Winter 12-2017

Blockchain Technology: An Analysis of Potential Applications and Uses

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Presentation date: December 12, 2017
Graduation date: December 2017
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Abstract

This paper will focus on explaining what blockchain technology is, the fundamentals of how it works, and applications of it. By utilizing sophisticated cryptography, a distributed network, a specified order of events the technology is able to create a ledger that cannot be altered due to its existence on many computers that able to detect if the data has been changed or tampered with. To help illustrate the uses of blockchain technology the technical explanation is complemented with real and hypothetical ways that the technology it being used. The use of blockchain technology originated with financial application and has expanded to many industries as new and creative ideas come to fruition.

Introduction

Blockchain technology was introduced to the world as a foundation layer to a project known as Bitcoin, the cryptographic currency. The fundamentals and principals of the new technology were quickly expanded into a wide variety of new projects because of the favorable attributes that blockchain technology offered. Among these include privacy, security, reliability, integrity, and assurance that eliminated the need for a third party such a bank or government. While originally used to support a digital currency, the technology can be implemented in a wide variety of industries that usually require two or more parties that transact worth in the form of currency, service, goods, or data with one another. Explaining what blockchain technology is, why it is important, and how it is used it is important to staying up-to-date in a technologically advanced world.

Theoretical Background

In understanding how blockchain technology works, it is important to break it down to its fundamental components. A blockchain is a ledger that holds digital information associated with transaction and events. The ledger is stored on multiple computers that are able to compare with one another, giving the ledger the characteristic of being distributed in multiple places at once. The only way to change or add information to the distributed ledger is for more than 51% percent of the computers to agree upon the new information. While it is common to regularly add information to the distributed ledger, it is in the best interest of all the computers cooperating to not change any of the previous data because it would diminish the integrity of the information and in effect make any value stored in the ledger worthless. To add security to the distributed ledger encryption is used to maintain the privacy of the information and users in the ledger. The encryption used is a type of cryptographic hash algorithm known as Secure Hash Algorithm –

256, where a hash is an output of alphanumeric characters that are calculated from the original plain text that is used as the input. The hash of the transactions and events are combined into a single group known as a block. The blocks are time-sequenced and use the information from the previous block, the value of the transactions, and a third variable to create a next block heading to denote the position of the block, typically in the form of a hash output. The output of the block heading will be included at the base of the next block to keep as the blocks chained in a sequential manner, in turn forming a blockchain.

Review of Literature

Antonopoulos (2015) created what is considered one of the most fundamental works in the cryptocurrency space. The book encompasses all aspects of crypto token creation from the distributed network, the process of mining digital tokens, and how the transactions are encoded into the blockchain with complicated cryptographic security and multisignature keys. While the focus is primarily on the cryptocurrency, Bitcoin, the use of a truly distributed network based on economic incentive and no third party can be implemented with other blockchains that run on their own network, both financial and non-financial. The key in how this is properly applied past the Bitcoin Blockchain is the proper processing of data in a safe and truly global way, ultimately giving the power to the participants in the network without the need to depend on a third party.

Wattenhofer (2016) had a clear focus on the technical aspect of what a blockchain is and how it works. This went past the conceptual idea that of often discussed of what a blockchain can do and instead how it does it through specialized software that acts as a foundation for many to build public application layers, private implementations of the blockchains core features, or a hybrid of both. Understanding how participants in a network work with one another to maintain a

distributed ledger is fundamental to establishing new blockchains that connect users in ways that have not been done yet.

Tapscott and Tapscott (2016) continue to build upon the basics of what blockchain technology is and how it is changing different industries on a global scale. They discuss some of the ways that the current monetary regime has been changing and even more changes that can be expected in the future. In addition to currency, they use businesses across a wide variety of industries as potential places for distributed ledger technology to flourish, many of which have startups working around the clock to be the first to come up with the best use case. This highly competitive environment is fueled with heavy funding that allows for the rapid growth of the technology. The brothers emphasize how the technology has already begun to change the way we think about the global business environment and will continue to be a big influence in the future.

