NAVITAS CAPITAL

EXPLORING BLOCKCHAIN & TRANSFORMATIVE APPLICATIONS IN REAL ESTATE

ABOUT THE AUTHOR

Navitas Capital is a venture capital firm focused on early-stage technology investments for the real estate and construction industries.

Navitas' investment strategy is to provide a combination of growth capital, industry expertise, and market access to high growth technology companies. Navitas tests and deploys technology solutions across its own portfolio of real estate assets as well as helps startups scale through providing access to Navitas' network of industry leading LPs.

Navitas is currently investing out of its second fund, a $60M vehicle that includes anchor strategic commitments from a number of industry leading LPs. Current and past real estate technology investments include: Katerra, PlanGrid, Aquicore, Matterport, Gridium, View, Honest Buildings, Truss, Bowery, Harbor, PeerStreet, HappyCo., Ravti, Sweeten, Comfy (Siemens) and Can2Go (Schneider Electric). Please visit our website for more information.

NORTHERN CALIFORNIA

1111 Broadway Ave.

Oakland, CA 94608

SOUTHERN CALIFORNIA

9460 Wilshire Blvd. Suite 850

Beverly Hills, CA 90212

www.navitascap.com

CONTENTS

NAVITAS
CAPITAL

Navitas Capital is a venture capital firm focused on early-stage technology investments in the real estate and construction industries. For the past 10 years, Navitas has been investing across a number of emerging and interrelated technology themes, including smart buildings (see our recently released 2018 white paper on "Smart Buildings"), big data analytics, construction tech, artificial intelligence, machine learning, visualization (AR/VR), mobility, marketplaces, Space-as-a-Service and software-based workflow solutions.

While technology innovations have already made a significant impact on our sector and have helped produce a number of highly impactful startups such as WeWork, Katerra, PlanGrid, and Matterport, the emergence of blockchain is potentially one of the most powerful and disruptive forces to date. Its fundamental value proposition could reshape some of the most basic functions of how the industry operates today. From a venture capital perspective, blockchain enables the formation of a new wave of startups that have the potential to be highly impactful in the coming years.

While the premise of blockchain is incredibly exciting, the technology is also highly technical and difficult to evaluate from an application perspective. Without careful examination, it is also unclear as to where we are in the adoption lifecycle vs. the hype in the marketplace. Perhaps more than any other technology theme in 2018, we are watching the industry struggle to understand what the technology means, how it could impact the real estate business, and what strategies the industry should consider to both protect and enhance their business. Admittedly, Navitas is struggling to answer these exact same questions!

That being the case, we set out to write this white paper to help organize our own thinking and approach to the sector. We are sharing our thoughts, research, and initial conclusions to help our audience gain a greater level of clarity on the basic questions being asked today. Our writing strategy combines both a simplified blockchain overview, as well as a deeper dive into the technology for our readers with both the stamina and interest to go further.

From a goal's perspective, we hope to accomplish the following:

- Help demystify blockchain technology and separate it from cryptocurrencies by introducing some of its fundamental technology components in a highly digestible format.

- Offer a concrete set of "key takeaways" for real estate leaders interested in blockchain.

- Provide a brief history of how the technology arrived at its current place and some context of where we are in the adoption curve.

- Offer a framework for understanding how to evaluate and apply blockchain applications to different segments of the real estate industry.

- Recognize some of the most notable "first inning" start-ups and blockchain projects in development.

Before we jump in, we want to thank some of the brilliant and generous contributors to this project, including special thanks to L.D. Salmanson at Cherre, Josh Stein at Harbor, Michael Mandel at CompStak and Avi Marcus at Old Republic Title, as well as the thoughtful research papers and Medium posts referenced throughout the texts, which helped build the foundation for this paper.

BLOCKCHAIN INTRODUCTION

The history of the Internet offers a compelling comparison to the current evolution of blockchain technology. In 1974, the term "Internet" was born, developed by scientists and researchers in universities and government organizations. In the following twenty years, the first technical layer of the Internet's foundation was built, well in advance of the actual adoption of the technology. Open protocols like GPS, HTTP or POP that define our geographic location, send email messages, and describe the addresses of web pages to this day, were key in building up to the actual implementation of the Internet by the general population. Years later, in 1994, Netscape Communications built the original web browser, enabling the general population to see the value of the Internet and began bringing businesses, information, and communication online. From this point on, the world started seeing the actual functionalities provided by the web. The Internet today is essentially a stack of protocols that enable many different types of software to exchange and make use of information. It functions as two different kinds of systems piled on top of each other. The open source infrastructure that led to the creation of the "world wide web" and the second layer: The web-based services and applications like Facebook, Google & Amazon.

The term "Blockchain" - initially coined in 2008 – shares a lot of the same characteristics with the early stages of the Internet. It's the technology *underlying* Bitcoin and many other cryptocurrencies. Similar to the open source software movement that created the Internet, blockchain entrepreneurs are developing building blocks for the future application of the technology. While there has been immense hype around cryptocurrencies like Bitcoin, only recently has the general public started to take an interest in the underlying blockchain technology.

The core component to Blockchain is its open distributed ledger technology that allows multiple stakeholders to confidentially and securely share access to the same copy of transactional data, going beyond cryptocurrency. Blockchain overcomes many of the limitations of traditional database models which rely on redundant, siloed and opaque systems. Think about it as a dynamic spreadsheet that is continuously duplicated across a network of thousands of computers worldwide – similar to Google Drive.[1] However, blockchain's data is immutable and decentralized creating a trusted network that cannot be breached.

> *"Blockchain is an incorruptible digital ledger of economic transactions that will eventually record not just financial transactions, but virtually everything of value including real estate assets."*
>
> **--Navitas Capital Observation**

Blockchain platforms have the potential to become a fundamental part of our digital infrastructure. Its core innovation is its "consensus system" that provides a way for economic actors to reconcile the truth without a central coordinator. That means the database works without anyone being "in charge", and it automatically compensates people for helping make the database function, which in turn makes the whole platform and the compensation – the cryptocurrency - more valuable. Its unique capability is to create trust between users, developers, and the platform itself. This trust emerges from the mathematical and game-theoretic properties of the system, without depending on the trustworthiness of individual network participants.[2] Therefore, just as the Internet digitized the process of communication, blockchain has the ability to digitize and discipline the process of agreement and trust.

Its private-public key structure may enable the creation of a secure digitized identity that can be used for any transaction. This will eventually allow us to hold ownership for many different types of assets in the same wallet[3] (*See more on the long-term potential of blockchain identity in appendix A*). Ultimately, we could securely transact

---

[1] Blockgeeks, "*What is Blockchain Technology?*"
[2] Chris Dixon, Introducing a16z crypto, Medium (blog), 06/2018
[3] Stephon McKeon, The Security Token Thesis, Medium (blog), 05/2018

NAVITAS
CAPITAL

ownership claims to a commercial building, equity of an early stage private company, and a single-family residence on the same digital platform with investors all over the globe.

The Internet has already allowed for a faster, more efficient exchange of goods and services, but it still needs intermediaries like Paypal or Airbnb for transactions. Those intermediaries earn fees for processing payments, maintaining a reputation system and matching supply and demand. In return digital identity and personal data has become a valuable commodity that is not controlled by its owners, but by web applications like Facebook, Google and Amazon. This is where blockchain technology, when combined with cryptocurrency, has the potential to rethink the entire value chain. [4]

Companies and individuals are already starting to create digital representation of ownership ("tokens") for a wide range of assets like real estate properties, equity in private companies, and even virtual cats ("cryptokitties") that are tradeable via blockchain. For real estate, this means that once property rights are digitized, owners would be able to subdivide a property into individual tokens and allow trading of fractional ownership via blockchain. This could eventually create a secondary global marketplace for real estate.

"Blockchain is going to change the world, but you have to walk in with your eyes open."

--L.D. Salmanson, Blockchain expert and founder of Cherre

However, similar to the Internet's natural evolution, there will be a continued period of development through trial-and-error and regulatory changes before highly scalable commercial applications start to emerge. The technology still suffers from issues like reliability, interoperability, compliance and privacy. In addition, every transaction on blockchain today requires an enormous amount of energy that makes high speed business applications almost impossible. Currently, most blockchain business applications require a set of uneconomical workarounds that undermine the core premise of automated trust. Actively used 'private' blockchains - created by companies like IBM - only allow trusted participants to make entries, which mostly only re-creates the 'trusted parties-only principle' for the blockchain ecosystem. This makes these blockchains look fairly similar to a classic ledger operated by a third-party entity.

In short, blockchain technology has a long way to go to become more scalable, less resource intensive, and more interconnected for its decentralized network capabilities to exceed today's advanced centralized services powering our transactions.

PUTTING CRYPTOCURRENCY INTO PERSPECTIVE

As stated in the Foreword, one of our first goals for this paper is to provide the reader a clear understanding of the relationship between blockchain and cryptocurrencies (e.g. Bitcoin) and how they work both together and independently from each other.

To start, cryptocurrency tokens (e.g. Bitcoin) are created as a byproduct of the blockchain development process, serving as a compensation mechanism to reward work being done to maintain and enhance the blockchain. From this standpoint, cryptocurrencies are an essential part of the creation process, providing the critical financial incentive for work to be completed. Separate from blockchain, cryptocurrencies have a market value that can be traded for on public exchanges similar to the stock market.

---

[4] Catalini & Gans, Some Simple Economics of the Blockchain, MIT Sloan Research Paper, 09/2017

NAVITAS
CAPITAL

Cryptocurrencies in this sense, allow speculators to buy and sell tokens hoping to make a profit or to hold as an asset similar to an investor electing to hold cash, buy gold, or invest in a real estate project. Therefore, the market value of a cryptocurrency like Bitcoin can in some cases operate completely independently from the underlying blockchain technology adoption

The potential for future blockchain adoption is already evident in the significant size of the cryptocurrency market today. To visualize its magnitude, we compared its market cap with some of the largest, international real estate companies and found the total market cap of cryptocurrencies already exceeds the market cap of three of the largest real estate owners (Blackstone, Brookfield, CBRE) and matches a conglomerate like Walmart. While a cryptocurrency like Bitcoin and Initial Coin Offerings (ICOs) have gained most of the public attention, there has also been hundreds of millions invested in companies like Coinbase or Circle via traditional private investments. Besides its size, cryptocurrency is also defined by its general unstableness and volatility. On its largest day in January 2018, the market cap of all cryptocurrencies was worth ~$800B+; however, it is (as of early August 2018) back to ~$250B, relative to ~$20B just over a year ago in April 2017.[5] This cryptocurrency wealth is actively looking for investment opportunities, particularly ones centered around blockchain based offerings, and is likely to help power the next phase of blockchain adoption and a transformative model for real estate investing.

