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# Global Micro-Payment System using Stable-Coins, Federated Byzantine Agreement(FBA) Protocol and Blockchain Technology

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**Abstract -** *Digital payments have emerged as a viable and crucial tool for merchants, individuals, expatriates and business firms as they enable transfer of funds in a flexible and convenient way. Digital payments are transactions of value or funds between the payee and the recipient within or across borders through a payment gateway. The payment services are provided by central authorities like Banks and government firms as they offer Credit/Debit card transfers, Bank transfers and Alternative Payment Methods(APMs). Digital payments have been proven important for advancing financial inclusion but they are considered expensive due to high fee cuts by third party service providers. To overcome the limitations of traditional payment systems, a Blockchain enabled Global Micro-payment system is introduced. Global Micro-payment System uses blockchain technology, Stable-coins and Federated Byzantine Agreement(FBA) protocol to transfer funds locally or globally in a decentralized Peer-to-Peer(P2P) network. This idea is a paradigm shift from centralization of payment systems to decentralization of payment systems which is built in prospective to eliminate middlemen fee cuts. It uses a single private distributed ledger unlike Banks where multiple ledgers are needed to maintain, verify and validate nodes participating in a transaction. Funds are directly deposited and stored in an escrow wallet and the wallet interacts with blockchain ledger to validate the transaction. Stable-coins enabled Global Micro-payment system can be a novel alternative to Fiat enabled Traditional payment system as it can solve major problems related to consumer benefits and can help in global financial inclusion.*

***Key Words*: Digital Payment, Global Micro-payment System, Stable-coin, Permissioned Blockchain, Single Private Distributed Ledger, Federated Byzantine Agreement(FBA), Peer-to-Peer(P2P) network, Escrow wallet**

## 1. INTRODUCTION

The total transaction value is expected to grow at a Compounded Annual Growth rate of 17% which is projected to reach a total amount of $8,266,971 million by 2024 Statista (2020) [1]. By 2025, the volume of total transactions in India is expected to be as high as $ 1 trillion Aciworldwide (2020) [2]. Digital payment markets have experienced a surge in transaction volume amidst COVID-19 pandemic Rahul De', Neena Pandey, Abhipsa Pal (2020) [3]. The market's major segment is e-commerce B Wire (2020) [4] where a huge volume of transactions is observed. The two basic payment methods are exchanging and provisioning - exchanging consists of transfer of bank-notes and provisioning consists of transfer of funds through third party service providers. Digital transaction accounts for the majority type of commodity exchanges practiced globally. This is because, Internet has enabled global participation, resulting in mass-adoption in a digital ecosystem.

**Table -1:** PayPal fees for different Payment Services [5]

| Service | Domestic | International |
|---|---|---|
| Online transaction | 2.9% + $0.3 | 4.4% + $ 0.3 |
| Store location | 2.7% +$0.3 | 4.2% + $0.3 |
| Nonprofit | 2.2% + $0.3 | 3.7% + $0.3 |
| Micropayment | 5% + $0.05 | 6.5% + $0.05 |

***Transaction fees are subject to change at any time.*`**

The traditional payment system has been expensive to firms and individuals as every transaction includes fee cuts. Table -1 shows PayPal fees for Domestic and International payment services. The critical elements of a digital transaction include

1. Participants in a transaction.
2. Sensitive information of nodes participated in a transaction.
3. Service providers and
4. A ledger.

For authorization and validation of participants, banks or authorities disclose sensitive information which is stored in a centralized digital ledger. This poses a threat to security and data privacy as they are vulnerable to hacking and mutilation. A conventional payment system requires a huge capital for maintenance and management of exchanges, ledgers, computation and network-congestion-

control. The cost incurred in a transaction is paid by the merchants which is often passed to the consumers. Fig -1 shows different entities involved in a single digital payment transaction. The commodity or exchange consists of -

1. A consumer
2. An issuing bank
3. Payment network or card network
4. An acquiring bank
5. Verification of funds by acquiring bank and
6. Merchants.

