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The Emergence of Web 3.0: Tokenization and the Internet of Value

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The Emergence of Web 3.0: Tokenization and the Internet of Value

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Abstract

Since the emergence of blockchain technology in 2009, with Satoshi Nakamoto's launch of Bitcoin as its first real-world application, there have been many claims that this technology will "change the world". At the heart of this claim lies the notion of blockchain technology's ability to replace the current monetary system by using the public Internet to manage the exchange of value in a peer-to-peer manner rather than through trusted middleman on private networks. In this paper, we discuss the basis for this claim and the basic tools and capabilities, including tokens and smart contracts, that make the emergence of an "Internet of Value" possible. We discuss where we are, what has already been accomplished, and the road ahead.

Keywords: Financial services, crypto, DeFi, tokenization, decentralized autonomous organizations (DAOs)

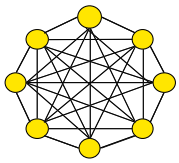
Introduction

The Internet, initially called ARPANET, was designed by the US government to share information among researchers who already knew and trusted each other. The University of California Los Angeles, the University of California Santa Barbara, the University of Utah and Stanford University were the first institutions to be connected to it in 1969. It wasn't easily accessible or readable to the average user. Then in 1989, Tim Berners-Lee, a British scientist, invented the World Wide Web (WWW) to enable better reading through browsers. Web 1.0, the read-only era as it was sometimes called, was born. However, it was still difficult for the average person to generate content. With the advent of social media and more user-friendly platforms, users could finally create content with ease on the Internet, bringing us Web 2.0, known as the read and write era. Web 3.0 is the idea that we will use the Internet for reading, writing, and execution. More specifically, we will increasingly use the Internet to exchange value with the same ease we share information today. We will exchange this value without needing trusted third parties (TTPs) to mitigate counter-party risks like double-spending, and we will do so with digital fiat currencies or with cryptocurrencies. A technology, called blockchain, is a key enabler of Web 3.0. (Campbell-Kelly and Garcia-Swartz, 2013; Rosenzweig 1998). To explain how Web 3.0 works, we begin by describing blockchain and its relationship to the Internet.

What is a Blockchain?

At its core, blockchain is software: it is both a database and a network protocol. The database is a distributed digital ledger that keeps track of transactions made between parties. A blockchain network connects computers, called nodes, which each maintains an identical copy of the digital ledger. The copies are kept in synchronization using pre-agreed upon code called a consensus algorithm. The consensus algorithm also determines what constitutes a valid transaction and what transactions get immutably added to the distributed ledger. The blockchain network usually manages tokens, which are blockchain's way to enforce digital scarcity. This paper will explore this in detail in further sections. eWallets are used in order to record which participant or entity owns which tokens. Smart contracts contain coded business logic that help manage the transfer of tokens (i.e., value) between eWallets (see Figure 1).

Blockchain is a **distributed infrastructure technology.** It is a decentralized ledger that keeps a record of each transaction that occurs across a **network,** which enables a **decentralized** exchange of trusted data – a "**shared record book.**"



Distributed ledger

- Every participant in the network keeps a copy of all (or part of) the transactions.
- Transactions are secured by encryption to prevent tampering.

Consensus algorithm

- No one node or server is responsible for approving transactions leading to genuinely distributed transaction processing.
- Each entry is validated and recorded on the ledgers across the network.

Tokens Are Items of Value Handled On The Blockchain

eWallets Are like Vaults for Managing Tokens

Contracts Control the Exchange of Tokens

Figure 1: Key components of a blockchain

In order to understand how these components give rise to an "Internet of Value", we first need to understand the history of value and why it needs improvement (Tapscott and Tapscott, 2016).

A history lesson about value

When trying to explain the rise of the "Internet of Value", we first need to define the meaning of the word "value". According to the Merriam Webster Dictionary, the definition of the word "value" is: "*a fair return or equivalent in goods, services, or money for something exchanged*".

Since the dawn of the formulation of human society and economy, value has been exchanged between human beings, but what was it that was exchanged? What is something of value? What makes something valuable? In order to answer these questions, let's take a short trip through the evolution of economy. Meet Alice and Bob, both living in a small village, about 3,000 years ago. The village doesn't have a lot of resources, but in the middle of their village, there's a stream of clean and fresh running water all year round. Water is in abundance, and as such, to our two villagers, water has very little value. All Alice and Bob need to do to obtain it, is to grab a bucket and draw some out (see Figure 2).

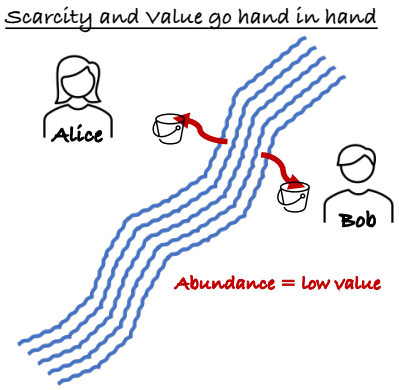


Figure 2: An early value stream

On the other hand, assume Alice is growing wheat and Bob is raising chickens. Both wheat and chickens would have value, as both are scarce. Alice and Bob would barter between them, exchanging goods for their needs. The scarcity of wheat or chickens is what makes them valuable (see Figure 3).

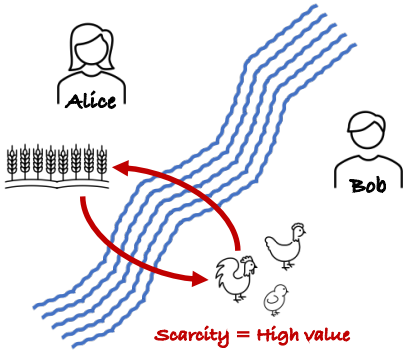


Figure 3: Scarcity is introduced

As the centuries pass and as the economy evolves, bartering for goods becomes more complex. Mankind started storing value in precious metals. Precious metals are durable, shiny, and heavy, but the value they represent can be imprinted on them, often along with the sovereign's image. Most of all, precious metals are scarce. It isn't easy to simply produce more of them, and as such, just like wheat or chickens, they are a good store of value (see Figure 4).

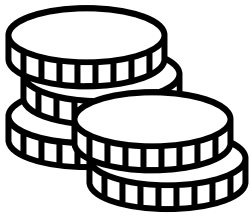


Figure 4: Precious metal as a store of value

Around the Middle Ages in Europe (15th century or so), carrying precious metals around in a leather sack became too dangerous and too complex, so we started seeing the emergence of paper money.[1] Paper money was issued to represent precious metals by a trustworthy, sovereign entity, and it represented the sovereign's obligation to honor them. The precious metals were stored somewhere safe and were redeemable on demand by presenting paper money. It became easier to carry paper notes around and exchange them. Redeeming them for scarce precious metal was an option available at any time.