Orrell and Chlupaty (2016) describe the progression of currency in our modern age and the way they believe it to be heading. Digital currency has the potential to change the way we think about money and transact on the individual and business level in a way that permits a large volume of smaller payments because of a scaling that was not possible before. Sundararajan (2017) discusses the shift to crowd-based capitalism where peer-to-peer transactions are now possible could not have been done before a distributed digital medium of transfer. They argue that we a shifting away from the need of clearing houses, stock exchanges, or even property deeds because of the nature of distributed ledgers.

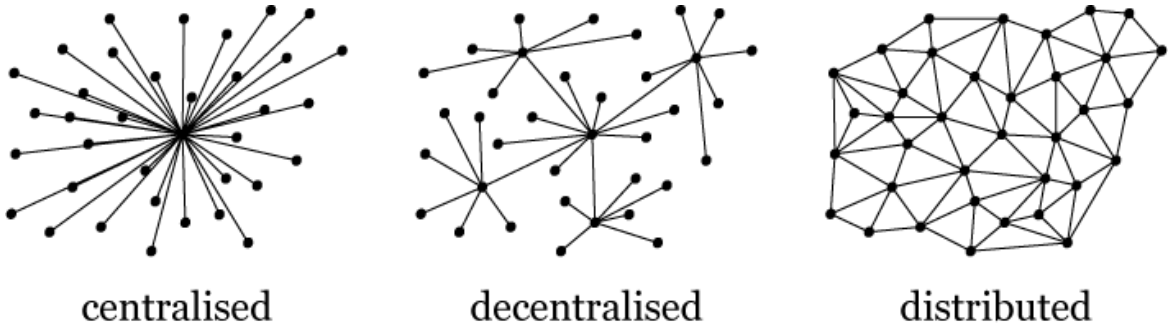
Application

In discussing the uses of blockchain technology and understanding possible applications it is appropriate to reference the first conceptualized use of the technology, Bitcoin. During 2008

an individual, or group of individuals, used the pseudonym Satoshi Nakamoto to distribute information about a digital currency which would run on a distributed ledger that would use peer-to-peer transactions known as a blockchain. On January 9, 2009, the first bitcoin transaction had occurred at a time when one bitcoin was worth less than one one-thousandth of a U.S. dollar (Genesis Block, 2009). Since then the popularity of both the cryptocurrency and the underlying technology has tremendously grown in popularity.

Financial; Cryptocurrencies

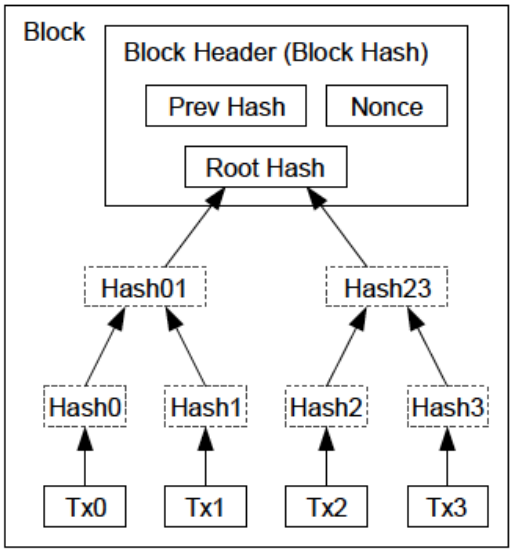
Blockchain technology was originally developed as a way to remove intermediaries, such as banks, and put the power to execute direct transaction back into the hands of individuals. A centralized intermediary acted as a bridge between two or more transacting parties, where each party only had to trust the central intermediary instead of all the parties they were dealing with. This put all of the reliance into a single actor that used the dependence of others to accumulate fees in exchange for their services (Sundararajan, 2017). The introduction of blockchain technology transitioned the ability to carry out transactions from a centralized intermediary to individual actors via a distributed ledger (Nakamoto, 2009). This means that sending money to another country no longer required currency translation and delivery that could take anywhere from days to weeks depending on the service. Citizens of countries that not even have access to banks could now be able to transact using only their smartphone. Sending money from New York to Nairobi could be done in a matter of minutes, minimal costs, and a fraction of the time with peer-to-peer transaction than with dependence on an intermediary.



