Gyancity Journal of Electronics and Computer Science,
Vol.8, No.1, pp. 1-17, March 2023
ISSN: 2446-2918 DOI: 10.21058/gjecs.2023.81007

APPLICATIONS OF BLOCKCHAIN TECHNOLOGY BEYOND CRYPTOCURRENCY

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Abstract

The idea of a blockchain was first conceived as the mechanism supporting Bitcoin. To solve the double-spending problem associated with digital currencies, Satoshi Nakamoto devised an immutable ledger of transactions that chains together block of data using digital cryptography. While the idea works extremely well for Bitcoin and other cryptocurrencies, there are loads of other useful applications of blockchain technology. This paper will discuss the 15 of them. To date, there are roughly 6,700 cryptocurrencies in the world that have a total market cap around $1.6 trillion, with Bitcoin holding a majority of the value. These tokens have become incredibly popular over the last few years, with one Bitcoin equalling $60,000. The research found that Blockchain applications go far beyond cryptocurrency and bitcoin. With its ability to create more transparency and fairness while also saving businesses time and money, the technology/application is impacting a variety of sectors in ways that range from how contracts are enforced to making government work more efficiently.

Keywords: *Bitcoin, Blockchain, Cryptocurrency, Technology, Applications, Electronic Money*

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1. Introduction

Blockchain (BC), the technology behind the Bitcoin crypto-currency system, is considered to be both alluring and critical for ensuring enhanced security and (in some implementations, non-traceable) privacy for diverse applications in many other domains including in the Internet of Things (IoT) eco-system. Intensive research is currently being conducted in both academia and industry applying the Blockchain technology in multifarious applications. Proof-of-Work (PoW), a cryptographic puzzle, plays a vital role in ensuring BC security by maintaining a digital ledger of transactions,

which is considered to be incorruptible. Furthermore, BC uses a changeable Public Key (PK) to record the users' identity, which provides an extra layer of privacy. Not only in cryptocurrency has the successful adoption of BC been implemented but also in multifaceted non-monetary systems such as in: distributed storage systems, proof-of-location, healthcare, decentralized voting and so forth. Recent research articles and projects/applications were surveyed to assess the implementation of BC for enhanced security, to identify associated challenges and to propose solutions for BC enabled enhanced security systems.

A cryptocurrency is a digital or virtual currency that is secured by cryptography, which makes it nearly impossible to counterfeit or double-spend. Many cryptocurrencies are decentralized networks based on blockchain technology—a distributed ledger enforced by a disparate network of computers. A defining feature of cryptocurrencies is that they are generally not issued by any central authority, rendering them theoretically immune to government interference or manipulation.

Blockchain technology has the potential to disrupt digital interaction in our economy and society. The technology's rapid and dynamic technical development is driven by start-ups and incumbents alike, creating a myriad of applications across economic and societal domains. However, the implications of this potential new technological paradigm have not yet reached wider public debate, nor have economic and societal implications been adequately explored. Distributed ledger technologies and blockchains stem from an ideological open-source movement and facilitate the exchange of assets via a complementary technical layer on top of the internet [1]. Current platform-based business structures like Facebook, Uber, Airbnb or Amazon could be replaced by evolving decentralized ecosystems. At the same time, community-owned neutral networks could facilitate a re-empowerment of individuals including but not limited to the sovereignty over one's data. It is likely that blockchain technology will eventually affect everyone in our society. In this book the key concepts of blockchain technology and an overview of the machinations of different blockchain ecosystems are presented. The socio-economic impact of this new technology is discussed including its impact on sectors such as energy, data, capital markets, logistics, and gambling. Challenges of adoption and roll out will be discussed with a specific focus on scalability and regulation. Non-technical and accessible, the book seeks to demystify the functionalities of blockchains, their potential as well as their likely socio-economic impacts.

The continued evolution of cryptocurrencies and the underlying exchanges on which they trade has generated tremendous urgency to develop our understanding of a product that has been identified as a potential enhancement of and replacement for traditional cash as we know it. The market efficiency of Bitcoin and found through a battery of tests that Bitcoin was inefficient, although it was becoming less inefficient over time [2]. Much research continues to identify this asset class to contain exceptionally high levels of volatility when compared to more established counterparts. However,

cryptocurrencies as a new asset class are not without its substantial issues, particularly that of the provision of a platform for criminality and, indeed, major cybercriminal events. While much debate surrounds the process in which this product can be regulated, there exists a wide variety of channels in which criminality can develop and thrive. Regulatory bodies and policy-makers alike have observed the growth of cryptocurrencies with a certain amount of scepticism, based on this growing potential for illegality and malpractice. Around $76 billion of illegal activity per year involve Bitcoin (46% of Bitcoin transactions) [3]. This is estimated to be in the same region of the U.S. and European markets for illegal drugs, and is identified as 'black e-commerce'. While the volatility of cryptocurrency price returns has been studied, the potential for market manipulation appears to have been broadly identified in cryptocurrency cross-correlations and market interdependencies. Such researches have fine-tuned the focus of regulators, policy-makers and academics alike, broad trust in both cryptocurrencies and the exchanges on which they trade cannot be sustained with such significant questions of abnormality remaining unanswered. Developing understanding of these new products and how to mitigate cybercriminal and their illicit use is an exceptionally important task in order to validate their further use and development [4].

Crypto currency is a collection of technologies based on Satoshi Nakamoto's 2009 invention, Bitcoin, which is counterfeit-proof and decentralized. Several cryptographic technologies (hash sums, asymmetric keys, and proof-of-work) are combined to make this possible via a global, peer-to-peer network. The currency is in use today: It can be traded for other currency, or used to buy goods and services. Bitcoin is an electronic currency designed to use public protocol that implements it in a totally decentralized manner, so as not to need the control of any central issuing organization that manages it. Though still in development, it has been proven to be a modern payment system referred to have been used in some procedures commonly associated to money laundering or trafficking of illegal substances of various kinds [5].

2. Types of cryptocurrency and tokens

While Bitcoin was the first operational public cryptocurrency, it is not the only type, and there certainly are many variations of cryptocurrencies [6]. We can identify at least four types of cryptocurrencies depending on how they are formulated or code design, application or use case, and other factors.

