digital ledger of economic transactions that can be programmed to record not just financial transactions but virtually everything of value” (Don & Alex ,2016). It acts as a shared database, keeping all of its copies synced and verified. The blockchain innovation is still in its initial stage, but among its characteristics is the potential to eliminate the need for third parties to act as a level of trust in exchange of transactions. The potential uses of the blockchain technology may bring a lot of expected benefits to the industry and give birth to a whole new generation of services. The Blockchain theme is a technology that can provide a strong and robust cyber security solution and a high level of privacy protection. Its proponents argue that such technology is safe by design. In a blockchain-based model, there is no need to store information with third parties (Kshetri, 2017). Blockchain is starting to be more significant to any business nowadays. According to (Tan et al. 2018), The blockchain technology market and its applications are expected to be worth around 13.96 billion dollars by 2023, with a compound annual growth rate of 42.8% over the forecasted period.

Distributed ledgers are public databases that no one controls, they are maintained by a group of people rather than being centralised in one location and the information is processed in a distributed ledger that is spread over thousands of locations (Pinna & Ruttenberg,2016).

The blockchain technology is a feature of a distributed ledger. The distributed ledger cumulatively stores the complete transaction history of the entire system, from its inception to the latest entry (Beck et al. 2016).

The data of the transaction is not stored in a central database, but it is distributed to all participants of the network to be stored locally (Mattila & Seppälä, 2015).

By this approach each node in the network has the same access to the database, while running the blockchain on their systems. The term “public distributed ledger”, refers here to a single shared truth (Christidis & Devetsikiotis, 2016).

The decentralized peer-to-peer system structure of a blockchain network is described in the figure 1 (Zheng et al. 2017).

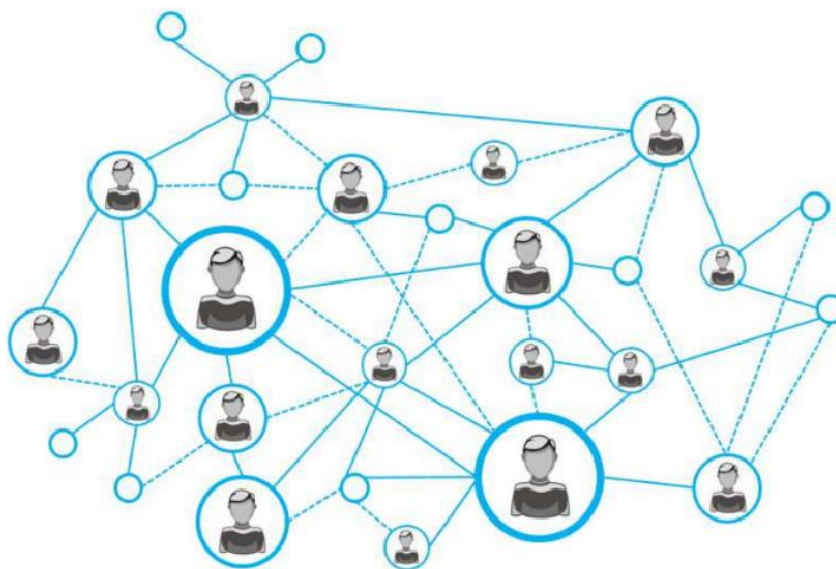


Figure 1: The decentralized peer-to-peer system structure

Source: <https://www.semanticscholar.org/paper/Digital-Identity-Management-on-Blockchain-for-Open/38e4ce3b747310a5189b53dd90bf8ca49313ccee>