This notion of paper notes representing precious metals stored in a safe is called the "gold standard" and was officially established in the United Kingdom in 1821.[2] During the next 50 years, the gold standard was adopted by more and more countries (starting with France, Germany, and the United States) that agreed to buy and sell gold, at a fixed price, against their own currency. By the late 1950s, most major European countries provided convertibility between their own currency and gold.

Every US-backed dollar note was exchangeable with gold stored in the vaults of Fort Knox until 1971. In 1971, dwindling gold reserves and a mounting national deficit led the United States to suspend the free convertibility of dollars into gold at fixed rates of exchange for use in international payments. The international monetary system was henceforth based on the dollar and other paper currencies, and gold's official role in world exchange was at an end. Today, sovereign currencies are now "fiat", backed solely on the promises of governments.

One thing is essential for our economy to work: money (or any other form of exchangeable store of value) needs to remain ***scarce***. When Alice gives Bob a paper note, (e.g., a $100 bill), Bob needs to know, Alice didn't get to make or retain a copy.

[1] The first true banknotes from Europe were in Sweden in 1661 according to the International Bank Note Society (https://www.theibns.org/joomla/index.php)
[2] The gold standard was first put into operation in the United Kingdom in 1821. (https://www.britannica.com/topic/gold-standard)

Indeed, up to today, when governments issue more money, they go through extreme effort to make sure money isn't easily printed, replicated, and forged. This effort is done in the interest of keeping money scarce.

Enter the digital era

Along the same timeline, and with no direct relation to the end of the gold standard era, an unrelated development happens. During the late 1960s and early 1970s, ARPANET was established to exchange information among a network of research scientists (see Introduction). ARPANET continued to evolve over the next several decades to what we now call the Internet. The Internet is basically comprised of two things:

1) **Infrastructure** comprising fiberoptic cables, satellites, and routers (see Figure 6)
2) P**rotocols** comprising a system of rules that determine how information is transmitted over the infrastructure (see Figure 7).

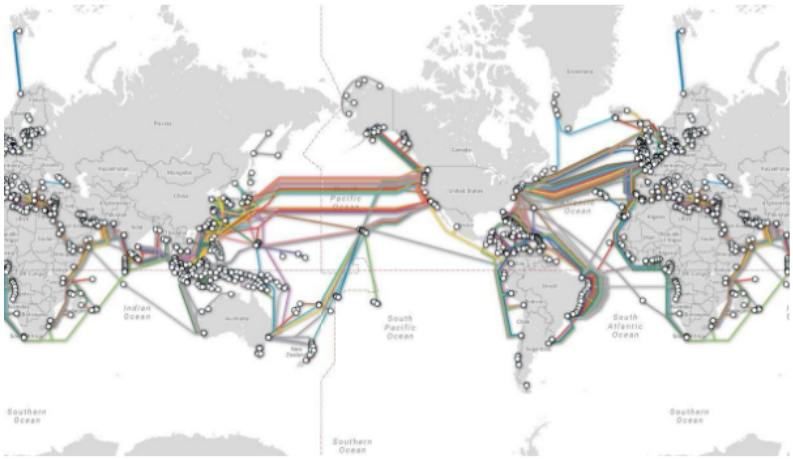


Figure 6: Internet Infrastructure
Source: The World Economic Forum

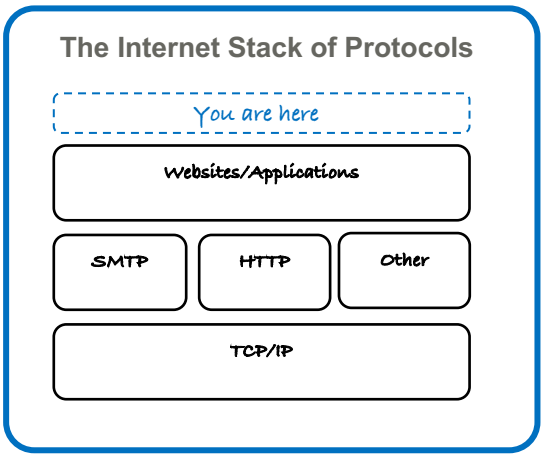


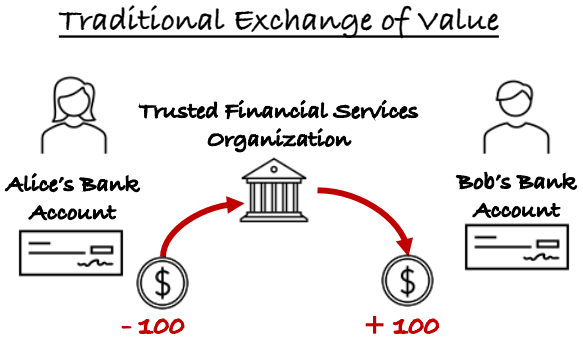
Figure 7: Internet Stack of Protocols

While the Internet is an amazing tool that has completely revolutionized the way we share, consume and exchange information, it has one significant limitation: anything "digital" is easily duplicated. In fact, the Internet is designed to send *copies* of information. For example, when Alice sends Bob an email with a picture attached, she is actually sending a COPY of the picture that exists on her computer. So, while the Internet is very good for spreading information around, it was not designed to manage exchanges of value. The Internet lacks the capability to keep assets and value scarce.

Does the above discussion mean we don't use the Internet to transfer money and value between us? Of course not, but the real question is: HOW do we do it?

In order to manage the exchange of value over the Internet today, we use trusted third parties (TTPs), such as banks and money transmitters. TTPs make sure value is kept scarce while being exchanged.

When Alice transfers 100 dollars electronically to Bob, there is a TTP in the middle of the transaction to make sure Alice's account is debited and Bob's account is credited. This is how we keep value scarce using today's Internet-based infrastructure (see Figure 8).



`Figure 8: Traditional Exchange of Value using a Third Party

The need to have a 3rd party that manages the exchange of value and prevents the double-spend of value has resulted in a complex and inefficient network of financial services. This network heavily taxes users via transaction fees and commissions, charging every exchange of value for their services. Credit card companies charging 3% fees for every swipe is an example.