You might get coins, payment tokens or altcoins, security tokens, non-fungible tokens or NFTs, decentralized finance tokens, utility tokens, and other categories.

This tutorial teaches about the different types of cryptocurrency and tokens. We also include information like how cryptocurrencies are differentiated, ways they are utilized, and rich examples of the different types [7].

Although the term cryptocurrencies are used to define all the different types of cryptocurrency or digital currencies, it is commonly interchanged with coins [8]. They are commonly regarded so despite many of them not serving as a unit of account, store of value, and a medium of exchange, although Bitcoin does.

However, coins can be differentiated from altcoins. The term altcoins are also a common reference to cryptocurrencies of all types apart from Bitcoin, in that they are seen as an alternative to Bitcoin [9].

- **Coins:**

Coins can be differentiated from altcoins because they are based on their blockchain. On such a blockchain, they act as the native token as well as gas or fuel payment token, although a blockchain can have the gas paid in a different cryptocurrency [10]. A good example is Bitcoin on the Bitcoin and Ether or ETH on the Ethereum blockchain.

In terms of constructing or developing a cryptocurrency, it starts or comes along with developing a blockchain.

- **Altcoins:**

Although these can be regarded as coins, they are all understood to be alternatives to Bitcoin as the first cryptocurrency. Also known as shitcoins, apart from Ethereum, most of the first ones were forked from Bitcoin. These include Namecoin, Peercoin, Litecoin, Dogecoin, and Auroracoin [11]. That said, some altcoins like Ethereum, Ripple, Omni, and NEO have their blockchains. Others do not.

- **Tokens:**

Tokens are the digital representations of a particular asset or utility in a blockchain. All tokens can be termed altcoins, but they are differentiated by residing on top of another blockchain and not being native to the blockchain on which they reside [12].

They are coded to facilitate smart contracts on blockchain networks like Ethereum, and we can transfer some from one chain to another. The tokens are embedded in self-executing computer programs or codes and can operate without a third-party platform. They are also fungible and tradable. They can be used to represent loyalty points and commodities or even other cryptos.

When designing or coding a token, the developer will require following a given template. The developer does not need to edit or code the blockchain from scratch [13]. All they have to do is follow a given standard template. It is faster to come up with a token.

It used to be Initial Coin Offering or ICOs and initial exchange offering as a method of distributing and initially raising capital for the projects issuing tokens. However, they can be issued without IEO or ICOs [14].

- **Types of Cryptocurrencies**

Bitcoin is the most popular and valuable cryptocurrency. An anonymous person called Satoshi Nakamoto invented it and introduced it to the world via a white paper in 2008. There are thousands of cryptocurrencies present in the market today.

Each cryptocurrency claims to have a different function and specification. For example, Ethereum's ether markets itself as gas for the underlying smart contract platform. Ripple's XRP is used by banks to facilitate transfers between different geographies [15].

Bitcoin, which was made available to the public in 2009, remains the most widely traded and covered cryptocurrency. As of May 2022, there were over 19 million bitcoins in circulation with a total market cap of around $576 billion. Only 21 million bitcoins will ever exist [16].

In the wake of Bitcoin's success, many other cryptocurrencies, known as "altcoins," have been launched. Some of these are clones or forks of Bitcoin, while others are new currencies that were built from scratch [17]. They include Solana, Litecoin, Ethereum, Cardano, and EOS. By November 2021, the aggregate value of all the cryptocurrencies in existence had reached over $2.1 trillion—Bitcoin represented approximately 41% of that total value [18].

- **Cryptocurrencies Legal**

Fiat currencies derive their authority as mediums of transaction from the government or monetary authorities. For example, each dollar bill is backstopped by the Federal Reserve [19].

But cryptocurrencies are not backed by any public or private entities. Therefore, it has been difficult to make a case for their legal status in different financial jurisdictions throughout the world. It doesn't help matters those cryptocurrencies have largely functioned outside most existing financial infrastructure. The legal status of cryptocurrencies has implications for their use in daily transactions and trading. In June 2019, the Financial Action Task Force (FATF) recommended that wire transfers of cryptocurrencies should be subject to the requirements of its Travel Rule, which requires AML compliance. [20]

As of December 2021, El Salvador was the only country in the world to allow Bitcoin as legal tender for monetary transactions. In the rest of the world, cryptocurrency regulation varies by jurisdiction.

Japan's Payment Services Act defines Bitcoin as legal property. Cryptocurrency exchanges operating in the country are subject to collect information about the customer and details relating to the wire transfer. China has banned cryptocurrency exchanges and mining within its borders. India was reported to be formulating a framework for cryptocurrencies in December [21].

Cryptocurrencies are legal in the European Union. Derivatives and other products that use cryptocurrencies will need to qualify as "financial instruments." In June 2021, the European Commission released the Markets in Crypto-Assets (MiCA) regulation that sets safeguards for regulation and establishes rules for companies or vendors providing financial services using cryptocurrencies [22]. Within the United States, the biggest and most sophisticated financial market in the world, crypto derivatives such as Bitcoin futures are available on the Chicago Mercantile Exchange. The Securities and Exchange Commission (SEC) has said that Bitcoin and Ethereum are not securities [23].

- **Advantages and Disadvantages of Cryptocurrency**
  - **Advantages [24]**
    - Cryptocurrencies represent a new, decentralized paradigm for money. In this system, centralized intermediaries, such as banks and monetary institutions, are not necessary to enforce trust and police transactions between two parties. Thus, a system with cryptocurrencies eliminates the possibility of a single point of failure, such as a large bank, setting off a cascade of crises around the world, such as the one that was triggered in 2008 by the failure of institutions in the United States.
    - Cryptocurrencies promise to make it easier to transfer funds directly between two parties, without the need for a trusted third party like a bank or a credit card company. Such decentralized transfers are secured by the use of public keys and private keys and different forms of incentive systems, such as proof of work or proof of stake.
    - Because they do not use third-party intermediaries, cryptocurrency transfers between two transacting parties are faster as compared to standard money transfers. Flash loans in decentralized finance are a good example of such decentralized transfers. These loans, which are processed without backing collateral, can be executed within seconds and are used in trading.
    - Cryptocurrency investments can generate profits. Cryptocurrency markets have skyrocketed in value over the past

decade, at one point reaching almost $2 trillion. As of May 2022, Bitcoin was valued at more than $550 billion in crypto markets.