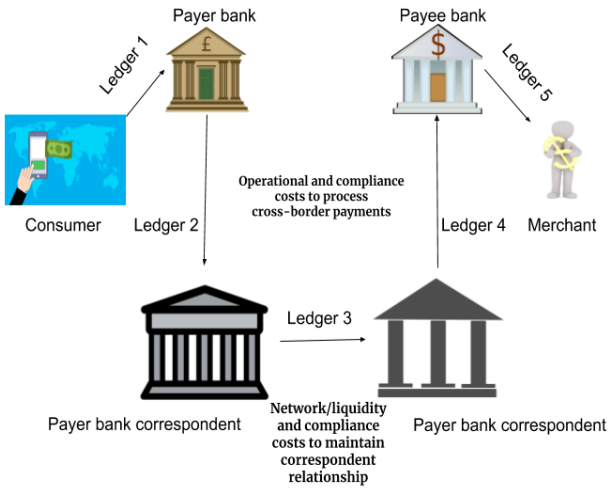



**Fig -1**: Entities involved in cross-border digital payments

To overcome the limitations of traditional payment system, a decentralized Global Micro-payment system is introduced which uses Stable coins K Mita, S Ito, H Ohsawa, Tanaka (2019) [6] and Permissioned Blockchain Technology Q Min, L Li, L Liu, Cui (2016) [7]. The transactions are recorded and stored in the Blockchain ledger and the data stored in the ledger is immutable and cryptographically secured. For verification and validation of participants in a transaction, a single private distributed ledger F Geyer (2019) [8] is required. A single distributed ledger helps to maintain limited exposure of sensitive information during a transaction process. The funds are directly transacted from the escrow wallets Q Wang, X Li, Y Yu (2018) [9] and the wallet validates the transaction independently by interacting with blockchain ledger. Byzantine Fault Tolerance(BFT) K Driscoll, B Hall, H Sivencrona, P Zumsteg (2003) [10] consensus is used to defend against system failure components. Byzantine Fault arises ambiguity in a system reaching an agreement. In order to meet consistency and eliminate Byzantine faults in the system, Federated Byzantine Agreement(FBA) J Yoo, Y Jung, D Shin, M Bae, E Jee (2019) [11] protocol is used.

## 2. METHODS

This section provides description of different components used in a Decentralized Payment System. The 4 main components of Blockchain enabled Global Micro-payment system are-

1. Stable coins
2. Permissioned Blockchain
3. Single Private Distributed Ledger
4. Federated Byzantine Agreement(FBA) protocol

### 2.1 Stable-coins

Payments within and across nations can be facilitated using Stable-coins. Stable-coins are a new set of security-tokens built as an alternative to Fiat currencies that attempts to maintain price stability and integrity within the government norms. Stable-coins are backed by assets and reserves similar to the working of fiat currencies. It attempts to offer instant processing and security. Stable coins achieve price stability through liquidation in the market. Unlike Bitcoin H Hellani, A E Samhat, M Chamoun, H E Ghor, A Serhrouchni (2018) [12] which has huge price fluctuations and follows a deflationary model, stable coins are introduced which are volatile-free and generally follow an inflationary model. The inflation can easily be controlled by central authorities in case of stable-coins by either changing interest rates or by providing liquidity in the market by printing notes. On the contrary, the supply of bitcoin is limited to 21 million D Canellis (2020) [13]and hence inflation cannot be controlled as prices are affected directly by demand. For instance, Bitcoin price rose from the level of around $5,950 in November 2019 to above $19,700 in December 2019, and then declined by around two-thirds to the level of $6,900 by February 2020 Adam Hayes (2020) [14]. This makes Bitcoin and many cryptocurrencies unsuitable for people as they would refrain from a value adoption where future purchasing power is unsure.