(Evans, 2015)

Peer-to-peer transactions are possible because of the cryptographic algorithm that is used in blockchain technology and in Bitcoin (Wattenhofer, 2016). By utilizing the SHA-256 cryptographic algorithm data is able to be grouped together in secure blocks of a blockchain, similarly how pages compose a ledger. The blocks group data in the form of transactions connected to one another via Merkle trees, or hash trees, in order to further organize data in instances in the block. The transactions are hashed and then combined without other hashed transactions, eventually coming together as a single hash in a block. Each block references the block behind it to create a sequential order of transactions, ultimately creating a primary chain that the blocks exist on. The previous block hash, the combined hash of transactions (root hash), and a number used once (nonce) are further hashed until they fulfill a specified requirement to be submitted to the blockchain network, as shown below. This requirement is determined by a bi-weekly self-correcting algorithm in Bitcoin that requires a certain number of leading zeros to be included in the sixty-four-character hash generated by the three components (Antonopoulos, 2015). This level of cryptographic complexity coupled with a block creation rate of approximately ten minutes per block for Bitcoin allows for a tamper resistant, immutable ledger of transactions that removes the need for an intermediary in sensitive transaction such as the transfer of money. While a system that does not require an intermediary is often referred to a

trustless system, it is more accurately described as a system that does not require trust due to complex cryptographic security.



Transactions Hashed in a Merkle Tree

(Nakamoto, 2009)

The generation of new blocks in a blockchain helps to process bitcoin transactions into the ledger and is also driven by an economic incentive. Being the first to find a hash that fulfills the requirements of the blockchain network will also give a specified payout of tokens to the miners or mining group that submits the answer (Orrell & Chlupaty, 2016). A miner is a node in the blockchain network that actively uses their available computational power to solve the hash of the next block in the blockchain under the specified parameter of difficulty (Tapscott & Tapscott, 2016). Similarly, a mining pool is a group of miners that dedicate their computational power to solve the hash of the next block and share the reward based on their contribution. Similar to traditional gold mining, bitcoin mining requires trudging through a lot dirt before finding the desired reward. The two also share a similarity that there is a limited amount that can be obtained, so finding it will become more difficult over time. Miners use application-specific integrated circuit (ASIC) machines for more computational power to generate a high hashrate in

order to increase their likely to find the correct hash. Once a miner finds the correct hash they forecast their findings to the rest of the network, where the hash for the block is considered their proof-of-work. After the majority of the nodes accept the hash the block is officially added to the blockchain and the miner receives their token payout. After bitcoins are generated they can be transacted for other currency, goods, or services.

Payment Systems

Bitcoin, and altcoins, as a method of payment continue to increase in popularity as the cryptocurrencies increases in value. While countries including Japan have accepted the currency as legal tender, the United States has taken its time to regulating the currency, and Russia is planning to ban cryptocurrencies that are not owned by the state. The use of cryptocurrency for payments remains controversial and is most commonly used as a storage of value instead of a currency for every day transactions.

Despite stores in the United States not accepting crypto for payments, many users continue to use software and hardware based wallets to send each other crypto tokens in exchange for goods and services. Currently, individuals are able to use exchanges to buy a specific token in exchange for dollars, euros, and pounds sterling. After their purchase, they are able to send their tokens to a wallet via their public key, which is commonly hashed into a public address to help keep transactions private. An address can change with every transaction, but will continue to link to a public key that is tied to a wallet. The tokens themselves are stored with private keys that should never be shared or displayed, similarly to how the password to a bank account should not be shared.

A software, soft, or hot wallet which is often on a smartphone can be compared to wallet kept in your pants or pocketbook. You would not carry all of your worth on you at one time so

you should not store all of your tokens in a hot wallet because of the chance of malicious actors and theft. Proper safety precautions can prevent theft and muggings, but it doesn't make it less likely to lose the wallet in your pocket or for that matter your phone. While it is possible to recover the tokens stored in a soft wallet, unlike paper currency, proper management of funds should further prevent exposure to loss of funds. A hardware, hard, or cold wallet is also sometimes called cold storage, because it is not connected to the internet and as easily accessible as a smartphone might be. Hard wallets use a separate device to store the private keys of the tokens held and are considered to be much safer than software based wallets. Even if your computer is attacked by a virus or malware, some hard wallets contain an additional level of encryption to protect against an infected computer. More crypto wallets are developed every day, but to truly ensure the safety of your tokens you must actively avoid exposure to malicious agents both physical and digital. In the same way that dark alleys are synonymous with muggings, suspicious behavior online and in emails should be avoided to ensure the integrity of your computer, personal information, and financial assets.

