

# **Blockchain Applications in the Fintech Sector**

*A Survey of Blockchain Companies solving current problems in the Fintech Sector*

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# Table of Contents

<b>INTRODUCTION .....</b>	<b>3</b>
<b>RELATED WORK .....</b>	<b>3</b>
<b>PAPER ORGANIZATION .....</b>	<b>3</b>
<b>FINTECH BACKGROUND .....</b>	<b>3</b>
PAYMENTS .....	4
DEPOSITS AND LENDING .....	5
INVESTMENT MANAGEMENT .....	5
<b>BLOCKCHAIN BACKGROUND .....</b>	<b>6</b>
BLOCKCHAIN ARCHITECTURE .....	6
<i>Key Characteristics of Blockchains</i> .....	7
<i>Description of Blockchain Platforms</i> .....	8
<i>Conclusion</i> .....	10
<b>THE PAYMENTS SECTOR .....</b>	<b>10</b>
RETAIL AND CONSUMER PAYMENTS .....	10
<i>Current Issues in the Retail and Consumer Payments Segment</i> .....	10
<i>RippleNet</i> .....	12
<i>Stellar Network</i> .....	12
<i>Conclusion</i> .....	13
<i>Retail and Consumer Payments Chart</i> .....	14
POINT OF SALE PAYMENTS .....	16
<i>Current Issues in the Point of Sale Segment</i> .....	16
<i>Algorand Blockchain</i> .....	17
<i>Pundi-X</i> .....	17
<i>Conclusion</i> .....	18
<i>Point of Sale Chart</i> .....	19
INTERNATIONAL MONEY TRANSFER (REMITTANCE) .....	21
<i>Current Issues in the Remittance Segment</i> .....	21
<i>SureRemit</i> .....	22
<i>Everex</i> .....	23
<i>Conclusion</i> .....	23
<i>Remittance (International Money Transfer) Chart</i> .....	24
<b>DEPOSITS AND LENDING .....</b>	<b>26</b>
SMALL BUSINESS AND PERSONAL LOANS .....	26
<i>Current Issues in the Small Business and Personal Loans Sector</i> .....	26
<i>Colendi</i> .....	27
<i>Figure</i> .....	28
<i>Celsius</i> .....	28
CONCLUSION .....	30
<i>Deposits and Lending Chart</i> .....	31
<b>THE INVESTMENT SECTOR .....</b>	<b>33</b>
INSTITUTIONAL INVESTMENT .....	33
<i>Grayscale</i> .....	33
<i>Fidelity Digital Assets</i> .....	34
VENTURE CAPITAL .....	34
RETAIL INVESTING .....	34

<i>Robinhood</i> .....	34
<i>WeBull</i> .....	35
CONCLUSION .....	35
<b>CONCLUSION</b> .....	<b>36</b>
<b>SOURCES</b> .....	<b>37</b>

## Introduction

A blockchain is a distributed ledger that creates a secure and decentralized infrastructure that enables the recording of resources in an immutable manner. Blockchain networks are peer-to-peer networks where a consensus algorithm enables decisions to be made without the need of a centralized authority. Through the network, two parties can exchange messages and resources in a secure way that is both verified and traceable. The resources that are exchanged can be anything that has value, be it tangible or intangible.

Bitcoin, the project that introduced the world to the concept of Blockchain, was created by Satoshi Nakamoto [2]. A once novel phenomena now has become an integrated part of technology solutions around the world. In 2019, Gartner estimated that blockchains will undergo more mainstream adoption in 2023, thus leading to a generation of \$3.1 trillion in new business value by 2030. The reason for this growth is due to multinational corporations and technology industry giants using blockchain to capture larger market shares [1]. There are currently several applications of blockchain that span a vast range of industries: healthcare [3], IoT [4], cyber security [5] and more. Due to the decentralization and transparency that blockchain provides, many companies that are interested in ensuring that their transaction are fast, secure, and traceable have turned to blockchain implementation to enable these qualities.

Among the various industries that want to implement blockchains for its many great properties, one industry that seems to have the ability to benefit greatly from a blockchain network is the Fintech sector. Currently, many Fintech companies employ a centralized, time-intensive, cost-intensive system to exercise many of the functions that they provide to their consumers. Traditional financial institutions are pouring money into Fintech companies and startups in order to leverage the innovation Fintech companies provide and thereby gain a competitive advantage over their peers. However, the primary source of income for these Fintech companies are individual customers as well as small to medium enterprises [6]. These traditional banking services are looking towards blockchain technology to improve the services they provide their clients. This incentivized the Fintech industry to begin to invest and attempt to rapidly adopt or develop their own blockchain infrastructure to capitalize on the desire of traditional financial institutions and increase their revenue handsomely.

This survey focuses on the use of blockchain to enhance the way services are offered to individuals and businesses by Fintech companies. This paper will discuss companies that are involved in the various sectors and how they leverage blockchain to realize their goal. It will also provide some critique on the issues that these companies face when trying to solve existing problems using blockchain.

## RELATED WORK

As of the writing of this paper, there is no other work that covers the issues faced by the Fintech sector and how current companies are using blockchain to solve these problems. This is, to the best of our knowledge, the first paper that evaluates these issues and discusses them in context to the sector as a whole.

## PAPER ORGANIZATION

The paper starts with introducing the Fintech landscape and basic properties of Blockchain architecture. It then discusses the problems in the Payments, Lending, and Investment sector and analyzes how current companies are attempting to solve these problems.

## Fintech Background

Fintech has recently become a common phenomenon within the technology and finance industries simply because it encompasses the developing and continually evolving intersection between technology and financial services. This industry is comprised of many different types of companies, from existing larger financial institutions that have dominated the financial sector for as long as we can remember to start ups that have just been created.

Fintech companies were brought about due to the surge of the technological age. Many financial institutions have had to adapt and modernize their approaches as finance as a whole has become more technology focused. Technology companies spotted this need and have jumped in to provide architecture, software, and services that enable these financial institutions to continue to provide the services on computer based platform [9].

The motivation that initially drove the dominance of Fintech is its promise to lower the cost of financial services in the attempt to improve the welfare of the consumer. There are, currently, three main categories that Fintech services cover: credit, deposits, lending and capital raising services; payments; and investment management services. In this paper, these different services will be describe as segments within the Fintech sector.

The first segment to boom was the Payments segment as it provided a new and easier way for payments to be exchanged from person to person almost instantaneously. For this reason, the Payments segment continues to be the largest segment of the Fintech space.

The next biggest segment that has been brought about due to technology has been Deposits and Lending. With application processes and background checks already being done online, this was a big avenue in which technology companies could apply big data principles and find a way to streamline the loan and refinancing processes even further to make them more accessible.

Following Deposits and Lending, the next biggest and certainly more blossoming (as of recent times) segment of the Fintech space is the Investment Management space. By making investing a more tangible and accessible action, be it through companies that offer a simple solution and UI, more novice investors are putting their money into apps that help them make investment and trading decisions.

Each of these segments can be further broken up and categorized by the services the companies aim to provide and specialize in. In the context of technology, and specifically blockchains, it is crucial to understand what exact services a company is attempting to provide to understand what the core components of these services are. By understanding the sub-sections of these segments, one can then formulate a plan to understand what the requirements for technology within this space is.

**Payments**

Payments is currently the biggest segment that is continually growing larger. A crucial reason for this large growth is due to the fact that access to mobile devices, data networks, and applications have allowed Fintech companies to lure traditional banking customers away from legacy traditional banking platforms to those that are online. These applications then enable a user to interact directly with a vendor, removing the third-party middle man that is used to help create a good customer experience. Companies focused in the payments segment are now driving innovation to increase speed, convenience, efficiency and accessibility [10].

This segment can further be broken up into categories that specify what services they offer within the realm of payment. They can be categorized in various ways, however, this paper will follow the categories selected by the Deloitte Original Venture Scanner [8].

<b>Part of Segment</b>	<b>Services</b>	<b>Companies</b>
Consumer Payments	Services and technologies that are focused on the payment between consumers and payment issuers	Doxo, Headnote, Affirm, Paypal, Stripe, Zelle, Ripple, Stellar
Financial Transaction Security	Companies that focus on security within financial transactions such as: securing transactions, authenticating users, and preventing overall fraud/theft	Venmo (a service of Paypal)
International Money Transfer	Companies that enable sending money (both personal and business) across countries	Remitly, Paypal, Ripple, SureRemit, Everex
Payment Backend and Infrastructure	Enabling payments by providing the infrastructure to payment issuers and acquirers	Circle, Stripe

Point of Sale Payments	Focused on payment acquirers (businesses and organizations) by providing the infrastructure as well as physical hardware for payment solutions	Square
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## Deposits and Lending

Deposits and Lending is another huge segment in the Fintech space. The purpose of this segment is to simplify the traditional banking flow: getting money, storing the money in the bank, building interest on that money, retrieving money, and spending money. It also incorporates companies that enable people or businesses to obtain loans and monitor/collect information about credit. The main categories of deposits and lending according to the Deloitte Original Venture Scanner [8] are:

Part of Segment	Services	Companies
Business Lending	Offering new ways for companies to assess their credit risk and raise financing for their debt	Credifi, Peer IQ, Celsius, Figure, Colendi
Consumer and Commercial Banking	Allowing small-to-medium businesses and consumers to interact with banking services in a more simple fashion	
Consumer Lending	Providing new ways for people to obtain loans and assess their credit risk	Salta, Tala, Avant, Celsius, Figure, Colendi

These companies attempt to make the loan process more simple by way of finding different ways to assess credit risk. It also provides more ways for companies to collect data and analytics to simplify the background checking process, which enables the loan application to loan grant/rejection turnover period much smaller. Some companies, such as PeerIQ provide a way to make decision making tools that are both transparent and responsible.