Tether(USDT) Johnson (2000) [15] is a popular stable-coin which is backed by the Federal Reserve Bank of USA. Price of 1 Tether equals the price of 1 USD and it is built on open blockchain technologies leveraging the security and transparency in a system. Tether is the most widely integrated digital-to-fiat currency and provides security while meeting Standards and Regulations. Local Payments or cross-border Payments are facilitated by Blockchain enabled Global Micro-payment system, where

the native Stable-coin can be converted to country specific Stable-coin. This process is carried out in a decentralized Peer-to-Peer J. Sen (2013) [16] network without any intermediaries or involvement of central authority. The process of converting one stable-coin to other stable-coin is called stable-coin swap or Atomic swap J Frankenfield (2020) [17]. The transactions are immediate and secure without any third party service provider. The exchange of funds is recorded in a single private distributed ledger unlike Banks which requires multiple ledgers for verification and validation of participants in a transaction. Permissioned Blockchain technology adds another security layer and access control in a transaction where only known participants are allowed to join the network.

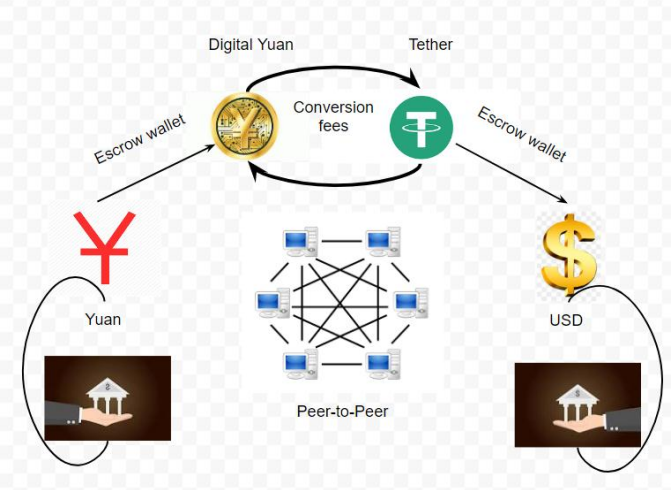



**Fig -2**: Atomic swaps of stable coins

In Fig -2 the payer deposits funds in the escrow wallet. The funds from the escrow wallet are converted to corresponding stable-coin. In order to transfer funds to a node who lives in another corner of the globe, the payer follows Atomic swaps. After the stable-coin is converted to country specific stable-coin, they are stored in the payee's escrow wallet.

## 2.2 Permissioned Blockchain

Permissioned Blockchain provides an additional layer of security over an open blockchain system like Bitcoin. They maintain access control to allow specific actions to be performed by known participants in a network. It is favorable for participants who require identity of the node and security in a blockchain along with special permissions to perform an operation. Permissioned Blockchain is different from private blockchain since any participant is allowed to join a network as far as the identity and role are defined. The permissioning and identity maintenance is managed by an access control layer which is one of the major characteristics that distinguishes permissioned blockchain with the unpermissioned blockchain.