PUTTING CRYPTOCURRENCY INTO PERSPECTIVE
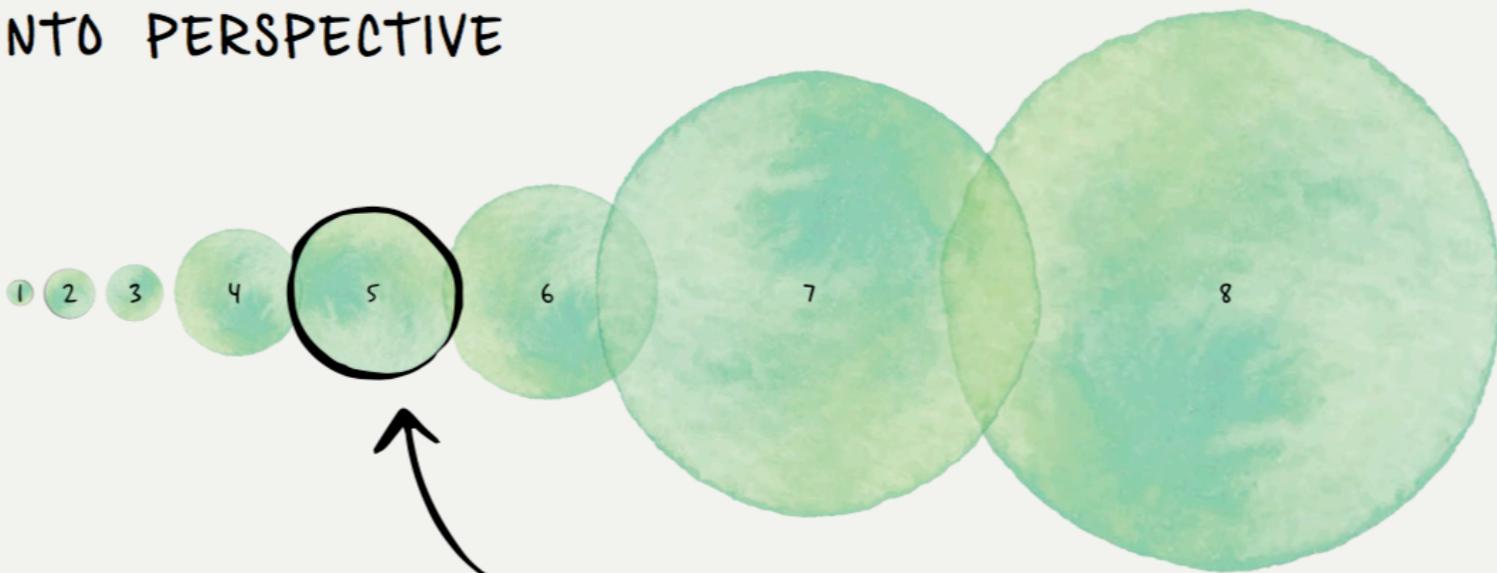
1. **CBRE** market cap: $16B

2. **Brookfield** market cap: $40B

3. Blackstone market cap $43B

4. 🅱 Bitcoin $119B

5. 💲 cryptocurrency market cap: $250B

6. Walmart ☀: 267B

7. : $1T

8. Ⓢ USD in circulation: $1.5T

---

[5] All data from Coinmarketcap

NAVITAS
CAPITAL

While cryptocurrency already achieved widespread notoriety with extreme value growth, business blockchain applications for the real estate vertical are still in their "first inning". Operators, owners and investors are now starting to learn about the technology and what strategies to consider for leveraging blockchain.

To help gain a greater level of clarity around those difficult questions, we summarized our research and key findings of this paper into a few key takeaways:

KEY TAKEAWAYS FOR REAL ESTATE EXECUTIVES

Real estate is ripe for blockchain adoption due to its size, fragmentation, multi-party transactions, and illiquidity.

Cryptocurrency wealth is real *(Market cap of ~$250B as of August 2018)* and offers a significant new source of capital looking for investment opportunities, not unlike investors under the EB-5 visa program.

Blockchain has the potential to unlock liquidity in certain real estate assets by allowing investors to freely trade previously illiquid positions, while simultaneously providing long-term committed capital for owners. This represents the largest opportunity in real estate as it can lead to a liquid secondary market.

2019 will be the year that large commercial assets become 'tokenized' and traded via blockchain based compliance platforms.

Blockchain will enable secure digital identities for investors.

Future blockchain adoption will *not* eliminate the need for third party service providers; instead it has the potential to automate workflows and accelerate transactions.

Until critical underlying industry data is digitized and structured, blockchain powered applications will have limited use cases and adoption.

Clear government regulation for cryptocurrency and blockchain platforms is required to allow for more institutional adoption.

Leading real estate players will likely need to embrace blockchain technology within their operations *(a la the internet in the 1990s),* or risk being left behind competitively.

NAVITAS
CAPITAL

Given its size, lack of digital infrastructure, transaction complexities, and illiquidity, the real estate industry stands to greatly benefit from blockchain's value proposition of helping digitize and exchange assets in a decentralized and secure manner.

Blockchain's inherent trust mechanism can be a compelling concept for reshaping businesses and transactions that are traditionally bogged down by inefficiencies. As such, the $200T+ real estate asset class - from landlords, to service providers, to data providers and others - needs to pay careful attention to this emerging technology and develop a strong understanding of the potential changes that could take place in the market.

Blockchain can be the technological foundation to create and trade *security-law-compliant* representations of traditional private assets via platforms like Harbor (a Navitas portfolio company) Polymath, tZERO or Meridio (See notable blockchain start-ups in appendix D). These so-called security tokens represent ownership claims of private securities on blockchain. Security tokens allow asset owners to easily convert the rights of individual properties on to a blockchain network, subdivide the asset into individual parcels and create tradeable fractional ownership of property rights.

HARBOR

Harbor's protocol automates regulatory compliance like anti-money laundering (AML) and "know your customer" (KYC) verification. This allows private securities to be issued as Security Tokens by asset owners and compliantly traded between accredited investors on the blockchain.
(Case study on page 21)

TOTAL FUNDING:
$38M, Series A

LOCATION:
San Francisco, CA

In practice, blockchain-based security tokens give real estate owners the ability to:

1. *Compliantly leverage new sources of equity in the form of crypto-wealth looking for quality investment opportunities and*
2. *Increase liquidity for investors.*

As a result, the security tokens can potentially transform capital formation as owners can obtain long term committed capital, while investors can freely trade the tokens on a secondary market with other accredited investors. Investors will eventually be able to get in and out of previously illiquid positions instantly, and more importantly without the involvement of intermediate fund managers. *This represents the largest opportunity for blockchain in real estate as it can lead to a liquid secondary market that potentially enables the true democratization of real estate access.*

Democratization will first require regulators to form the necessary guidelines, similar to how Title III of the JOBS Act established crowdfunding provisions. The continuous regulatory process will be the only viable path to create a truly liquid, blockchain enabled marketplace for real estate. Blockchain adoption will therefore depend on the progress of the technology alongside the advancement of regulations, making it impossible to forecast its full impact and the timing of that impact. However, the eventual efficiency gains that can be achieved are significant, especially in regard to broadening the investor base for commercial real estate transactions, where an added layer of security and verification can provide significant value.

Looking ahead, blockchain also has the potential to lower transaction costs, as the ease and security of transactions would permit the efficient unbundling of property rights. Today, transaction costs for the median

NAVITAS
CAPITAL

home sold in the United States constitute up to 10% of the total sales price.[6] Entire industries, such as the $15 billion title insurance industry[7], have emerged for the sole purpose of capitalizing on the inefficiencies that exist around property transfers. Blockchain could directly affect these inefficiencies, as its value proposition comes from removing intermediaries by creating *automated trust*.

Title insurance, for example is a necessary, albeit highly inefficient process to create trust between two transacting parties. Storing property records on a digital, blockchain-based registry could automate clearing titles and other time-consuming and expensive functions like escrow deposits. A blockchain database could also help eliminate the need to reconcile documents, as all parties maintain an identical, immutable and timestamped copy. With registries becoming digitized via blockchain, assets could eventually be reliably identified by a digital blockchain record that contains not just ownership, but also information regarding occupancy, physical characteristics, legal status, historical performance, financial position, and other key data points.

"Blockchain's success largely depends on the breadth of collaboration and data sharing between involved parties. Existing legal frameworks will need to be updated to provide support for the technology's use in the real estate industry."

--Stanislav Kreuzer, Senior Analyst at JLL

Multiple startups including Propy, Velox.RE, Bitfury and Ubitquity are already working on digitizing and recording property documents on blockchain. Propy, for example, is creating a platform for domestic and cross-border real estate transactions and has already completed a land sale in Los Angeles, where ownership rights were transferred via blockchain.

While property records are theoretically a promising use case for blockchain integration, there are fundamental problems that need to be solved before blockchain can be implemented at scale. The title industry is widely dispersed with thousands of different registries in the US. In addition, many of these registries are still, to this day, paper-based, which means that any form of rapid blockchain adoption and integration between registries is highly improbable. Initially it would require significant capital and a coordinated effort by governmental entities and major real estate players to fully digitize property records. Legally it would most likely involve a hybrid solution of private and public blockchains that combine access for regulators, privacy and security. However, even if we were willing to fully implement the technology, current public blockchains would not necessarily even be able to handle the volume of data involved. This shows that the actual implementation of the technology is highly challenging and often not necessarily more efficient than current methods.

We believe that the application of the technology can be best categorized by its impact on liquidity for real estate assets and the digitization of real estate ownership, which will be detailed in the coming sections:

BLOCKCHAIN-ENABLED MARKETPLACE: DRIVING LIQUIDITY

BLOCKCHAIN-ENABLED TRANSACTIONS: WORKFLOW DIGITIZATION

Moving forward, we divide the rest of the paper into a technical overview and a deep dive into blockchain's integration and adoption for real estate. We describe how blockchain companies are attempting to transform how people buy and sell real estate assets, the biggest opportunities to generate efficiencies, and the challenges that

---

[6] Graglia & Mellon, Blockchain and Property in 2018, At the end of the beginning, future of Property Rights program, New America Foundation, World Bank Conference, 03/2018
[7] IBIS, Title Insurance - US Market Research Report, 09/2017

NAVITAS CAPITAL

will potentially inhibit initial blockchain implementation in the industry. Finally, based on that analysis, we created a framework that will help readers gain an overview of the key findings.

Notably, a more in-depth explanation of blockchains fundamentals, its consensus mechanism and the underlying crypto-economics is provided in the appendix. Here we detail what makes the blockchain secure, how miners verify transactions, and how ICOs work in a beginner-friendly way that should provide readers interesting context on the technology.

In addition, we provide a descriptive summary of first-mover blockchain startups and notable projects in the real estate industry (*See appendix D*). It is important to note that the blockchain space (like the internet space in the mid-1990s) is very dynamic and fluid; accordingly, we would expect any list of start-ups and blockchain-related projects to be significantly different even six months from now.

TECHNOLOGY OVERVIEW

As a starting point, it is critical to understand that there is not just one, but many different blockchain networks with varying functionality and purposes. Examples include general programming platforms like Ethereum, which can be used for almost any business or transactional purpose. Other blockchain networks have specialized functionalities. For example, the Bitcoin blockchain is intended primarily for storing and transacting bitcoins.

All blockchains descended from the same underlying structure developed in Bitcoin's original manifesto that was circulated as a paper in 2008 on a cryptography mailing list by a mysterious programmer (or group of programmers) going by the name of Satoshi Nakamoto. Here, Bitcoin is described as a "peer-to-peer electronic-cash system" built on a secure database – a "blockchain" - scattered across hundreds or thousands of computers, with no single authority controlling and verifying the authenticity of the data. The work of maintaining that distributed ledger was how the actual currency – the Bitcoin – is created and distributed. The network leverages its user's computer processing power to get its work done – a process that has come to be called "mining" – by paying these miners through Bitcoin. To get a better understanding of that structure and blockchain's value proposition, we decided to simplify the protocol as much as possible and divide it into its core interacting technological elements:[8]

1. *Database*
2. *Peer-to-peer network*
3. *Consensus formation*
4. *Crypto token*
5. *Virtual machine (Ethereum)*

Database

The basic component of the technology is the actual blockchain *database*, which serves as a back-end office of the blockchain network. The blockchain database synchronizes data between and amongst multiple users. It can be imagined as a spreadsheet that is regularly updated and duplicated thousands of times across a network of computers, just like Google Drive. Similar to Google Drive, all parties have access to the same document at the same time, and every update of that document is always visible to everyone. The actual database consists of data

---

[8] As described by Ethereum Co-Founder Joseph Lubin in a 2016 BlackRock Meetup

NAVITAS
CAPITAL

blocks that are linked to each other. After a certain interval (for bitcoin, every ~10 minutes) a new block of data is created and connected to the previous block. That block includes all historical data plus the new information on transactions that occurred within that time interval.