## Investment Management

The Investment Management segment of the Fintech sector is comprised mainly of companies that attempt to make investing a more simple and automated process. The companies make access to various securities so much easier and intuitive to those who are not as familiar with the finance space. According to the Deloitte Original Venture Scanner [8] the categories of Investment Managements companies are:

Part of Segment	Services	Companies
Financial Research and Data	Businesses that enable people to make informed and better investment decisions by providing information services	Addepar

Institutional Investing	Directed towards managers (wealth/hedge fund) and other professional traders, these businesses help manage portfolios with the goal of optimizing the return on investment	Wealthfront, Betterment
Retail Investing	Companies that enable investing in securities with new methods and means. These services are targeted towards newer and younger investors.	Robinhood, WeBull

## Blockchain Background

In this section, a brief introduction to blockchain technology will be given. It will then give a description of different open-source blockchain implementations and a comparison between them. The purpose of this section is to ensure the readers are familiar with blockchain technology and the key characteristics that will be used to create a framework later on in the paper.

## Blockchain Architecture

A blockchain is an entity that encompasses a database and a network of nodes. The database is an append-only, shared, fault tolerant database that allows for transactions to remain recorded via the blocks. Since the database is append only, once a block is added to the chain, it is immutable. Though they are immutable, the blocks can be accessed by all of the users of the blockchain. The chain is formed by the blocks being connected to each other by each block containing the hash value of the block before it. Each block also stores the time of creation, several verified transactions, and for cryptographic reasons – a nonce. By having the nodes linked to each other, the blockchain network is able to implement a peer-to-peer, distributed network that is maintained by the nodes themselves. The decentralized approach ensures that no one block can completely control any of the other blocks or the database.

The purpose of the peer-to-peer network is to eliminate the necessity of a middle man. When a node wants to carry out a transaction within the network, it broadcasts the transaction. Then, several nodes check to ensure the nodes involved and the transactions are valid, and then a block is made that consists of the valid transactions. Once the new block is deemed to be valid, it is then added to the database. If the block is *not* valid, the block is not added to the database. The transactions and the block are signed such that in the future, there is no revocation or denial that the transaction between the two entities took place.

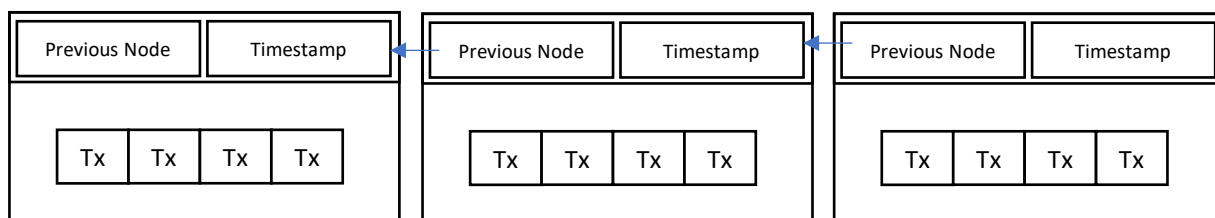


Fig 1: Blocks within a Blockchain Database

### Key Characteristics of Blockchains

There are several properties of blockchains that are critical: Decentralization, Persistence, Auditability, and Security. The table below summarizes what these key characteristics are.

Characteristic	
Decentralized	No longer needing a third party to verify transactions with the blockchain. The verification of these nodes are done by the network through the use of a consensus algorithm [30]
Security	Blockchains employ elliptic curve cryptography. Additionally with the inability to manipulate established nodes due to the decentralized consensus, the blockchain is secure [12]
Persistence	The chain ensures that all the blocks are connected and therefore cannot be changed as any modification would be detected by the network. The chain is thus an immutable ledger that cannot be manipulated [11]
Auditability	All of the transactions are recorded and therefore can be verified and traced which enables a level of transparency between nodes within the blockchain network [11].

### Smart Contract

Smart Contracts are a relatively new addition to Blockchain frameworks. They are contractual clauses that have been converted into programs that can be run on top of a blockchain network. The purpose of smart contracts is to embed the contractual clauses such that they are enforced automatically when conditions are met. The advantages offered by Smart Contracts are risk reduction, cost reduction, and an increase in the efficiency of business processes [13].

Smart Contract Advantage	Description
Risk Reduction	Smart contracts adhere to the immutability of the network, therefore the smart contract cannot be altered once issued. Behaviors that violate the contract, such as financial fraud, can be caught and avoided.
Cost Reduction	Since blockchain bypasses the need for a third party, smart contracts also eliminate the need for a central entity to enforce the contracts. Therefore, administration and services costs brought about by a third party are mitigated.
Efficiency Increase	The automatic settlement of transactions due to the elimination of a third party intermediary improves the efficiency of businesses by reducing turn around time. The transaction occurrence once a condition is met implies little delay in carrying out the transaction itself.

### Consensus Algorithms and Security

This paper does not focus on the implementations of consensus algorithms and security in terms of how they affect the overall implementation of the blockchain. Though they are very important parts of the blockchain



infrastructure and impact transaction time and scalability quite significantly, the actual implementations of the Consensus Algorithm’s and Security will not be discussed in depth.

*Comparative Analysis of Open-Source Blockchain Implementations*

<b>Characteristic</b>	<b>Ethereum</b>	<b>Hyperledger Fabric</b>	<b>Quorum</b>	<b>R3 Corda</b>
Platform Description	General Platform for Blockchain Solutions	Business to Business-centric Blockchain module [14]	Financial Focused DLT [15] (Built on Ethereum)	Financial Focused DLT [15]
Governance	Ethereum Developers	Linux Foundation	ConsenSys	R3
Public or Private	Both	Private	Private	Private
Permissions	Permissionless	Permissioned	Permissioned	Permissioned
Consensus	PoW, PoS	Multiple	Raft-Based, IBFT, PoA [17]	Own Implementations (Notary Nodes) [16]
Smart Contract Implementation	Yes	Yes	Yes	Yes
Digital Currency	Ether, and Tokens through the smart contract	No Native asset, Internal Token [18]	None	Native token, XDC

*Private vs Public Blockchain*

A blockchain can be categorized as either public or private. A public blockchain network is similar to an infrastructure that of Bitcoin. Anyone can participate in the network and leave the network at will. The blockchain itself is completely decentralized. This ensures there is no single one entity that controls the network and therefore, no one single point that is vulnerable. A private blockchain network implies that the nodes within it need to be granted access to the network – otherwise they will not be authenticated. Hyperledger, Quorum, and R3 Corda are all private networks. Private networks are more secure and provide more granular control over who belongs to the network. In the sense of Financial Applications, a private network makes the most sense as they are more secure and are more akin to how traditional banking is done [19].

*Description of Blockchain Platforms*

*Ethereum*

Ethereum’s purpose of creation was to create an alternative protocol to Bitcoin that allows for building decentralized applications. It intended to be a blockchain that allowed anyone to leverage it in order to write smart contracts and decentralized applications that followed the users rules, transaction formats, and state transition functions [20]. It has a native digital currency, ether (ETH) that has three main purposes: to settle transactions through exchange of ETH, enable network operations by using ETH as currency to pay transaction fees, and to store value. Ethereum’s main qualities are: decentralization, permissionless, secure, open-source, transparent, pseudo-anonymous, disinflationary supply [21].

<b>Advantages</b>	<b>Disadvantages</b>
Innovators of the smart contract	Limitations in terms of scalability
Open-Source – provides an active community of developers	Risk from high level of decentralization

Enterprise Ethereum Alliance which is dedication to promote Ethereum adoption. This indicates a lot of support within the landscape.	Smart Contract volatility
	Lack of a clear Monetary Policy
	Uncertainty with SEC regulations

### *Hyperledger Fabric*

Regulated by the Linux Foundation, the Hyperledger Fabric is a permissioned, private blockchain platform where the nodes (members) trade or exchange assets. The exchanges are executed by transactions which are directed by chaincode. Chaincode is code that is contained on the nodes of the blockchain network and is executed when directed. In this regard, chaincode is what executes the functionality of a smart contract within the Hyperledger framework. The execution of chaincode is what creates the interactions between the nodes and the shared ledger. The goal of the Hyperledger fabric is to enable blockchain adoption within enterprise ecosystems.

Since it is a permissioned blockchain, all nodes within the network needs to know and maintain the identity of the other nodes within the network. There are subnetworks with in the larger Hyperledger network called channels. Channels are restricted to a particular subset of the participants from the larger network. Here, the channel can create their own ledger that only maintains a record of their transactions and digital assets, and can only be accessed or viewed to nodes in that channel [19].

<b>Advantages</b>	<b>Disadvantages</b>
Permissioned Membership – security in knowing entities	Limitations in terms of scalability [23]
Immutable Ledger	Not Fault Tolerant
Protection of Digital Keys	Lack of transparency as it is permissioned
Modular architecture – supports plug-in components [22]	Consensus Algorithm not as secure as PoW
Channels allow for abstraction of unnecessary data	No Native Currency

### *Quorum*

Quorum is a permissioned based implementation of Ethereum that was developed by JP Morgan and was later acquired by ConsenSys. The difference between Quorum and Ethereum lies in it being a permissioned implementation. Therefore, nodes have to verified before they can enter the Quorum network. Additionally, the consensus algorithms used by Quorum are RAFT and IBFT which replace the PoW implementation of Ethereum. There is also the support for privacy in Quorum which means that transaction are not visible to members of the larger network. This is similar to Hyperledger’s channels where some transactions can only be visible to a smaller group of people that is maintained on a smaller, private ledger. Quorum also eliminates costs for transaction and does not have any cryptocurrency costs associated with its transactions [24].