- The remittance economy is testing one of cryptocurrency's most prominent use cases. Currently, cryptocurrencies such as Bitcoin serve as intermediate currencies to streamline money transfers across borders. Thus, a fiat currency is converted to Bitcoin (or another cryptocurrency), transferred across borders and, subsequently, converted to the destination fiat currency. This method streamlines the money transfer process and makes it cheaper.

- **Disadvantages [25]**
  - Though they claim to be an anonymous form of transaction, cryptocurrencies are actually pseudonymous. They leave a digital trail that agencies such as the Federal Bureau of Investigation (FBI) can decipher. This opens up possibilities of governments or federal authorities tracking the financial transactions of ordinary citizens.
  - Cryptocurrencies have become a popular tool with criminals for nefarious activities such as money laundering and illicit purchases. The case of Dread Pirate Roberts, who ran a marketplace to sell drugs on the dark web, is already well known. Cryptocurrencies have also become a favourite of hackers who use them for ransomware activities.
  - In theory, cryptocurrencies are meant to be decentralized, their wealth distributed between many parties on a blockchain. In reality, ownership is highly concentrated. For example, an MIT study found that just 11,000 investors held roughly 45% of Bitcoin's surging value.
  - One of the conceits of cryptocurrencies is that anyone can mine them using a computer with an Internet connection. However, mining popular cryptocurrencies requires considerable energy, sometimes as much energy as entire countries consume. The expensive energy costs coupled with the unpredictability of mining have concentrated mining among large firms whose revenues running into the billions of dollars. According to an MIT study, 10% of miners account for 90% of its mining capacity.
  - Though cryptocurrency blockchains are highly secure, other crypto repositories, such as exchanges and wallets, can be hacked. Many cryptocurrency exchanges and wallets have been

hacked over the years, sometimes resulting in millions of dollars' worth of "coins" stolen.

- Cryptocurrencies traded in public markets suffer from price volatility. Bitcoin has experienced rapid surges and crashes in its value, climbing to as high as $17,738 in December 2017 before dropping to $7,575 in the following months. Some economists thus consider cryptocurrencies to be a short-lived fad or speculative bubble.

Any investor can purchase cryptocurrency from popular crypto exchanges such as Coinbase, apps such as Cash App, or through brokers. Another popular way to invest in cryptocurrencies is through financial derivatives, such as CME's Bitcoin futures, or through other instruments, such as Bitcoin trusts and Bitcoin ETFs [26].

Cryptocurrencies are a new paradigm for money. Their promise is to streamline existing financial architecture to make it faster and cheaper. Their technology and architecture decentralize existing monetary systems and make it possible for transacting parties to exchange value and money independently of intermediary institutions such as banks.

Cryptocurrencies are generated by mining. For example, Bitcoin is generated using Bitcoin mining. The process involves downloading software that contains a partial or full history of transactions that have occurred in its network. Though anyone with a computer and an Internet connection can mine cryptocurrency, the energy- and resource-intensive nature of mining means that large firms dominate the industry [27].

Bitcoin is by far the most popular cryptocurrency followed by other cryptocurrencies such as Ethereum, Binance Coin, Solana, and Cardano [28]. The SEC has said that Bitcoin and Ethereum, the top two cryptocurrencies by market cap, are not securities. It has not commented on the status of other cryptocurrencies.

3. The blockchain technology

Blockchain technology was first outlined in 1991 by Stuart Haber and W. Scott Stornetta, two researchers who wanted to implement a system where document timestamps could not be tampered with. But it wasn't until almost two decades later, with the launch of Bitcoin in January 2009, that blockchain had its first real-world application [29].

The Bitcoin protocol is built on a blockchain. In a research paper introducing the digital currency, Bitcoin's pseudonymous creator [30], Satoshi Nakamoto, referred to it as "a new electronic cash system that's fully peer-to-peer, with no trusted third party."

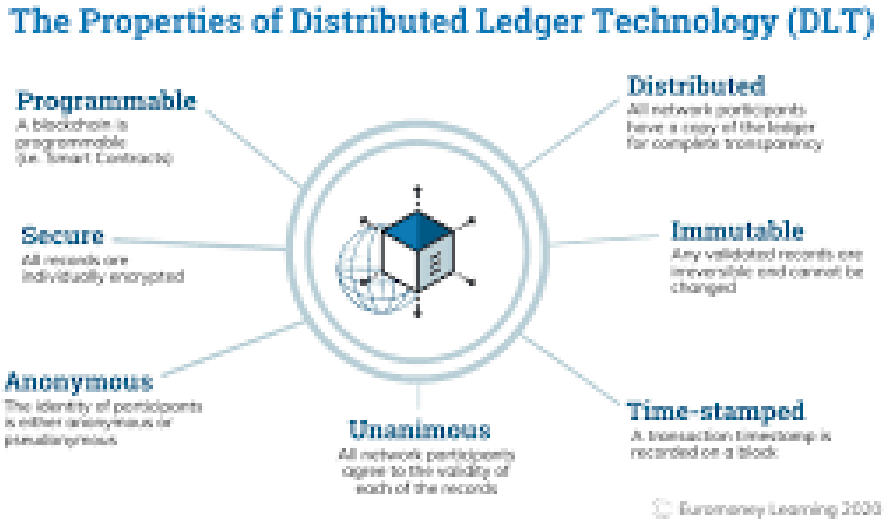
The key thing to understand here is that Bitcoin merely uses blockchain as a means to transparently record a ledger of payments, but blockchain can, in theory, be used to

immutably record any number of data points [31]. As discussed above, this could be in the form of transactions, votes in an election, product inventories, state identifications, deeds to homes, and much more.

Currently, tens of thousands of projects are looking to implement blockchains in a variety of ways to help society other than just recording transactions—for example, as a way to vote securely in democratic elections [32]. The nature of blockchain's immutability means that fraudulent voting would become far more difficult to occur. For example, a voting system could work such that each citizen of a country would be issued a single cryptocurrency or token. Each candidate would then be given a specific wallet address, and the voters would send their token or crypto to the address of whichever candidate for whom they wish to vote. The transparent and traceable nature of blockchain would eliminate both the need for human vote counting and the ability of bad actors to tamper with physical ballots [33].