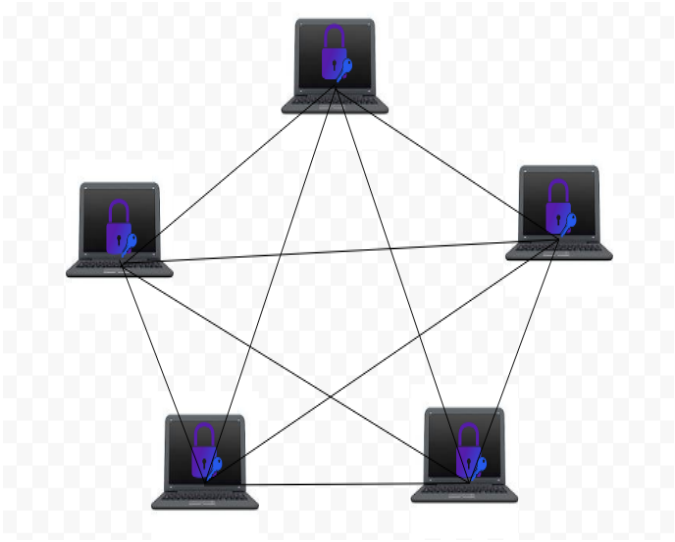


**Fig -3**: Permissioned Blockchain

In Fig -3 the identity and role of nodes are defined, hence they are allowed to participate in the network. A control layer runs above the blockchain network that governs the action performed by the allowed nodes or participants. This enables Permissioned blockchain architecture to be highly configured and controlled by the owners.

## 2.3 Single Private Distributed Ledger

A distributed ledger N Zivic, C Ruland, J Sassmannshausen (2019) [18] is a shared ledger or database where digital data in the ledger is replicated across nodes in a peer-to-peer network. In a shared network, identical copies of ledger are replicated and updated independently in synchronization across the nodes. The records made in the ledger are secured using keys Yao-Jen Chang, Wende Zhang, Tsuhan Chen (2004) [19] and multi-signatures Nurzhan Zhumabekuly Aitzhan, Davor Svetinovic (2018) [20]. There are no central authorities required to maintain and update a Distributed ledger as they update independently using consensus mechanism. Each node votes and agrees if the copy in the network is correct or morphed. The Distributed ledger can either be public where data is shared across each node or private where data is shared to specific nodes in a network. A single private distributed ledger can be a great

alternative to the traditional system of multiple ledgers. Banks and central authorities can use single distributed ledger instead of multiple different ledgers for verification and validation of nodes participating in a transaction.

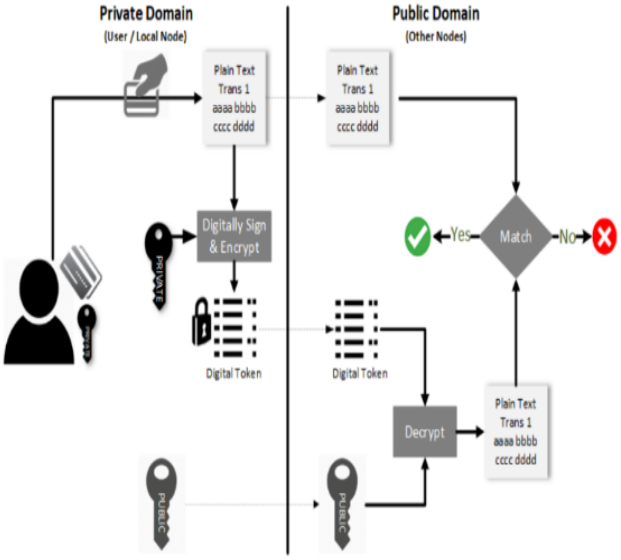



**Fig -4**: Single Private Distributed Ledger for authorization and validation of nodes in a transaction

In Fig -4 the transactions by the participants are recorded in a single private distributed ledger. The escrow wallet is made interactive with the distributed ledger in order to verify and validate the participants, before the successful transaction. The funds are deposited in the payee's escrow wallet only after the validation of participants.

## 2.4 Federated Byzantine Agreement

A Byzantine fault is a condition of a distributed computing system where components fail without any perfect information of system failure. In a Byzantine fault, a component can inconsistently appear both functioning and failed at same time by different nodes and hence need a consensus algorithm for agreement. Byzantine Fault Tolerance(BFT) is a protocol used to eliminate inconsistency in a system and carry out an agreement independently by nodes.

