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An Analytical Study of the Blockchain Technology as a Future Technology

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KEYWORDS

blockchain, decentralization, scalability.

ABSTRACT

Blockchain technology has gained popularity recently. It is a decentralized, distributed, and oftentimes public, digital ledger that is used to record transactions across many computers so that any involved record cannot be altered retroactively, without the alteration of all subsequent blocks. The structure of a blockchain is presented as having a database which is managed autonomously using a peer-to-peer network and a distributed time stamping server. The benefit of blockchain is evidence in terms of security, scalability, immutability and transparency. Blockchain has also shown its potential in industry and academia. Possible future directions are with respect to four areas: blockchain testing stop the tendency to centralization, big data analytics and blockchain application.

1. Introduction

A blockchain is, in the simplest of terms, a time-stamped series of immutable records of data that is managed by a cluster of computers not owned by any single entity. Each of these blocks of data (i.e. block) is secured and bound to each other using cryptographic principles (i.e. chain).

A blockchain is a decentralized, distributed, and oftentimes public, digital ledger that is used to record transactions across many computers so that any involved record cannot be altered retroactively, without the alteration of all subsequent blocks. This allows the participants to verify and audit transactions independently and relatively inexpensively (www.wikipedia.org).

A blockchain carries no transaction cost. (An infrastructure cost yes, but no transaction cost.) The blockchain is a simple yet ingenious way of passing information from A to B in a fully automated and safe manner. One party to a transaction initiates the process by creating a block. This block is verified y thousands, perhaps millions of computers distributed around the net. The verified block is added toa chain, which is stored across the net, creating not just a unique record, but a unique record with a

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unique history. Falsifying a single record would mean falsifying the entire chain in millions of instances. That is virtually impossible. Bitcoin uses this model for monetary transactions but it can be deployed in many other ways.

Think of a railway company. We buy tickets on an app or the web. The credit card company takes a cut for processing the transaction. With blockchain, not only can the railway operator save on credit card processing fees, it can move the entire ticketing process to the blockchain. The two parties in the transaction are the railway company and the passenger. The ticket is a block, which will be added to a ticket blockchain. Just as a monetary transaction on the blockchain is a unique, independently verifiable and unfalsifiable record (like Bitcoin), so can your ticket be. Incidentally, the final ticket blockchain is also a record of all transactions for, say, a certain train route, or even the entire train network, comprising every ticket ever sold, every journey ever taken.

But the key here is this: it's free. Not only can the blockchain transfer and store money, but it can also replace all processes and business models that rely on charging a small fee for a transaction or any other transaction between two parties.

The History of Blockchain

The first work on a cryptographically secured chain of blocks was described in 1991 by Stuart Haber and W. Scott Stornetta [1].They wanted to implement a system where document timestamps could not be tampered with. In 1992, Bayer, Haber and Stornetta incorporated Merkle trees to the design, which improved its efficiency by allowing several document certificates to be collected into one block[2]

The first blockchain was conceptualized by a person (or group of people) known as Satoshi Nakamoto in 2008. Nakamoto improved the design in an important way using a Hashcash-like method to timestamp blocks without requiring them to be signed by a trusted party and introducing a difficulty parameter to stabilize rate with which blocks are added to the chain. The design was implemented the following year by Nakamoto as a core component of the cryptocurrency bitcoin, where it serves as the public ledger for all transactions on the network.

In August 2014, the bitcoin blockchain file size, containing records of all transactions that have occurred on the network, reached 20 GB (gigabytes) (Nian et al, 2015). In January 2015, the size had grown to almost 30 GB, and from January 2016 to January 2017, the bitcoin blockchain grew from 50 GB to 100 GB in size.

The words block and chain were used separately in Satoshi Nakamoto's original paper, but were eventually popularized as a single word, blockchain, by 2016.According to Accenture, an application of the diffusion of innovations theory suggests that blockchains attained a 13.5% adoption rate within financial services in 2016, therefore reaching the early adopters phase. Industry trade groups joined to create the Global Blockchain Forum in 2016, an initiative of the Chamber of Digital Commerce.