### *R3 Corda*

R3 Corda is an open sourced software project that creates the Corda Network. The main goal that Corda is trying to accomplish is to ease the current problem of managing contracts and other agreements between parties, especially when there is not enough trust between the parties. This distributed ledger software is used for recording and processing data. It supports smart contracts and is private and permissioned. Unlike Hyperledger or Ethereum, to achive consensus, it uses the idea of notary pools. For brevity, this paper will not go into this consensus method, however, it is noted in the Introduction to the Corda Platform Whitepaper [25]. Corda’s focus is mainly on financial services in order to create a global independent network, and therefore abstracts away from a lot of the components of a typical blockchain structure that causes time and computational overhead. However, some argue that one could leverage the full functionality of Corda by using components of Hyperledger, and get the additional components that are provided by Hyperledger.

### *Transaction Throughput*

<b>Platform</b>	<b>Throughput (Tx/Sec)</b>
Ethereum	40 [21]
Hyperledger Fabric	300 [21]
R3 Corda	170 [26]
Quorum	750 [24]

It is evident that of them, Quorum provides the fastest transaction throughput. However, it also provides the less flexibility in terms of what it can do. Ethereum provides security but limits the scalability. In time critical situations, Ethereum does not prove to be the most efficient blockchain implementation that can be used. The Hyperledger fabric conducts transactions much faster than Ethereum. However, it also is limited in scalability as the more nodes that are added to the network, the lower the throughput. It only scales well when regarding the number of transactions [23]. R3 Corda also has higher transaction rates than Ethereum but has lower throughput than Hyperledger Fabric. As mentioned before, the Hyperledger Fabric with its "plug 'n play" components can be build such that is performs similar to Corda platform. It should also be noted that for the scope of this paper, only transaction throughput is reported, however there are other important metrics such as CPU consumption and Transaction Latency that are important to understand the limits and constraint of these platforms. Furthermore, it should be noted that there is no standard when it comes to obtaining performance measures. Experiments that are conducts are limited by resources as well as are focused on testing certain use cases. Therefore, these measurements are not wholly accurate as there is no literature that exists, to the best of current knowledge, that conducts the same controlled experiment on all of these platforms in order to obtain perfect comparative metrics.

### *Conclusion*

This section gave a brief overview of Blockchain Architecture, as it pertains to this paper. It omits much of the low level descriptions for the sake of brevity, but ensures the reader has a general understanding of how Blockchains work. It then discusses four blockchain platforms that are used to build Blockchain Fintech applications. Once the platforms are introduced, it gives a brief comparative analysis and comparison of transaction rates.

## **The Payments Sector**

### Retail and Consumer Payments

With the increased traffic in online shopping, ride sharing, food delivery, and much more, the payments experience has now moved away from in person exchanges of money and gravitated towards other methods of payment. According to Oliver Wyman, the payments space has "become a key enabler of an integrated and seamless shopping experience that provides a unique competitive advantage" [27]. Merchants are now looking towards payments solutions that are fast, quick, and versatile. The ability to leverage blockchain to not only allow customers to use accepted cryptocurrency in their transactions, but these transactions also have the ability to get settled faster, traced, as well as with fewer errors. The current issues that are befalling companies in the retail and consumer space are: high transaction fees, time delays errors in transactions, lack of transparency, and lack of traditional financial services offered my small to medium banks. This section will discuss these issues and then provide information how two companies, Ripple and Stellar, attempt to solve these issues.

### *Current Issues in the Retail and Consumer Payments Segment*

### *High Transaction Fees and Time Delays*

Currently, there are many transaction fees associated with traditional banking strategies within the Fintech space. With the rise in payments solutions, technology experts have been trying to leverage different mechanisms to attempt and alleviate these fees.

Generally the bank or financial institution that issues a credit card partners with a network (ie. Visa or Mastercard). For every transaction, the card issuer charges the *merchant* a fee associated with the ability to accept that card. Additionally, a payments processor charges a fee in order to facilitate all of the background work that performs the transaction. Therefore the merchant is paying additional fees in order to accept the payment from a customer. According to Square, the average cost for payments processing is about 2.87% to 4.35% per transaction [28].

Along with transaction fees, the intermediaries create time delays during the transaction. Each intermediary has to process the transaction, obtain the fee that they are owed, validate the transaction, and then send it to the next intermediary to process. Each intermediary processing the transaction increases the time it takes for the transaction to complete its life cycle. Not only does this pose a risk in terms of fraudulent transactions, but it is also cost and time inefficient.

Blockchain Payment solutions can eradicate these transaction fees as they allow the customer and merchant to settle transactions with as few intermediaries in between as possible. Thus, the transaction costs associated with the intermediaries are significantly. Most existing payment solutions attempt to find the path of least cost in order to execute the transactions. Most blockchain payment solutions also operate with smart contracts -- thus decreasing the time at which the transaction is spending at each intermediary. By reducing the number of intermediaries and ensuring smart contracts execute these transactions within the blockchain network, the time of transaction also speeds up as delays are reduced.

### *Errors in Transactions and Lack of Transparency*

Errors in transactions occur within payments processing for many reasons. Sometimes there could be issues with the physical condition of the card, whether or not there is money in the card holder's account, or even the terminal of the merchant. There could be a lack of authorization, a duplicate charge, or even an incorrect amount charged [29]. It is often hard to understand where an issue is occurring, and even harder to ensure that the money is recovered despite who the guilty party is. Furthermore, because the transaction is passing through so many intermediaries, it is hard to understand at what point the transaction was faulted.

Blockchain allows the entirety of the transaction to be transparent and immutable. Therefore if one of transaction participants is fraudulent it is evident and easy to be able understand where the transaction went wrong. Furthermore, the consensus mechanism that govern most blockchain payments solutions ensures that there are minimal errors when conducting transactions. If there are errors, the immutability and transparency allows the transaction participants to understand where the errors were and correct them.

### *Lack of Traditional Financial Services*

One big issue that small to medium businesses face is that they are not connected to a large financial institution. This is quite common in countries that lack the infrastructure to have large financial institutions, but have many small to medium banks. These small to medium banks lack the same services that their larger counterparts have (for example, they don't work with some networks or they can't conduct currency conversion). Without some basic services, merchants have a difficult time processing and conducting electronic payments.

Blockchain enables these small to medium banks to have the services by connecting them to larger financial institutions and banks around the world through their network. This way, when paying with FIAT money or

cryptocurrency, the transaction can travel through many intermediaries within the blockchain network and complete the transaction. Thus, the small to medium businesses can still conduct the same type of transactions that larger businesses are able to do with the large banks. This opens up commerce in many areas of the world.

### *RippleNet*

RippleNet is a network of financial infrastructure (such as banks, payment providers, and other financial institutions) that allows those leveraging Ripple's solution to send and receive payments through the network [30]. RippleNet efficiently routes payments through the financial institutions on their network in order to settle transactions as fast as possible as well as reduce cost. The network itself is a decentralized global network that uses a Ripple developed consensus protocol in order to validate account balances and transactions within the network. The network therefore keeps track of all the transactions that occur and they are publicly recorded and viewable. By having banks and payment providers within the network itself, Ripple removes the fragmentation that is a problem within the payments processing landscape. By using blockchain to record and facilitate these transactions, payments are able to find the shortest path (involving the least amount of intermediaries as possible) as well as find the least amount of cost in regards to transaction fees. Though Ripple charges a fee for using the network, it is significantly lower than normal fees associated with other payment providers.

RippleNet also allows for the use of the Ripple Cryptocurrency, XRP. This enables global payments at a much faster settlement rate as the FIAT currency does not need to be converted multiple times. Once the initial FIAT payment is made and converted into XRP, the XRP travels through the various nodes and reaches its destination, then gets converted back to the FIAT currency of the destination. This reduces transaction time incredibly as these transactions now take minutes instead of days however it also significantly reduces the transaction costs for both the banks and the consumer. The fees that accumulate by going through each intermediary every time a currency needs to change ends up being larger than expected. Thus, using RippleNet, these transaction fees are avoided as the standardized currency within RippleNet is XRP.

Ripple's solutions also open up a host of services for small to medium banks and merchants, especially in countries where there is little financial infrastructure in place. RippleNet's integrated solution of having banks and payments providers within the network allows these smaller banks and merchants to complete transactions by leveraging the financial services of Ripple's financial partners. The access to the network allows these previously challenged companies to complete cross border transactions as well as allow different payment services within their own country. It also allows Ripple's financial partners to reach a host of customers that they would not have been able to before due to the distance and lack of infrastructure.

### *Stellar Network*

The Stellar Network is a peer-to-peer payments network that originates from the early iterations of the XRP Ledger developed by Ripple. RippleNet and the Stellar Network differ based on their fundamental purposes. The Ripple network was built to provide liquidity solution to larger institutions. Ripple is the central organization that oversees the transactions that are occurring. Stellar's goal is to provide payments solution on a smaller scale and increase global financial inclusion. It uses the Stellar consensus protocol (SCP) and utilizes smart contracts in order to swiftly carry out transactions [33].

The Stellar Consensus Protocol utilizes quorums in order to emphasize security within the blockchain but also to speed up transactions within the network itself. Quorums are a group of nodes. A Quorum slice is "a subset of nodes on the network that a given node chooses to trust and depend on" [31]. Stellar allows each individual node to choose what node is within its slice – this enables open participation and more jurisdiction over who is validating the transactions, leveraging trust that has been built through intrapersonal interactions. However, in order to reach global consensus, there has to be intersections between quorums – meaning that one node in the quorum slice must *also* be in another quorum slice to maintain the integrity of the network as a whole. This protocol has been employed in order for the network to reach consensus without relying on a centralized/closed

system. The quorum slices also allow transactions to be accepted quicker by the nodes in the quorum, thus increasing the speed at which the transactions are carried out. Since the protocol also allows an open network, there are many ways to decrease the amount of intermediaries the money travels through, thus providing shorter options which then decrease any transaction fees. Quorum slices play a big role in ensuring the security of each and every node as well as ensuring the transactions are recorded without error and are valid.