In a traditional database, a permissioned user can perform four functions: Create, Read, Update, and Delete (collectively known as the CRUD commands). Users are therefore reliant on the security infrastructure of the database administrator as anybody with sufficient access to a centralized database can destroy or corrupt the data within it. Blockchain, however, is designed to be an "append-only" structure. Once it is confirmed on blockchain, all of the data is irreversible and transparent for all users. A user can only add more data, in the form of additional blocks. All previous data is permanently stored and cannot be altered. For example, if blockchain records a wallet balance, a new transaction will change the balance that is recorded. However, the pre-transaction balance also remains on the blockchain permanently.

That database can be created in a public (permission-less) or a private (permissioned) form. Private blockchains behave in the same way as public ones, except that they require users' identities to be validated against a list of authorized members. While public blockchains allow for full transparency, private blockchains ensure that only parties who have validated their identity to the satisfaction of the administrators are transacting. Similar to the evolution of the Internet that began on private Intranets, permissioned blockchains will give way to the public blockchains if they successfully achieve scalability.

Peer-to-Peer Network

The next element is *the peer-to-peer network* on which that database is built on. A peer-to-peer network is a system where every user is simultaneously a user and a host. That means that there is no centralized authority that controls who has access. This is why blockchain is called a decentralized network.

Anyone can download a (public) blockchain onto their own computer and become part of the network by installing an online wallet that functions like a bank account. As a result, every connected computer on the network has a complete or partial copy. Every transaction on blockchain is permanently recorded and transparent for all participants, but the individual participant's information can only be decrypted through each user's private key (or digital access code) making the data secure.

In some ways, the rise of blockchain technology can be seen as the evolution of the peer-to-peer networks from the early 2000s, which were mostly piracy-driven and ultimately hit a wall as people started to prefer organized and, therefore, centralized architectures. Thereafter, open peer-to-peer internet networks were replaced by closed single database models controlled by companies like Facebook or Google with nearly unlimited access to capital. Blockchain networks have similar open source peer-to-peer structures. However, blockchain's token model creates new ownership models. (*More on new ownership models in the following paragraphs and appendix C*).

Consensus Formation Networks'

The third element is the *consensus formation algorithm* or the process in which the users collectively come to a decision about what event and when an event occurred that should be recorded in the data blocks.

The current method to reach that consensus is called proof-of-work. It is a probabilistic solution to address the "Byzantine Generals' Problem", which is the problem to reach consensus for a distributed system that does not have a central authority. In its current format, the connected computers compete with each other to add a new block to the database and get a reward in the form of the respective cryptocurrency. This prevents any one user from getting too much power and potentially manipulating the data. This consensus mechanism allows the blockchain to be a distributed network.

NAVITAS
CAPITAL

However, the proof-of-work process uses an immense amount of energy due to the raw computing power necessary to complete each data entry. Therefore, it is not sustainable on the increasingly large scale that blockchains operate on. As a result, blockchain developers are working on moving to a process called proof-of-stake, which would pre-determine who gets to add a new block to the database (*See appendix B for more detail*).

Cryptographic Token

The forth element is the *cryptographic token*. We use the term *token*, rather than cryptocurrency, to emphasize that the technology is not necessarily aiming to disrupt existing currencies. Much of the public interest has been directed towards the significance of cryptocurrencies in replacing traditional currencies, but their primary function is to reward and to incentivize users to keep building the blockchain network.

Cryptocurrencies and tokens are related but separate concepts. All cryptocurrencies are cryptographic tokens, but not all tokens are cryptocurrencies. *Cryptocurrencies* like Bitcoin *do not* have another use case other than being a medium of exchange, while most of the blockchain tokens are not meant to be real currencies. A token can be either classified as

1. *Utility Tokens:* represent tokens that provide access to a company's product or service. Utility tokens are not designed as investments, but only to provide owners with an actual functionality of a decentralized network. Filecoin, for instance, raised $257 million by selling tokens that will provide users with access to its decentralized cloud storage platform.

2. *Security Tokens:* represent tokens whose value is tied to an outside, tradable asset like equity, debt, derivatives or real estate. These tokens are bought by investors with the anticipation of future profits. One example is Overstock, which is raising funds to develop a licensed security token trading platform called tZERO. The tZERO tokens will be issued in accordance with SEC regulations and the company has stated that token holders will be entitled to quarterly dividends derived from the profits of the platform.

On a technical level, tokens differ between blockchain 'native tokens' - like Ether for Ethereum blockchain - that are implemented in the core process of blockchain and 'non-native tokens'. The native tokens are necessary for blockchain to function, as each exchange that occurs on blockchain is metered by those tokens. However, there are a number of different types of tokens even within the same blockchain platform. These are non-native tokens that sit on top of the blockchain network and are non-essential. Non-native tokens can represent anything from a salary, to an employee badge, to equity in a blockchain project working on a business application. Therefore, the tokens also differ in underlying value, utility and legal status (*For a detailed explanation of cryptographic tokens please see appendix C*).
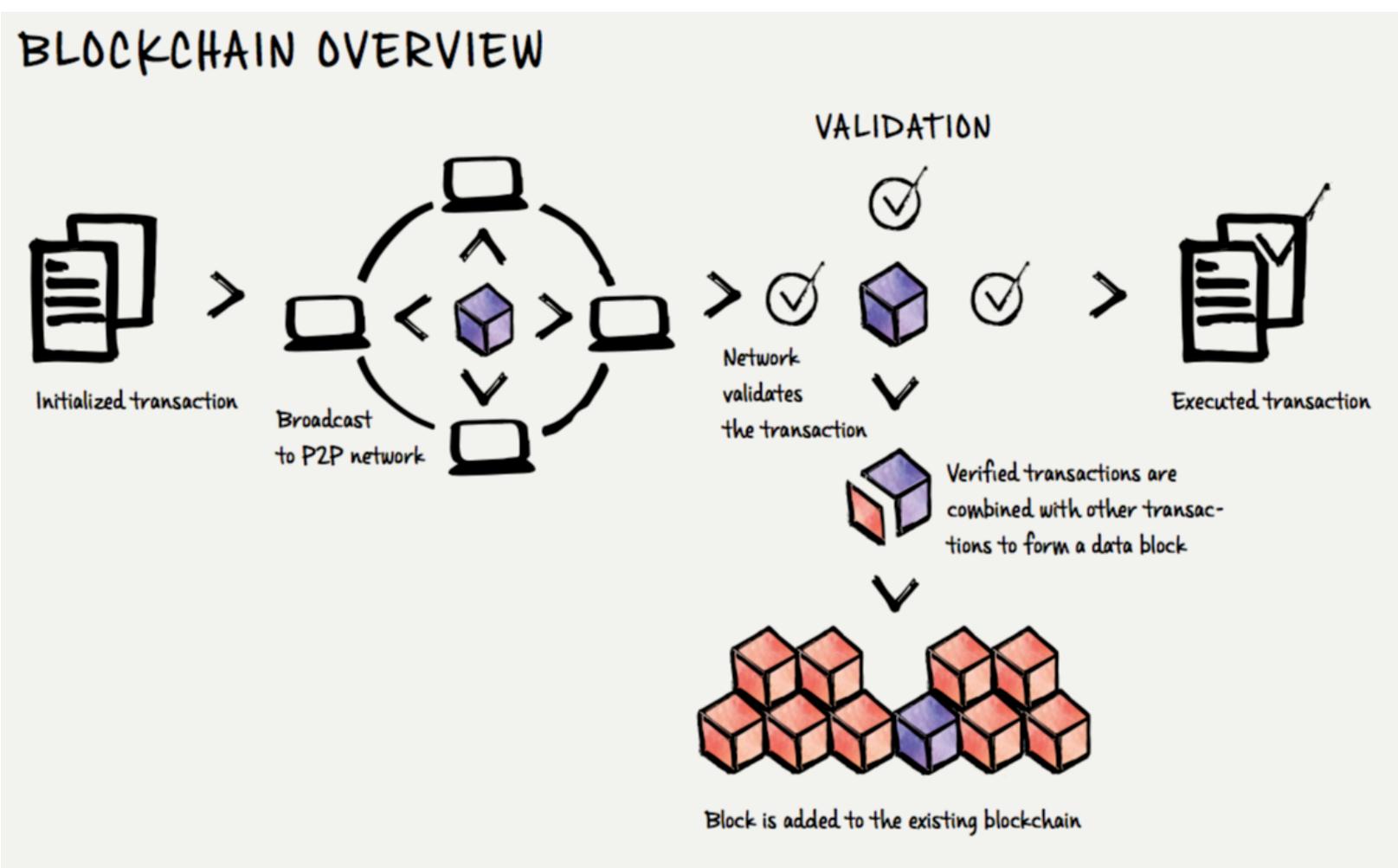
Virtual machine (Ethereum)

Bitcoin blockchain is an innovative database to safely verify and transfer Bitcoins between users and keep the transaction records secure. After bitcoin's success, more advanced blockchain iterations like Ethereum were created, which allowed blockchain to become an engine for different business applications.

This is due to its so-called *virtual machine* that enables decentralized applications or even fully decentralized autonomous organizations to be built on top of and powered by blockchain. It is easiest to imagine this as the software combining all the computing power of the network and its consensus mechanism to allow users to build applications on top of the protocol layer. Essentially, the blockchain's protocol powers an application layer that allows anyone to create and trade their own network token for any blockchain-based business. It lets users automate any direct interaction between peers or facilitate group interactions across a network.

NAVITAS
CAPITAL

These automated transactions are called *smart contracts*. The key feature of a smart contract is that it has "trustless" execution; effectively replacing third-party intermediaries. That is, a written code automatically executes a transaction depended on various conditions, similar to an IF THEN Excel function. These smart contracts give blockchain technology the ability to grow beyond a decentralized database of cryptocurrency transactions and can fuel any type of value transfer.

To visualize blockchain, we created a simplified "sketch" overview below. For interested readers that want to learn more about the technology, we have also included a detailed description of the consensus mechanism and the crypto-tokens in appendix B & C.

BLOCKCHAIN OVERVIEW

VALIDATION

Initialized transaction

Broadcast to P2P network

Network validates the transaction

Verified transactions are combined with other transactions to form a data block

Block is added to the existing blockchain

Executed transaction

BLOCKCHAIN ENABLED MARKETPLACES: DRIVING LIQUIDITY

Today, the exchange of real estate assets suffers from highly limiting trade restrictions and illiquidity. Why? In short, there are significant trade frictions starting with sellers and buyers not being able to find each other. Subsequently, each trade requires a significant amount of underwriting and legal documentation. Ownership can include various security distinctions that carry significant transfer prohibitions. Any limited partnership investment, and even the trade of an investment property deeded to two people, may be considered a regulated

NAVITAS
CAPITAL

security offering, making trade activity highly manual and costly. To account for the lack of liquidity, the value of private securities is generally discounted (the "illiquidity discount"), preventing issuers from capturing the full value of the underlying asset.