In the next section, we discuss how blockchains and asset tokenization solve for the double-spend problem, why that is significant, how new crypto-native companies are moving us to Web 3.0, and how existing financial organizations are responding.

Tokens and digital scarcity

Arguably, the most important part of blockchain innovation comes from the notion of tokens.

Tokens are basically a digital entity that exists in the form of a very long and unique number. Within any given blockchain network, the consensus algorithm guarantees that this unique number (i.e., token), exists only once. For example, if Alice transfers 100 tokens from her eWallet to Bob's eWallet, the network will guarantee Alice's eWallet is credited (-100) and Bob's eWallet is debited (+100). The network prevents Alice from double spending her tokens; Alice cannot concurrently send them to Carol, Carlos, or Charlie, thus keeping the tokens themselves scarce (see Figure 9). An important feature is that this network does not require the use of a TTP. That is the functionality behind the first and most famous blockchain – Bitcoin.

In other words, tokens are digital scarcity and blockchains facilitate peer-to-peer exchanges of value.

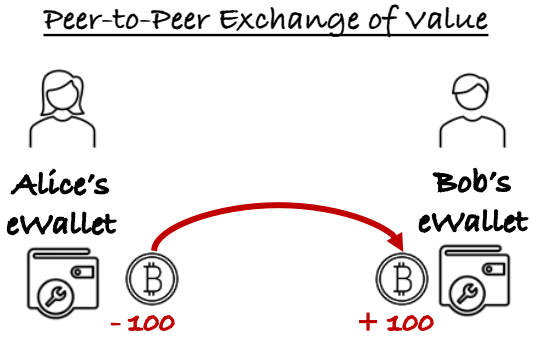


Figure 9: Peer-to-Peer Exchange of Value

While the use of tokens spans across multiple areas, such as security or digital identity, the focus of this discussion is tokens as digital scarcity.

There are many examples of token usage in digital exchanges of value. The major evolution of different asset classes that are being tokenized include:

Cryptocurrencies - As discussed in this paper, the Bitcoin network is a perfect example of tokenized, digital, and peer-to-peer exchange of value. Holding the private key to an address that contains bitcoin tokens in an eWallet represents the ownership of the digital currency. A cryptocurrency is simply a token who's ownership is managed by a blockchain network (either natively like Bitcoin or Ethereum or via a smart contract like the many ERC-20 tokens[3] in use).

[3] **ERC-20 tokens**: Standard for creating a token for *fungible digital assets* that can be exchanged with other fungible tokens on Ethereum. Each token is interchangeable and has the same value. The token must meet mandatory requirements for defining the total money supply, specifying the number of tokens than can be transferred to a user

Stablecoins and tokenized commodities - Stablecoins are tokens pegged to/backed-up by a fiat currency and tokenized commodities, such as gold or a barrel of oil. While allowing for both peer-to-peer exchange of value, the stability comes from being pegged to a real-world asset. Stablecoins and tokenized commodities are two examples where the ownership over a physical/real world asset is proven by the ownership over the representing token. Any token owner can redeem their token and get the asset back. The supply of stable coins and tokenized commodities has grown exponentially over the past few years (see Figure 10).

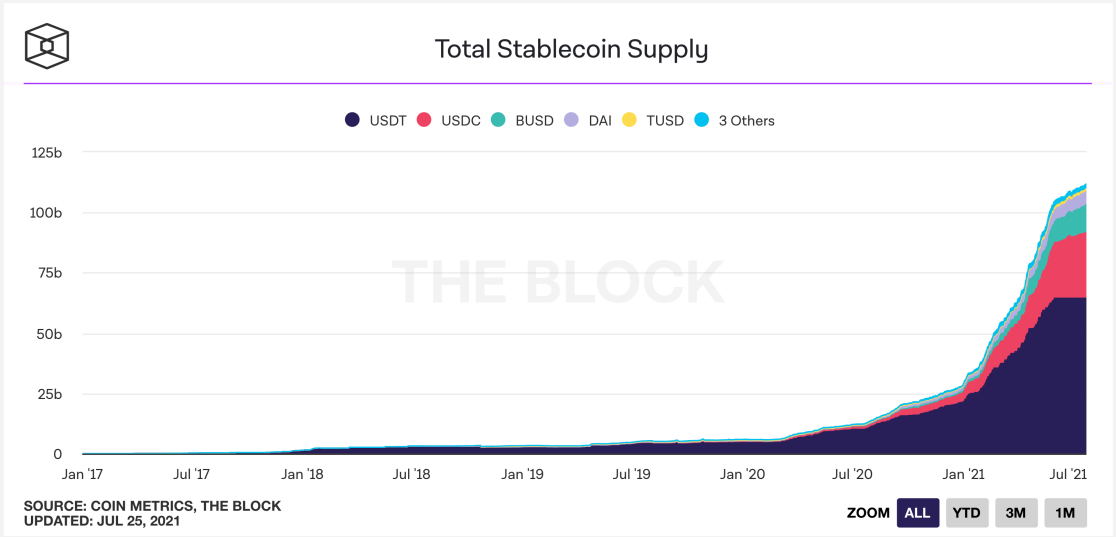


Figure 10. Total Stablecoin Supply
Source: Coin Metrics

Non-Fungible Tokens (NFTs) Stage 1 – while both cryptocurrencies and stablecoins represent a fungible asset, meaning one token does not differ from another, each NFT is unique. An NFT represents a non-fungible asset. Each NFT token is tracked separately and uniquely using a blockchain network's smart contract. Starting with CryptoKitties on 2017 and up to the most recent NFTs (such as NBA TopShots), owning an NFT represents the holder's ownership over a unique digital collectable.

Decentralized Autonomous Organizations (DAO) Tokens – A DAO is special kind of smart contract that runs an entire organization automatically based on codified rules. The idea of a DAO is to create a completely independent entity that is exclusively governed by the rules that you program into it and 'lives' on a blockchain. Analogous to equity stock in a traditional company, the owners of DAO tokens have the voting rights (and likely future revenue rights). As DAOs evolve as a legitimate way for an organization to formalize, we will see more and more DAO ownership tokens being minted, issued and traded.

account, providing a way to extract the balance of an account, allowing the transfer of tokens to other accounts, and checking a transaction against the money supply to prevent counterfeits.

Securities Tokens – The issuance of regulatory-compliant security tokens, such as stocks and bonds. These tokens support functionality that is required to comply with regulations such as Know Your Customer (KYC) and Anti-Money Laundering (AML). For example, a security token's smart contract can be programmed to limit distribution to authorized eWallets only. As blockchain technology evolves, it will become increasingly more efficient to trade in securities peer-to-peer, rather than use the existing traditional rails of value exchange. We will see more and more security (and security types) issued, managed, and traded, using blockchain technology.