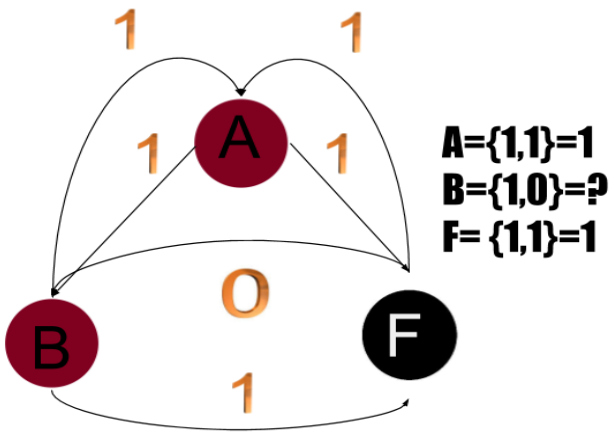



**Fig -5**: Byzantine Fault

Fig -5 describes a Byzantine Fault system. There are 2 perfect nodes and 1 faulty node. For a node to be perfect, it should agree with all nodes. The node that fails to agree with all nodes in a quorum is a faulty node. Here A and B are perfect nodes, hence they agree with all nodes, but B is a faulty node as it agrees with A and disagrees with B. The majority votes are to be considered in order for nodes in a network to reach an agreement. As vote by B is ambiguous, the system faces a Byzantine Fault.

Federated Byzantine Agreement(FBA) is a protocol designed to eliminate Byzantine faults in the system where individual nodes trust the participant node independently without any centralized control using quorum slices. A quorum is the minimum number of nodes required to reach an agreement by casting votes in a network, whereas quorum slices are a subset of a quorum, which convinces another node to agree. A node can be part of another node's quorum slice at the same time where each node chooses its own quorum slices and decides whom they trust without any centralized control. Nodes can be explicitly programmed to trust a quorum slice based on different characteristics like performance of a node over time. The transactions in the network can be recorded in a FBA ledger which is accurate and updated without requiring all nodes in a network to agree. A transaction is performed only when a minimum of 67% of votes are casted by the nodes in a quorum with no disjoint quorum slices in a quorum network. A Federated voting by a node in a quorum slice can have 4 cases:

1. node doesn't know the participant node
2. node votes for participant node

3. node is accepted either by quorum slice or blocking set and
4. node confirms the participant node.

In order to overcome the Byzantine fault shown in Figure 5 a new node is added to the quorum slice.

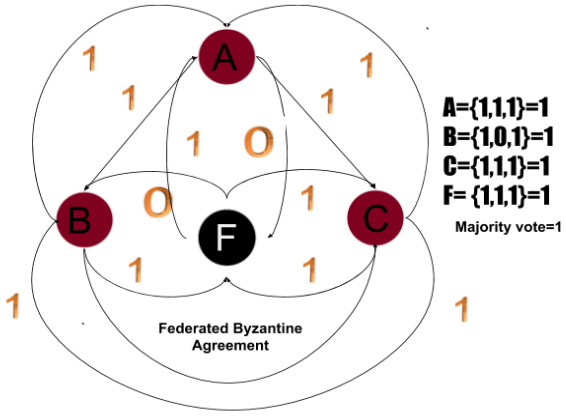



**Fig -6**: Federated Byzantine Agreement(FBA) protocol

Fig -6 shows a Byzantine Fault Tolerance system where a new node C is added to the previous quorum slice in Fig -5. Here, the node C convinces the Faulty node to agree thus reaching an agreement in the network. The faulty node is identified in the network.

## 3. RESULTS

### 3.1 Comparison Table

**Table -2:** Characteristic table of traditional and blockchain enabled payment system

| Characteristics | Traditional payment system using fiat-currencies | Blockchain enabled payment system using stable-coins |
|---|---|---|
| Security | Yes | Yes |
| Trustworthy | No | Yes |
| Decentralization | No | Yes |
| Low-processing fee | No | Yes |
| Immediate transfer | No | Yes |
| Single distributed ledger | No | Yes |
| private | Yes | Yes |
| Permissioned | Yes | Yes |
| Low latency | Yes | Yes |
| Escrow wallet | Maybe | Yes |
| Privacy disclosure | Yes | No |
| Flexible trusts between nodes | No | Yes |
| Transaction reversibility | Yes | Maybe |

Table -2 describes a precise comparison of 13 factors or features between Traditional Payment system and Blockchain driven Global Micro-payment system. The major problems with traditional payment systems are solved by the new payment system.