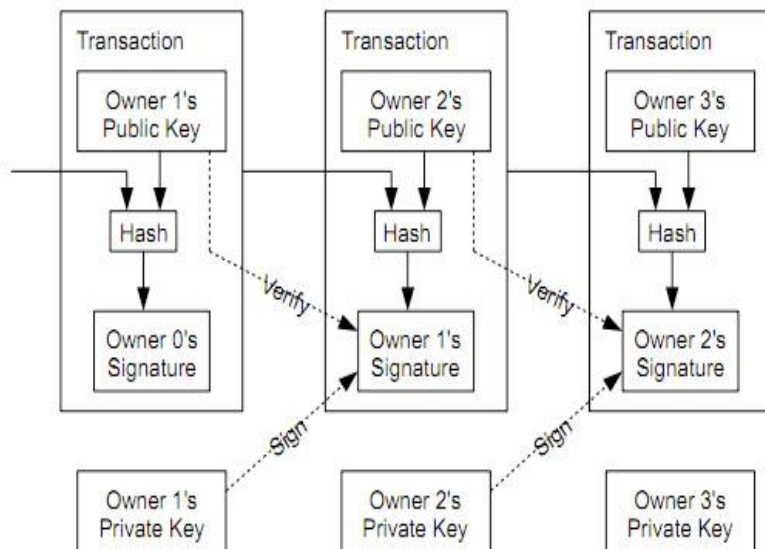


Figure 2: Security flow of the Blockchain Transaction

Source: https://www.researchgate.net/figure/The-data-structure-of-the-Bitcoin-Blockchains_fig1_330351295

All blocks in the Blockchain are in a chronological order. Every node has a copy of the Blockchain that is automatically downloaded when the miner enters the network. All information about all transactions ever executed is recorded in the blockchain (Swan, 2015).

According to the Blockchain implementation it is impossible to erase or alter the transaction once it was entered. Blockchain is a network and database that is safe and easy to use. Blockchain can create transactions based on mathematically specified and mechanically implemented rules.

Cryptographic algorithms verify all transactions between users or counterparties, which are then grouped into blocks and added to Blockchain. Since the information in blocks is linked together, no one can alter it.

By having the private keys required to write to the file, cryptography guarantees that users can only edit the parts of the blockchain that they "own." It also means that all copies of the distributed blockchain are up to date. The highest degree of hack resistance and security optimization is provided by blockchain, and its popularity is far from over.

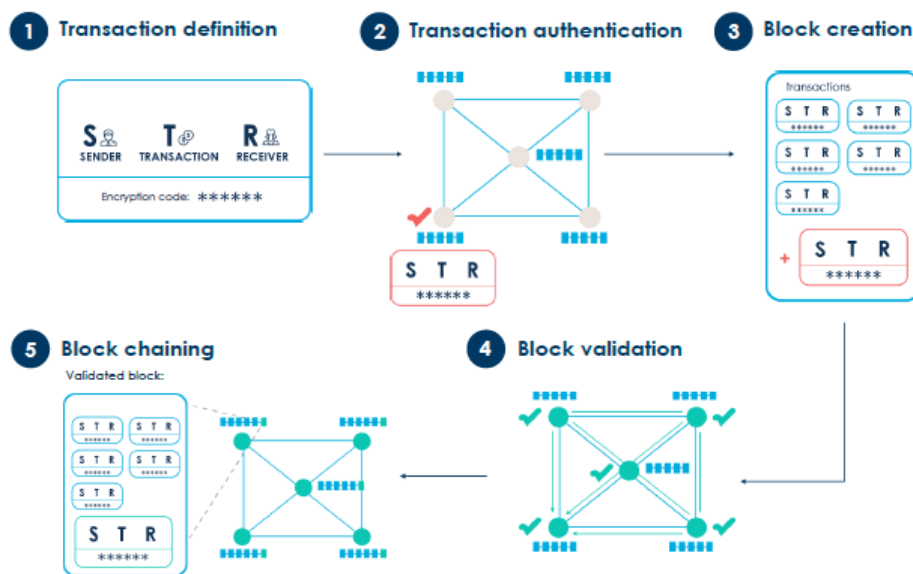


Figure 3: Transaction steps of the Blockchain

Source: https://www.researchgate.net/figure/Transaction-flow-in-a-Blockchain_fig1_342012510

Suppose person **A** want to send 100 units of value to person **B**

According to the blockchain architecture, all new transactions need to be grouped within blocks. Each block is verified and validated by the “nodes” (network participants) or the network “miners” using complex crypto techniques which will depend on the type of blockchain in our transaction example: the miners will verify that A is indeed owner of the hundred units of value and once this is confirmed, the transaction is validated and visible for B and the other network participants B thus becomes the owner of the that units.

All network participants are performing the necessary verification and approval tasks, mostly by receiving fees or new cryptocurrencies. If there is Mismatching, the block is rejected. Otherwise, authenticated transactions in the block are time stamped and applied to the transaction chain in a linear and sequential order, resulting in a chain of transactions that shows every network transaction in the transaction history of the blockchain.