Non-Fungible Tokens (NFTs) Stage 2 – as more and more business processes and business-to-business (B2B) exchanges of value are recorded on blockchains, we will see the use of NFTs to describe and manage the ownership over more and more asset classes. Some examples that are already being developed include:

1) Ownership over cashflow-generating royalty rights
2) Ownership over account receivable balances
3) Ownership over inventory and other physical goods/assets
4) Ownership over real estate assets

Bringing these ideas together, the combination of digital means of payments (stablecoins and eventually Central Bank Digital Currencies or CBDCs), the representation of ownership over real-world assets as NFTs, and the ability to code business deals' terms and conditions as smart contracts, likely will evolve over the next decade so that token-based digital exchanges of value will be the standard way of doing B2B and B2C transactions (see Figure 11).

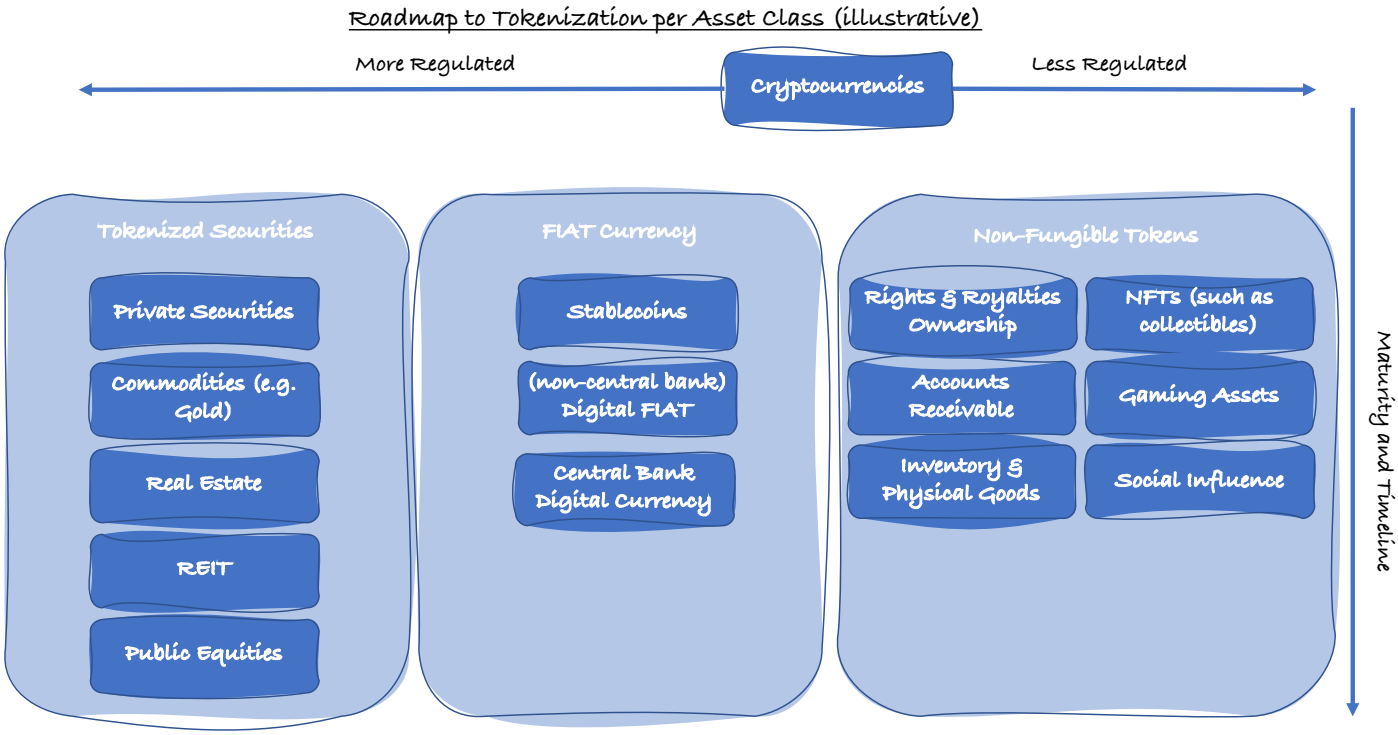


Figure 11: Roadmap to Tokenization per Asset Class

In the next section, we will discuss what this means at the macro level.

An "Exchange of Value" layer atop the Internet's infrastructure

Since 2008 with the publication of Satoshi's Bitcoin white paper, a new era has begun in terms of humankind's ability to manage and exchange value. In the first few years of the technology (2009-2015), all we had is the ability to manage the peer-to-peer exchange of fungible tokens.

With the introduction of the Ethereum blockchain in 2015 came the ability to support smart contracts and utilize token standards, as well as manage more types of tokens/assets within them (other than its native ETH token). We have essentially evolved a "2nd layer" for blockchain technology: the ability to describe assets in a standard way. For example - ERC-20 for fungible tokens, ERC-721 for non-fungible tokens (NFTs) or ERC-1404 for regulated securities (see Figure 12).