The tokenization of illiquid assets like real estate can potentially reduce trade frictions. Once these asset-backed tokens are created, a market for trading the tokens could possibly reduce the estimated 20%-30% illiquidity discount common to many traditional private securities[9]. Considering only the $13T U.S.[10] Commercial Real Estate Market, there is huge potential for real estate investors. The key takeaway is that even just a small decrease of that illiquidity discount achieved via freely tradeable asset-backed tokens, would potentially represent billions of dollars in unlocked value.

"Assuming even just a small decrease of the illiquidity discount reduced via freely tradeable asset backed tokens and applied to the US Commercial Real Estate market would represent billions of unlocked value."

--Navitas Capital Observation

LIQUIDITY UNLOCKED 🔓

US Commercial Real Estate is a $13 Trillion market

~20% illiquidity discount can be eliminated through blockchain

---

[9] A. Damodaran, Marketability and Value: Measuring the Illiquidity Discount, Stern School of Business, 06/2005
[10] Why Commercial Real Estate? Devonshire REIT, 05/2014

NAVITAS
CAPITAL

While REITs (Real Estate Investment Trusts) already provide liquidity, they typically hold a basket of properties rather than a single property. Investors in REITs face significant fees and are dependent on the REIT manager's ability to invest. Tokenization would allow owners to subdivide individual assets and allow fractional ownership of investment rights, potentially creating a secondary global marketplace for real estate via blockchain. With evolving blockchain regulations, new groups of investors could buy small shares in a given property, receive their return via an automated payment, trade fractionalized rights instantaneously at scale, and eventually even create their own real estate investment strategies. In short, blockchain could lead to a democratization of real estate.

As described by Professor Stephen McKeon[11], the thesis underpinning the idea that everything will be tokenized is grounded in the aspiration that everything will be interoperable. If the ecosystem for global assets becomes interconnected, it means we could hold ownership claims to a commercial building, early-stage equity, a corporate bond, a T-bill and a single-family residence on the same platform. It could mean global, pooled liquidity for all asset classes through a single interface. It is unclear if anything resembling a blockchain-enabled marketplace will ever fully materialize, but it is safe to say we have only just begun to tap the possibilities that blockchain can facilitate, and we do not yet know how it will evolve from where we stand today.

REGULATORY LANDSCAPE

Blockchain technology has been a canvas for new financial innovations like Cryptocurrency, Initial Coin Offerings (ICOs) and new ownership models via Utility Tokens (*See appendix C for more detail on ICOs and Crypto-economics*). However, the immense wealth that Cryptocurrency has created, emerged over just a few short years - effectively "around" existing finance and security laws. After the ICO run-up in the end of 2017, the SEC became more actively involved in the crypto world. This has led them to re-classify most ICOs as security offerings in early 2018, when the SEC stated that almost all ICOs, even if marketed as utility tokens, fall under security laws.[12]

Given the SEC's latest announcement, it's clear that blockchain technology faces not only technical, but regulatory hurdles with respect to adoption in the United States. Institutionalized adoption of any real estate token will require a compliance standard set by regulators with investor protection and private placement guidelines.

This security classification for blockchain tokens is a continuously evolving process. In July 2018 as part of a House Financial Committee hearing, the SEC's Director of Corporate Finance clarified that not all tokens will be classified as securities. The SEC stated that tokens that are undoubtedly bought to be used in a functioning decentralized network with no centralized actors will still be considered utility tokens. As of today, every company that has not yet created a functional decentralized network and raised money through an ICO or is currently launching an ICO is (retroactively) obligated to comply with U.S. security laws or face enforcement action by the SEC. ICOs now have to either be registered with the SEC or issued under an exemption from registration, using a 506(c) private placement. This means that all purchasers of the tokens must be accredited investors, generally requiring a minimum of either $200,000 in income or $1 million of net worth. This change in regulation has helped reinforce the rising popularity and relevance of security tokens.

Security Tokens

Security tokens can be described as digital assets that are subject to federal security regulations. Consider them blockchain-based, security law-compliant representations of traditional assets like equity, debt, derivatives or real estate. Security tokens essentially allow for the tokenization of any asset, as long as all trade partners are accredited investors. These tokens constitute an investment contract, where the main use case and the appeal for

---

[11] Stephen McKeon, The Security Token Thesis, Medium (blog), 05/2018
[12] https://www.sec.gov/news/public-statement/enforcement-tm-statement-potentially-unlawful-online-platforms-trading

NAVITAS CAPITAL

contributors to buy the tokens is the anticipation of future profits in the form of dividends, revenue shares, and, more commonly, price appreciation.[13]

Now that it has been made clear by the SEC that they will regulate cryptocurrencies just like any other security, blockchain entrepreneurs have realized that issuing security tokens under a regulatory framework such as Regulation D is the safer option in the long run – as opposed to conducting an Initial Coin Offering structured as a utility token sale. Therefore, STOs (Security Token Offerings) have already accounted for 84% of all U.S. crypto fundraising in 2018.[14]

Previously, most ICOs tried to avoid being classified as securities – essentially taking advantage of the unregulated nature of cryptocurrencies. A classification as a security automatically comes with many regulations and limitations on who can invest in these tokens and how they can be exchanged. This reduces liquidity, as securities cannot be traded freely and are subject to many restrictions, limiting the network effect of the tokens that is needed to build a widely adopted decentralized platform. This shows that there is a clear need for a standardized legal structure between real assets and blockchain that will allow more than just accredited investors to participate in using and funding blockchain tokens in the future.

ASSET TOKENIZATION

Tokenization of real estate assets via security tokens allows owners to convert the rights of individual properties or fractions thereof onto blockchain. It has the potential to transform capital formation by allowing private securities to be issued and automatically traded between a qualified investor base. It is a mechanism to raise permanent capital, while accredited investors can freely trade the tokens on a secondary market with other accredited investors. This would allow an increase in the liquidity of private security issuances, while maintaining its cost-effectiveness compared to public securities.

"Blockchain will be the smart transactional system that allows for seamless transactions across borders and across trading partners."

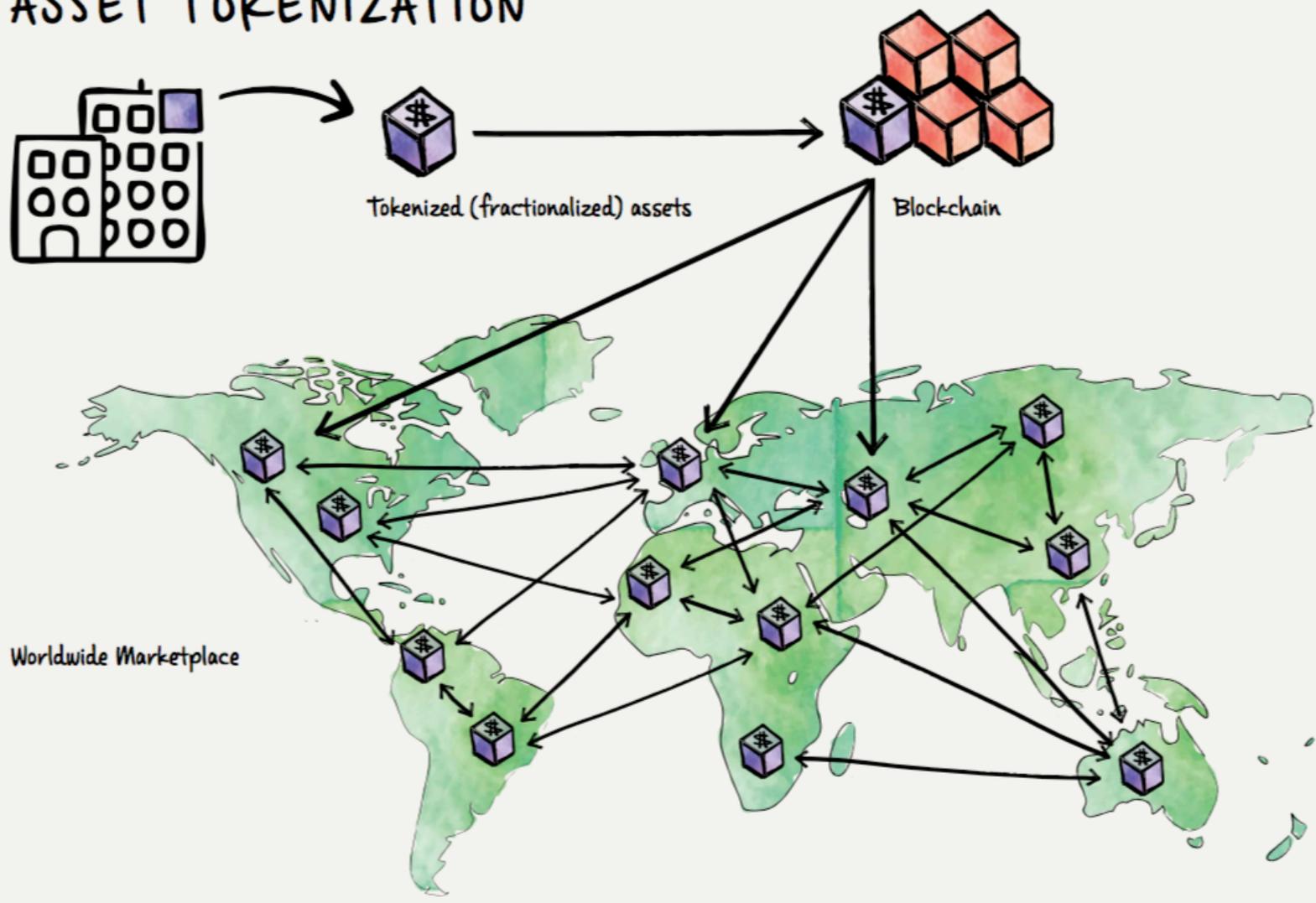--Robert Entin, CIO at Vornado Trust Realty

Real estate owners can tokenize a whole fund, a building, or just a minority interest in a single asset to obtain long-term committed capital. Initially, we expect that institutional owners are going to be the first to leverage tokenization, because they have the capital and power to bring regulatory change. One possibility is that tokenization will start with a non-controlling stake of a single property, so the institutional owner is able retain full authority over the asset. By converting the ownership of properties into tokens, multiple owners can invest in a single property and, conversely, individuals can own shares in multiple properties. This could have a long-term effect on liquidity, eliminating counterparty risk and documentation of transactions, allowing for a more transparent, real-time transaction process without the need for middlemen. Further, the tokenization of assets onto the blockchain would allow the emerging wealth created through cryptocurrencies in the last years to participate in U.S. real estate investments and give owners access to new investors. Fundraising using tokenized assets could develop somewhat similarly to the EB-5 U.S. Visa investor program, which allows developers to raise relatively inexpensive capital from foreign investors. In practice, the owners would have to work with a protocol like Harbor (*See case study on page 20*) to ensure compliant issuance of these tokens. We, therefore, identified automated compliance for asset-backed tokens as a promising entry point for the implementation of blockchain in real estate. We believe this will be the initial beachhead to start tackling liquidity and lower transaction costs.

---

[13] Lukas Schor, Token Regulation, Argon Group, Medium (blog), 11/2017
[14] David Sacks & Josh Stein, Introducing the Private ICO (PICO), Medium (blog), 02/2018

NAVITAS CAPITAL

ASSET TOKENIZATION

Tokenized (fractionalized) assets

Blockchain

Worldwide Marketplace

GLOBAL BLOCKCHAIN

If there will ever be easily tradeable, liquid and compliant asset tokens, it will require interoperability between blockchains. Interoperability is one of the most critical concepts for the long-term adoption of blockchain technology. In this context, interoperability refers to enabling seamless transactions between multiple blockchain-registries, regardless whether the property is in California, Europe or China.