Blockchain, sometimes referred to as Distributed Ledger Technology (DLT), makes the history of any digital asset unalterable and transparent through the use of decentralization and cryptographic hashing, see Figure 1 [34].

Figure 1
Blockchain Explained



A simple analogy for understanding blockchain technology is a Google Doc. When we create a document and share it with a group of people, the document is distributed instead of copied or transferred. This creates a decentralized distribution chain that gives everyone access to the document at the same time. No one is locked out awaiting changes from another party [35], while all modifications to the doc are being recorded in real-time, making changes completely transparent.

Of course, blockchain is more complicated than a Google Doc, but the analogy is apt because it illustrates three critical ideas of the technology [36], [37]:

- **Blocks**

Every chain consists of multiple blocks and each block has three basic elements:

  - The data in the block.
  - A 32-bit whole number called a nonce. The nonce is randomly generated when a block is created, which then generates a block header hash.
  - The hash is a 256-bit number wedded to the nonce. It must start with a huge number of zeroes (i.e., be extremely small).

When the first block of a chain is created, a nonce generates the cryptographic hash. The data in the block is considered signed and forever tied to the nonce and hash unless it is mined.

- **Miners**

Miners create new blocks on the chain through a process called mining.

In a blockchain every block has its own unique nonce and hash, but also references the hash of the previous block in the chain, so mining a block isn't easy, especially on large chains.

Miners use special software to solve the incredibly complex math problem of finding a nonce that generates an accepted hash. Because the nonce is only 32 bits and the hash is 256, there are roughly four billion possible nonce-hash combinations that must be mined before the right one is found. When that happens, miners are said to have found the "golden nonce" and their block is added to the chain [38].

Making a change to any block earlier in the chain requires re-mining not just the block with the change, but all of the blocks that come after. This is why it's extremely difficult to manipulate blockchain technology [39]. Think of it as "safety in math" since finding golden nonces requires an enormous amount of time and computing power.

When a block is successfully mined, the change is accepted by all of the nodes on the network and the miner is rewarded financially.

- **Nodes**

One of the most important concepts in blockchain technology is decentralization. No one computer or organization can own the chain. Instead, it is a distributed ledger via the nodes connected to the chain. Nodes can be any kind of electronic device that maintains copies of the blockchain and keeps the network functioning [40].

Every node has its own copy of the blockchain and the network must algorithmically approve any newly mined block for the chain to be updated, trusted and verified. Since blockchains are transparent, every action in the ledger can be easily checked and viewed [41]. Each participant is given a unique alphanumeric identification number that shows their transactions.

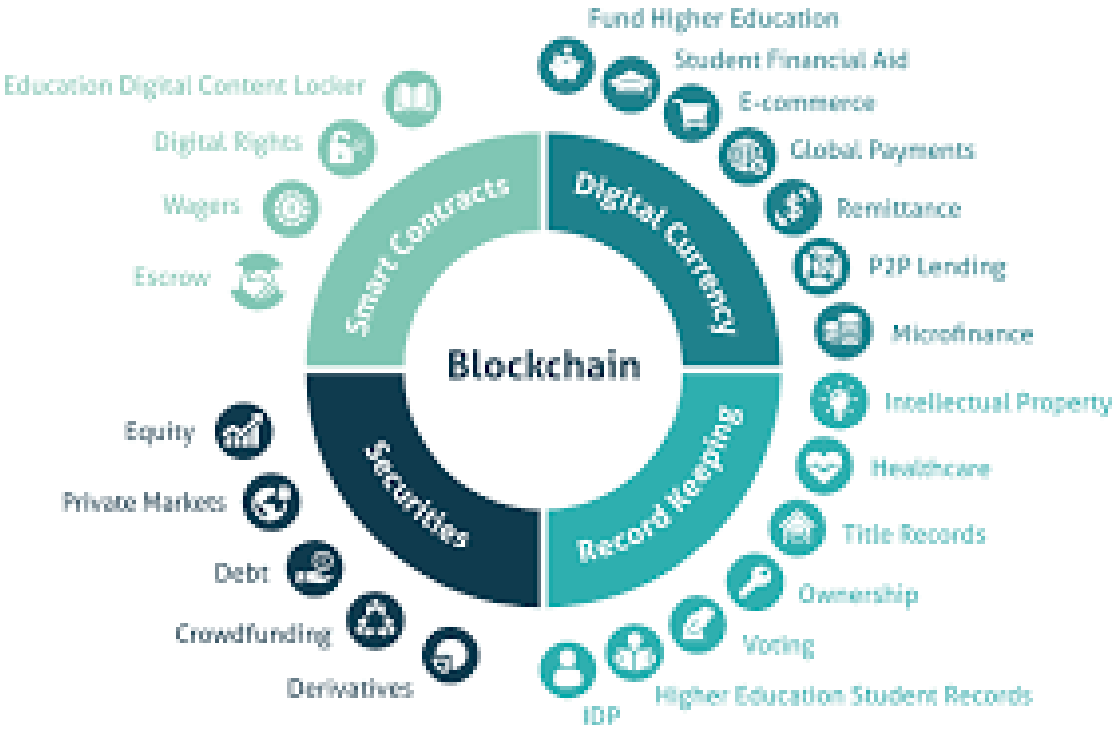
Combining public information with a system of checks-and-balances helps the blockchain maintain integrity and creates trust among users. Essentially, blockchains can be thought of as the scalability of trust via technology.

4. Applications for blockchain technology

The idea of a blockchain was first conceived as the mechanism supporting Bitcoin. To solve the double-spending problem associated with digital currencies, Satoshi Nakamoto devised an immutable ledger of transactions that chains together block of data using digital cryptography. While the idea works extremely well for Bitcoin and other cryptocurrencies, there are loads of other useful applications of blockchain technology, see Figure 2 [42].

Figure 2

Technology Partners of Blockchain



Here are 15 of them [43], [44], [45], [46], [47], [48]:

1. Money transfers

The original concept behind the invention of blockchain technology is still a great application. Money transfers using blockchain can be less expensive and faster than using existing money transfer services. This is especially true of cross-border transactions, which are often slow and expensive. Even in the modern U.S. financial system, money transfers between accounts can take days, while a blockchain transaction takes minutes.