Government and Crypto tokens

As cryptocurrencies continue to grow in popularity, with a total market cap over 20,000,000,000 USD as of November 2017, many governments and multinational organizations have continued to try evaluate and often regulate the use of crypto tokens (Coldwey, 2017). While many countries continue to observe the still developing market for cryptocurrencies, some have taken opposing stances of either legalizing specified tokens as currency or outright banning all cryptocurrencies.

On April 1, 2017, Japan had legalized Bitcoin as a payment method (Kharpal, 2017). While this move helped to raise the value of the cryptocurrency and increase its legitimacy, the

adoption of proper hardware to transact the tokens at retailer location continues to be a gradual process. By mid-2017 many of the vendors that accept Bitcoin for goods tend to be single-location shops and local bars. Several larger retailers are planning on adding the necessary hardware to accept bitcoin by the end of 2018. Despite being legalized as a currency; many people use Bitcoin in particular as a store of value instead of for daily transactions. Once the cryptocurrency becomes less volatile it is likely to see a higher rate of adoption for everyday use. It is also possible that a different crypto token could be used for daily transactions while Bitcoin remains an investment for the years to come. In either case, the legalization of cryptocurrencies would further the acceptability of crypto token transactions and the potential of blockchain technology.

Russia has also supported the idea of crypto tokens with the twist that they would be entirely controlled by the state (Buck, 2017). At the time when the proposed CryptoRuble would come to fruition, it is likely that all other cryptocurrencies would be banned from use in Russia. The CryptoRuble would paired with the physical Ruble and cannot be created outside of being obtained from the government. Little is known about the secretive plan to create the state sponsored crypto token outside of the information Russia's Minister of Communication, Nikolay Nikiforov, has told a few news agencies. Whether the plan comes to fruition or not, the dependence on a central actor to distribute an otherwise secure cryptocurrency would remove the power from the individuals that was intended with the use of blockchain technology. A single entity with the power to mint and distribute tokens would ultimately undo the reasoning behind creating a system that does not depend on a third party.

Federal Reserve Perspective

At this time the Federal Reserve Banks have decided to observe the potential and application for different instances of distributed ledger technology. The Federal Reserve Bank of Chicago has even gone so far as to state that the use of distributed ledgers could very well be the future of the financial industry, it simply needs to be proven further (Lewis et al., 2017).

This precautionary position is wise as the technology continues to develop at a rapid pace. It is vital to distinguish the true innovation that is happening in the distributed ledger field and the thousands of start-up attempts hoping to ride a new wave of technology. In large part, many of these start-ups fail because blockchain technology is not a fix all solution. The Federal Reserve banks are aware of this and have chosen to see how the technology continues to play out as it continues to expand to every industry.

The Federal Reserve Board has noted the potential benefits of using blockchain technology in payment, clearing, and settlement (Mills et al., 2016). One of the biggest benefits of using a distributed ledger for any of these transactions is that it can happen is almost real-time instead of the usually waiting period of one to three days, if not longer. In addition to much faster settlement speed, a distributed ledger accessible by all relevant parties would also offer increased auditability, resilience, and cost efficiency. Though the Federal Reserve Banks have not adopted these systems yet, many start-ups are racing to find the best solution to clearing and settlement that could work with, or compete against, the current financial system.

Venezuela & Hyperinflation

By the end of August 2017, Venezuela had struggled with severe hyperinflation that continued to plummet the Venezuelan Bolivar (VEF) into crisis. As paper currency lost its worth many looked to other ways to store their value. Slowly people began transferring their Bolivar

into Bitcoin so that the worth of their assets could be protected against the disastrous economic conditions they were facing. Additionally, people used the extremely subsidized electricity in Venezuela to begin mining their own bitcoin to generate further revenue (Suberg, 2017).