"Interoperability is one of the most critical concepts for the long-term adoption of blockchain technology."

--Navitas Capital Observation

Full interoperability of assets allows investors to frictionlessly move value in and out of a diversified portfolio. Investors could cross-reference and trade assets or give access rights, while using the same programmable security. It could immensely impact how investors manage short-term liquidity needs and unbundle value like dividends or voting rights. It could enable multiple registries at different jurisdictions to be merged and standardized, allowing for seamless, cross-border, real estate transactions.[15] Cross-border real estate investments are already projected to grow to over $500B annually in 2020, and the emergence of blockchain could amplify this trend by introducing a class of real estate investors not limited by geography.[16]

---

[15] Stephen McKeon, The Security Token Thesis, Medium (blog), 05/2018
[16] JLL, Global Capital Markets Research, 03/2016

NAVITAS
CAPITAL

The core problem of cross-border real estate transactions today is the lack of international standards and comprehensively available platforms for the electronic transfer and recording of real estate. Each country maintains its own registry and establishes national (or even regional) rules for property deed registration and transfers. Moreover, legacy registry systems handle local real estate transfers but are ill-equipped for international ownership transfers.[17] Blockchain has the opportunity to connect these different registries and standards to allow for frictionless cross-border transactions.

Obviously, legal and technical challenges to such a blockchain marketplace are momentous. It requires data standardization, clarification of legal rights, and some legal adoption of blockchain. There will be a period of regulatory uncertainty before instantaneous trading of property tokens can ever occur, given security transfer prohibitions and ownership requirements for interests in SPVs. Additionally, any system that involves tokenizing real-world assets has to ensure that the digital token stays linked to the real-world asset to circumvent fraud. This means digitizing property ownership (a concept we will detail in the next section).

Aside from the obvious challenges, the development of security tokens shows that there is an opportunity for a fractionalized, real estate marketplace. Asset tokenization via security tokens can improve liquidity for investors, formerly unable to quickly and easily get in and out of private funds and can open up new ways of fundraising for asset owners. While it undoubtedly will take significant time and effort by all stakeholders, asset tokenization has the opportunity to change the real estate market fundamentally.

CASE STUDY: HARBOR

To detail how the compliance process for tokenization would actually work, we chose to highlight Harbor, a Navitas portfolio company.

COMPANY DESCRIPTION:

Harbor enables asset owners to tokenize real estate assets compliantly via security tokens. The company, which was incubated by David Sacks' Craft Ventures, is pursuing the enormous opportunity for bringing more liquidity and transparency to private securities through blockchain. Harbor is building a platform with a software protocol that automatically verifies accredited investors, matches them with owners raising capital, facilities the security issuance and validates compliance for all secondary trades of that security.

More specifically that means, Harbor is developing a compliance protocol that will allow real estate owners and investors to issue and to trade tokenized private securities for real estate assets on the Ethereum blockchain. The protocol is focused on regulatory compliance as the most critical part of tokenizing assets onto blockchain. This means that Harbor will be the compliance tool for private security issuers hoping to leverage blockchain to create their own Reg-D-compliant security tokens. The company enables automated "Know Your Customer" (KYC) verification to allow the tokens to be compliantly issued to accredited investors and then automatically verifies the necessary accreditation for each subsequent trade. That allows Harbor's platform to act as the centralized trade controller that automatically initiates a trade approval check for any transaction. The protocol contains an off-chain approved list of accredited individuals, trade rules, and list of approved exchanges for private securities

---

[17] Propy Team, Global property store with decentralized title registry, White Paper, 07/2017

on blockchain to ensure that every trade is compliant with security laws, required holding periods, and trade maximums. The service can be configured to meet the respective relevant securities regulations, KYC policies, "Anti-Money Laundering" (AML) requirements and tax laws for each jurisdiction. Subsequent to a successful issuance, the automated compliance allows the tokens to be traded anywhere amongst the accredited investor base (after the initial lock-up period). This solves the Reg-D challenge of enforcing restrictions on initial issuance and secondary trading, while at the same time allowing tokens to be sufficiently available to enable the use of the protocol.

Harbor allows issuers to lock up the invested capital, while at the same time creating more liquidity for investors by removing transfer restrictions. The promise of greater liquidity with less friction, by tapping into the growing global investor base eager to use crypto channels, could potentially lower the cost of capital. While there may always be some centralized verification involved, Harbor's platform allows for the creation of new ways to raise private capital via blockchain by managing the regulation requirement at the issuance and during the trading process.

KEY DIFFERENTIATORS

Team: Incubated by serial entrepreneur David Sacks' Craft Venture fund, Harbor has attracted a premier compliance and technical team that has been working together at Sacks' former companies including Yammer and Zenefits. Harbor is led by CEO Josh Stein, former Chief Compliance Officer at Zenefits and a former federal prosecutor with David Sacks, former COO of PayPal, Founder of Yammer, Founder and interim CEO of Zenefits, as Harbor's Chairman.

First Mover Advantage: The appetite for owning real-world assets using blockchain is considerably broader than just cryptocurrency enthusiasts, as asset tokenization has potentially large implications on liquidity. Tokenization can help erase some of the estimated 20%-30% illiquidity discount common to many traditional private securities[18]. The potential to decrease illiquidity through a secondary marketplace, however, starts with the ability to issue and to trade these tokens, which is only achievable through a compliant protocol and the legal framework that Harbor is developing. The norms around this technology are only beginning to manifest and Harbor's protocol has the chance to be the standard for any future token issuance.

Capitalization: The company has raised $38M in 2 equity rounds from some of the most notable investors in the world, which include Craft Ventures, Founders Fund, Andreessen Horowitz, Fifth Wall and *Navitas Capital*. Through the combined network of investors and the highly experienced team, Harbor is educating real estate owners on tokenization and the security token opportunity. Harbor is now preparing to launch their first tokenized commercial real estate properties in the coming months.

---

[18] A. Damodaran, Marketability and Value: Measuring the Illiquidity Discount, Stern School of Business, 06/2005

NAVITAS
CAPITAL

BLOCKCHAIN ENABLED TRANSACTIONS: WORKFLOW DIGITIZATION

In this section, we dive deeper into the value proposition of blockchain technology for real estate transactions. We offer a framework for how blockchain technology can potentially integrate and reduce some of the existing challenges by analyzing different aspects of a blockchain-enabled transaction process. We determine how and where blockchain can be utilized, its potential advantages, and its viability based on the current technical and regulatory challenges.

As a starting point, blockchain promises to reduce the friction caused by multiple middlemen and provide a "trustless" system capable of offering a transparent ledger of all payments and records. Blockchain could automate some processes, which have historically required human labor, such as the wiring of funds or the change and recording of property ownership in the registry system. The ultimate vision is to have digitized property records entrusted to blockchain via smart contracts, which automatically transfers the ownership when all established conditions are satisfied.

"We have been following the blockchain phenomenon since 2013. The bold predictions of dramatic changes to (…) the title recording systems, and title insurance industry have yet to produce any tangible results."

--Steve Gottheim, American Land Title Association (ALTA)

We ultimately believe that the use of blockchain will *not* eliminate the need for third parties. Even in a blockchain world, title and escrow companies will still have a place, potentially running the transactions on the blockchain ledger on behalf of their clients. Furthermore, blockchain – at its current stage - makes none of the existing problems of closing a transaction easier and many of them harder. Today, integrating blockchain into real estate transactions requires a set of workarounds that undermine the core premise of the trustless blockchain environment. To ensure that the entries on blockchain are valid, only trusted entities are allowed to make entries. Therefore, instead of creating a trustless blockchain world, the technology currently only re-creates a trusted, centralized process on a different ledger.

Over the long run, governments and regulatory bodies will play an integral part in the adoption of blockchain. However, before mass adoption by governmental entities, we believe that private entities will need to first prove out the actual viability of blockchain solutions. While we believe that a blockchain ledger could become the primary ownership registry in the future, especially for countries where fraud is particularly rampant and government systems are more favorable, there will most likely be an extended period where both a new blockchain authentication system and the current status quo will exist in tandem.

DATA

Access to commercial property data such as location, rental rates, capital values, and property features is typically subscription-based. Commercial property listing has traditionally been a closed storage system where comparable data is siloed and controlled by centralized entities. CRE brokers, owners, tenants, buyers and sellers need local MLS access and pay for services like CoStar to find these listings and to analyze deals. These services tend to suffer from a lack of standardized processes and require substantive human intervention by analysts. This may result in the information being inaccurate, dated, or incomplete. Further, the search process itself tends to be inefficient, as the data is usually fragmented across multiple platforms, leading to low levels of trust in the quality of the available information.[19]

---

[19] Deloitte Center for Financial Services, Blockchain in Commercial Real Estate, 05/2017

On the supply side, there has traditionally been misaligned incentives for market participants to provide data to aggregators, who spend a significant portion of their revenues on researchers who typically cold call property owners and brokers for information on deals.

A recent Deloitte study[20] found that industry executives believe blockchain technology will allow market participants to access more reliable data at a lower cost. Blockchain could be the catalyst for better data collection as it provides an inherent financial incentive to participate in data validation. Blockchain services could increase transparency by incentivizing community curation through cryptocurrency payments. The token would simultaneously function as an access token for the platform and a currency that can be bought and sold on exchanges. The goal is to have data distributed across a peer-to-peer network that would allow more freely accessible listings and enables an ecosystem of data sharing. This could open up new data channels and potentially lead to more accurate insights. Blockchain start-ups like Imbrex or Knotel's recently launched blockchain platform Baya are already working on the idea of blockchain-based listing services in the U.S., while Land Layby is testing a token-incentivized private registry in Ghana that "rewards users for adding correct entries to the blockchain and penalizes them for erroneous ones."[21] Similarly, platforms like the FOAM protocol are using economic incentives to open-source geospatial data and create a consensus-driven property map that can be combined with ownership data.

In theory, there are interesting economic benefits for utilizing blockchain, as the tokens allow companies to commercialize the interest in the platform. Users essentially become platform shareholders by owning the network tokens. This creates an ecosystem where participants have an incentive to see the platform succeed and gain initial traction. Now all users such as tenants, investors, financing sources and advisors, etc. are incentivized to validate the data and ensure accuracy. A unique platform token also allows the network to control the credits, who can earn tokens, and who can be on the platform.

This model is somewhat similar to the crowdsourced data model of CompStak. CompStak has created a successful platform, which allows data curation by users who are rewarded for participating in data sharing with credits to access the platform. The question is why a decentralized platform is the better alternative for data-sharing than a crowdsourced platform with a centralized intermediary. An intermediary, like CompStak, controls and normalizes data outliers, while a distributed or decentralized blockchain database does not inherently denote more data accuracy. It merely enables auditing to check whether the data has been tampered with. Just like a centralized database, a decentralized database does not differentiate between right and wrong data. It doesn't resolve the process of initial data collecting and bringing data into the system. Reconciliation and clean data are even more imperative as importing any type of data onto the blockchain cannot be easily reverted. Verification of the data could be done through trustworthiness scores of each data contributor and might still need an intermediary to create an auditing system. Blockchain is designed to be an append-only structure; as such, past entries on the blockchain must always remain the same. One can only

Imbrex's goal is to create a global listing network that connects buyers, sellers and agents for commercial and residential properties via blockchain.
(Formerly known as REX)

TOTAL FUNDING:
$3.8M via ICO

LOCATION:
New York, NY

---

[20] Ibid
[21] Kevin Mwanza and Henry Wilkins, African startups bet on blockchain to tackle land fraud, Reuters, 02/2018

NAVITAS CAPITAL

change the state of the data in the present, which is less efficient than correcting centralized databases. However, blockchain based data platforms allow to audit the complete backlog of every input ever made, which creates the ability to add more applications and better algorithms that benefit from processing the complete dataset in the future.