2 Research Problem

Currently, the global financial system is enormous, Billions of individuals and businesses are served, and trillions of dollars are moved around the

antiquated global financial system each day. While we can send an email around the world in a second, transferring money can take days or even weeks to arrive at its destination. Financial intermediaries are required to transfer any sum of money, each of which takes a service charge. These financial middlemen are more often the victims of fraud than the rest of the economy, which results in greater regulation and higher costs for all parties involved. Blockchain would reduce the number of middlemen while also improving security, lowering costs. The velocity of money would increase as a result of blockchain, resulting in increased cash flow and capital investments.

financial institutions and banking systems should use blockchain technology to simplify local and foreign payments and bond trading. In the banking system of today international payments can take up to several days to reach their destinations and furthermore, they can be costly procedures. These types of payments can be exchanged instantly or in a matter of minutes with minimal transaction costs. However, unlike bitcoin transactions, these transfers cannot be made anonymously since they must be traceable. The regulatory and compliance requirements around the details of the transaction for transaction monitoring or validating the details of the originator and beneficiary for screening can be properly and easily implemented. The number of suspicious transactions for AML (Anti Money Laundering) purposes, as well as transactions through high-risk countries will be reduced.

3 The Research Hypothesis

- The blockchain technology has great opportunities to improve and reshape entire e-payment process between financial industries
- The financial sector can benefit from the new technology applying blockchain based payment architecture.

4 Objective

Applying blockchain payment-based framework to avail instant transaction between the sources of fund like bank accounts around the clock 7*24

The main Objective of conducting this paper is to investigate the hypothesis and know the impact of using blockchain based payment network on the performance of financial sector business process in Egypt.

5 Research Methodology

This paper had adopted the descriptive analytical approach, with descriptive analytical approach we will be able to understand the context of our problem and gain insight on what we have now in our payment network process and the different challenges within the current implementation of the E-payment networks and the blockchain requirements implementation. The reason we chose the descriptive analytical approach is to get a comprehensive understanding of the problems that we about to conduct a study on.

6 The Proposed Instant Payment Network Based on Blockchain and open API Architecture:

The open banking API allows a secure way of integration to give the third parties access to a user's financial information such as balances, customer information, cash flow, and creating transactions. This way of integration and communications is called open banking API.

Banks in the United Kingdom are now by law PSD2 (Payment Service Providers Directive) should provide account information about their customers to companies in other sectors, such as payment initiators or account aggregators.

PSD2 regulations require banks to develop processes that enable third-party providers to integrate safely, efficiently, and quickly with the bank's services and data on behalf of their customers, with their consent.

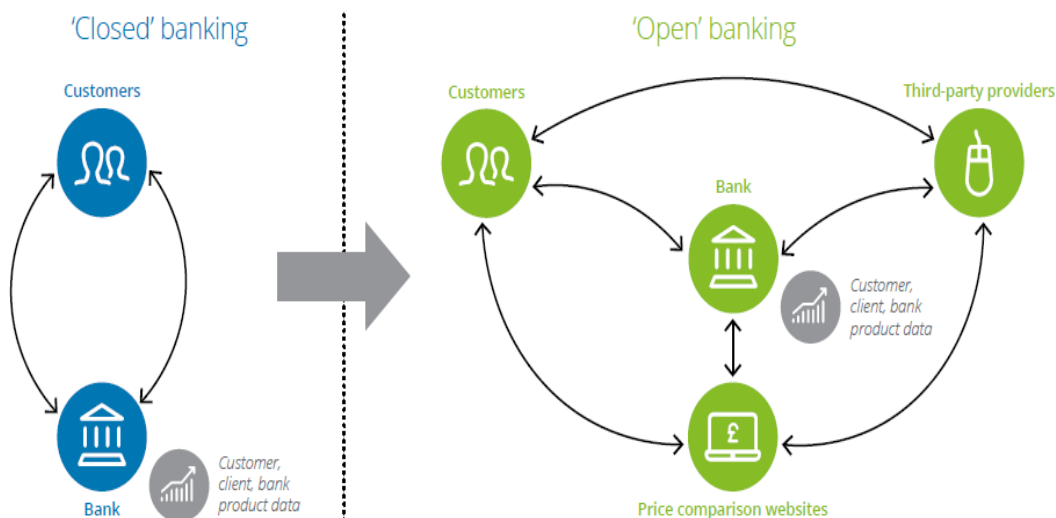


Figure 4: Open banking and closed banking transactions

Source: <https://zanders.eu/en/latest-insights/how-open-banking-will-change-the-banking-landscape/>