2. Financial exchanges

Many companies have popped up over the past few years offering decentralized cryptocurrency exchanges. Using blockchain for exchanges allows for faster and less expensive transactions. Moreover, a decentralized exchange doesn't require investors to deposit their assets with the centralized authority, which means they maintain greater control and security. While blockchain-based exchanges primarily deal in cryptocurrency, the concept could be applied to more traditional investments as well.

3. Lending

Lenders can use blockchain to execute collateralized loans through smart contracts. Smart contracts built on the blockchain allow certain events to automatically trigger things like a service payment, a margin call, full repayment of the loan, and release of collateral. As a result, loan processing is faster and less expensive, and lenders can offer better rates.

4. Insurance

Using smart contracts on a blockchain can provide greater transparency for customers and insurance providers. Recording all claims on a blockchain would keep customers from making duplicate claims for the same event. Furthermore, using smart contracts can speed up the process for claimants to receive payments.

5. Real estate

Real estate transactions require a ton of paperwork to verify financial information and ownership and then transfer deeds and titles to new owners. Using blockchain technology to record real estate transactions can provide a more secure and accessible means of verifying and transferring ownership. That can speed up transactions, reduce paperwork, and save money.

6. Secure personal information

Keeping data such as your Social Security number, date of birth, and other identifying information on a public ledger (e.g., a blockchain) may actually be more secure than current systems more susceptible to hacks. Blockchain technology can be used to secure access to identifying information while improving access for those who need it in industries such as travel, healthcare, finance, and education.

7. Voting

If personal identity information is held on a blockchain, that puts us just one step away from also being able to vote using blockchain technology. Using blockchain technology can make sure that nobody votes twice, only eligible voters are able to vote, and votes cannot be tampered with. What's more, it can increase access to voting by making it as simple as pressing a few buttons on your smartphone. At the same time, the cost of running an election would substantially decrease.

8. Government benefits

Another way to use digital identities stored on a blockchain is for the administration of government benefits such as welfare programs, Social Security, and Medicare. Using blockchain technology could reduce fraud and the costs of operations. Meanwhile, beneficiaries can receive funds more quickly through digital disbursement on the blockchain.

9. Securely share medical information

Keeping medical records on a blockchain can allow doctors and medical professionals to obtain accurate and up-to-date information on their patients. That can ensure that patients seeing multiple doctors get the best care possible. It can also speed up the system for pulling medical records, allowing for more timely treatment in some cases. And, if insurance information is held in the database, doctors can easily verify whether a patient is insured and their treatment is covered.

10. Artist royalties

Using blockchain technology to track music and film files distributed over the internet can make sure that artists are paid for their work. Since blockchain technology was invented to ensure the same file doesn't exist in more than one place, it can be used to help reduce piracy. What's more, using a blockchain to track playbacks on streaming services and a smart contract to distribute payments can provide greater transparency and the assurance that artists receive the money they're owed.

11. non-fungible tokens

Non-fungible tokens, or NFTs, are commonly thought of as ways to own the rights to digital art. Since the blockchain prevents data from existing in two places, putting an NFT on the blockchain guarantees that only a single copy of a piece of digital art exists. That can make it like investing in physical art but without the drawbacks of storage and maintenance.

NFTs can have varied applications, and ultimately, they're a way to convey ownership of anything that can be represented by data. That could be the deed to a house, the broadcast rights to a video, or an event ticket. Anything remotely unique could be an NFT.

12. Logistics and supply chain tracking

Using blockchain technology to track items as they move through a logistics or supply chain network can provide several advantages. First of all, it provides greater ease of communication between partners since data is available on a secure public ledger. Second, it provides greater security and data integrity since the data on the blockchain can't be altered. That means logistics and supply chain partners can work together more easily with greater trust that the data they're provided is accurate and up to date.

13. Secure Internet of Things networks

The Internet of Things (IoT) is making our lives easier, but it's also opening the door for nefarious actors to access our data or take control of important systems. Blockchain technology can provide greater security by storing passwords and other data on a decentralized network instead of a centralized server. Additionally, it offers protection against data tampering since a blockchain is practically immutable.

14. Data storage

Adding blockchain technology to a data storage solution can provide greater security and integrity. Since data can be stored in a decentralized manner, it will be more difficult to hack into and wipe out all the data on the network, whereas a centralized data storage provider may only have a few points of redundancy. It also means greater access to data since access isn't necessarily reliant on the operations of a single company. In some cases, using blockchain for data storage may also be less expensive.

15. Gambling

The gambling industry can use blockchain to provide several benefits to players. One of the biggest benefits of operating a casino on the blockchain is the transparency it provides to potential gamblers. Since every transaction is recorded on the blockchain, bettors can see that the games are fair and the casino pays out. Furthermore, by using blockchain, there's no need to provide personal information, including a bank account, which may be a hurdle for some would-be gamblers. It also provides a workaround for regulatory restrictions since players can gamble anonymously and the decentralized network isn't susceptible to government shutdown.

5. Beyond bitcoin: Ethereum blockchain

Blockchain’s most well-known use (and maybe most controversial) is in cryptocurrencies. Cryptocurrencies are digital currencies (or tokens), like Bitcoin, Ethereum or Litecoin, that can be used to buy goods and services. Just like a digital form of cash, crypto can be used to buy everything from your lunch to your next home [49]. Unlike cash, crypto uses blockchain to act as both a public ledger and an enhanced cryptographic security system, so online transactions are always recorded and secured.

To date, there are roughly 6,700 cryptocurrencies in the world that have a total market cap around $1.6 trillion, with Bitcoin holding a majority of the value. These tokens have become incredibly popular over the last few years, with one Bitcoin equalling

$60,000 [50]. Here are some of the main reasons why everyone is suddenly taking notice of cryptocurrencies [51], [52], [53], [54]:

- Blockchain's security makes theft much harder since each cryptocurrency has its own irrefutable identifiable number that is attached to one owner.
- Crypto reduces the need for individualized currencies and central banks- With blockchain, crypto can be sent to anywhere and anyone in the world without the need for currency exchanging or without interference from central banks.
- Cryptocurrencies can make some people rich- Speculators have been driving up the price of crypto, especially Bitcoin, helping some early adopters to become billionaires. Whether this is actually a positive has yet to be seen, as some retractors believe that speculators do not have the long-term benefits of crypto in mind.
- More and more large corporations are coming around to the idea of a blockchain-based digital currency for payments. In February 2021, Tesla famously announced that it would invest $1.5 billion into Bitcoin and accept it as payment for their cars.