In May 2018, Gartner found that only 1% of CIOs indicated any kind of blockchain adoption within

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their organisations, and only 8% of CIOs were in the short-term "planning or [looking at] active experimentation with blockchain" (Nian et al, 2015)[5].

The Structure of a Blockchain

A blockchain database is managed autonomously using a peer-to-peer network and a distributed timestamping server. They are authenticated by mass collaboration powered by collective self-interests Such a design facilitates robust workflow where participants' uncertainty regarding data security is marginal. The use of a blockchain removes the characteristic of infinite reproducibility from a digital asset. It confirms that each unit of value was transferred only once, solving the long-standing problem of double spending. A blockchain has been described as a value-exchange protocol. A blockchain can maintain title rights because, when properly set up to detail the exchange agreement, it provides a record that compels offer and acceptance.

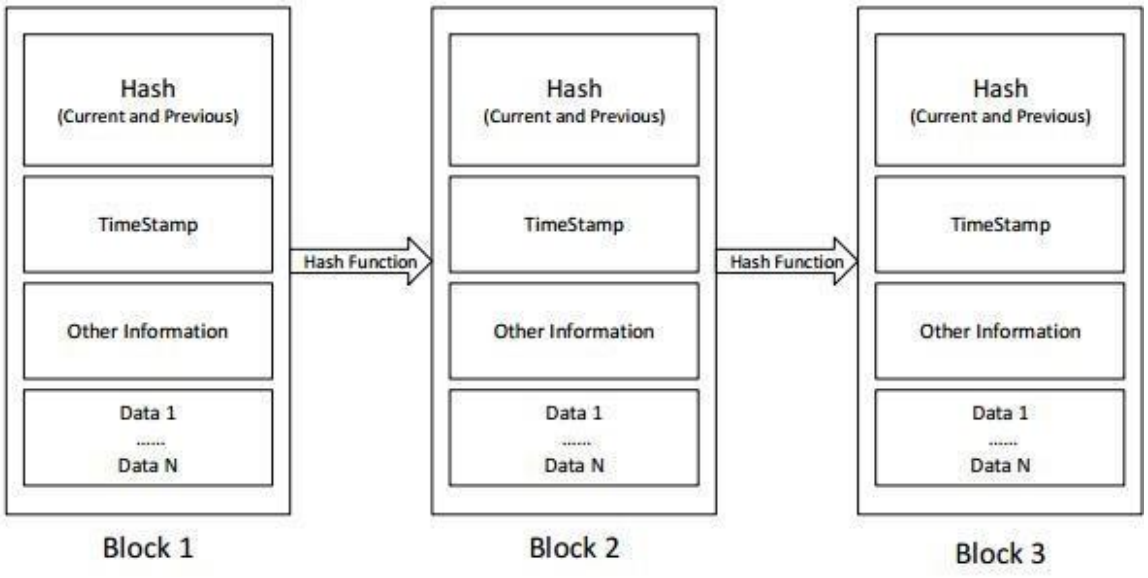

Figure 1: a block structure of a blockchain

How a Blockchain Works

Don T. & Alex T. (2016)[3] puts that the most important and far-reaching blockchains are based on the bitcoin model. Bitcoin or other digital currency isn't saved in a file somewhere; it's represented by transactions recorded in a blockchain—kind of like a global spreadsheet or ledger, which leverages the resources of a large peer-to-peer bitcoin network to verify and approve each Bitcoin transaction. Each blockchain, like the one that uses Bitcoin, is distributed: it runs on computers by volunteers around the world; there is no central database to hack. The blockchain is public: anyone can view it at any time because it resides on the network, not within a single institution charged with auditing

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transactions and keeping records. And the blockchain is encrypted: it uses heavy-duty encryption involving public and private keys–like the two-key system to access a safety deposit box–to maintain virtual security. You needn't worry about the weak firewalls of Target or Home Depot, or a thieving staffer of Morgan Stanley or the U.S. federal government.