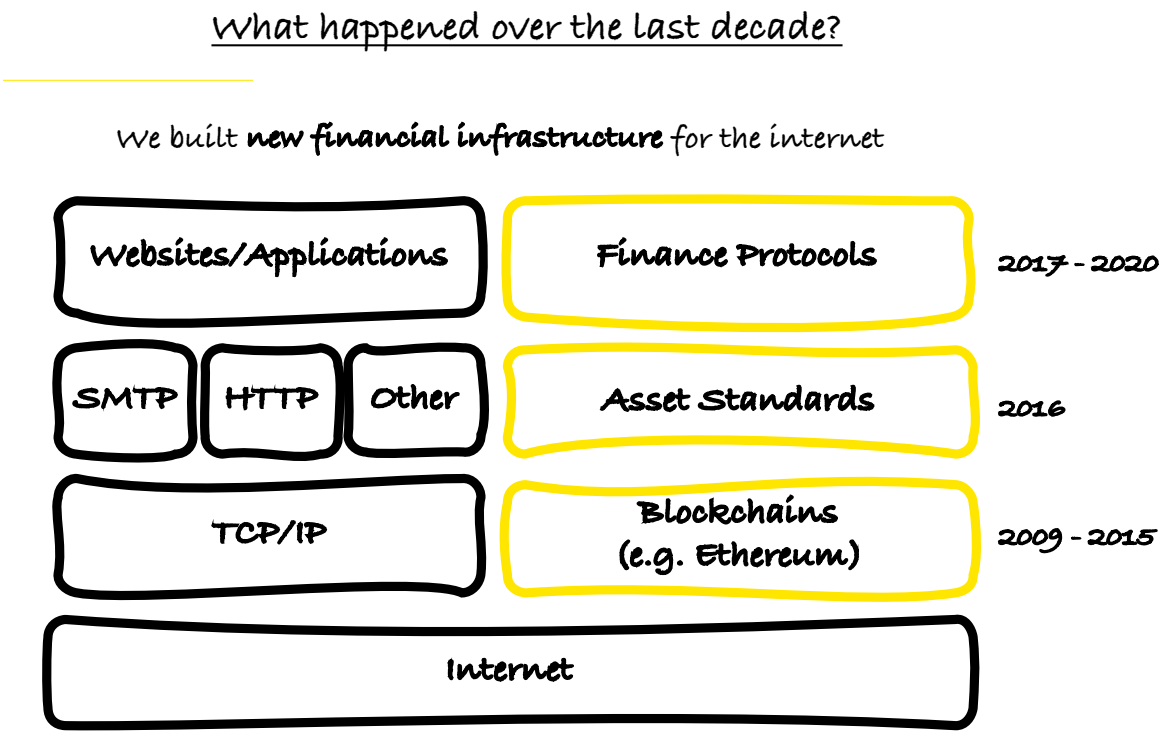


Figure 12: Financial Infrastructure

As we have a base layer that is able to manage peer-to-peer exchange of value and prevent the double spend of assets, and a 2nd layer that is able to describe all types of assets in a standard way, the stage was set for a 3rd phase/layer of evolution: Decentralized Finance (DeFi).

Best thought of as "vending machines", DeFi protocols take traditional financial services provided by TTPs, such as banks, and replace them with decentralized code that natively lives on a Blockchain (see Figure 13).

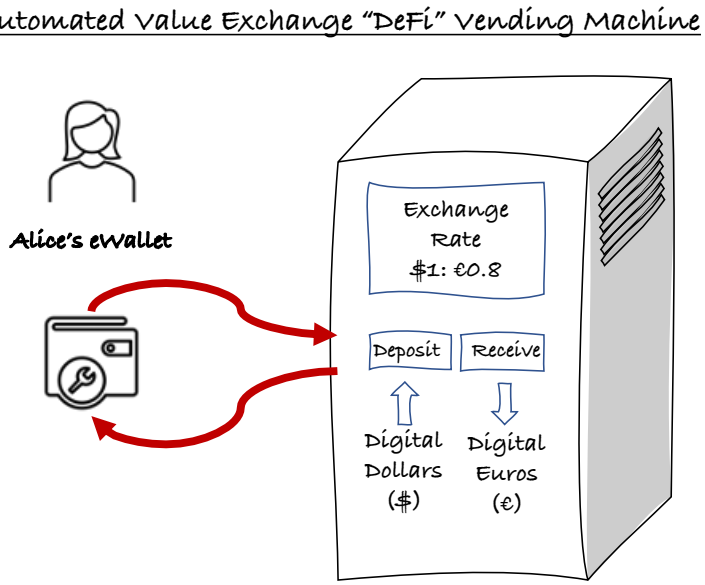


Figure 13. Automated Value Exchange "DeFi" Vending Machine

Consider the following example. Alice is looking to travel from the US to Europe, and for that, she needs to exchange her USD for EUR. Using our traditional financial infrastructure, Alice would interact with an exchange service such as her bank. The bank would provide the service to her, but while doing so, would apply a high buyer's exchange rate, and would probably take time and charge Alice a hefty commission for its service (see Figure 14).

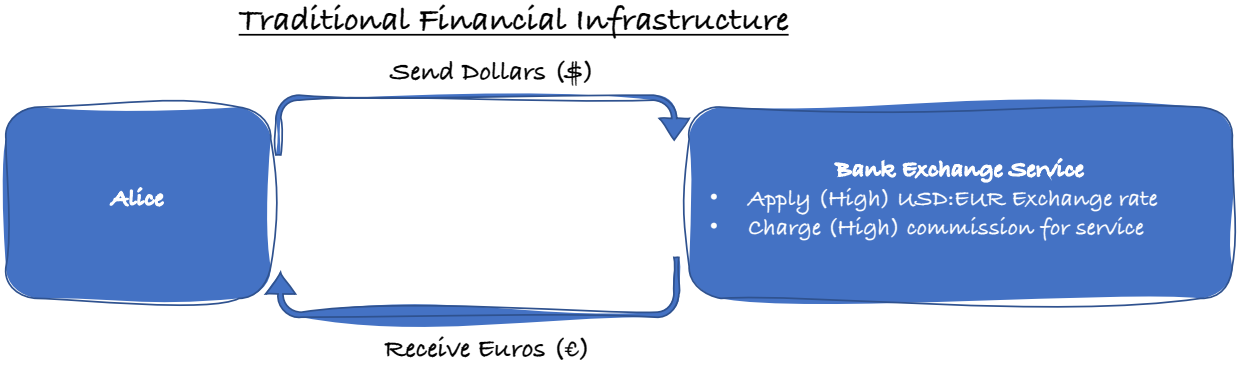


Figure 14. Traditional Financial Infrastructure

In the alternative DeFi world, Alice turns to exchanging her dollars for euros interacting with a DeFi exchange protocol (such as Uniswap) rather than a financial service provider. In this scenario, Alice would send her digital dollars to a decentralized exchange (i.e., DEX) smart contract. The smart contract's code would convert the digital dollars to digital euros and send them back to Alice. With Defi, the exchange is

faster, the exchange rate is more attractive, and the fee is lower, as there's no middleman in this process (see Figure 15).