Of course, there are many legitimate arguments against blockchain-based digital currencies. First, crypto isn't a very regulated market. Many governments were quick to jump into crypto, but few have a staunch set of codified laws regarding it. Additionally, crypto is incredibly volatile due to those aforementioned speculators. In 2016, Bitcoin was priced around $450 per token. It then jumped to about $16,000 a token in 2018, dipped to around $3,100, then has since increased to more than $60,000 [55]. Lack of stability has caused some people to get very rich, while a majority have still lost thousands.

Whether or not digital currencies are the future remains to be seen. For now, it seems as if blockchain's meteoric rise is more starting to take root in reality than pure hype. Though it's still making headway in this entirely-new, highly-exploratory field, blockchain is also showing promise beyond Bitcoin.

Originally created as the ultra-transparent ledger system for Bitcoin to operate on, blockchain has long been associated with cryptocurrency, but the technology's transparency and security has seen growing adoption in a number of areas, much of which can be traced back to the development of the Ethereum blockchain.

In late 2013, Russian-Canadian developer Vitalik Buterin published a white paper that proposed a platform combining traditional blockchain functionality with one key difference: the execution of computer code [56]. Thus, the Ethereum Project was born.

Ethereum blockchain lets developers create sophisticated programs that can communicate with one another on the blockchain.

Ethereum programmers can create tokens to represent any kind of digital asset, track its ownership and execute its functionality according to a set of programming instructions.

Tokens can be music files, contracts, concert tickets or even a patient's medical records. Most recently, Non-Fungible Tokens (NFTs) have become all the rage [57]. NFTs are unique blockchain-based tokens that store digital media (like a video, music or art). Each NFT has the ability to verify authenticity, past history and sole ownership of the piece of digital media [58]. NFTs have become wildly popular because they offer a new wave of digital creators the ability to buy and sell their creations, while getting proper credit and a fair share of profits.

Newfound uses for blockchain have broadened the potential of the ledger technology to permeate other sectors like media, government and identity security [59]. Thousands of companies are currently researching and developing products and ecosystems that run entirely on the burgeoning technology.

Blockchain is challenging the current status quo of innovation by letting companies experiment with ground-breaking technology like peer-to-peer energy distribution or decentralized forms for news media. Much like the definition of blockchain, the uses for the ledger system will only evolve as technology evolves.

6. Conclusion and recommendations

Blockchain technology has only been around for a dozen years, and businesses are still exploring new ways to apply the technology to support their operations. With the growing amount of digital data used in our lives, there's a growing need for the data security, access, transparency, and integrity blockchain can provide.

Here, we discussed all the different types of cryptocurrencies. For those asking how many types of cryptocurrencies are there, we have listed the common types. Of all types of cryptocurrencies, the main ones are payment tokens.

Based on these categories, security tokens are the best to invest in, although basically all payment tokens are ideally fit for that purpose. Only that utility tokens are not backed by regulation and so no one to hold accountable if an investment goes bad.

If it is a scam, it would be known long before it goes far. Most utility token projects survive in the market based on keeping their word to their investors because that affects demand and usability or utility directly.

A potential solution to this could be the Enigma Project, an off-chain network serving as an extension to conventional blockchain platforms.

Gretton adds: “It allows code to be processed both publicly on the blockchain, maintaining a public ledger of a transaction, and on Enigma’s off-chain network where the data is encrypted. By processing data off-network, the Enigma network can process-intensive comutations that remain publicly verifiable on the blockchain.”

Imogen Farham, a researcher Reform, sums up blockchain’s use in the healthcare industry, explaining: “What blockchain does well is present a way forward to transform the relationship patients have with their healthcare data.

“To achieve this, standardising how healthcare data is formatted to facilitate meaningful interoperability between systems would be a good place to start.”.

References

Iansiti, Marco; Lakhani, Karim R. (January 2017). "The Truth About Blockchain". Harvard Business Review. Harvard University. Archived from the original on 18 January 2017. Retrieved 17 January 2017. The technology at the heart of bitcoin and other virtual currencies, blockchain is an open, distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way.

Raval, Siraj (2016). Decentralized Applications: Harnessing Bitcoin's Blockchain Technology. O'Reilly Media, Inc. pp. 1–2. ISBN 978-1-4919-2452-5.

Park, Sehyun; Im, Seongwon; Seol, Youhwan; Paek, Jeongyeup (2019). "Nodes in the Bitcoin Network: Comparative Measurement Study and Survey". IEEE Access. 7: 57009–57022. doi:10.1109/ACCESS.2019.2914098. S2CID 155106629.

Hern, Alex (17 January 2018). "Bitcoin's energy usage is huge – we can't afford to ignore it". The Guardian. Archived from the original on 23 January 2018. Retrieved 23 January 2018.

Baraniuk, Chris (3 July 2019). "Bitcoin's global energy use 'equals Switzerland'". BBC News. Retrieved 2 February 2020.

"Blind Signatures for Untraceable Payments" (PDF). Archived from the original (PDF) on 18 December 2014. Retrieved 26 October 2014.

"Untraceable Electronic Cash" (PDF). Archived (PDF) from the original on 3 September 2011. Retrieved 10 October 2012.

Pitta, Julie. "Requiem for a Bright Idea". Forbes. Archived from the original on 30 August 2017. Retrieved 11 January 2018.

"How To Make A Mint: The Cryptography of Anonymous Electronic Cash". groups.csail.mit.edu. Archived from the original on 26 October 2017. Retrieved 11 January 2018.

Law, Laurie; Sabett, Susan; Solinas, Jerry (11 January 1997). "How to Make a Mint: The Cryptography of Anonymous Electronic Cash". American University Law Review. 46 (4). Archived from the original on 12 January 2018. Retrieved 11 January 2018.