### 3.2 Optimization in Performance

A Permissioned Blockchain system helps in increased performance of a system as only known nodes are allowed to participate in the network. This makes the system highly scalable and fast with limited congestion in the network. It also allows role-limited operations which helps to maintain transparency in the system. For network security, Permissioned blockchain allows limiting the participants to act as nodes on the network. It also has defined governance architecture for secure transactions since it provides certain rules and regulations.

### 3.3 Elimination of transaction delays( T+Now)

For authorisation and validation of nodes in a transaction, a single private distributed ledger is maintained in the network. The main advantage of blockchain is that records stored in the ledger are immutable and time-stamped. Hence, it enables a simpler transaction process which eliminates delays in processing of a transaction. As time delay is negligible, there is no requirement of collaterals for a transaction. The funds are immediately transferred without waiting for several business days unlike banks.

### 3.4 Minimum exposure of Sensitive Information

In traditional payment systems, there are many informational exchange points in payment processing between financial institutions and third party validators. In the Global Micro-payment system, the disclosure of sensitive information is limited due to single distributed ledger. Also this same ledger can be used by banks and government bodies during withdrawal of funds by individuals from escrow wallet to the bank account.

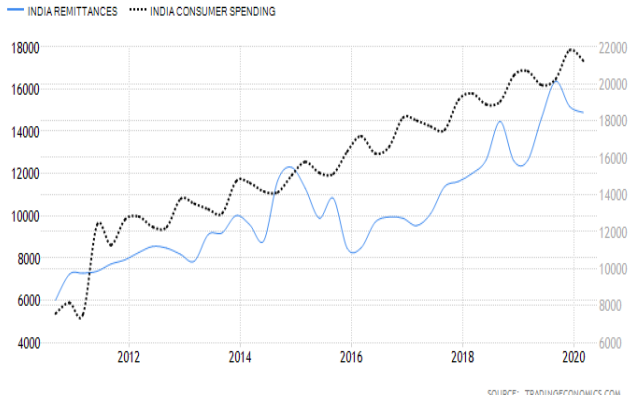
**Table -3:** Information types with sensitive data exposure

| Information type | Personal Identification Number | Personal Health Information | Employee data | Non-public information |
|---|---|---|---|---|
| Sensitive | Yes | Yes | Yes | Yes |
| Requires Encryption | Yes | Yes | No | No |
| Applicable security standards | Yes | Yes | Yes | Yes |

Table -3 shows exposure of Sensitive information in a transaction during verification and validation of the nodes participated in a transaction.

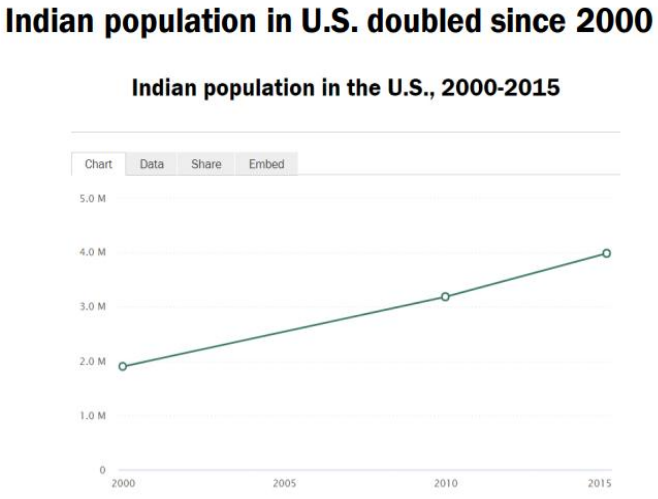
### 3.5 Increased Remittances by Expatriates

The major problem faced by the expatriates are fee cuts involved in the remittances. This issue can be greatly resolved by the Global micro-payment system since the cross-border fees are drastically reduced.