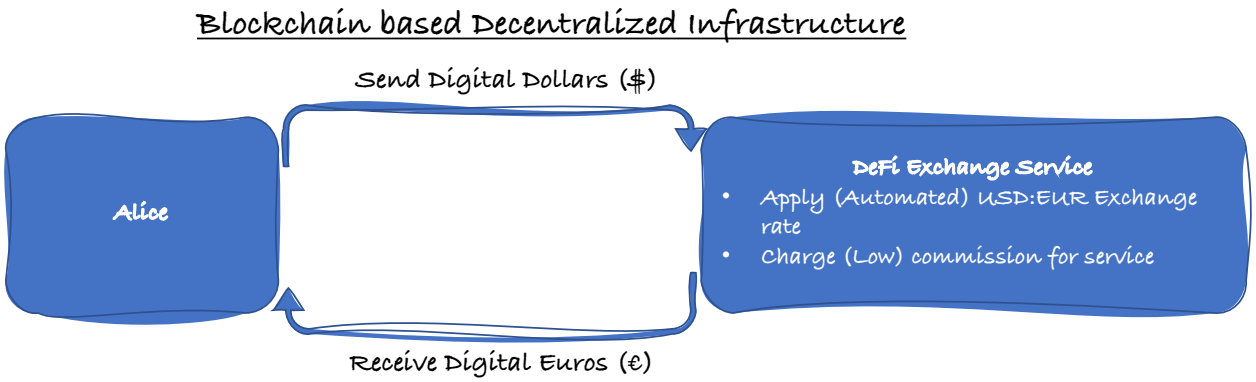


Figure 15: Blockchain-based Decentralized Infrastructure

It is important to understand that decentralized services don't stop with the exchange of currency/tokens, or with financial services for that matter. We are already seeing the emergence of more and more services that have been traditionally provided by TTPs and are now being replaced by blockchain-based decentralized code. Figure 16 provides a snapshot of the recent growth of DeFi.

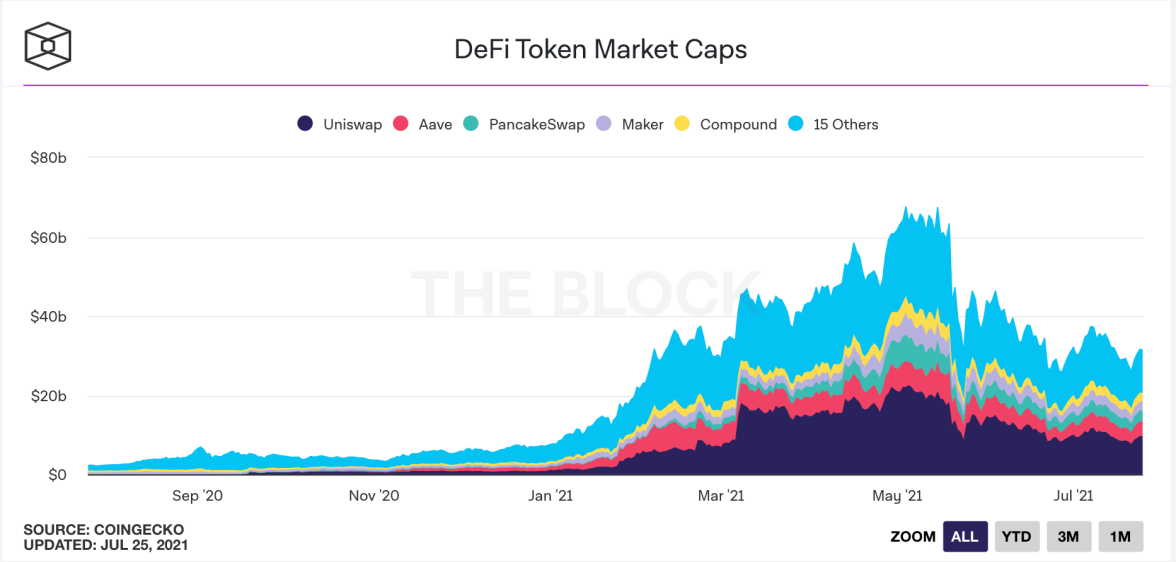


Figure 16: Defi Token Market Caps
Source: CoinGecko

The great migration

Once we understand and acknowledge that blockchain technology and DeFi offer a guaranteed, faster, less expensive, widely available, and more equitable way to consume and provide financial services, we must concede the future of its adoption is inevitable. It becomes more a question of *when* rather than a question of *if*.

When it comes to adoption, one can say there's a "pincer movement"[4] towards blockchain technology. On the one hand, nimble crypto natives such as Coinbase, Kraken, Gemini and many others offer easy (and getting easier) access to blockchain-based financial services. On the other hand, over the last year or so, we are witnessing more and more traditional financial services organizations acknowledging this trend, and starting to migrate, adopt and adapt their abilities to blockchain-based financial infrastructure (see Figure 17).

Figure 17. Migration to Blockchain Infrastructure

Some public announcements for example:

- BNYM investing in Crypto custody provider Fireblocks https://www.wsj.com/articles/bank-of-new-york-mellon-invests-in-crypto-startup-11616063404
- Santander launches a blockchain based digital bond on Ethereum https://www.santander.com/en/press-room/press-releases/santander-launches-the-first-end-to-end-blockchain-bond
- Citi invests in a blockchain-based trade finance solution https://www.crowdfundinsider.com/2020/03/159052-citi-increases-equity-stake-in-komgo-an-ethereum-powered-enterprise-blockchain-platform-for-trade-financing/

[4] "The pincer movement, or double envelopment, is a military maneuver in which forces simultaneously attack both flanks (sides) of an enemy formation." (https://en.wikipedia.org/wiki/Pincer_movement)

DeFi – the decentralized finance revolution

As discussed above, the emergence and development of decentralized finance is happening, and it can be seen from the significant rise of both value and revenues of DeFi protocols (see Figure 18).