"Bitcoin: The Cryptoanarchists' Answer to Cash". IEEE Spectrum. Around the same time, Nick Szabo, a computer scientist who now blogs about law and the history of money, was one of the first to imagine a new digital currency from the ground up. Although many consider his scheme, which he calls "bit gold", to be a precursor to Bitcoin

Jerry Brito and Andrea Castillo (2013). "Bitcoin: A Primer for Policymakers" (PDF). Mercatus Center. George Mason University. Archived (PDF) from the original on 21 September 2013. Retrieved 22 October 2013.

Bitcoin developer chats about regulation, open source, and the elusive Satoshi Nakamoto Archived 3 October 2014 at the Wayback Machine, PCWorld, 26 May 2013

Wary of Bitcoin? A guide to some other cryptocurrencies Archived 16 January 2014 at the Wayback Machine, ars technica, 26 May 2013

"UK launches initiative to explore potential of virtual currencies". The UK News. Archived from the original on 10 November 2014. Retrieved 8 August 2014.

"UK regulatory approach to cryptoassets and stablecoins: Consultation and call for evidence" (PDF). HM Treasury. Retrieved 1 October 2021.

Morris, David Z. (15 May 2016). "Leaderless, Blockchain-Based Venture Capital Fund Raises $100 Million, And Counting". Fortune. Archived from the original on 21 May 2016. Retrieved 23 May 2016.

Jump up to:a b Popper, Nathan (21 May 2016). "A Venture Fund With Plenty of Virtual Capital, but No Capitalist". The New York Times. Archived from the original on 22 May 2016. Retrieved 23 May 2016.

Jump up to:a b c d e f g h i j "Blockchains: The great chain of being sure about things". The Economist. 31 October 2015. Archived from the original on 3 July 2016. Retrieved 18 June 2016. The technology behind bitcoin lets people who do not know or trust each other build a dependable ledger. This has implications far beyond the crypto currency.

Jump up to:a b c d e Narayanan, Arvind; Bonneau, Joseph; Felten, Edward; Miller, Andrew; Goldfeder, Steven (2016). Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton: Princeton University Press. ISBN 978-0-691-17169-2.

Iansiti, Marco; Lakhani, Karim R. (January 2017). "The Truth About Blockchain". Harvard Business Review. Harvard University. Archived from the original on 18

January 2017. Retrieved 17 January 2017. The technology at the heart of bitcoin and other virtual currencies, blockchain is an open, distributed ledger that can record transactions between two parties efficiently and in a verifiable and permanent way.

Jump up to:a b "The World's Oldest Blockchain Has Been Hiding in the New York Times Since 1995". www.vice.com. Retrieved 9 October 2021.

"Blockchain may finally disrupt payments from Micropayments to credit cards to SWIFT". dailyfintech.com. 10 February 2018. Archived from the original on 27 September 2018. Retrieved 18 November 2018.

Jump up to:a b c d e Hampton, Nikolai (5 September 2016). "Understanding the blockchain hype: Why much of it is nothing more than snake oil and spin". Computerworld. Archived from the original on 6 September 2016. Retrieved 5 September 2016.

Jump up to:a b Bakos, Yannis; Halaburda, Hanna; Mueller-Bloch, Christoph (February 2021). "When Permissioned Blockchains Deliver More Decentralization Than Permissionless". Communications of the ACM. 64 (2): 20–22. doi:10.1145/3442371. S2CID 231704491.

Sherman, Alan T.; Javani, Farid; Zhang, Haibin; Golaszewski, Enis (January 2019). "On the Origins and Variations of Blockchain Technologies". IEEE Security Privacy. 17 (1): 72–77. arXiv:1810.06130. doi:10.1109/MSEC.2019.2893730. ISSN 1558-4046. S2CID 53114747.

Haber, Stuart; Stornetta, W. Scott (January 1991). "How to time-stamp a digital document". Journal of Cryptology. 3 (2): 99–111. CiteSeerX 10.1.1.46.8740. doi:10.1007/bf00196791. S2CID 14363020.

Bayer, Dave; Haber, Stuart; Stornetta, W. Scott (March 1992). Improving the Efficiency and Reliability of Digital Time-Stamping. Sequences. Vol. 2. pp. 329–334. CiteSeerX 10.1.1.71.4891. doi:10.1007/978-1-4613-9323-8_24. ISBN 978-1-4613-9325-2.

Nian, Lam Pak; Chuen, David LEE Kuo (2015). "A Light Touch of Regulation for Virtual Currencies". In Chuen, David LEE Kuo (ed.). Handbook of Digital Currency: Bitcoin, Innovation, Financial Instruments, and Big Data. Academic Press. p. 319. ISBN 978-0-12-802351-8.

Johnsen, Maria (12 May 2020). Blockchain in Digital Marketing: A New Paradigm of Trust. Maria Johnsen. p. 6. ISBN 979-8-6448-7308-1.

"The future of blockchain in 8 charts". Raconteur. 27 June 2016. Archived from the original on 2 December 2016. Retrieved 3 December 2016.

"Hype Killer - Only 1% of Companies Are Using Blockchain, Gartner Reports | Artificial Lawyer". Artificial Lawyer. 4 May 2018. Archived from the original on 22 May 2018. Retrieved 22 May 2018.

Kasey Panetta. (31 October 2018). "Digital Business: CIO Agenda 2019: Exploit Transformational Technologies." Gartner website Retrieved 27 March 2021.

Armstrong, Stephen (7 November 2016). "Move over Bitcoin, the blockchain is only just getting started". Wired. Archived from the original on 8 November 2016. Retrieved 9 November 2016.

Catalini, Christian; Gans, Joshua S. (23 November 2016). "Some Simple Economics of the Blockchain" (PDF). SSRN. doi:10.2139/ssrn.2874598. hdl:1721.1/130500. S2CID 46904163. SSRN 2874598. Archived (PDF) from the original on 6 March 2020. Retrieved 16 September 2019.

Tapscott, Don; Tapscott, Alex (8 May 2016). "Here's Why Blockchains Will Change the World". Fortune. Archived from the original on 13 November 2016. Retrieved 16 November 2016.