While many people have deliberated on the advantages of not needing a third party to transact value, the benefits become clear when the theoretical is applied into a real-world case. In an economic crisis, like Venezuela continues to face through 2017, people are able to protect themselves from hyperinflation with the use of distributed ledger technology that is the Bitcoin blockchain. Despite the current condition of any government, bank, or other third party, public crypto token blockchains would continue to retain the value that is determined by the user-base as whole.

Smart Contracts

A smart contract is an agreement between two or more parties that automatically executes through commands given to a computer once a specific set of requirements has been fulfilled. The term smart contract was created by Nick Szabo in 1996, who is well known for his research in digital currencies and digital contracts. Smart contracts can be digitally executed and enforced which would reduce the typically high costs otherwise associated with creating legal contracts (Tapscott & Tapscott, 2016). Additionally, the terms of the contracts are written in computer code and instead of complex jargon that can be intentionally vague.

Blockchain technology creates a foundation using distributed ledgers, cryptographic hash algorithms, and time-stamped transactions to establish consensus over the majority users of a public, private, or hybrid blockchain. Certain blockchains have enabled the creation and execution of smart contracts by adding an application layer on top of the foundation of pre-existing blockchain technology. The application layer that holds smart contract capability on

different blockchains continue to develop and the use of smart contracts becomes more plausible. The Ethereum Blockchain is currently the best-known example of a public blockchain that enables the functionality of smart contracts as well as the source code and tools to build user-specific contracts (Wattenhofer, 2016).

Many of the intricacies that are possible with written legal contracts are slowly being adapted to be used with digital code. For example, leases on property often have a deposit that can be paid completely, partially, or not at all depending on the condition of said property at the end of the lease. New projects continue to find ways to code such dilemmas in the smart contract to achieve the maximum level of digital execution without dependence on a single party. The Ethereum Project has been around since August 2014 and despite being only a few years old has seen tremendous growth to the point where it is the largest blockchain application platform and second largest crypto asset by market capitalization (Prisco, 2017).

The phrasing of a sentence in a legal contract can often have different interpretations and meaning that can be disputed in a court of law. Ambiguous meanings of a word or phrase in a contract can lead to lengthy and costly disputes that usually require the hiring of representation for both parties and an outside governing force to conclude on the matter. In contrast to this, lines of code are very literal, practical, and precise in most cases. The code is typically written to take a specific action, or set of actions, when a certain requirement has been fulfilled. For example, many banks offer the ability to automatically transfer money to pay bill for a specified amount on a given day of the month. This allows users to pay their rent in full on the same to avoid the penalties associated with a late payment. The same procedure can be applied to automate transactions on a larger and more complex scale on a blockchain. The transfer of a digital deed of a home can automate the payment of a set amount of a given crypto token. The

delivery confirmation of an item ordered online could trigger an event that will charge your account for an agreed upon value of cryptocurrency when the correct item has arrived in working condition. The use of smart contracts could reduce the latency of real-life transactions to help develop a more efficient tomorrow.

Uses in Everyday Life

Any application layer that utilizes blockchain technology must maintain a distributed network of hashed transaction that link together in a sequential way to maintain the properties that make a distributed solution superior to a centralized solution like a database. Companies can choose to use a database system with built in cryptographic hashes, but risk that the program can be altered or compromised without any external securities and redundancies. This would work well in situations where there are multiple parties involved that would benefit from a single distributed ledger of transaction that can instantly transmit information to all other relevant actors based on an action or sequence of events that would add a block to the blockchain.

This could be particularly useful when applied to distribution logistics, where instant transmission of information could greatly increase the operations and efficiencies of the supply chain. Instead of relying on reports from other facilities and database management systems, a single blockchain could have near real-time data without redundancy or inefficiency that comes with separate ledgers of events. The cycle below demonstrates six distinct actors in the purchasing life cycle from warehouse to consumer. As soon as the consumer submits a request for an item, the item could be can be instantly identified and processed for shipment. The outgoing sorting center would obtain the item and follow to proper procedure to ready it for departure. As the item continues closer to the consumer, all information would be updated each time the item is scanned and confirmed at a new location, increasing the efficiency of logistics

and current location of the item. While all actors would have access to this blockchain, only the information deemed relevant or necessary to each actor would be available in an effort to further secure the privacy of the consumer. Upon the final scan when the item is delivered, the payment would be transferred to the correct party.