Today, blockchain does not necessarily create value for listings, and there is no obvious economic need for a token other than attracting price speculators. The value for a token that represents access to listing and comps data for commercial real estate in exchange for participation in data sharing should not largely increase over time as the number of users is finite and consists mostly of CRE professionals. There is no obvious benefit or reason for retail investors to invest and to actively participate in a data listing platform. Further, buyers and sellers have no reason to pre-buy access to a premature blockchain platform for reasons other than price speculation. CRE brokers and investors want data when they need it and do not require access token to a platform that cannot actually be used for some time. Data providers also have to take the open questions around legality and permissibility of selling these types of utility tokens to U.S. residents into account. This makes the platform development even more difficult as the main class of token holders and platform investors will be foreign investors who have little overlap with the actual users and providers of the data.

While in the long run, blockchain technology, in combination with digital registries, can eventually reduce search costs for all real estate transactions, blockchain currently complicates the process, instead of making it more efficient. Given the current regulatory and technical risks, we believe blockchain adoption will first require tokenization and interconnected digital property records before listings and data services are more efficiently run on blockchain.

"Required information – such as property records – needs to be digitally available."

--Stanislav Kreuzer, Senior Analyst at JLL

WORKFLOW

For blockchain-enabled transactions, the most important prerequisite is the digitization of property records. We see standardization and the structuring of data as the first challenge in the effort to change antiquated processes and create a more efficient market. Many billion-dollar real estate portfolio managers still send around Excel spreadsheets and PDFs to convey property financials, updated valuations, and other financial data. It is very common that important documents for commercial leases are completely paper-based. Therefore, significant time is spent on due diligence activities related to financial, environmental, and legal review to assess rental rates/bid price for leasing and sales transactions[22].

This is predominantly due to the use of physical documents for proof of identity, which are generally stored in silos. Physical letters represent the source of truth for all parties to the transaction, and its enforceability is cemented by the business frameworks and processes that have been built around it. Numerous third-party service providers' involvement tends to prolong the due diligence process and increase transaction-related costs. Furthermore, many diligence steps are duplicated by both the buyer and the lender.[23] Even just the tracking and reporting of the current status of the diligence can be significantly inefficient. The need to issue, handle, store, exchange and manage a physical document is a key source of inefficiency for all involved parties. For example, in a typical leasing process, the tenant needs to sign various application forms, get them co-signed by a bank, and eventually deliver them to the landlord.

A shared ledger, which could be relied on as the single source of truth for the existence and current diligence status, could resolve the challenges associated with physical document storage and tracking, while acting as a

---

[22] A Blueprint for Digital Identity, World Economic Forum, 08/2016.
[23] Deloitte Center for Financial Services, Blockchain in Commercial Real Estate, 05/2017

NAVITAS
CAPITAL

catalyst for increasing standardization. In an ecosystem where multiple parties (i.e. the tenant, the bank, and the landlord) participate in a transaction, a blockchain based solution could provide the optimal medium for facilitating the necessary flow of information, while balancing the competing needs of transparency and confidentiality. Collaboration via blockchain, by publishing the completion of each step of the transaction on a private or consortium chain and making those events visible to other participants in the transaction, will allow the relevant participants to collapse the timeline and to realize significant efficiencies. Along with transaction transparency, document exchanges between parties become easier since everyone is using the same workflow rather than integrating numerous existing systems, which often introduces error.

Title Registries

Most of the early blockchain-based real estate products have been oriented towards the title industry as tasks like recording transactions, managing workflows, and researching chains of titles create opportunities for cost-savings from increased efficiency.[24] For instance, according to American Land Title Association, in nearly all real estate transactions there is at least one defect that must be corrected before transferring the title.[25] As a result, property owners often incur high legal fees verifying ownership. Estimates suggest that nearly $1B is spent annually on title fraud resolutions.[26]

Having a secure online registry for a property would greatly ease the closing and diligence process by automating pre-closing activities such as underwriting, financial evaluation and obtaining a mortgage commitment. Digitization could start simply by creating a property record that is backed up via blockchain to create a more secure and cleaner registry for the transacting parties. This could speed up title transfer execution, use of title as a collateral, and reduce overall transaction time in the long run. By aggregating localized public records in a commonly accessible format, blockchain could reduce the need for title insurers to build and to maintain centralized electronic title plants that are meant to index public real estate records.

A 2016 Goldman Sachs report[27] estimates that blockchain could drive as much as "a 30% reduction in fixed headcount personnel in search & examination, combined with a 20% reduction in variable expenses from commissions and sales & marketing" in the title industry. Based on the ~$15B title insurance market, this could result in ~$2.3B in total headcount savings. However, as the title industry is widely dispersed with thousands of different registries in the U.S. alone, any form of quick blockchain adoption and integration between registries is highly improbable.

There are already multiple start-ups working on the integration of title records on the blockchain, among them Propy & Velox.re. Both have run first pilots with different Counties' recorder of deeds (ROD) to transfer ownership and record the conveyance via blockchain. These pilots show that the most realistic approach to build a blockchain-powered platform for real estate transactions is to move properties to a parallel, blockchain-based title registry. This is achieved through incentivizing property owners to make the transition voluntarily in order to gain access to an international market for fractionalized property or peer-to-peer sales with foreign and domestic buyers.

Transfer ownership via Blockchain

One technical solution on how to actually convey ownership on blockchain is the "colored coins method", which are Bitcoins marked with metadata linking them to off-chain assets. By "coloring a token," the user can attribute specific value to that token, such as the ownership of a particular property. Colored coins could be used to

---

[24] Graglia & Mellon, Blockchain and Property in 2018, At the end of the beginning, future of Property Rights program, New America Foundation, World Bank Conference 03/2018

[25] American Land Title Association, 06/2017.

[26] Kyle Torpey, why 2016 May Be the Year of Real Estate on the Bitcoin Blockchain, Inside Bitcoins, 12/2015.

[27] Goldman Sachs Group, Profiles in Innovation: Blockchain-- Putting Theory into Practice, 05/2016

NAVITAS
CAPITAL

represent property title, as well as the corresponding registry details, such as physical characteristics, location, liens & encumbrances, and ownership transfer records.

The exchange of a particular token would mark the transfer of title. The public entity involved in creating the token, such as the recorder of deeds or the tax assessor, would act as the "public key" in the transaction, signing off on the legitimacy of the transfer. The public key would be paired with a private key, which would be the buyer's exclusive access code to the token. Confirmation from the buyer's key would complete the transaction. However, some legal scholars have concerns, as the property ownership would be linked to fungible currency[28]. This means that there would be no adequate process for reversing the loss of the token, and ownership of the property could potentially not allow for reassignment.

Regardless of whether title registries will ultimately become fully blockchain-powered, the only way blockchain can be truly useful for real estate transactions is if the underlying records are also digitized. This is the model chosen by both Sweden and Georgia (powered by the Exonum platform), which have fully digitized their registry system first, before starting to incorporate blockchain.[29]

The examples of Georgia and Sweden prove that one of the most significant obstacles to modernizing land registries is not technical, but political.[30] Both countries use a Torrens title registry system, where the government performs the conveyance between the parties and keeps the Certificate of Title. This explains the significant governmental support for blockchain in these countries to create a more transparent, efficient, and effective land registration system. These examples also acutely demonstrate the necessity of having buy-in from public and private stakeholders.

In contrast, the majority of the U.S. has a deed registration system whereby the title transfer process is peer-to-peer. Here, the deed holder is responsible for keeping a clear chain of title – typically conducting due diligence during escrow.[31] In the long-term, adoption of blockchain registries and transaction tools could allow countries like Sweden or Georgia to benefit immensely from a greater degree of liquidity and efficiency, while it benefits peer-to-peer title countries like the U.S. on a much smaller scale.

> *"So long as there is no central agency willing to accept blockchain ledger of ownership as a definite proof of title, it will always be a shadow system."*
>
> --L.D. Salmanson, Blockchain Expert and Founder of Cherre

A Torrens system is currently being used in certain parts of Minnesota, Washington and New York. The benefits of blockchain's ease of use would need to justify the added expenses and disruption of legal reforms to get the rest of the U.S. to transition to a full Torrens title system. At this stage, it is highly unlikely for states to embrace a new system, which would assume taking on liability and maintenance of an indemnity fund by the individual jurisdictions, particularly as it likely involves an expensive migration of all property records.[32] In the context of these challenges, it is possible that the overwhelming majority of blockchain-based real estate transactions will be in non-controlling stakes, in which ownership is not transferred.

---

[28] Rod Thomas, Blockchain's incompatibility for use as a land registry: issues of definition, feasibility and risk, European Property Law Journal 6, 12/2017

[29] Joon Ian Wong, Sweden's blockchain-powered land registry is inching towards reality, Quartz, 04/2017, Michael Graglia, Tbilisi agreement herald's significant expansion of blockchain to manage property registries, FPR New America, 02/2017

[30] Michael Graglia, Christopher Mellon, and Evan Akin, Prerequisites for Incorporating Blockchain into a Registry, FPR Blog, New America, 07/2017

[31] Lifthrasir, Ragnar, Permissionless Real Estate Title Transfers on the Bitcoin Blockchain in the USA!—Cook County Blockchain Pilot Program Report, 2017

[32] Graglia & Mellon, Blockchain and Property in 2018, At the end of the beginning, future of Property Rights program, New America Foundation, World Bank Conference 03/2018

NAVITAS CAPITAL

IPFS is an open-source data storing protocol that seeks to connect all computing devices with the same system of files. IPFS links large amounts of data securely to a blockchain transaction, without having to put the data on the chain itself.

LOCATION:
Palo Alto, CA

Another challenge is the actual storage of the related documents. It is possible to utilize distributed solutions created by organizations like StorJ, Filecoin and IPFS. IPFS, for example, breaks a legal document, like a deed or lease, into multiple pieces, signs it cryptographically, and stores it on different computer nodes across the globe. It returns back a "hash" - basically an encrypted file that takes any string of data of any length and gives out an output of a fixed length *(See more about hashes and blockchain in appendix B).* The encryption allows only the holder of the right access key to uniquely identify and decode that file. You could then take this encryption and store it on a blockchain network like Ethereum, thereby creating a digital fingerprint and unique identifier of the document and connecting it to the chain. This creates a cryptographically secure link to the blockchain network and generates a blockchain receipt that anyone can use to verify the data's integrity and timestamp. Those digital identifiers can consolidate information such as vacancy, tenant profile, financial and legal status, and performance metrics in digital form.

However, access to this file would first require querying the Ethereum network to pull out the hash. Once the hash is decrypted, a query would need to be sent to the IPFS network. IPFS would then return the original file that was uploaded to the IPFS network. This example shows that storing and retrieving documents for diligence on blockchain requires multiple steps that are both more complicated technologically and not necessarily more efficient than physical storage.