Every 10 minutes, all the transactions conducted are verified, cleared, and stored in a block that is linked to the preceding block, creating a chain. Each block must refer to the preceding block to be valid. This structure permanently time-stamps and stores exchanges of value, preventing anyone from altering the ledger. If you wanted to steal a Bitcoin, you'd have to rewrite the coin's entire history on the blockchain in broad daylight. That's practically impossible. So the blockchain is a distributed ledger representing a network consensus of every transaction that has ever occurred. Like the World Wide Web of information, it's the World Wide Ledger of value—a distributed ledger that everyone can download and run on their personal computer.

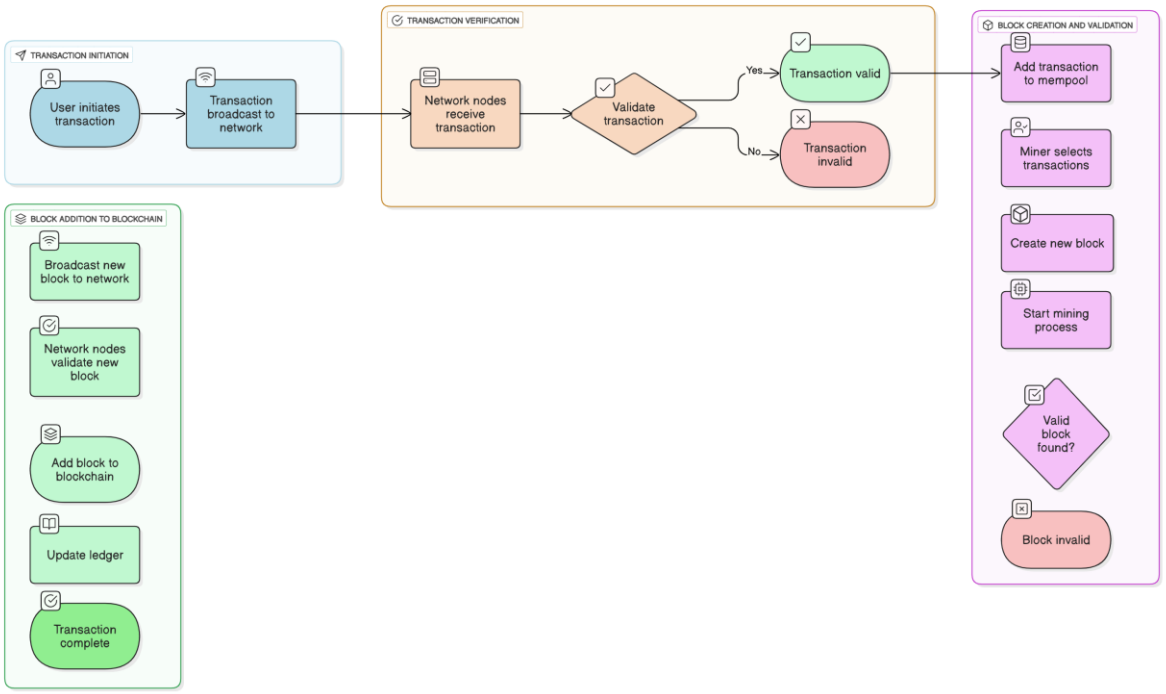

Figure 2: Structure of how a blockchain works

Types of Blockchains

There are currently at least four types of blockchain networks — public blockchains, private blockchains, consortium blockchains and hybrid blockchains.