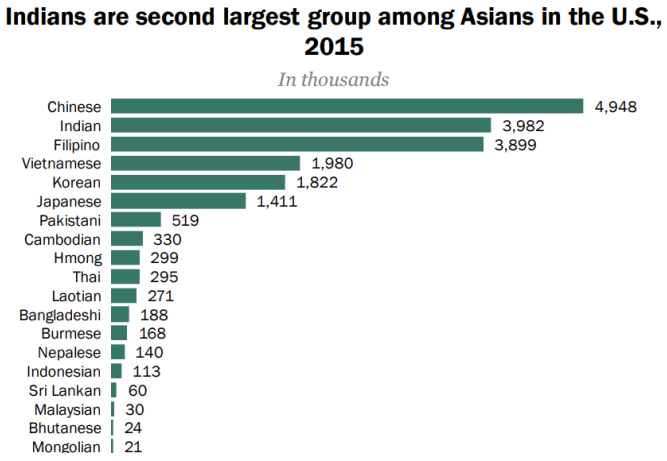



**Graph -1:** India Remittances vs India Consumer Spending TRADING ECONOMICS (2020) [21]

In Graph -1 , we observe the comparison chart of India Remittances and Consumer Spending. India is an emerging country and the number of Indian immigrants in the USA are also increasingly drastically.




**Graph -2:** Indian population in USA from 2000-2015 G Ruiz, N (2020) [22]




**Graph -3:** Number of immigrants in USA in 2015 G Ruiz, N (2020) [22]

Graph -2 shows that the indian population in the USA has doubled in 2015 since 2000. Graph -3 describes the population of migrants in the USA in 2015 where China leads the number followed by India. As the number of migrants increases in the USA and other parts of the globe, remittances also drastically increase. Hence, Blockchain enabled Global Micro-payment systems can be a new alternative to traditional payment systems for huge increased remittances.

### 3.6 Increased Revenues by Nation trades

| Actual | Previous | Highest | Lowest | Dates | Unit | Frequency | |
|---|---|---|---|---|---|---|---|
| 14891.13 | 15185.47 | 16373.32 | 5999.10 | 2010 - 2020 | USD Million | Quarterly | NSA |

| India Trade | Last | Previous | Highest | Lowest | Unit | |
|---|---|---|---|---|---|---|
| Balance of Trade | 790.00 | -3150.00 | 790.00 | -20210.90 | USD Million | [+] |
| Current Account | 584.38 | -2604.62 | 7360.00 | -31857.18 | USD Million | [+] |
| Current Account to GDP | -0.90 | -2.10 | 2.30 | -4.80 | percent | [+] |
| Imports | 21110.00 | 22200.00 | 45730.00 | 117.40 | USD Million | [+] |
| Exports | 21910.00 | 19050.00 | 32720.00 | 59.01 | USD Million | [+] |
| External Debt | 558548.00 | 563938.00 | 563938.00 | 96392.00 | USD Million | [+] |
| Terms of Trade | 73.30 | 71.10 | 100.00 | 57.90 | points | [+] |
| Foreign Direct Investment | 2016.00 | 1366.00 | 8569.00 | -1336.00 | USD Million | [+] |
| Capital Flows | -19.36 | -149.89 | 766.97 | -822.33 | USD Million | [+] |
| Remittances | 14891.13 | 15185.47 | 16373.32 | 5999.10 | USD Million | [+] |
| Tourist Arrivals | 328462.00 | 1015632.00 | 1225672.00 | 129286.00 | | [+] |
| Gold Reserves | 641.80 | 618.16 | 641.80 | 357.75 | Tonnes | [+] |
| Crude Oil Production | 633.00 | 649.00 | 813.00 | 526.00 | BBL/D/1K | [+] |
| Terrorism Index | 7.52 | 7.57 | 8.09 | 7.22 | | [+] |
| Tourism Revenues | 58330.00 | 182810.00 | 226170.00 | 31530.00 | INR Million | [+] |
| Weapons Sales | 46.00 | 56.00 | 56.00 | 0.00 | USD Million | [+] |