The rise of open platforms (Open API architecture) that are enabling buyers and sellers of a core service to come together without the help of any intermediary institutions. On the one hand, these systems allow companies to easily onboard using application programming interfaces, or APIs, and on the other, they allow consumers to quickly search for and use the services they want.

Currently, there are three types of APIs integration that used by banks:

I. Private APIs

These are for internal use of the bank or financial institution and are used for information exchange and creating transactions within the same private systems for example the integration between core banking system and the HR system inside the banks.

II. Partner APIs

These are open and built for building integration layer between banks and its strategic business partners, other governmental institutions or financial institution.

III. Open APIs

These make data and the operations to create specific transactions available to third-parties or other banks by using secure and pre-defined way of integration.

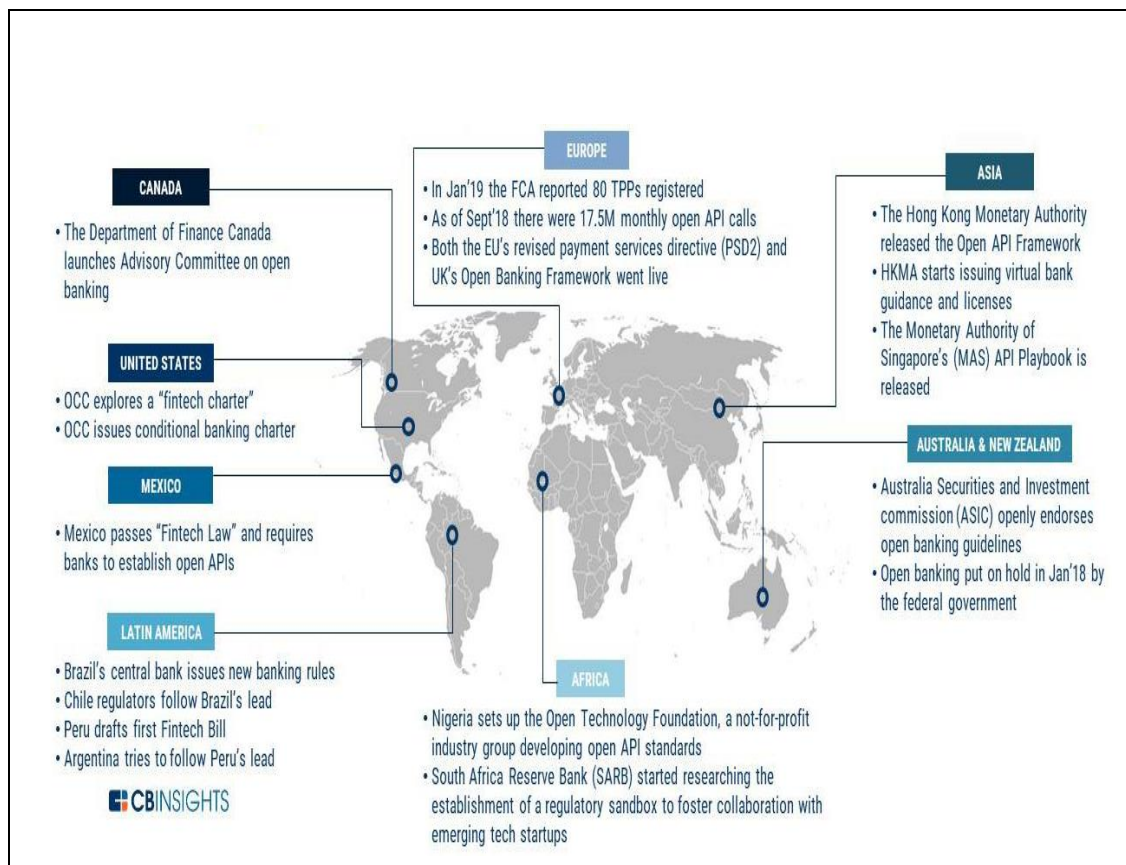


Figure 5: The spreading of the open banking across the world

Source: <https://www.paymentscardsandmobile.com/open-banking-the-future-of-banking/>

Using the open banking APIs, the banking industry will improve the customer satisfaction, financial inclusion and distribution e-channels, provide better products, services and customer support.