Blockchain Identity

Identity verification is essential to enable blockchain-powered transactions, as registries and tax authorities need to know who is transferring property records. The challenge and part of the innovation of public blockchains is that they allow anyone with the correct keys to broadcast valid transactions, regardless of who or what they are. A robust digital registry system would need to be able to digitally verify humans, parcels, and buildings. Leveraging blockchain and smart contracts to record the relationships between participants might be the best way to create a standardized digital instrument for representing and conveying property ownership[33].

In addition, for many high-value commercial transactions, data privacy is just as important as identity validation. As described in our long term blockchain vision (*see appendix A*), the technology holds the promise to return ownership of personal data to the individual, along with the power to share that data with others and revoke it as they please. Truly decentralized personal data management systems will ensure that users control their data. Companies like Enigma are already trying to implement a protocol that turns a blockchain into an automated access-control manager, allowing users to alter the set of permissions and to revoke access at any time.

Until these solutions become scalable and people become more comfortable with decentralized solutions, the majority of commercial applications will use some form of a hybrid blockchain model combining private with public blockchains to create trust between users and around privacy. Private blockchains essentially behave in the same way as public ones, except that they require users' identities to be validated against the list of authorized

---

[33] Ibid

NAVITAS CAPITAL

members. While public blockchains allow for full transparency, private blockchains ensure that only parties who have validated their identity to the satisfaction of the authorities are transacting.

A private blockchain can be utilized among participants where trust has already been established, allowing corporations to create rules around data restrictions and information sharing with transaction partners. This would also give authorities the power to regulate property transactions as blockchain solutions need to allow for legal recourse after the transaction. Judges need to be able to adjust ownership records in case of legal disputes. This would work via so-called 'multi-signature wallets' where a regulator has a key allowing for the creation of new transactions that essentially reverses previous transactions. Instead of a seller simply pressing a "sell" button, a registry configuration could require both a seller and a banker to sign-off on the transaction. A multi-signature transaction would coordinate and would confirm the process with notaries, banks and attorneys. After the confirmation, the transaction record is put on a digitized blockchain registry. Since all transactions will be recorded to the private chain and made visible to those with access, the process seamlessly verifies all adjustments made. This new model has been established in Eastern European country Georgia where decisions are tracked on a private chain via the Exonum platform, with hashes of key documents recorded on a public chain.[34]

Software company that provides the technology infrastructure to allow organizations to synchronize data - like national registries - and control business processes on the blockchain.

LOCATION:
Stockholm, Sweden

How to establish identity on the blockchain?

Decentralized blockchain-based identity platforms are currently in development and may soon be viable options for registries. These include uPort, Civic or Remme. However, the more viable approach to validate identity would be to use an established system similar to the pilot in Sweden. Here the blockchain startup ChromaWay built a blockchain application for the Swedish land registry by allowing buyers and sellers to identify themselves via their telecom prover IDs. Telia - the largest Swedish telecom company- provided the digital keys to verify identity [35]. Potential U.S. equivalents, aside from telecom companies, could be the Social Security Administration or DMVs, as these identities would need to include passport, taxes, and credit information. Another opportunity would be tech companies like Google that can seed any blockchain platform for consumers and identity verification, just like Facebooks' login feature helped scale the Airbnb platform by providing trust for both hosts and guest. [36]

SMART CONTRACT EXECUTION

The final phase of blockchain-enabled transactions is the actual value exchange. Payments and money transfers are expensive and time-consuming due to the involvement of multiple-channel partners and extensive documentation. This is perhaps most pronounced when a buyer funds a purchase through combination of debt

---

[34] Bitfury, Exonum—A framework for blockchain solutions, exonum.com
[35] Graglia & Mellon, Blockchain and Property in 2018, At the end of the beginning, future of Property Rights program, New America Foundation, World Bank Conference 03/2018
[36] Marc Bhargava, The Use of Blockchain in Real Estate, Medium (blog) 02/2016

and equity or when the transaction is cross-border, as foreign exchange fees and the involvement of multiple intermediaries typically increase payment lead times and transaction costs.

Blockchain technology with smart contract capabilities might, over time, replace the role of escrow companies in transactions and even banks, in the context of conducting the actual wiring of funds. The concept of smart contracts is a critical aspect in the business application of blockchain. "Smart contracts" are self-executing computer codes that can facilitate the exchange of money, content, property, shares, or anything of value without any intermediation. Smart contracts not only define the rules and penalties around an agreement, in the same way that a traditional contract does, but also automatically enforce those obligations. After the transaction is completed, they also store and replicate all the information, which gives the transaction security and immutability. As if they were accountants, smart contracts track and define all the main data associated with a given token (e.g. the addresses of token owners, or the number of tokens in existence).

Smart contracts in a real estate transaction could potentially disintermediate middlemen and provide a trustless blockchain system that is capable of offering a transparent ledger of all payments to the landlord. So instead of buyers, sellers and banks depositing deeds, down payments, and mortgage payments through a professional escrow firm, all of those transfers would be digitized and entrusted to a blockchain-based program and transfers ownership when all conditions are digitally satisfied.

SMART PROPERTY

BUYER submits offer and then sends funds

SELLER accepts

AUTOMATED SMART CONTRACT

SERVICE PROVIDERS notified and carry out relevant workflows

Transfers ownership

Grants access

Digitized Registry on Blockchain

Smart Property

To visualize how a smart contract and digitized blockchain registry could eventually work, we created a simplified "sketch" of a sales process. As soon as the buyer and seller agree to transact, and the necessary due diligence is approved, the transaction is recorded on the blockchain. The process that used to be highly manual is now significantly more efficient and automated, but still requires approvals and some human touch via service providers. After the due diligence is done and both seller and buyer agree, the smart contract initiates payment either through blockchain wallets or bank accounts using a payment interface.

The smart contract could subsequently initiate a regular mortgage payment, while automatically transferring ownership of the property from the seller to the buyer. The same smart contract would send a signal, assuming an interconnected "*smart*" *property*, to the installed IoT sensor and automatically allow access to the tenant, creating a crypto-based, biometric, access control infrastructure. Upon completion of the sale, the smart contract also withdraws access to the building from the seller. While this vision of interacting smart contracts and smart properties would undoubtedly drive down transaction costs and time significantly, it is also highly difficult to envision in the near future.

NAVITAS
CAPITAL
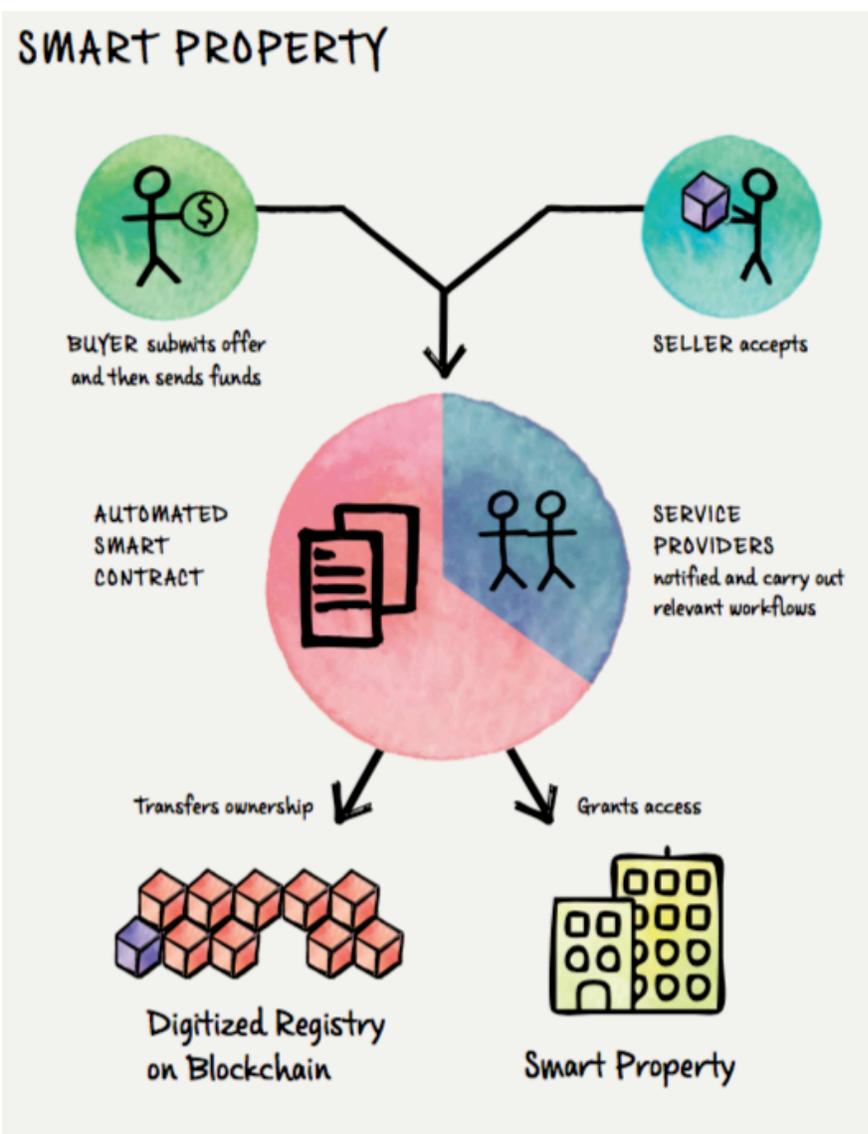
One company starting to enable blockchain real estate transactions via smart contracts is California-based startup, Propy. Propy aims to reduce the role of service providers in the transaction process and automate processes which have historically required human labor, such as the wiring of funds or the change and recording of property ownership in the registry system. Propy already completed a transaction in Ukraine, in which a property was acquired by a buyer in California using Ether and their native Propy PRO tokens.[37] Since then, Propy has recorded 2 government-sanctioned, blockchain-recorded real estate deals in Vermont and California.

Propy's platform recorded the purchase agreement and payments on the public Ethereum blockchain using the Propy Blockchain Registry, a set of smart contracts designed to store land records on blockchain. Their property smart contract is responsible for storing and updating property information, while another smart contract, the Deed contract stores the metadata of the actual ownership transfer. The deed recorded at the county land records office contains the printed address of the smart contract.[38]

Platform to buy and sell real estate. The platform works with governments to record and secure the sales and title information on the Ethereum blockchain.

TOTAL FUNDING:
$15M via ICO (PRO Tokens)

LOCATION:
Menlo Park, CA

The difficulty around introducing smart contracts to create a blockchain transaction platform is the often-misunderstood fact that smart contracts are not truly smart. Smart contracts tend to be portrayed like an artificial intelligence robot that automatically learns and improves over time. The true power of smart contracts is, however, very simple: they exactly execute an "agreed-to" code on the blockchain network.

Smart contracts are, therefore, ideal for transactions that are not only completely digital, but are also bearer instruments; meaning whoever is in possession of the representative ownership token will always be the presumed owner of the underlying asset. Thus, connecting ownership of blockchain-based tokens traded via smart contracts to *off-chain* real world tangible assets can never be fully trustless. There is an intractable problem in linking a digital and physical asset via a smart contract. The digital world needs to "know" what actually happened in the physical world. When a seller transfers a house to the buyer, the smart contract needs to know that the transfer actually occurred, and the new owners were able to move into their new house.

This means that we first need to digitize all ownership records, so we can automatically transfer them via a smart contract and even then, the smart contracts only work if there is some definitive link between the digital version and the physical version. For this to happen, we would need to live in a fully interconnected IoT world with biometric sensors that control access to our properties. Physical assets are regulated by a local jurisdiction, meaning trust in something else is still required beyond smart contracts. This shows that a smart contract suffers from the same exact trust problem as normal contracts. In other words, a smart contract that requires trust from a third party removes the advantage of a trustless system.