### *Conclusion*

This section discussed the two fintech companies Stellar and Ripple and how they leveraged blockchain architecture to solve problems that the sector currently faces. Blockchain allows these two companies to make payments more time and cost efficient by having their own networks and utilizing their own cryptocurrency. The Distributed Ledger attribute enables transparency of transactions and guarantees immutability leaving a permanent record of transactions that have taken place. They also open up banking services to unbanked populations in certain countries.

*Retail and Consumer Payments Chart*

<b>Problems Faced by Financial Institutions</b>	<b>How does Ripple’s Blockchain solve these problems?</b>	<b>How does Stellar’s Blockchain solve these problems?</b>	<b>Problems in Ripple’s Current Implementation</b>	<b>Problem with Stellar’s Current Implementation</b>
High transaction fees	RippleNet finds the most efficient (time and cost) path through its network of banks to complete the transactions	The Stellar Consensus Protocol utilizes Quorum Slices to ensure that transactions can be validated in a matter of seconds with the least amount of fees as possible	Ripple charges quite a bit for transactions that take place on RippleNet	Stellar charges fees in their native currency, Lumen which proven to be highly correlated with the price of Bitcoin [32] – therefore can be volatile
Time Delays			XRP can reduce transaction times, but they are still too high as cross border payments need to be fast as they increase	If the transaction needs to be converted into multiple currencies, the transaction time could increase
Errors in Transactions	Blockchain Implementation provides transparency through the DLT by information redundancy and transaction immutability that is visible	The Quorum Intersection ensures that a general consensus is made such that there are no errors in deductions from accounts		There have been cases of errors occurring when a transaction is starting due to an insufficient amount of funds or due to nodes being offline because of the consensus protocol.

Lack of Transparency		A decentralized, immutable blockchain system provides transparency when looking at the transactions that occur	Ripple is centralized as a majority of the nodes belong to Ripple. Thus, the possibility of complete transparency is not possible.	
Lack of traditional financial services (small to medium banks)	RippleNet connects banks together through its infrastructure such that small to medium banks can complete cross-border transactions	Stellar connects banks together across the world in a public manner. This means anyone can join the Stellar network.	There may not be a bank in that country of interest that has enough money to complete large transactions as not many well funded large banks are part of the RippleNet	



## Point of Sale Payments

This segment of the Payments sector is focused on the actual place and technology used where a customer executes the transaction for goods and services provided by the merchant. Point of Sale payments can be online or they can be physical devices that the customer interacts with. They are systems comprised of both hardware and software that facilitate the transactional process from customer to merchant. It also can provide services as order management, inventory tracking, and card payments processing.

### *Current Issues in the Point of Sale Segment*

#### *High Fees*

Point of Sale systems often are physical devices in stores that have the ability to be quite cheap to a very expensive unit. Whether or not a merchant buys or rents their POS hardware and software, there is still a non-negligible upfront cost. On top of the actual system, most POS vendors charge payment processing fees. Some vendors will allow the merchant to work with a third-party credit processor or they will require the merchant to pay some fee per transaction. Other vendors also ensure that you pay for their own processing service. These fees then accumulate overtime and the merchant loses quite a bit of profit to fees. Often time, to cover these fees or the cost of the POS system itself, merchants charge the customer a fee for processing the transaction. The proceeds from this transaction will then cover the cost of anything related to the POS.

By having a POS that operates within a Blockchain framework, any processing fees in regards to payment can be disregarded as by accepting Blockchain, the payment is almost instantaneously processed on the network itself. Furthermore, if there is a slight fee involved the blockchain is transparent in that a merchant or customer can see what fees are associated to what part of the transaction (ie. where the money is going).

#### *Scalability*

Since Point of Sale systems tend to be physical devices in stores or online payments systems, the ability to scale is somewhat limited. There are many taxes and fees associated with credit card providers that merchants have to worry about that reduce the amount of transactions that can be made in a given time frame due to the computational overhead.

Thus, by using a blockchain which support smart contracts, the transactions are triggered instantaneously, and transactions can be resolved at a much faster rate. Furthermore, the consensus mechanisms can be manipulated such that it allows for the growth of more nodes in a system which then allow many more customers to enact payments without slowing down transactions.

#### *Large Amounts of Information*

Currently, traditional Point of Sale systems are required to maintain several different databases as well as storing information of various parties that they need to connect with. All of this information is then stored on some software or a centralized database. The information that needs to be stored that are related to customers, such as billing, ratings, and orders can be stored on individual nodes within a blockchain. Additionally, inventory can also be stored on nodes across the chain. Alternatively, the network can be built on top of a decentralized database that can be accessed by nodes when needed. Smart contracts can then trigger processes regarding incoming data and then ensure that transactions between existing nodes and new nodes are complete and valid. By having a decentralized system, the information is stored on the blockchain which gives every participant the ability to see and understand the transactions as well as the data that is being stored. Not only does storing the data on the blockchain make everything more efficient, it also ensures security as there is no one centralized database that could be tampered with [34].

### *Algorand Blockchain*

The Algorand Blockchain is a payments solution that has their own Point of Sale implementation. Their application that acts as a PoS allows the PoS to communicate with a crypto wallet containing Algorands through their transaction gateway. The application captures the details of the transaction and creates an unsigned transaction that is then sent to the transaction gateway. The transaction gateway forwards this to the wallet. The signing wallet receives the unsigned transaction and waits for approval from the consumer. If the consumer approves the transaction, it gets signed and sent back to the Transaction gateway. The entire receipt is stored in an off-chain storage system – essentially recording the transaction in an immutable manner so it can be retrieved when needed [35].

The storage system eliminates the need for data to be managed by the PoS system/application as it is getting stored on an off-chain system. That way all the data can be managed in one location and can be retrieved at any time. This storage system can be any third-party storage system the merchant chooses to use. This could cause some security issues as it is one decentralized location, however the information is encrypted and decentralized – thus providing a general semblance of security. Furthermore, the blockchain information is stored in the storage system, relieving the actual block of retaining that information. Thus it allows the blockchain transactions to be faster and scalable as the blocks do not contain as much information as other blockchains do.

According to tests done on the blockchain, the Algorand blockchain can handle around 1000 transactions/second. This not only increases efficiency and allows the blockchain to scale at a more rapid pace, but it also significantly reduces settlement times. Additionally, since the blockchain operates within its own network (from PoS application to Gateway to Wallet) there are no outside transaction fees associated with third party intermediaries in the transaction. The speed will also not take a significant reduction as the blockchain scales because the consensus mechanism used is Pure Proof of Stake [36]. Essentially, it requires very limited computation and simply relies on how much Algorand a user has in their wallet. However, the fact that the PoS solution relies entirely on the adoption of the Algorand blockchain and whether or not consumers have a wallet that contains enough Algorand in it to make a transaction. Limiting the currency does pose a threat to scaling as in order to use it to use it, consumers would need to make an initial investment in Algorand.

### *Pundi-X*

Pundi-X is an end-to-end platform that allows consumers to use cryptocurrency at retail Points of Sale [37]. In order to use the platform, the consumer must have a Mobile Wallet. It allows the private and public keys necessary to maintain a secure blockchain to be hidden behind a normal password-based system that is more user friendly. The platform also allows for a smart card that can be loaded by the mobile app that allows the currency to be used even without access to a smartphone.

Although VISA and Mastercard have networks that enable using cryptocurrency as payment through conversion to FIAT, the issue is that not all locations in the world have access to these services. Pundi-X is opening up to under-serviced countries and allowing merchants and users to begin to transact in a more digital manner.

Pundi-X is currently marketing in Indonesia, giving a hardware device to merchants in retail environments when a smart phone is available. Otherwise, merchants can carry out their transactions on an smart phone based application as well. In order for a consumer to carry out transactions with the Pundi-X platform, the must buy currency through their mobile wallet. By having a physical device as the entry point to transaction, the Pundi-x blockchain is offline and decentralized. All of the rates that are required for the transaction are set by the merchant at about 1-2%. 65% of that fee is given to the merchant, while the rest is given to Pundi-X or the issuer of

the digital asset used in the transaction. Though this does not eliminate third party fees entirely, merchants still have control over the fee that is being charged. The merchant also is very aware of who is receiving the fees.

Furthermore, in the rise of Digital Assets, the Pundi-X platform now enables people to use some of their investments to pay for things today. Most cryptocurrencies can be used on the Pundi-X platform. The platform is open – this allows digital assets to be submitted to be evaluated on the possibility of being used as currency. This enables long term scalability as it allows the platform to start incorporating popular digital assets as well as opens up accessibility to various regions of the world. Furthermore, Merchants can chose whether to get their payments in FIAT currency or a stable coin of their choice. Therefore, if a consumer chooses to pay with a more volatile coin, the merchant has control over the currency they receive that payment in.

All of the information of the blockchain transaction is printed on a receipt for the consumer, but is also maintained within the Pundi-X blockchain. An issue for scalability may arise in this situation as once the ledger needs to maintain a lot more information than just a simple transaction – especially if it is being used to calculate inventory for a merchant. Therefore, this large amount of data storage could affect scalability and thereby transaction time. Additionally, scalability comes into question when it is realized that a physical offline device is needed in order to scale the use of the platform as a whole. Therefore, since the XPOS machine is acting as a node, there will be slow growth if the adoption process itself is slow.

### *Conclusion*

The Pundi-X and Algorand blockchain implementations both solve the issues this segment faces in their own unique ways. By leveraging the blockchain architecture, data is stored efficiently, scalability is more feasible as transactions are faster, and cryptocurrency can be used to make purchases. The ability to have a point of sale system that uses cryptocurrency allows underbanked populations to be able to have a wallet that contains money without having a bank close by. The time efficiency of the transactions also reduces the cost, allowing sales for both merchant and consumer to be easier and less costly.