We will introduce the proposed framework to improve the e-payment systems in the banking industry with the fund transfer use-case, as it is one of the main applications of the e-payment systems.

6.1 The main Methods of Money transfer in Banking Industry

- a. ACH transfers (Automated Clearing House)
- b. wire transfers
- c. electronic transfers
- d. direct deposits
- e. e-checks
- f. ACH check conversions

Each money transfer method has pros and cons for example, a wire transfer is faster than all the other methods listed on this section, but it is also (usually) the most expensive.

Our current financial payment system relies largely on ACH transfers for money transfer between local banks, it is a reasonably good system, but one of the problems with it is that it takes time, money, and a lot of reconciliation activities to process transactions. Using Blockchain based payment systems can outsmart conventional wire transfer companies by providing a fast, low-cost, and safe method of transferring funds between banks.

ACH Transfer

An ACH transfer is the electronic movement of money between banks through the Automated Clearing House network. Automated Clearing House payments are electronic payments that can be made as single payments or as frequent and recurring payments.

- Pros

- ACH transfers are almost always cheaper than other methods
- It supports batch paying like employees and suppliers' payment
- Set up recurring payments so you do not have to do it manually
- There is no need to write or send checks
- Issues like missing checks and forged checks are no longer an issue

- Tracking our transactions is a little simpler
- It is more efficient than using checks
- Issues such as lost checks and forged checks become a thing of the past
- Tracking your payments is a little easier
- More environmentally friendly than using checks

- **Cons**

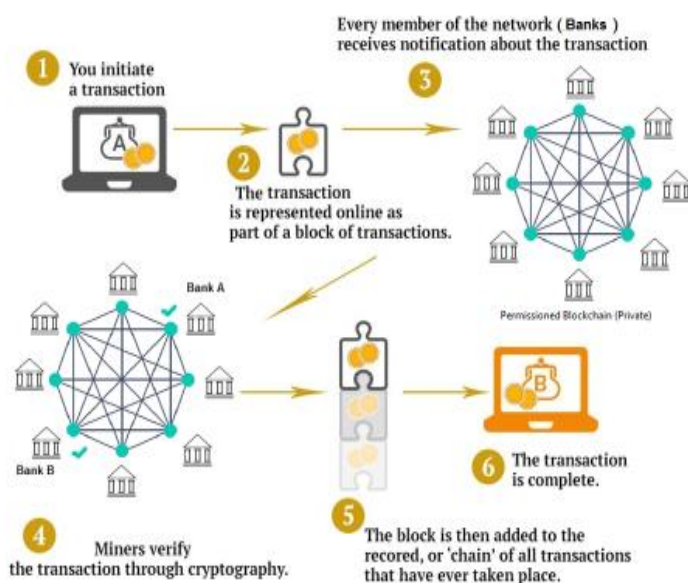
- An ACH transfer takes at least one night to be in the completed status
- Some ACH transfers take four to seven business days to be completed
- Using ACH to pay people in other countries is difficult and/or impossible.
- If you do not catch payment mistakes right away, they'll happen again.
- Some people forget about recurring transfers and end up paying more than they should.
- If you don't have the funds in your account when the transfer happens, you risk overdrawing your account.

Although sending money between banks via ACH can be convenient, we have the following system limitations:

- **Amount limits:** we could have a restriction on how much money we can transfer per specific period(day/month) and sometimes the restriction applied on the transaction level (the amount per transaction).
- **Cut-off times:** A transfer will not be accepted after a certain hour until the next business day. For example, if you submit money on a Friday, processing will not begin until the following Sunday.
- **Insufficient funds fee:** If you do not have enough money in your account, your bank can charge you a fee and cancel the transaction.

- **Not often available for international transfers:** Your bank probably will not allow consumer ACH transfers to banks outside the country.