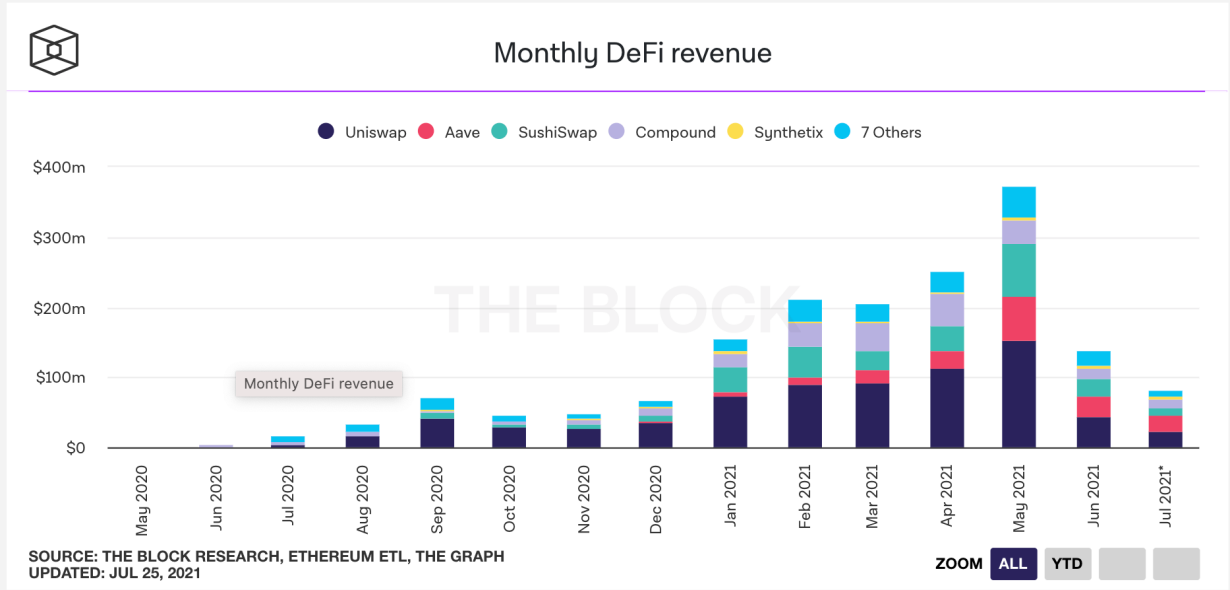


Figure 18. Monthly DeFi Revenue
Source: The Block Research

Next, we describe and give examples of financial and other services which are being decentralized and developed as DAOs. While not an exhaustive list, the list below gives the reader a sense as to the magnitude of change that is emerging from our ability to decentralize more and more services that traditionally have required 3rd party participation:

- **Exchange of (digital) assets** – a Decentralized Exchange's (DEX) smart contract holds liquidity in multiple assets and offers exchange services for a small fee. (You send dollars and receive euros in return) – Uniswap and Sushiswap are two examples of such exchanges.

- **Interest bearing deposits** – in order to provide the exchange service above, the DEX needs liquidity. This liquidity comes from participants who deposit their tokens into the DEX's liquidity pools, for which they earn interest. Compound is an example (https://compound.finance). Figure 19 shows the value locked by various DeFi projects, including Aave, Compound, Maker, and Uniswap.

- **Lending against collateral** – One of the leading examples is MakerDAO, which accepts assets (such as ether) as collateral in exchange for a stablecoin loan in the form of DAI. As more and more asset classes and types are being tokenized and managed over blockchains, we will see an evolution of more and more assets being eligible to serve as collateral, and as a basis for taking out loans

against them. Note that no 3rd party is directly involved in these transactions. When you return the DAI (plus interest), your asset is sent back to your eWallet. Fail to do so, and the smart contract would sell your asset to regain its lost DAI.

- **Investment portfolio management** – Yearn Finance (https://yearn.finance) is an example where a decentralized smart contract constantly scans the different interest-bearing deposits and automatically invests funds in places that yield the highest return.

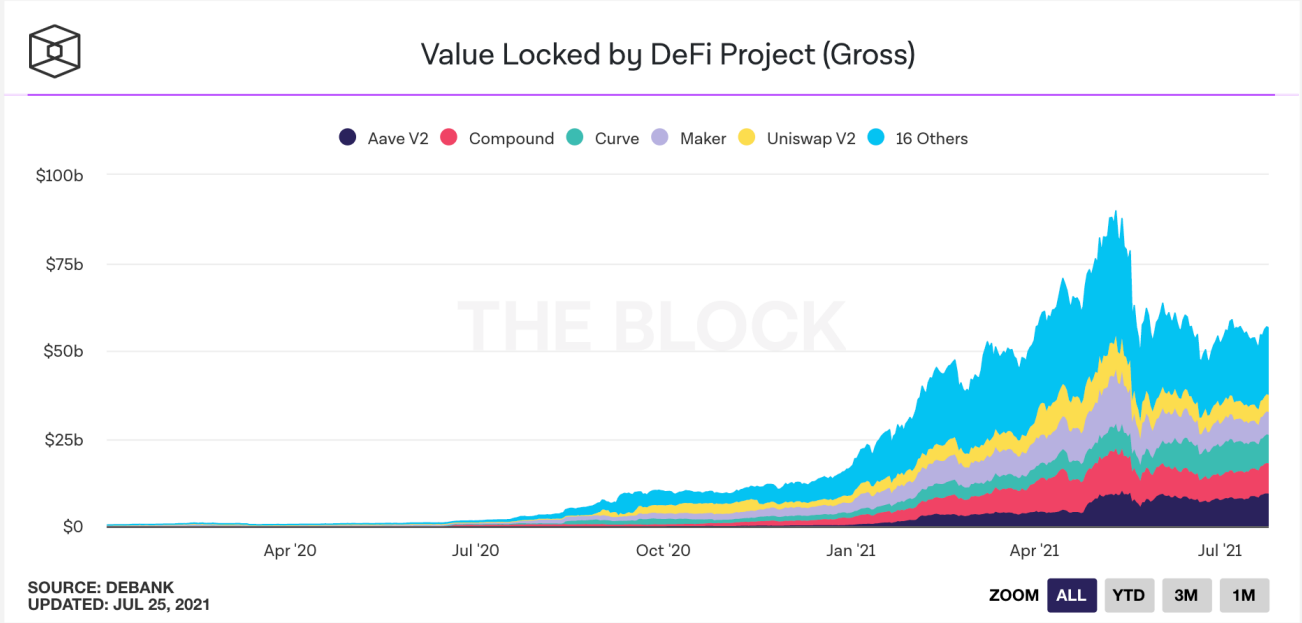


Figure 19. Value Locked by DeFi Project (Gross)
Source: DeBank

- **Procurement agreements** – while these might be a bit further out, we are already seeing procurement scenarios evolve as decentralized code. In this scenario, the terms and conditions of standard procurement agreements are coded into smart contracts that allows two parties to enter into a binding agreement. The smart contract monitors and enforces the agreement. EY OpsChain Procurement is a great example (see https://www.ey.com/en_us/blockchain-platforms/opschain-network-procurement.)

- **Decentralized storage (and decentralized compute)** – Storj is an example of a decentralized protocol facilitating the exchange of "available decentralized storage capacity" for consumers looking to store their information on the cloud (see https://www.storj.io). One can think about the suite of services offered by Amazon Web Services, essentially offering cloud storage and cloud compute, that would now be offered by a DeFi-like protocol.

The power of compound innovation

Often times, the really disruptive innovations come by combining earlier innovations, creating 1+1=3 scenarios.