Point of Sale Chart

Problems Faced by Financial Institutions	How does the Algorand Blockchain solve these problems	How does Pundi X XPOS solve these problems?	Problems with the Algorand Blockchain	Problems with the Pundi XPOS
High Fees	The fast transaction times incurs fewer transaction fees. Thus, the high transaction fees associated with normal credit cards are avoided	Merchant sets the fee rate (between 1-2%) and gets 65% of the service fee. The rest of service fee is given to Pundi X or the Payment Issuer (issuer of the digital asset used) [3]	Since the transaction fee is .001 Algorand/transaction, if the price of an Algorand increases to a large amount – the transaction fee could increase as well.	The merchants set the service fee rate which can be between 1-2% -- it is not standardized.
Settlement Time	Processes transactions within 5 seconds such that the smart contracts execute and settle the transactions as fast as possible	Transactions occur almost instantly – at less than half a second		
Subject to fraud	Due to real time settlement and immutable transactions, it is hard to initiate and complete fraudulent transactions.	The immutable transactions are recorded within the PundiX blockchain.		
Rise of Digital Assets		Using the Pundi X wallet, XWallet, which allows them to manage and use their digital assets. It also links with a card called XPass that can be used with the XPOS machine that links to their XWallet.	Users need to have a Signing Wallet which is linked to their Algorand account. Thus, the only crypto asset allowed to be used is the Algorand.	Users need to create an XWallet such that they can use the XPOS terminals. In order to use the XPass, they will also need to link their card to the XWallet.
		The Open Platform allows digital assets (ECR20s) to be submitted to PundiX such that they can be used on the PundiX platform. This allows for scalability in terms of incorporating		

		popular digital assets as payment.		
		Merchants get paid in FIAT currency or a stable coin of their choice, therefore they don't run the risk associated with the volatility of cryptocurrency		
Scalability	The Algorand Blockchain can process 1000 transactions/second. This increases efficiency and the ability to carry out more transactions with security.	The PundiX XPOS runs within the PundiX blockchain ecosystem. Therefore, the XPOS will scale with that of the blockchain as it acts as a node within the blockchain.		Since each XPOS terminal is a node, it has not been seen how many nodes the PundiX blockchain can manage a large amount of nodes.
	Uses a Pure Proof of Stake consensus mechanism – meaning the only factor that affects the block creator is the number of Algorand tokens held by the participant. It benefits speed while maintaining decentralization.		Have been issues with the consensus algorithm when one node has <i>too</i> much stake – thus the other nodes were unable to form a consensus.	
Large Amounts of Information	Implements something called Off-chain Storage which is essentially a decentralized file storage system that encrypts the data and makes the content immutable. Open-source solutions such as Interplanetary File System can be used or other commercial file systems can be used.	A receipt is printed at the terminal that contains the transaction information that is maintained within the PundiX blockchain.	Because the blockchain transaction storage itself is limited, there needs to be a third party component to act as an intermediary between the Point of Sale application and the blockchain. This could cause delays, errors, and efficiency loss.	In order to see the transactions made, one would need to use the PundiX interface. The large amount of data storage could affect scalability and transaction time.

## International Money Transfer (Remittance)

Remittance is a section of the economy that is based off of the exchange of money across international borders. Currently, the remittance market is dominated by SWIFT, Society of World-Wide Interbank Financial Telecommunication. SWIFT is a network of banks that connects corners of the world together. In order for a transaction to be completed, the transaction needs to go clearing or settlement center before the transaction is cleared. SWIFT itself does *not* settle the transaction, it simply sends the message that a person would like the transaction to occur. It is up to the banks to settle the transaction and relay that message back to SWIFT such that both sides are able to acknowledge the completion of the transaction [38].

Blockchain has revolutionized cross border payments by carrying out transactions in cryptocurrency. The blockchain infrastructure supports real-time settlement with a low cost. Several companies (such as Ripple, Everex, SureRemit, etc) has capitalized on using blockchain for remittance. This section will discuss the current issues surrounding Remittance and then will analyze how Everex and SureRemit solve these issues leveraging blockchain architecture.

### *Current Issues in the Remittance Segment*

#### *Transaction Fees and Settlement Time*

One of the biggest challenges that is encountered when consumers use SWIFT is the accumulation of transaction fees. These transaction fees are a result of the money passing through several intermediary banks that charge their own fees. The total of those fees has to be paid by the sender – resulting in each transaction costing a lot more than what the sender wants to send. Several banks are used within the network because FIAT money in one currency needs to be exchanged into other FIAT currency. Not all banks operate with a large amount of FIAT currency in other countries, thus a route between banks needs to be established that allows sending currency to be translated into the desired receiving currency. Cryptocurrency can fix this problem as it is not a FIAT currency, therefore sending money to another person is not dependent on the location of the receiver or the sender. It is simply dependent on the amount of funds available in the senders wallet. The contingency that lies with using cryptocurrency is that cryptocurrency needs to be able to be exchanged into FIAT currency, thereby allowing it to be used in the country that it is received in. The third party banks in the network are removed or there is no need for currency to be “converted” such that the amount of transaction fees that are accumulated are minimal in comparison to using SWIFT.

As mentioned earlier, SWIFT is simply a network of messages, the actual transactions occur at the banks themselves. Therefore, by the time the transaction passes through the several banks to be exchanged into the desired currency, a lot of time passes by as each bank has to settle and clear the transaction. Blockchain could speed up the transaction time as a decentralized ledger keeps track of all transactions and displays them all. Furthermore, a blockchain transaction is settled as soon as the payment is made. By bypassing the third party intermediaries, sending money globally via blockchain reduces settlement time significantly.

#### *Risk*

When using international currency, the exchange rates for various FIAT currency changes quite sporadically. Therefore, the long settlement time poses the risk of changing it's value from the time it is sent to the time it is settled. Furthermore, most banks have a clause in their remittance contract that disclaims any liability if the transaction remains incomplete. Thus, the risk is undertaken primarily by the person who initiates the transaction (the sender of the money).

A blockchain architecture mitigates the risk associated with currency exchange rates as the transactions are settled in real time, thus, the value that is sent has a very high probability of being completed without any changes to the

conversion rate. Additionally, since all transactions are recorded visibly on a ledger that is accessible, the sender can understand whether or not the transaction has completed – giving the sender the ability to track the path of the transaction. [39]

### *Lack of Financial Inclusion*

Transaction fees are accumulated heavily when money is sent to a country with little to no financial infrastructure – therefore, finding a bank that operates with the currency of the desired country would result in many intermediary banks which increases the cost of transaction. Additionally, as some countries don't have financial infrastructure, some people do not have bank accounts. Without a bank account, it is hard for money to exchange hands without physically handing the money to the desired recipient.

By using blockchain solutions, it does not matter whether or not the country has a bank that is connected to the rest of the world, it simply relies on internet and the conversion between cryptocurrency to the FIAT currency of that country. Furthermore, some blockchain companies have taken interest in the lack of infrastructure in under-banks population and are finding ways for money to be exchanged and used within the country of that region.

### *Cost of Compliance and Interoperability*

The cost of compliance due to varying regulatory environments increases the more money exchanges hands. Compliance refers to the operational efficiency and reliability that the money will be moved safely to the recipient. With the current SWIFT system, it is hard for the sender to track the transaction as it passes through many third party financial institutions before it reaches the desired recipient. Furthermore, different countries require a different amount of information in order for transactions to be processed. Thus, when a transaction is initiated, the interoperability between countries becomes another aspect of delay when attempted to complete the transaction.

Blockchain solves both of these problems by allowing the entire lifecycle of the transaction to be easily tracked through a transparent ledger. Furthermore, there can be more rules and regulations surrounding cryptocurrency that allow it to bypass the various regulatory environments as the cryptocurrency could have its own set of rules and regulations. The interoperability issue is solved as when cryptocurrency is used to complete the sending of money, the transaction lives within the blockchain architecture. Thus, no additional information is ever needed as the transaction is simply passing through the same network.

### *SureRemit*

SureRemit is a blockchain platform started by the makers of Suregifts, that leverages the Stellar Network that is targeted towards customers of the SureRemit platform and immigrants. SureRemit's goal is to provide cashless remittance services for immigrants. Within the platform, the Remit token (RMT) can be used by RMT token holders to pay bills and access vouchers. Customers will be able to select the country for which they want the money to be sent to, look for the category, and thus create a voucher that can be sent via text or email. These vouchers freeze the tokens -- when the voucher is used, the merchant gets paid in their FIAT currency (or if they prefer, RMT) [40].

By utilizing vouchers that are sent over SMS or Email, SureRemit breaks through the barriers that are created due to lack of financial infrastructure. A person does not need to have a bank account in the country of origin in order to pay and send vouchers. Since the RMT tokens are built on the Stellar blockchain platform, they can be converted into FIAT currency, or if the merchant would rather hold the RMT they could choose to do so. However, the drawback to using RMT vouchers to pay the merchant is that the merchant must be partnered with

SureRemit and accept vouchers in order for the vouchers to be used. This creates an issue in places where merchants are not willing to partner with SureRemit .

As noted above, SureRemit leverages the Stellar Platform and also partners with merchants. This allows the transaction to bypass different regulatory environments as the RMT tokens can be converted into FIAT currency via the Stellar Platform. Furthermore, using the SureRemit network, the sender is cutting out banking intermediaries. The minimal fees charged by SureRemit do not come close to the amount of fees that would be accumulated when sending money through SWIFT. Additionally, the transaction time is much faster as Stellar transactions on average take 5 seconds to process. Without the need of interacting with several intermediaries, using the SureRemit vouchers not only reduces transaction fees but also transaction time. With the lack of time in between the start of the transaction to its completion, the risk associated with changing conversion rates does not pose a threat. The Remit Token is not subject to the volatility of the exchange rates – therefore what the sender sends, is what the receiver will receive [41].