Blockchain promises a more reliable way of storing and protecting data, which can reduce fraud while also reducing transaction times and fees.



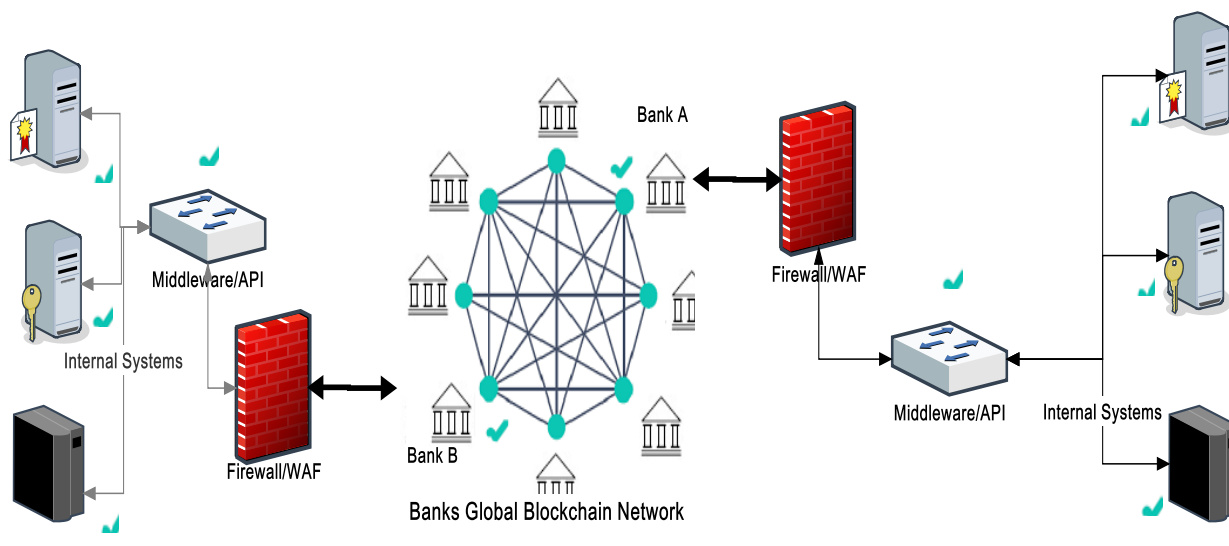


Figure 5: The proposed Blockchain based payment network

Prepared by Researcher

Blockchain and the concept of the distributed ledger has been echoing well among the banking and financial sector. Blockchain is a universal ledger present in a distributed network which is accessible to every member in the network so, each node in the network will have a complete copy of the entire database or replica of the ledger and any updates of the transactions. Any new transactions have to be verified by other network members (banks) to validate on the new transaction done. It requires a consensus of nodes to agree upon every change on the state of the ledger to be a valid state. This means that we can use this architecture for instant money transfer between banks without fear security and reconciliation because there are no intermediaries involved in the transaction flow between banks. Using blockchain based payment framework for instant payment between banks makes it possible for the banks to have a secure, visible and unchangeable transfer of value by using the standard process flow of the transaction in the blockchain architecture.

7 The Process Flow of The Standard Blockchain Transaction

- **Suppose Sender S wants to send data to receiver R:**
 - I. S (sender) initiates a financial transaction message includes the details of the recipient, the transaction details and a cryptographic digital signature that proves the authenticity of the transaction.
 - II. The blockchain node(initiator) authenticates the digital signature of the transaction and put the created transaction into the pending transactions pool.
 - III. The initiator node creates a block of pending transaction and broadcasts it to the network
 - IV. The other nodes in the network validate the block through a process called a “proof of work”
 - V. After validation of the transaction and proof of work, the block is added to the chain and all nodes can see the newly added block
 - VI. The value transferred from S to R
- The above process flow is the standard process flow of the blockchain transaction. Now, we will use the same concept of the process flow in addition to leveraging open banking API to our process flow as flows:

8 The Process Flow of The Proposed Framework

- **Assumptions:**
 - All API gateways of the local banks is connected to the blockchain network
 - The API of debit / credit bank accounts and cards are up and running in the banks API Gateway and exposed to the network