1. **Public Blockchains**: Public blockchains are open source. They allow anyone to participate as users, miners, developers, or community members. All transactions that take place on public

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blockchains are fully transparent, meaning that anyone can examine the transaction details.

i. Public blockchains are designed to be fully decentralized, with no one individual or entity controlling which transactions are recorded in the blockchain or the order in which they are processed.
ii. Public blockchains can be highly censorship-resistant, since anyone is open to join the network, regardless of location, nationality, etc. This makes it extremely hard for authorities to shut them down.
iii. Lastly, public blockchains all have a token associated with them that is typically designed to incentivize and reward participants in the network.

2. **Private blockchain:** Another type of chains are private blockchains, also known as permissioned blockchains, they possess a number of notable differences from public blockchains;

i. Participants need consent to join the networks
ii. Transactions are private and are only available to ecosystem participants that have been given permission to join the network
iii. Private blockchains are more centralized than public blockchains

Private blockchains are valuable for enterprises who want to collaborate and share data, but don't want their sensitive business data visible on a public blockchain. These chains, by their nature, are more centralized; the entities running the chain have significant control over participants and governance structures. Private blockchains may or may not have a token involved with the chain.

3. Consortium Blockchain?

Consortium blockchains are sometimes considered a separate designation from private blockchains. The main difference between them is that consortium blockchains are governed by a group rather than a single entity. This approach has all the same benefits of a private blockchain and could be considered a sub-category of private blockchains, as opposed to a separate type of chain.

i. This collaborative model offers some of the best use cases for the benefits of blockchain, bringing together a group of "frenemies"- businesses who work together but also compete against each other.
ii. They are able to be more efficient, both individually and collectively, by collaborating on some aspects of their business.

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iii. Participants in consortium blockchains could include anyone from central banks, to governments, to supply chains.

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4. **Hybrid blockchain:** Dragonchain occupies a unique place within the blockchain ecosystem in that it's a hybrid blockchain. This means that it combines the privacy benefits of a permissioned and private blockchain with the security and transparency benefits of a public blockchain. That gives businesses significant flexibility to choose what data they want to make public and transparent and what data they want to keep private.

i. The hybrid nature of Dragonchain blockchain platform allows for easy connection with other blockchain protocols. Allowing for a multi-chain network of blockchains
ii. This functionality makes it simple for businesses to operate with the transparency they are looking for, without having to sacrifice security and privacy.
iii. Also, being able to post to multiple public blockchains at once increases the security of transactions, as they benefit from the combined hashpower being applied to the public chains.

TABLE I: Comparisons among *public blockchain*, *consortium blockchain* and *private blockchain*

Property	Public blockchain	Consortium blockchain	Private blockchain
Consensus determination	All miners	Selected set of nodes	One organization
Read permission	Public	Could be public or restricted	Could be public or restricted
Immutability	Nearly impossible to tamper	Could be tampered	Could be tampered
Efficiency	Low	High	High
Centralized	No	Partial	Yes
Consensus process	Permissionless	Permissioned	Permissioned

3.0 Benefits of Blockchains

This system of organising and storing information ensures a number of benefits. The benefits of blockchains as presented at blockchain.com are as follows:

Immutability
Since multiple copies of a block chain are kept and managed by consensus across a peer-to-peer network, no one peer can alter past transactions.

Security
It is a fundamental cryptological law that it is relatively easy to set a problem that is very, very difficult to solve. What is relatively easy for a network of computers to do is, in practice, impossible even for much larger networks to undo.

Verifiability
The combination of transparency and immutability also allows us to satisfy full public verifiability: anyone in the world can check for themselves that the rules of the system - in the case of digital currencies, that coins should be spent only once - are being followed. Whilst information cannot be manipulated, it can be easily verified thanks to the size and power of the network.

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Resilience

The distributed nature of the ledger makes it resilient. Even if many peers go offline, the information is still accessible.

Transparency

The fact that all transactions are broadcast to all peers also makes the ledger transparent. However, the encrypted nature of the transactions means that privacy is also assured.

These benefits can be tuned and block chains tailored to their specific functions to ensure that issues such as privacy, accountability, and transparency are tightly managed.