### *Everex*

The main purpose Everex hopes to serve is to “achieve financial inclusion of the underbanked” [42]. In order to do this, Everex uses a cryptocurrency called “Cryptocash” . Each unit of Cryptocash is equivalent to the fiat currency it represents. Cryptocash balances are underwritten by third -party cash custodians that allow users to convert their FIAT currency into Cryptocash. They then can exchange and transfer the Cryptocash via blockchain. This allows Everex to obtain their goal of financial inclusion as they can avoid the volatility of current, non-stablecoin cryptocurrencies.

The Cryptocash is an Ethereum based token that enables the transaction times to be minimal and reduces the need for a third party intermediary. Therefore, the transaction fees and time associated to the transfer of Cryptocash in relation to a transfer made via SWIFT is much smaller. Since wallet to wallet interactions have no fees associated with them, the only fee would be due to the use of the Ethereum token – which comparatively is also minimal. Since the Everex Token is a “fiat” pegged stablecoin, the money that is being transferred is equivalent to the same FIAT currency that is being transferred – without needing to converted multiple times into various currencies. This poses a risk because the conversion from eFiat (Cryptocash) to FIAT is subject to conversion rates and can be volatile.

Furthermore, in order for transactions to take place, Everex has to have trusted banking partners in the countries they wish to interact with. This allows there to be an easy of interoperability between regions as Everex has handled the process and regulations directly with the banking partner. The partners banks enable Everex to provide a 1:1 conversion rate, but it also limits the geographical inclusion based on existing financial infrastructure. If a banking partner does not exist in a region, the eFiat money cannot be redeemed and converted into FIAT money.

### *Conclusion*

The most common problems with remittance are the cost and time it takes for the transaction to complete. SureRemit and Everex both solve these problems by utilizing the blockchain architecture and enabling non traditional ways of sending money. They both approach the problem differently, however they use the architecture to lower cost due to fees, reduce time of transaction, as well as working around regulatory environments and serving underbanked populations – which tend to be the main targets of remittance.



Remittance (International Money Transfer) Chart

Problems Faced by Financial Institutions	How does SureRemit use blockchain to solve these problems?	How does Everex use blockchain to solve these problems?	Problems with the SureRemit Blockchain	Problems with the Everex Blockchain
Lack of Financial Inclusion	Does not need a bank account on the receiving side to use the voucher that is sent – the receiver simply needs a mobile phone to be able to use the sent voucher.	Partners with banks that target under-banked populations and allows workers to send money back home without paying high remittance fees.	Merchants must be partnered with SureRemit and accept tokens in order for the tokens to be used.	Everex needs to have licensed exchange partners in the country of receipt in order to exchange tokens into local currency.
Cost of compliance among different regulatory environments	Leverages the Stellar platform and also acquires partner merchant – bypass the different regulatory environments altogether by settling Remit tokens with FIAT currency via Stellar		The Token can only be used to make purchases with partner merchants. Therefore, if a partner merchant does not accept the Remit token, then the money cannot be used.	
Interoperability	SureRemit has standardized the process regardless of country. The same information is required no matter where and with whom the transaction is being placed.	Everex has trusted banking partners in the countries they interact with, thus promising a 1:1 conversion rate of their eFiat stable coins.		In order for the stablecoins to be redeemed in Fiat currency, Everex must have local banking partners that operate within that currency. Otherwise, the eFiat cannot be sent/redeemed.
Risk	Remit Token is not subject to the volatility of currency exchange rates. Immediate and continuous liquidity provided by Stellar allows for the issuance and trading of tokens immediately – therefore they are not subject to the risk of exchange rates.	The Everex Token is a dollar pegged stable coin ensuring that the money being transferred is equivalent to the same FIAT currency that is being transferred.		The Stablecoins used by Everex when redeemed from eFiat to Fiat is subject to conversion rates that can be volatile.
Fraud & Transparency	The blockchain ledger is publicly verifiable and immutable. It will confirm whether the money was	The blockchain ledger is publicly verifiable and immutable. It will confirm	Remit Tokens are sent via a “voucher” outlining what the tokens are to	

	sent and received by the correct parties.	whether the money was sent and received by the correct parties.	be used for. This restricts the voucher to be used with only specific merchants.	
Transaction/Settlement Time Delays	Stellar transactions take 5 seconds to process, so by using the Remit Token instead of FIAT currency, there are no intermediaries when sending Tokens around the world.	Ethereum transaction take anywhere from 1 minute to settle using the eFIAT token. There are no intermediaries, thus the account gets credited based on the speed of the Ethereum blockchain.		The Ethereum blockchain has longer transaction times than other platforms – this could cause an issue when considering conversion rates.
Transaction Fees	By cutting out banking intermediaries, transaction fees are also removed. There is a 0-2% fee when sending using SureRemit which is significantly less than the standard 7%-14%.	The transaction fees are removed due to the transfer of eFiat stable coins bypassing banking intermediaries. Wallet to Wallet interactions have no fees associated with them.		

## Deposits and Lending

Deposits and Lending is a huge segment of the fintech industry that relies on companies enabling people to obtain loans and monitor/collect information about their credit. Blockchain has the capability of speeding up the processes, simplifying and breaking down barriers to obtaining a loan, and even allows other people to lend money without risk of not knowing who they are lending to. Businesses and Consumers can use blockchain aided platforms in order to quickly initiate transactions and loans that are guaranteed through the transparency and immutability of the ledger.

This section focuses primarily on the Lending aspect of this segment as it has the largest application within blockchain. Though there is a difference in the purpose of Business Lending vs Consumer Lending, the fundamental principles behind both are very similar. Furthermore, Blockchain has yet to reach a stage where it can support large business loans, therefore blockchain companies that specialize in loans and deposits target many Small Business and Personal loans.

### Small Business and Personal Loans

Small Business and Personal Loan companies that utilize blockchain have leveraged the architecture in several different ways. Colendi uses blockchains to perform Credit Assessments, Figure uses blockchain to provide credit based loans, and Celsius uses blockchain to provide Crypto based loans. However, within this segment the problems that are encountered are relatively the same – the solution by each company is what differs. This section will discuss the issues that exist within Lending and then will discuss how Colendi, Figure, and Celsius solve these problems by leveraging blockchain.

#### *Current Issues in the Small Business and Personal Loans Sector*

##### *High Fixed Costs*

Loan approval currently is a lengthy processes that involves several credit checks, background checks, paperwork, and other processes that often require the use of third party intermediaries. These third party intermediaries accrue costs that often have to be paid for by the customer who is taking the loan. The fees not only are high, but often times for personal loans can be a significant barrier because the customer may not be able to afford it. Furthermore the transaction fees from obtaining the loan and the administration fees associated with the loaner of the money also drive up the overall price of the loan – making the person or customer borrowing responsible for paying back a lot more than the amount they require in the loan.

Blockchain has the capability of solving these problems by providing a clear and direct translation of the money. Credit worthiness can be tracked by transactions on the blockchain, providing an immutable and transparent account of the person's financial history. It reduces a lot of the third-party verification needed to approve a loan, thus cutting costs down significantly.

##### *Lack of Information to Make a Credit Decision*

The process of obtaining information of a person or company's financial history and security in order to approve or reject the loan is a very lengthy process for the bank. Due to the time required to conduct the investigation, many loans take a long amount of time to be processed. Additionally the information, though through a third party, isn't always accurate. This could pose a risk for both the lender or the borrower depending on if the accuracy. Therefore, there needs to be a transparent way for the checks to be done.

Blockchain can not only keep a ledger that ensures that financial transactions and trustworthiness can be seen by both parties, but it also allows this data to be accessed in real time. Therefore, no large hunt is needed to investigate whether or not the person or company is qualified for the loan. The information lies within the immutable ledger that is fully accessible. Another component that Blockchain allows for is the reliance on Cryptocurrency as an investment. Now, Cryptocurrency can be an asset that is used to back certain loans. This doesn't rely on Blockchain as an architecture but is enabled by the financial value some cryptocurrencies have.

#### *Time of Application Process to Approval*

One of the largest pain points of loans is the time it takes for the loan to be approved once it has been requested. This is due to the immense amount of third parties that need to either provide information for the approval process, or to look over the loan application themselves. When it comes to evaluating collaterals, many people have to become involved in the process to assess the worth of the collateral to ensure that it can truly cover the cost of the loan. Furthermore, humans are involved heavily in the process, therefore time delays occur due to humans having a limited capacity when processing documents.

Blockchain architecture enables the possibility of speeding up the process by the utilization of smart contracts and by verifying information via the immutable ledger. Smart contracts allow for agreements to automatically be executed and efficient, thus reducing the time it takes from one approval action to another. Furthermore, it reduces the cost as legal fees and administrative fees could be cut. The immutable ledger allows documents and information to be shared via the ledger, that way there needs to be no investigation that takes place off the ledger. All the information is available and can be easily accessed by those processing the loans. When loans are backed by cryptocurrency, the currency exists on the blockchain, thus it is clear and evident that the applicant has collateral funds, reducing any time needed to understand and investigate whether or not the collateral can support the loan.

#### *Colendi*

Colendi is a Fintech company that "is a credit scoring and microcredit platform that can leverage new sources of information about borrowers to assess creditworthiness in addition to traditional measures" [43]. In order to provide new avenues of credit worthiness, Colendi uses machine learning based scoring technologies to evaluate data segments of a user. Colendi leverages the Ethereum blockchain to generate an accurate metric to allow underserved populations to have the ability to assess populations with less traditional information.