(Draglet image, 2017)

A system of instant funds transfer based on the completion of digital parameters would create a completely new paradigm of the freelance economy. A plethora of one-off jobs could be listed on an online marketplace where the stake of a given job is held in escrow to be distributed to the freelancer upon the completion of a task. Because of the low transactions fees and effortless transfer of cryptocurrency it would be possible and practical to create listings for jobs starting at the equivalent of a few USD and any amount greater than that. The party that puts the listing up knows the funds would not leave escrow until the parameters of a given task have been completed. Alternatively, the freelancer does not have to worry about being paid for the full amount because the value of the task would be automatically and autonomously paid out upon

the completion of a set of parameters. This could theoretically create a market where anyone in the world is able to view and complete a task for a set stake offered by another party.

Unlike other freelance markets, this market could take leverage distributed ledger technology such as blockchain to create a system that prioritizes privacy, verified completion of the task, and payment for the work completed. To implement a system like this beyond a strictly digital medium, physical objects could be given unique identifiers for the purpose of transferring ownership, renting, or leasing for a given period of time. Service based tasks however would require the deliberation and consensus of all parties involved. In such a scenario, it is likely the party requesting the task would have the final judgement if the task would be considered complete or not. The freelancer is protected to the extent that the work presented will not be given to the requestor until the payment is distributed, even though they have already spent their time on the request. Tasks that are open to arbitration among the involved parties would have to be specified when the original request is presented to the market, making all parties fully aware of the risks. Tasks that are considered straight forward would likely not be open to debate and therefore fulfill payment immediately upon completion. In this system, the tasks would not require the various parties to ever meet or know each other's identity, which not only retains the privacy of each party, but also means that anyone in the world with access to the internet could complete the task free of prejudice, geographic constraints, or market pre-requisites. The request is fulfilled and payed out completely based on merit of work.

Non-financial Distributed Ledgers

The first implementation of blockchain technology was for Bitcoin, a peer-to-peer electronic cash system. Since then the possible uses of the fundamental technology that makes Bitcoin possible has expanded in new and creative ways to solve problems across the globe. The

distributed and immutable nature of blockchain has also disrupted many outdated processes found in finance, healthcare, government, and many other fields. The possibilities for the technology, when executed properly, will have a significant impact on the digital environment in such a way that many systems will become more efficient, resilient, reliable, and available for all to see without compromising the privacy of its users. It is important to look at some of the ways blockchain technology is being put to work to revolutionize different industries today.

In Healthcare

Healthcare spending in the United States has reached record highs of approximately 3.2 trillion USD in 2016. Within that incredible amount, it is estimated that roughly a quarter of that is being spent on administrative costs. Several start-ups, including Hashed Health, are attempting to revolutionize several processes in the healthcare industry to greatly reduce redundancy, administrative costs, and file transfer while still maintaining a high level of privacy by utilizing the cryptographic hash function used in blockchain technology.

The implementation of a distributed ledger accessible by doctors, pharmacies, clinics, healthcare providers, and the many parties that create the enormous healthcare industry could greatly reduce costs. Currently, many players in healthcare use expensive file maintenance systems that often require the manual input of redundant data that take time and money away that could be used for more beneficial purposes. The goal of the healthcare industry should ultimately be the cater to the patient. Not only could administrative costs be cut significantly, but the efficiency provided by a distributed ledger could greatly increase the efficiency for all parties involved, saving time for all actors in a healthcare blockchain as well as the patient.

The patient records could be store under a unique identifier such as a hashed public address that the different parties would be able to follow. Depending on the permissions that

each actor is granted, varying levels of the patient's history could be kept confidential and only permit the necessary information that is relevant to a given actor. For example, a doctor would be able to view more information about the patient history than a pharmacy might need to, all while still being able to confirm a prescription and noting any allergies that are relevant to the medication. Because of a unique identifier for each patient, possibly provided under a universal insurance code, any visit to a specialized physician or emergency visit to a hospital would be clearly and accurately stated as a record for that patient's history. This would create a complete patient history that encompasses all medical visits while also eliminating any redundancies that are associated with keeping separate records by different company's database systems.