**Table -4:** India TradeTRADING ECONOMICS (2020) [21]

Table -7 shows a detailed information of 2020 India trade. The revenue generated to India are majorly contributed by Tourism, Imports, Exports and Remittances. In order to boost global financial inclusion, the Global Micro-payment system should be implemented since digital payments will be flexible, cheap and convenient. This results in a boost of the nation's economy and global participation becomes easy and transparent.

## 4. DISCUSSIONS

Stellar F H Sporer, C J Moss, Mathias (1988) [23] and Ripple F Armknecht, G O Karame, A Mandal, F Youssef, E Zenner (2015) [24] are some of the blockchain projects, currently working on cross-border payments which are carried out by their respective tokens. The projects are mainly focused on Interoperability Thomas Hardjono, Alexander Lipton, Alex Pentland (2019) [25] and integrity with the banks and financial firms. The two main disadvantages of Ripple and stellar are that the tokens are pre-mined and the supply is fixed thus creating a deflationary model. Also, the technology benefits are limited to banks and financial institutions and perks of this innovation are not enjoyed by individuals. In this research paper, the Blockchain enabled Global micro-payment system uses Stable-coin cryptocurrency unlike single token used by Ripple and Stellar. Stable-coins are made directly available to the users, thus making digital micro-payments common, efficient and flexible. Stable-coin follows an inflationary model since, they are not premined and their supply is not fixed. The value of stable-coin is backed by reserves and derivatives which helps central authority to control inflation. Inflation is controlled either by changing interest rates or providing liquidity in the market which is not possible with Ripple and Stellar as their supplies are fixed.

## 5. CONCLUSIONS

The cost of services provided by third party service providers are quite expensive to individuals and business firms especially for cross-border payments. The proposed research paper helps the digital payment technology to expand globally for micro-payment systems as it implements Blockchain technology and Stable-coins.

The shift from centralized payment system to decentralized payment system facilitates a fast, cheap, flexible and secure payment system for individuals and firms. A decentralized Global micro-payment system enables-

1. No cross-border transaction fee
2. Low conversion fee.
3. Low service charge.
4. Immediate transfer of funds.
5. Secure transaction using Cryptography.
6. Authorization and validation of nodes using a single private distributed ledger.
7. Shift from fiat currency to stable-coin cryptocurrency.
8. Ease in international business and
9. Increased throughput.

Total Processing fee becomes significantly low due to decentralization of the payment technology. Permissioned Blockchain enables any node to participate in a network whose identity and role are defined, thus providing transparency and flexibility in a system. Unlike traditional ledgers which can easily be mutilated by third parties, Blockchain provides immutability, that helps in record maintenance and security of information. The authorization and validation of participants in transaction is carried with minimal disclosure of sensitive information of clients or nodes which maintains privacy of a node. The transaction can be maintained by a single private distributed ledger T Oliveira (2019) [26] unlike traditional banking where verification and validation of participants require multiple ledgers. The nodes gain trust independently in a network without any central authority with the help of Byzantine Fault Tolerance(BFT) consensus. For BFT, Federated Byzantine Agreement(FBA) consensus is introduced, which works on the concept of quorum slices. This concept will be considered beneficial to both, the user who uses the payment service and the service-provider who provides the service to the user U Mukhopadhyay, A Skjellum, O Hambolu, J Oakley, L Yu, R Brooks (2016) [27]

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