- **Suppose Customer C1 in Bank A wants to send money M to Customer C2 in bank B**
 - I. Customer C1 will login to his mobile banking application / internet banking application /ATM
Or he can use bank branch applications
 - II. Customer C1 initiates a transaction message includes the details about the recipient and the transaction value and a cryptographic digital signature that proves the authenticity of the transaction.
 - III. The blockchain node (Bank A) authenticates the digital signature of the transaction and put the transaction pending transactions pool. The transaction instructions will be the following:
 - Debit the customer account C1 and credit the ledger of the bank A which is exposed to the network with M amount
 - Debit Bank A ledger which is exposed to the network
 - Credit Bank B ledger which is exposed to the network
 - Credit the customer account C2 and debit the ledger of the bank A which is exposed to the network with M amount
 - IV. Bank A node creates a block of pending transaction and broadcasts it to the other banks in the network.
 - V. The other banks nodes in the network validate the block through a “proof of work” process
 - VI. After validation of the transaction and proof of work, the transaction calls the concerned API gateway to execute the transaction instructions as follows:

Transaction posted to the API gateway of Bank A:

- Debit the customer account C1 and credit the ledger of the bank A which is exposed to the network with M amount
- Debit Bank A ledger which is exposed to the network

Transaction posted to the API gateway of Bank B:

- Credit Bank B ledger which is exposed to the network
- Credit the customer account C2 and debit the ledger of the bank A which is exposed to the network with M amount

- VII. The block is added to the chain and all banks in the network can see the newly added block
- VIII. The value M transferred from Customer C1 in Bank A to Customer C2 in Bank B
- By applying the above process flow of using blockchain based to implement instant payment network with open API architecture we can get the following benefits:
 - Reduce costs and charges of the financial transactions
 - Excluding any middlemen from the payment processing
 - Increase the payment transparency by using distributed ledger as the sender bank and the receiver bank are members of the network as nodes
 - Reduce the time and the cost required for settlements
 - Better monitoring capabilities for regularity and compliance purposes
 - Instant and secure payment between banks
 - Very good customer satisfaction
 - Seamless integration of the financial among the banks
 - We can implement any global business rules on the network level or private business rules on API level
 - Senders and Recipients are not restricted by bank working hours the transactions will be available by the network 24*7

9 Conclusion:

Table 1: shows the characteristics of blockchain technology (Zhu and Zhou,2017).

Characteristics	Explanation
Distributed ledger and transparency	A shared public list of transactions (the exchange of data) allows every peer in the network to have access to every transaction made, making the system transparent.
Decentralized data management	Every peer in the system has the authority to add data to the ledger, in other words, make transactions. Meaning no one user owns the system more than any other.
Data security, tamper-proof, anti-forgery and data integrity	Blockchain is architected to store data such that it is immutable and tamper-proof. The decentralized nature of blockchain makes it overly challenging to take advantage of the system by ill-intentioned users.

<p>High efficiency Checking balances and completing transactions in a blockchain system can, in theory, be instantaneous.</p>	<p>No risk of centralized failure the lack of a centralized storage system removes the risk of losing data and downtime due to problems with a centralized unit.</p>
<p>Flexible and reliable</p>	<p>Blockchains programmable features increase flexibility and reliability in different application scenarios</p>

- Our proposed framework which uses the blockchain and open banking API architecture in fund transfer between local banks will provide great opportunity and space to banks to improve and positively impact for the following areas:
 - ✓ digital transformation strategy
 - ✓ financial inclusion
 - ✓ digitization of payments
 - ✓ e-commerce
 - ✓ SME Finance
 - ✓ Increasing access points, partnerships with non-bank FinTechs and using innovative technologies further to bring efficiency in banking and payments.
- This approach will facilitate a wide range of instant transactions between all business models of e-commerce C2C (customer to customer), B2B (business to business), C2B (customer to business) and B2C (business to customer).
- Using open API architecture will give us seamless integration of financial services and application between the deferent core banking systems that used by the banks in the network with even if it is

legacy systems with no need to use a unified core banking this give us the ability to build private business rule (on the bank level) or public business rule on the network level.

- This model connects all business partners to do business and instant fund transfer between them using the same network.
- When it comes to customer services and time to market our framework allows easy and fast product development through banks and enable accounts, wallets and cards interoperability.

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