Ghana & Land Registry

Ghana has faced a serious problem with land ownership for decades. This problem stems from the fact that the current system of land registry is corrupt, as well as antiquated. Holding all land related information on paper documents in a central office allows for the physical manipulation of records that leads to serious distrust amongst the population. A citizen has no incentive to buy land, invest in property, or obtain a loan if they can't verify the legitimacy of their purchase. The current system has been criticized for lack of transparency, reliability, accessibility, and clarity. These circumstances have led to a situation where 78% of the land in Ghana is unregistered (Aitken, 2016).

Several years back a few blockchain-based startups recognized the severe problem with the current system and have proposed new ways to use distributed ledger technology as a solution to land registry in Ghana. By creating a blockchain for land registry in Ghana, there would be an immutable source of online information that a relevant party could access quickly. The greatest value added in this process is that the information retrieved would be accurate,

reflecting every legitimate transaction in real-time to ensure that a property has the correct owners and could not be sold multiple times. The purchasers of land could be certain that they hold the title and would be secured against any illegal transfer of property without their knowledge. If a government official were able to authorize a transfer of property, any public participant would be able to immediately see the illegal transaction and have record of proof to speak against their actions.

Citizens would be able to finally invest in land and take out loans on existing property which could in turn stimulate the local economy. The lender would be able to correctly verify the owner of the land and place the loan directly on the same ledger against the property. This secure process would encourage lenders to give out more loans than it would have previously in a murky and corrupt system. The borrower would be able to use the new funds to invest in local business or start their own venture. Lenders in this scenario could be traditional parties like banks as well as crypto based lending services that deal directly in the asset-backed token paired with the lending blockchain. A higher amount of lenders would make borrowing rates more competitive, ultimately making a favorable market for the borrower. The result could be a progressive boom in the economy starting from the local level and spreading through Ghana.

Startups like BitLand have been working to create a real solution to the land registry problem in Ghana. They have also taken further steps to prevent poor infrastructure and unstable electrical grids from stopping their plans from coming to fruition. BitLand plans to create solar powered centers that would maintain the land registry ledger in several locations. The centers would also offer free courses in understanding how the registry works, about distributed ledger technology, and how this system can help stimulate the local economy. The project is currently

expected to take place in 28 communities in Southern Ghana with the hopes of expanding their project to the whole country and beyond (BitLand, 2017).

Delaware & Data Storage

Delaware has more incorporated entities than it has citizens. After legalizing the explicit right to trade stock on a blockchain on August 1st, 2017, it enabled all the necessary factors to move any entity incorporated in Delaware to exist on a blockchain without the need for separate manual record keeping (Mammerella, 2017). This can help reduce the time between exchanges on information, transfer of rights in the form of stock, and oversubscription due to systems that were previously not able to keep the timely information that would avoid such problems. Holding all of the records in relation to stockholder rights would add a great layer of security and needed transparency that would let a relevant party access the needed information without a threat of tampering the data. Just as important as reviewing the data, the unrelated parties could believe that the data is valid and up-to-date at any given time they need to retrieve the information they are looking for (Del Castillo, 2017).

The Future

The future of blockchain technology holds great promise for the fields it has begun to improve and the many more uses that are still yet to be discovered. Because the technology is so new it continues to develop every day and gradually shifts into our professions, transactions, and more generally into our daily lives. While blockchain technology was first used as a foundation for cryptographic currency, it has shifted in many non-financial directions as well. It can be expected that it will be further enhance the many industries it has begun to change in addition to widening its influence as a disruptive force.

The crypto tokens embedded in public blockchains and the facilitation of smart contracts have the potential to change the economy as a whole. By utilizing the technology available, payments are able to be instantly executed upon the completion of a requirement placed in computer code. Because of the flexible nature of digital currency, it is easy to transacts amounts that would be otherwise impractical to use in paper currency. This means that a fraction of a token can be sent between to user's every time a task is completed instead after a certain amount of time set by regular intervals. Commission based sales could instantly pay an associate for a completed sale. A musician could receive royalties after every purchase of their song. A student could take on several tasks in a day and receive the payment almost immediately after completion.