A land registry, for example, must be universally visible for it to be useful. The distribution and use of government funding, on the other hand, may need to be publically verifiable without certain sensitive details being available to all. Similarly, an individual may wish to establish their identity with a bank, hotel, airline or doctor without the other party knowing more than is absolutely necessary.

Taken individually, these benefits would mark the block chain technology as an extraordinary system. But it's when we consider how these benefits combine that the technology's truly transformative potential is revealed.

4.0 Future Directions in Blockchain Technology

Blockchain has shown its potential in industry and academia. Possible future directions are with respect to four areas: *blockchain testing*, *stop the tendency to centralization*, *big data analytics* and *blockchain application* (Zibin et al 2017).

a. Blockchain testing

Recently different kinds of blockchains appear and over 700 cryptocurrencies are listed in (coinmarketcap.com) up to now. However, some developers might falsify their blockchain performance to attract investors driven by the huge profit. Besides that, when users want to combine blockchain into business, they have to know which blockchain fits their requirements. So blockchain testing mechanism needs to be in place to test different blockchains.

Blockchain testing could be separated into two phases:

standardization phase and *testing phase*. In standardization phase, all criteria have to be made and agreed. When a blockchain is born, it could be tested with the agreed criteria to valid if the blockchain works fine as developers claim. As for testing phase, blockchain testing needs to be performed with different criteria. For example, an user who is in charge of online retail business cares about the throughput of the blockchain, so the examination needs to test the average time from a user send a transaction to the transaction is packed into the blockchain, capacity for a blockchain block and etc.

b. Stop the tendency to centralization

Blockchain is designed as a decentralized system. However, there is a trend that miners are

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centralized in the mining pool. Up to now, the top 5 mining pools together owns larger than

51% of the total hash power in the Bitcoin network (bitcoinworldwide.com). Apart from that, selfish mining strategy [10] showed that pools with over 25% of total computing power could get more revenue than fair share. Rational miners would be attracted into the selfish pool and finally the pool could easily exceed 51% of the total power. As the blockchain is not intended to serve a few organizations, some methods should be proposed to solve this problem.

c. Big data analytics

Blockchain could be well combined with big data. Here we roughly categorized the combination into two types: *data management* and *data analytics*. As for data management,

blockchain could be used to store important data as it is distributed and secure. Blockchain could also ensure the data is original. For example, if blockchain is used to store patients

health information, the information could not be tampered and it is hard to stole those private

information. When it comes to data analytics, transactions on blockchain could be used for

big data analytics. For example, user trading patterns might be extracted. Users can predict their potential partners' trading behaviours with the analysis.

D. Blockchain applications

Currently most blockchains are used in the financial domain, more and more applications for different fields are appearing.

Traditional industries could take blockchain into consideration and apply blockchain into their fields to enhance their systems. For example, user reputations could be stored on blockchain. At the same time, the up-and-coming industry could make use of blockchain to improve performance. For example, Arcade City (Solat S. & Potop-Butucaru M. 2016), a ridesharing startup offers an open marketplace where riders connect directly with drivers by leveraging blockchain technology. A smart contract is a computerized transaction protocol that executes the terms of a contract (Szabo, 1997). It has been proposed for long time and now this concept can be implemented with blockchain. In blockchain, smart contract is a code fragment that could be executed by miners automatically. Smart contract has transformative potential in various fields like financial services and IoT.

CONCLUSION

It is a decentralized, distributed, and oftentimes public, digital ledger that is used to record transactions across many computers so that any involved record cannot be altered retroactively, without the alteration of all subsequent blocks. The structure of a blockchain is presented as having a database which is managed autonomously using a peer-to-peer network and a distributed time stamping server. The benefits of blockchain is evidence in terms of security, scalability, immutability and transparency. Blockchain has also shown its potential in industry and academia. Possible future directions are with respect to four areas: *blockchain testing*, *stop the tendency to centralization*, *big data analytics* and *blockchain application*.

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