Banks create scores that are dependent on the records of their own customers, so if a potential borrow isn't evaluated based upon their own real characteristics. The customers private data shows a lot more information than what the bank has access too, thus Colendi's goal is to utilize the transparent property of blockchain to create a high standard of evaluation transparency combined with their machine learning algorithms to allow for a comprehensive understanding of the borrower's full potential.

The blockchain component of the Colendi platform has three main functions: identity management, collecting/storing data, and generating a credit score that can lead to a lending decision based off of the stored data. The data storage, due to its large nature, is a combination of both blockchain and the decentralized storage, Storj. The Colendi SDK allows the user to interact with Storj without needing to know the underlying technology. The computation of scores is not done on the blockchain itself but rather by the Engima Protocol where data can be split across nodes and can be used for computation. The score is then relayed back and stored on the blockchain such that computations can be easily accessed once done.

By using blockchain in this manner, Colendi is opening up the opportunity for the underbanked populations to gain access to microfinanced loans. If a user does not have enough data to secure a loan, Colendi offers the option for a

borrower to stake Colendi Tokens. Though these tokens cannot be used as collateral against a loan, they are used to provide a positive number when it comes to scoring. Furthermore, the data that is drawn upon goes beyond just traditional assets and bank history by including mobile data, social media data, and external data partners. All of this information is then stored in the decentralized storage and then drawn into the Engima Protocol to create a score [44].

All of these processes taking place on the blockchain reduces costs significantly as everything takes place within the Colendi network and doesn't have to go through several intermediaries. Furthermore, it reduces time delays as these activities are triggered via Smart Contracts on the blockchain network and are all within the Colendi network. Thus, there is no time delay that is associated to the processing of information by third party companies verifying the data. Furthermore, this data is secured as only the Colendi network has access to the decentralized storage system. All that will be garnered by lenders will be the final score that is produced by the Colendi Protocol. The blockchain provides an integral abstracting layer that ensures the protection and confidentiality of the borrowers data and information.

### *Figure*

Figure is a fintech company that is leveraging blockchain technology in order to quicken the loan application process. Figure has its own blockchain platform called Provenance. Provenance is used to store data within the blockchain to ensure that the data is accessible and untampered with. The data is digitally signed and validated using smart contracts. This inherently reduces the need for third party companies to verify the data, saving time and cost throughout the loan process.

The transactions are granted by the administrator and need to be approved by the stakeholders. The administrator is a key player in the blockchain as they create and review smart contracts that are held by the node to process transactions. They are also in charge of determining the cost of the transaction and the amount of stake that each node needs to hold.

When a loan originator selects an offer from a consumer's application for a loan, they generate a funding transaction that enables them to provide the amount required in the loan. Once the loan is funded, the originator can either retain servicing or sell the servicing. The loan payments are collected through a remittance agent. The smart contracts that are created by the administrator related to the transactions by "taking encrypted data from the member and transform that information to encrypted data in the blockchain" [45]. Omnibus banks are responsible for facilitating fiat settlement on the blockchain. When fiat is used, the members check to ensure that the omnibus bank account has enough money, the bank then generates a settlement token backed by the member's omnibus account, and then the token is passed to the receiving member. This transaction is immutable and present on the blockchain such that it can be referenced later on if needed.

By performing all of the transactions on the blockchain, Figure cuts out all other intermediary fees – leaving only the origination fee as the primary fee on the blockchain. However, one caveat to using Figure for loans is that they default to traditional methods to determine credit worthiness, primarily a high credit score [46]. This does not open up Figure to those who have no banking infrastructure or to those who do not have a good credit history. However, since the data is stored on the ledger, the time of approval for the application is much faster as the records within the ledger are trusted. Furthermore, the smart contracts enable many functions within the entire loan process to be automated and reduce any overhead of maintenance by a person.

### *Celsius*

Celsius is a Fintech lending platform that leverages blockchain technology in order to allow people to use cryptocurrency as a collateral to FIAT loans.

Currently, with the hype surrounding cryptocurrency many people are investing their money into digital assets. They hold onto their digital assets as they invested in cryptocurrency with a long-term mindset. Simply put, they are investing now for great payoffs in the future. However, although some businesses and companies allow the use of cryptocurrencies in transactions, crypto assets still don't have a lot of "real value". The only way to obtain value from them is to sell them – in which case, with such volatile prices an investor doesn't know if the sale will be for profit or for a loss. This is extremely important as when a person needs cash instantly, they can't always wait for the market to regulate such that their coins are valued higher. This often leads people to have to leverage real world assets in order to obtain a loan from the bank.

Celsius now offers a platform in which a person can leverage their cryptocurrency as collateral in order to secure a loan in FIAT currency. Rather than selling the cryptocurrency, members are able to leverage it while still holding onto that crypto portfolio such that they can obtain the future value [47].

They even take it one step further and allow members to accrue interest on their crypto assets similar to how money in a bank accrues interest. When asset holders deposit coins on the Celsius Network, they are then able to earn interest on their lent coins.

Celsius Tokens are the heart of the blockchain implementation of Celsius. These CEL tokens are an Ethereum ERC-20 coin that are issued on the Ethereum network. Celsius uses these tokens so that the lending and borrowing model is transparent. The Ethereum platform is leveraged by Celsius such that they can utilize the idea of smart contracts and leverage quick transaction times as well as leaving a very traceable footprint that allows for transparency of trade on coin exchanges.

Lenders in the Celsius network can be anyone who deposits crypto assets into the Celsius Wallet. These assets are stored in the Lending Stake Pool which are Celsius accounts. These accounts then transfer the coins to coin exchanges. The lender's wallet then accrues interest in the form of Celsius Tokens.

Lenders also can leverage their crypto assets in exchange for a FIAT based loan. In this instance, the user requests a loan and in exchange transfers crypto assets which are then locked. These crypto assets cannot be withdrawn until the loan is paid. The user then receives the fiat loan via a debit card or a direct bank transfer to a Celsius bank account. The payment plan and instructions are also issued at this time. Then, much like any other traditional loan, the user would pay the loan installments. Once the payments are paid, the crypto assets are then unlocked and the user may withdraw them as they please. However, if the user fails to pay, then Celsius has the authority to sell the crypto assets in exchanges in order to recover the Fiat value and reduce the loan amount.

In order to borrow coins, a borrower would deposit a FIAT value into a custodian trader account owned by Celsius. The borrower then, in efforts to short the crypto asset, places a limit sell order. This sell order acts as a request that includes conditions of the trade (time and price) as well as a fee to get access to the assets. While the borrower is requesting, the Celsius service checks to ensure the funds that are being requested are available based on the assets from lenders. If the trade is approved by Celsius, then Celsius issues a sell order of the crypto asset on the exchanges in order to hold a short position on behalf of the borrower. Once the crypto assets are sold, Celsius then orders exchanges in order to purchase the crypto assets back.

When the Celsius platform and the borrower make a profit off a short, the Celsius master account gets a percentage of that profit in addition to the fees accrued from making holding the short position. The money received by the master account from the borrowers is in FIAT, but the Celsius platform converts this FIAT value into CEL tokens and then distributed back to the *lenders* wallets as a form of daily interest. The amount that is distributed back is contingent on a Proof-of-Stake. In other words, the more crypto-assets the lender puts into the Celsius Network, the more interest in the form of CEL tokens they accrue. Lenders then are able to buy and sell these CEL tokens on exchanges however they wish. Additionally, lenders can pay off their Celsius loans via CEL tokens.

As the number of CEL tokens grows, the more stable it becomes as it becomes less and less dependent on the already volatile cryptocurrency market.

By using the CEL token, not only is Celsius offering a very transparent and efficient method of making exchanges, but it also provides a great incentive for people to lend out their crypto assets and use them as a collateral for FIAT currency while still holding onto them such that they can realize their long-term investments.

The Celsius network leveraging blockchain eliminates any third party cost as the loans are lent and borrowed within the Celsius platform – effectively making it a P2P loan. This cuts out any loan application or approval process that requires anybody other than the borrower or lender making the entire process faster. It also significantly reduces transaction and administrative costs. The loan is also not based off credit, but it is contingent upon the amount of stake (ie. the amount of crypto coin) that is held and put up as collateral. These crypto assets when used as collateral however, also are subject to volatility. Therefore, in the instance where the crypto asset has lost much of its value, the Celsius network will require more assets to be put up as collateral. Furthermore, the transactions all taking place on Ethereum and the ability to use smart contracts enables all internal functions such as checking the availability of funding or performing the transaction more time efficient, significantly reducing the overhead that comes with administrative work with traditional loans.

## Conclusion

Lending processes can be significantly more efficient when using blockchain – especially when the network leverages smart contracts to perform much of the functionality. The immutable ledger provides an accurate record that can later be referenced (or in some cases used) to ensure the validity and honesty of an entity, and even be a marker of how responsible they are. All three companies, Colendi, Figure, and Celsius utilize blockchain differently within the loans process, however they address the pain points that they all face and have been able to leverage the architecture to their benefit, and to the benefit of their users.

*Deposits and Lending Chart*

	<i>Credit Assessment</i>		<i>Credit Based Loan</i>		<i>Crypto Based Loan</i>	
<b>Problems Faced by Individuals and Small Businesses</b>	<b>How does the Colendi Blockchains solve these problems?</b>	<b>Problems with the Colendi Blockchain</b>	<b>How does Figure use Blockchain to solve these problem?</b>	<b>Problems with the Figure Blockchain</b>	<b>How does the Celsius Blockchain solve these problems?</b>	<b>Problems with the Celsius Blockchain</b>
High Fixed Costs (Administration Fees and Transaction Fees)	It uses blockchain to track and keep records of people's trustworthiness. There are less third parties to go through and therefore costs are reduced.		Figure only has an origination fee as all of the other intermediary fees are cut out due to the loans being sold and obtained via the Provenance blockchain.		Celsius does not charge any fees and the loans are lent and borrowed within the Celsius Platform – making it a P2P loan.	Centralized network as the wallet is held and managed within Celsius's platform
Lack of information to make credit decision	Uses a decentralized scoring system that consists of smartphone and social media data, transaction logs showing repayment performance.	Due to the goal of serving the underbanked population, more people may get loans that they are unable to pay off – which could hurt financial institutions		Figure does not check other aspects to determine credit worthiness – therefore a high credit score is needed	The loan is not based off of credit, but rather the amount of crypto coin that is held//put up as collateral.	
Lack of Collateral	Allows borrowers without much collateral to stake Colendi Tokens that contribute to a positive score		-----		Celsius allows Crypto Assets to be used as collateral when trying to obtain a FIAT loan	Crypto Asset volatility may cause Celsius to request more Crypto Assets as collateral for loans if the assets' value drops below a certain threshold.