The significance of these payments isn't just that they are timely, but that they have occurred in a secured way that cannot be tampered with and did not involve a third party to establish trust between the parties actually engaging in the transaction. By bypassing the economic hurdles imposed by banks and governments, individuals are able to instantly transact on a global scale in a fraction of the time and fees that are typically associated with such events. If time truly is money, then reaching an optimal level of efficiency should be an ideal goal for any entity that uses a currency to purchase goods and services.

Conclusions and Suggestions for future work

Blockchain technology utilizes distributed ledgers, cryptographic hash algorithms, and time-stamped transactions to reach an acceptable level of immutability and consensus amongst its users. The technology has proven to be a disruptive force in several industries because of some of its coveted properties including permanence, tamper-resistance, accessibility, data integrity, and privacy. It can be predicted that blockchain technology will continue to be a

powerful force among the many industries it has begun to affect, while also transitioning into new industries. Understanding the fundamentals and application of the technology is advantageous for entrepreneurs, innovators, and firms alike to staying competitive in today's global economy.

Even with all of the incredible advantages of distributed ledger technology it is important to remember that a blockchain must meet certain requirements to be utilized to its fullest extent. If an implementation is too small in scope, or completely centralized, many of the reasons to use a distributed ledger are lost. An example of a centralized implementation of blockchain could be if a government decides to create their own crypto token with a value controlled by a single entity. The ability to create a peer-to-peer transaction without the need of an intermediary would be compromised. This is an important point to consider because once the attributes that make a blockchain desirable begin to be stripped away, the resulting instance could be a simple database that happens to use cryptography. While there could be thousands of uses for a distributed ledger, each proper use should retain a level of integrity and decentralization to get the most out use out of a single implementation.

There are many opportunities for future research in the field. Among the more pressing issues include the displacement that distributed ledger technology will create in many jobs related to administrative work. Because a distributed ledger can reduce the amount of redundancy that two or more parties deal with in keeping their own records, the job of someone collecting that data will no longer exist at a point. In fact, several of the properties that make blockchain so appealing include reducing the manual tasks that are currently done by members of a workforce which can theoretically be replaced with autonomous technology that will do the job more efficiently that their human counter-part. However, with the jobs that are lost it is

important to weigh new types of jobs that such a system will create that focus more on technical skills. It will be as imperative as ever to keep up with the pace of change to stay relevant in a constantly evolving world.

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Appendix – Summary of Concepts

Address: a public string of alphanumeric characters used to transact crypto tokens on a blockchain network. This is a hash of the public key.

Altcoin: a common name for cryptocurrencies other than Bitcoin, the first blockchain based cryptocurrency

ASIC: Application Specific Integrated Circuit; used by miners to obtain a higher hashrate.

Block: a package that holds immutable data in a blockchain ledger which is connected cryptographically to the block before and block after it.

Blockchain: a permanent data system that uses a distributed ledger to facilitate peer-to-peer transactions without the need of an intermediary

Difficulty: The self-adjusting rate at which a block can be added to the blockchain

Distributed Ledger: a connected storage of information that relies on many nodes instead a single centralized actor

Hashrate: a measurement of power that a machine is able to exert which is usually measured in hashes per second

Mining: the act of solving an algorithmic puzzle to lengthen a blockchain which is usually accompanied by an economic incentive in the form of crypto tokens.

Node: a participant in a blockchain network that holds the entire blockchain and validates the transactions on said blockchain

Peer to Peer: refers to a transaction between two parties without the need of an intermediary such as a bank

Proof of Work: a typically resource intensive process that allows a machine, or group of machines, to use computational power to solve a hashing algorithm, where the answer is the proof to be presented to the rest of the network

Public Key: the alphanumeric identifier assigned to a wallet for transaction on a blockchain network

Private Key: a string of data that allows transactions of specific tokens in a wallet and should never be disclosed

SHA-256: Secure hashing algorithm 256; a cryptographic algorithm developed in 2001 by the NSA and used in proof of work blockchains

Wallet: software or hardware that stores private keys of held crypto tokens. Can be used to view and create transaction on for specified blockchains.