For example, when Global Positioning System (GPS) apps combined with social media apps, the compound innovations are apps that help us find good restaurants. We can instruct our apps, for example, to choose nearby restaurants with social media ratings greater than four stars. The ratings were created by a few hundred unrelated people; this crowd provides convincing evidence of food quality (see Figure 20).

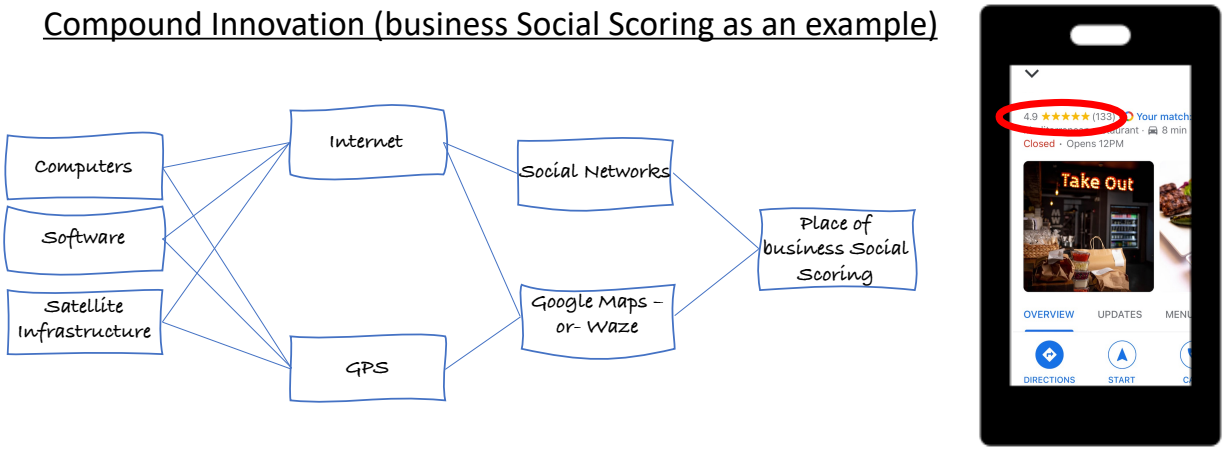


Figure 20. Compound Innovation of Food Location and Quality

When considering the power of compound innovation in our "Internet of Value" scenario, we can already detect the same pattern. Let's focus on the examples highlighted in orange in Figure 21. Innovations in the Internet and in cryptography helped to create blockchains. Social networks together with blockchain powered social investment tracking.[5] The innovations behind blockchains, smart contracts and tokenization enables the evolution of decentralized finance (Defi) services and decentralized exchanges (DEX). Combining a DeFi protocol with social investment tracking allows for a new way for users to invest "with the experts" without using 3rd party brokerage services. Where will it go next from here? Where is the next blockchain-based "Airbnb" or "Uber" looming ahead?

[5] A link to eToro's CopyTrader functionality https://www.etoro.com/en-us/copytrader/

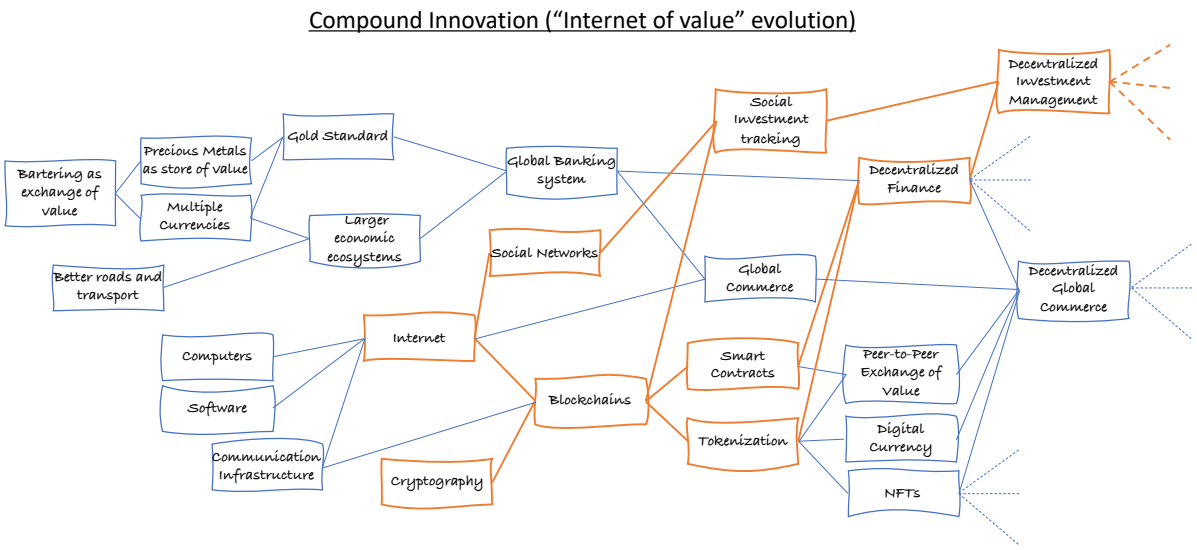


Figure 21: Compound Innovation and the Internet of Value evolution

Conclusion

Since the emergence of blockchain technology with Satoshi Nakamoto's 2008 Bitcoin whitepaper, there have been many claims that this technology will "change the world".

We hope that readers are now able to understand the disruption potential of decentralized peer-to-peer exchange of value, and the new layer that is emerging on top of the Internet's infrastructure.

We will see compound innovation accelerate and fortify a meaningful move towards an "Internet of Value" as more organizations, business processes and value are tokenized, as more terms and conditions are put into smart contracts, and as more decentralized autonomous organizations are created to automate governance.

As far as timing, it is difficult to predict. The year 2000 and the year 2010 were fundamentally different because mobile technologies and Web 2.0 completely transformed modern life. While we can understand the change looking back, we could not see it in 2000 looking forward. But if we use the past as a model to understand the magnitude of change caused by blockchain technologies, they will transform our lives between the years 2020 and 2030.

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About the Blockchain Center of Excellence (BCoE)

The Blockchain Center of Excellence is housed in the Information Systems Department of the Sam M. Walton College of Business at the University of Arkansas. The BCoE was officially launched by Arkansas Governor Asa Hutchinson on August 1, 2018. The center's vision is to make the Sam M. Walton College of Business a premier academic leader of research and education on blockchain-enabled technologies and digital ecosystems. The BCoE's research briefing series is one activity toward achieving that vision.

Disclosure:

EY is a member of the BCoE's Executive Advisory Board and is an active participant in the University of Arkansas' blockchain research and events.