Bheemaiah, Kariappa (January 2015). "Block Chain 2.0: The Renaissance of Money". Wired. Archived from the original on 14 November 2016. Retrieved 13 November 2016.

Chen, Huashan; Pendleton, Marcus; Njilla, Laurent; Xu, Shouhuai (12 June 2020). "A Survey on Ethereum Systems Security: Vulnerabilities, Attacks, and Defenses". ACM Computing Surveys. 53 (3): 3–4. arXiv:1908.04507. doi:10.1145/3391195. ISSN 0360-0300. S2CID 199551841.

Shishir, Bhatia (2 February 2006). Structured Information Flow (SIF) Framework for Automating End-to-End Information Flow for Large Organizations (Thesis). Virginia Tech.

Jump up to:a b c d Bhaskar, Nirupama Devi; Chuen, David LEE Kuo (2015). "Bitcoin Mining Technology". Handbook of Digital Currency. pp. 45–65. doi:10.1016/B978-0-12-802117-0.00003-5. ISBN 978-0-12-802117-0.

Jump up to:a b c Antonopoulos, Andreas (20 February 2014). "Bitcoin security model: trust by computation". Radar. O'Reilly. Archived from the original on 31 October 2016. Retrieved 19 November 2016.

Jump up to:a b Antonopoulos, Andreas M. (2014). Mastering Bitcoin. Unlocking Digital Cryptocurrencies. Sebastopol, CA: O'Reilly Media. ISBN 978-1449374037. Archived from the original on 1 December 2016. Retrieved 3 November 2015.

Nakamoto, Satoshi (October 2008). "Bitcoin: A Peer-to-Peer Electronic Cash System" (PDF). bitcoin.org. Archived (PDF) from the original on 20 March 2014. Retrieved 28 April 2014.

"Permissioned Blockchains". Explainer. Monax. Archived from the original on 20 November 2016. Retrieved 20 November 2016.

Strydom, Moses; Buckley, Sheryl (July 2019). AI and Big Data's Potential for Disruptive Innovation. IGI Global. ISBN 978-1-5225-9687-5.

Kumar, Randhir; Tripathi, Rakesh (November 2019). "Implementation of Distributed File Storage and Access Framework using IPFS and Blockchain". 2019 Fifth International Conference on Image Information Processing (ICIIP). IEEE: 246–251. doi:10.1109/iciip47207.2019.8985677. ISBN 978-1-7281-0899-5. S2CID 211119043...

Y. A. Baker El-Ebiary et al., "Blockchain as a decentralized communication tool for sustainable development," 2021 2nd International Conference on Smart Computing and Electronic Enterprise (ICSCEE), 2021, pp. 127-133, doi: 10.1109/ICSCEE50312.2021.9497910.

Y. A. Baker El-Ebiary et al., "Track Home Maintenance Business Centers with GPS Technology in the IR 4.0 Era," 2021 2nd International Conference on Smart Computing and Electronic Enterprise (ICSCEE), 2021, pp. 134-138, doi: 10.1109/ICSCEE50312.2021.9498070.

S. I. Ahmad Saany et al., "Exploitation of a Technique in Arranging an Islamic Funeral," 2021 2nd International Conference on Smart Computing and Electronic Enterprise (ICSCEE), 2021, pp. 1-8, doi: 10.1109/ICSCEE50312.2021.9498224.

J. A. Jusoh et al., "Track Student Attendance at a Time of the COVID-19 Pandemic Using Location-Finding Technology," 2021 2nd International Conference on Smart Computing and Electronic Enterprise (ICSCEE), 2021, pp. 147-152, doi: 10.1109/ICSCEE50312.2021.9498043.

Y. A. Baker El-Ebiary et al., "E-Government and E-Commerce Issues in Malaysia," 2021 2nd International Conference on Smart Computing and Electronic Enterprise (ICSCEE), 2021, pp. 153-158, doi: 10.1109/ICSCEE50312.2021.9498092.

Y. A. B. El-Ebiary et al., "Determinants of Customer Purchase Intention Using Zalora Mobile Commerce Application," 2021 2nd International Conference on Smart Computing and Electronic Enterprise (ICSCEE), 2021, pp. 159-163, doi: 10.1109/ICSCEE50312.2021.9497995.

S. Bamansoor et al., "Efficient Online Shopping Platforms in Southeast Asia," 2021 2nd International Conference on Smart Computing and Electronic Enterprise (ICSCEE), 2021, pp. 164-168, doi: 10.1109/ICSCEE50312.2021.9497901.

S. Bamansoor et al., "Evaluation of Chinese Electronic Enterprise from Business and Customers Perspectives," 2021 2nd International Conference on Smart Computing and Electronic Enterprise (ICSCEE), 2021, pp. 169-174, doi: 10.1109/ICSCEE50312.2021.9498093.

A. Altrad et al., "Amazon in Business to Customers and Overcoming Obstacles," 2021 2nd International Conference on Smart Computing and Electronic Enterprise (ICSCEE), 2021, pp. 175-179, doi: 10.1109/ICSCEE50312.2021.9498129.

Y. A. Baker El-Ebiary et al., "Mobile Commerce and its Apps - Opportunities and Threats in Malaysia," 2021 2nd International Conference on Smart Computing and Electronic Enterprise (ICSCEE), 2021, pp. 180-185, doi: 10.1109/ICSCEE50312.2021.9498228.

M. B. Mohamad et al., "Enterprise Problems and Proposed Solutions Using the Concept of E-Commerce," 2021 2nd International Conference on Smart Computing and Electronic Enterprise (ICSCEE), 2021, pp. 186-192, doi: 10.1109/ICSCEE50312.2021.9498197.

P. R. Pathmanathan et al., "The Benefit and Impact of E-Commerce in Tourism Enterprises," 2021 2nd International Conference on Smart Computing and Electronic Enterprise (ICSCEE), 2021, pp. 193-198, doi: 10.1109/ICSCEE50312.2021.9497947.

K. Aseh et al., "The Future of E-Commerce in the Publishing Industry," 2021 2nd International Conference on Smart Computing and Electronic Enterprise (ICSCEE), 2021, pp. 199-205, doi: 10.1109/ICSCEE50312.2021.9498175.