Poor or Insufficient Credit	In underbanked populations, other data will be drawn upon (see above) to determine credit worthiness.			Figure still does a soft-credit pull and requires a decent line of credit in order to obtain a loan	The loan is not based off of credit, but rather the amount of crypto coin that is held//put up as collateral.	
Time of Application Process to Approval/Rejection	Smart contracts via the Coledi Token enable efficient and automatic fulfillment of agreements that reduce cost and time delays		The immutable ledger allows administrators who verify the paperwork can trust the records held within the ledger – saving time during the process.		The checks that Celsius does is the availability of funding in relation to the collateral that is being offered – therefore it is a simple check on the Ethereum Blockchain Platform via smart contracts – which is time efficient	
			The Hash token enables the use of smart contracts that allow for the automation of many functions during the loan process.			

## The Investment Sector

The investment sector of the Fintech landscape has approached blockchain in a different manner. Although blockchain has the ability to solve problems that occur due to the traditional operating procedures of investing, the focus at present is on investing *in* blockchain rather than *using* blockchain. What this means is that institutional and retail investors are investing in digital assets to obtain long-term profits.

Of the many digital assets that exist on Blockchain frameworks, the two major players are Bitcoin and Ether. Bitcoin specifically has ignited the need for institutional investors to join the surge of Bitcoin investing primarily because it is now showing to have increasing and stable value. Alongside Bitcoin, Ethereum is now steadily rising in popularity among institutional investors because the value store of the Ether has been increasing.

What is key to note here is that unlike the other Fintech sectors, investors are treating digital assets as an entity that holds value – not as a technology that simplifies the ease of transaction as the other sectors do.

### Institutional Investment

Prior to developments in regulatory requirements surrounding Bitcoin, Institutional Investors stayed away as digital assets were did not have clear rules across borders – therefore trading and investing in digital assets were not equivalent to assets already being traded. However, as Bitcoin became more popular and mainstream by the economy as the use of digital assets in payments rose, governments around the world began to formulate rules and regulations around Bitcoin, making a once gray area more filled out.

Furthermore, due to the Covid-19 Pandemic that affected global economy, Bitcoin and digital assets appeared to hold their power – inspiring the buy in of Institutional Investors due to its ability to hedge against inflation. In other words, as FIAT money was losing its value, Bitcoin was able to hold its value and be a safe investment. Additionally, Bitcoin halved the amount of coin in the market which meant that the number of newly mined coins was cut in half which made it less inflationary than gold during the Pandemic.

Additionally, now countries such as Canada and Europe have ETP's which allows institutional investors to place money on stock exchanges that are backed by crypto assets. ETPs are a great way for investors to get involved with crypto but ultimately do not need to handle the actual management of the assets themselves. According to Finoo, many different types of institutional investors are entering the market in order to capitalize on crypto opportunity. In order to facilitate these institutional investors, different digital currency asset managers have entered the scene – mostly started by giant investment management firms who noticed a growing interest within the Crypto space. Two such companies are Grayscale and Fidelity Digital Assets, started by the Digital Currency Group and Fidelity Investments respectively.

### **Grayscale**

Grayscale is a digital currency asset manager that offers a variety of “investment products”. These investment products serve the purpose of retaining a value of its shares that reflect the actual performance of the digital assets that compose the product. These products can either be single asset products or diversified asset products. In this scenario, Grayscale is *not* using blockchain to carry out the investment procedures but is rather using the *value store* of the cryptocurrency to realize a profit for its investors.

These products enable investors to gain exposure to digital currency asset classes without actually having to worry about buying, storing, or safe keeping the digital currencies themselves. The products are held in cold, offline storage with the Coinbase Custody Trust Company, which ensures security of the assets. Furthermore, by investing in products rather than holding the assets themselves, Investors are saving money by eliminating the expensive and time consuming processes required to trade, acquire, secure, and keep the assets. Grayscale enables the

investor to bypass having to deal with different intermediaries when doing the trading as they handle those tasks themselves.

Once again, it is key to note that Grayscale is holding crypto assets in a cold store wallet for the sake of realizing its value on the stock market rather than for the properties that the crypto assets due to being built on a blockchain.

### ***Fidelity Digital Assets***

Fidelity Digital Assets places a distinct focus on custody solutions for institutional investors who don't want to worry about the security of said assets. Therefore, the company found their market in offering trading and custody services that enable their investors to realize the true potential of their blockchain holdings without doing the trading themselves. The assets are stored in cold storage, thus they are physically separated from the internet making them extremely secure. Furthermore, the trade execution services will leverage the same internal crossing engine and smart order router that the larger Fidelity Investments group uses, and will execute trades via third-party cryptocurrency liquidity suppliers.

Similar to Grayscale, Fidelity Digital Assets is *not* harnessing the utility of blockchain as an entity, but placing emphasis on the value of cryptocurrency and using it to make a profit.

### Venture Capital

Venture Capitalists are utilizing crypto-assets to diversify their portfolios and creating crypto-based funds that will be used in investing in Blockchain start-ups, Initial Coin Offerings, and crypto assets. Start-up blockchain companies will obtain funding from venture capitalists by issuing a certain number of tokens to be sold to the Venture Capital that has invested in them. [48]. This type of investment is so captivating not only because it gives VCs an early jump on stake within the company, but also because cryptocurrencies are liquid. When investing in a typical company, Venture Capitalists are putting FIAT money in *hopes* of obtaining a long term profit. They really only see value once the company succeeds – and sometimes they don't see money at all. However, with cryptocurrencies the profits need only be transferred into Bitcoin or Ether, then online services can convert that into FIAT currency. Therefore, investors can realize gains and obtain them much more easily using ICOs. There are now several Cryptocurrency Venture Capital firms such as SPICE, Pantera, and Blockchain Capital. Each firm has its own unique way of building portfolios and offering their investors various incentives – all emphasizing the fact that crypto assets are liquid assets that allow investors to realize their money sooner.

### Retail Investing

Crypto markets initially surged to prominence in 2017 due to the investment of retail investors into crypto assets [49]. However, they pulled out of the markets after making profits and witnessing the volatility of Bitcoin – hoping to avoid losing the investment they had made due to the high volatility. Due to the various exchanges that now handle crypto trading as well as increased regulation and stabilization of price (due to institutional investors providing liquidity to the market), retail investors have once again entered the crypto market. There is speculation whether or not this will be similar to 2017 where assets are held for the short term or whether it will be similar to institutional investors who are making a long term investment into crypto assets.

Brokerage platforms have been set up specifically for the crypto space that ease the transition of new investors into the market. Robinhood and WeBull are two of the most popular brokerage platforms that are used to exchange crypto.

### ***Robinhood***

Robinhood has recently surged to become one of the most popular Brokerage platforms that allow the trading of stocks and ETFs in the crypto space. It has no fees associated to trading assets. The main difference between putting FIAT money into Crypto stocks instead of purchasing Crypto directly (say through a company such as Coinbase) is that the crypto currency that is bought in Robinhood cannot be taken out or converted into something else. Instead, in order to realize the value of the money, the crypto assets need to be converted back into FIAT money. is great for newcomers who are not entirely sure what crypto currency is to invest their money in a simple to use app that allows them to take part in the rise and fall of crypto currency. It is not for large traders who want to make large volume trades or to expand their trading portfolio.

### ***WeBull***

WeBull's marketing strategy is dependent upon the amount of research and analysis done on the market. WeBull is a subsidiary of Fumi Technology, a multinational Chinese company. Therefore, though it has similar trading capabilities as Robinhood – it seems the better application for more sophisticated investors as it has more in depth analysis and metrics than Robinhood. Similar to Robhinhood, once FIAT money is converted into crypto assets, the only way to realize that value is to convert it back into FIAT money. WeBull's platform is for trading and exchanges, not for the storage of crypto assets.

### Conclusion

In the cases of the case of both institutional and retail investing, the crypto assets are again held for their marginal value on the stock market. The assets are not being used for their blockchain capabilities, but rather for the value store it has as a good investment to increase the value of their FIAT money. Crypto assets are used to hedge bets against inflation, diversify portfolios, and provide an easy way for those who are interested in crypto to become somewhat involved in it.

## Conclusion

In this survey, we analyzed several segments of the fintech sector and identified what current problems existed. We then investigated various companies in those sectors that are using blockchain to tackle these issues. This survey evaluates these companies and describes how the blockchain architecture is leveraged in order to rectify these issues and provide better financial experiences across the board.

Most of these companies are in their nascency or are attempting to run trials in underbanked populations. The adoption of certain cryptocurrencies and practices are impeding these companies from expanding rapidly, however they demonstrate effective ways to solve inefficiencies and extend services in banking around the world. Future research is needed as to how to get these companies to scale and become more accessible. Furthermore, that research could delve into which blockchain platform (such as Ethereum, Bitcoin, Ripple, etc) could be leveraged in a more efficient ways for financial purposes such that new Fintech companies can build their solutions on top of these platforms.

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