---

[37] Natalia Karayaneva, How A Smart Contract replaced An Escrow Company in a $60k deal, Hackernoon (blog), 10/ 2017,
[38] Alexander Voloshyn, First Government Sanctioned Blockchain Recorded Real Estate Deal in the US, Medium (blog) 05/2018

NAVITAS
CAPITAL

What makes smart contracts even less smart is that a legally-binding smart contract needs to encode all possible outcomes, with the subjectivity and risk of human judgement in all its complexity, into lines of codes. Making a contract "smart" presents the risk of making it drastically more complex to write and audit.

The problem with smart contracts, therefore, is that they are difficult to write, hard to make trustless and possess too many external dependencies to work for most applications. While there is promise to, at some point, minimize litigation exposure, smart contracts currently remain a vulnerability and may open a Pandora's box of legal issues.[39] Thus, even though there is progress being made, technical as well as regulatory issues will need to be addressed first in order to create true blockchain-enabled transactions.

CONCLUSION

This paper's goal was to highlight an emerging technology that will over time play an increasing role in transforming real estate workflows. It aims to serve as an introduction to blockchain technology and its potential near and long-term impact on the built world. We explored how those technologies have, thus far, been applied to real estate and contemplated how blockchain could be a catalyst for a more digitized and interconnected world. We underlined the technology's core innovation, which creates security and resilience advantages over traditional transaction and record-keeping systems - given its decentralized, fault-tolerant, and virtually immutable attributes.

In describing the blockchain technology, we tried to emphasize the opportunity that blockchains offers in creating the foundation for more liquidity and standardization in real estate transactions in the long-run, as well as the inherent limitations and regulatory challenges. Blockchain could potentially democratize access to real estate and, at a minimum, be an improved underlying "ledger" to help eliminate the need for parties to reconcile documents and to simplify processes.

While the actual implementation of the technology and the regulatory process will be highly demanding, blockchain has the potential to lead to the efficient unbundling of property rights that will allow fractionalized assets to be traded instantaneously. The continuous adoption of blockchain will depend on the progress of the technology and the advancement of regulation, making it impossible to forecast its full impact just yet. That said, we believe the ability to promote data standardization, property registry digitization, and the promise of process automation via smart contracts will make blockchain a disruptive technology for the real estate industry.

To summarize our findings, we developed the following framework on how blockchain can potentially enable more efficient transactions and greater liquidity; the challenges, and examples of startups that are already making an impact in the space. Finally, we highlighted the steps that will be required for actual blockchain integration, its value proposition, and viability.

NAVITAS
CAPITAL

	Blockchain enabled Marketplace	
Blockchain Application	**ASSET TOKENIZATION**	**GLOBAL BLOCKCHAIN**
Description	Fractionalized and tradeable property rights via blockchain	Democratizing real estate via liquid worldwide property exchange.
Value Proposition	Liquidity, New Sources of Capital	Interoperability
Blockchain components	Security tokens	Interconnected blockchains
Challenges	Compliance & regulation	Blockchain scalability, Legal standardization
Blockchain Viability	Initial steps taken through automated compliance	Not feasible for the foreseeable future
Examples	Harbor, Meridio, RealBlocks	tZERO

NAVITAS
CAPITAL

Blockchain enabled Transactions

Blockchain Application	DATA	WORKFLOW	SMART CONTRACT EXECUTION
Description	Blockchain enabled MLS and data platforms	Property records and identity validation via blockchain	Smart Contracts to automate ownership exchanges, payments and access control
Value Proposition	Transparency & accuracy	Expedited verification	Disintermediation, & real time settlement
Blockchain components	Token incentivized network	Hybrid blockchains, Colored coins & Multi-signature wallets	Interacting smart contracts
Challenges	Efficiency, limited token upside & data collection	Digitization of records, identity verification & privacy	Legality of smart contracts, physical and digital assets linkage & Scalability
Blockchain Viability	Decentralized databases still too inefficient.	Requires buy-in by all stakeholders first	Uncertain as smart contracts are not inherently intelligent
Examples	Imbrex, Baya	Velox.Re, Chromaway, Bitfury	Propy
Affected Incumbents	Data & Listing Platforms	Title Industry, Mortgage Lenders, ROD's	Escrow Agents & Lawyers

NAVITAS
CAPITAL

APPENDIX A: BLOCKCHAIN'S LONG TERM VISION

Blockchain promises to create a transaction environment that is completely trustworthy, whereby transactions occur without any of the traditional institutions that we rely on today. However, blockchain skeptics rightfully mention that most of our transactions are processed faster and more securely by *trusted* middleman rather than using a decentralized peer-to-peer blockchain network.

Blockchain also requires no intermediaries, like banks or credit bureaus to build a process of financial trustworthiness. Yet even for strangers transacting directly with each other on the Internet, the use of reputation scores popularized by companies like Ebay, Airbnb or Uber has successfully created trust. Further even decentralized systems will likely still need to rely on third parties to input the required data for blockchain business applications.

Given the discussion around its value proposition, it is important to understand the true long-term promise of this new technology. Blockchain has the potential to be a new protocol layer that enables us to control our digital identity. Offline, we don't have an open market for physical passports or Social Security numbers. We have a few reputable authorities that we use to confirm to others that we are who we say we are. Online, however, these authorities do not exist to the same extent. As a result, the private sector has swooped in to fill that vacuum. Identity has become a valuable commodity that is not controlled by its owners, but by web applications like Facebook, Google and Amazon. Blockchain's private-public key structure may enable the creation of a secure digitized identity that can be used for any online transaction. Its 'private key' is a way of proving identity, in the same way that real-world keys attest to your identity when you unlock your front door.[40] While every transaction on blockchain is permanently recorded and transparent for all participants, individual participants' information can only be decrypted through the individuals' respective private key (or digital access code), making the data secure. Blockchain technology now holds the promise to return ownership of personal data to the individual, along with the power to share that data with others and revoke it as they please. Via blockchain's public wallets, participants can verify that the funds are actually there and transfer value globally without requiring a bank or PayPal in the middle.[41]

Powered by a universally applicable identity solution and its consensus mechanism, blockchain networks offer a standard upon which global trade of any asset can eventually be completely interoperable. What that means is that while most ownership claims are already digitally represented today, they mostly do not interact with each other. Current centralized solutions for electronic value transfer lack compatibility. We cannot currently send value from PayPal to Venmo, or from E*Trade to RealtyShares without intermediaries or incurring charges. The innovation is that blockchain will allow us to hold ownership for many different types of assets in the same wallet.[42]

APPENDIX B: HOW DOES BLOCKCHAIN WORK?

It all starts with a user creating a simple online wallet on a respective blockchain like the Bitcoin blockchain or Ethereum. Think of this wallet as having elements of a bank account, an email address and a social security number. This wallet is represented as a string of characters that exists only on the individual's computer, until

---

[40] Steven Johnson, Beyond the bitcoin bubble, New York Times, 01/2018
[41] Catalini & Gans, Some Simple Economics of the Blockchain, 09/2017
[42] Stephon McKeon, The Security Token Thesis, 05/2018

they perform any kind of transaction, like buying a bitcoin. Then the address is broadcasted out to an improvised worldwide network of computers (called nodes) that try to verify the transaction. [43]

The results of this initial validation are then broadcasted to a wider network where "miners" (people with computers actively trying to help process data entries) enter into a competition to perform complex mathematical calculations. The winner (or the quickest) computer to solve for this calculation - gets to confirm and record that transaction in the single, canonical record of every transaction ever made in the history of the system, while the other miners in the network communally confirm the result. Confirmation is the critical concept in cryptocurrencies. Only miners can confirm transactions. They take transactions, stamp them as legitimate and spread them as a block in the network. After a miner confirms a transaction, every participant has to add it to its database. It is no longer forgeable and cannot be reversed. It is now part of the immutable record of historical transactions.

By the end of the process, every machine on the network has a record of the complete history of all transactions, and thus of the balance of every account. This includes all the previous transaction data, including all origination and trade partners. This is a crucial differentiator from traditional bank accounts, which treat all money equally once it hits your account. Cryptocurrency transactions specify exactly which incoming deposit you are receiving or spending, and who and where that currency was previously held. In theory, this makes every transaction traceable right back to the coin's creation.

When thinking about blockchain, it is simplest to imagine a sequence of blocks of data, with each block linking to the next. What makes the blockchain so reliable and trailblazing is that each block contains the transaction data of the *previous* block as a pointer to connect the data. The data is stored in the form of a hash. In simple terms, hashing means encrypting a file by taking an input string of any length and giving out an output of a fixed length. You can hash or encrypt the whole library of Wikipedia or just a simple text message. One has infinite amount of data, while the other has almost none, but both hashes will have the same fixed length. Every blockchain transaction is taken as an input and run through a hashing algorithm, which gives an "encryption" of a fixed length (256 characters for a bitcoin transaction). Blockchain, due to the sheer amount of data, uses hashes of hashes, which are called merkle trees. The blockchain works by taking the hash of existing files, and then combining those old fixed-length encryptions with the hashes of the new files created. As a result, the system gets a new root, which can be used to prove the entire order of each data point added to the blockchain. These data trees are essential in a distributed database as they prove if a dataset is corrupted or valid. A blockchain is effectively an ever-growing merkle tree.[44]

The combination of the linked chain and the hash file system makes the blockchain immutable. The hash function's core advantage is that a slight change, like an added decimal in a transaction, changes the resulting hash dramatically, therefore any small changes to the data will try to change the previous block, which is impossible as it has already been confirmed by the network.

HOW MINING WORKS

The miner's activity is the single most important part of cryptocurrency-system. In principle, everybody can be a miner. In order to find the hash that connects the new block with its predecessor, the miners need to invest computing power. Since a decentralized network has no authority to delegate this task, a blockchain network needs some kind of mechanism to both incentivize people to offer computing power and prevent one ruling party

[43] Steven Johnson, Beyond the bitcoin bubble, New York Times, 01/2018
[44] Dan Finlay, IPFS Ethererum Hackathon 2017 Panel, 02/2017

NAVITAS
CAPITAL

from abusing it. Just as a real estate broker makes commission from facilitating transactions, a miner is paid in cryptocurrency for helping facilitate crypto transactions.

The technical explanation of mining is that they solve for the cryptographic algorithm hash that produces a repeatable but non-reversible string of numbers and letters. The process is often described as the miner's computer solving a very advanced math problem, but in reality, it is more like spending a lot of effort making guesses until they guess correctly. Miners are essentially trying to reverse-engineer the data string of the last hash function. The target number to find is the number whose hash is equal to or less than the number of the previous block. The miner who guesses correctly is rewarded with the block reward, a specified amount of the respective token. They get to broadcast the block across the network for each connected computer or node to validate and add to their own copy of the ledger. If miner A finds the hash, miner B will stop work on the current block and repeat the process for the next block. It is a puzzle-solving method known as 'proof-of-work'. The benefit of that process is while finding the right hash value takes large amounts of computing power, it takes almost no time for others to verify that the hash value is correct, which is exactly what each connected computer does. Since the difficulty of this puzzle constantly increases, the amount of computing power that miners must invest also increases. As a result, there is only a limited number of bitcoins that can ever be created over a given amount of time, as the energy consumption increases for each added block.

The challenge with the proof-of-work concept is the amount of wasted energy that goes into mining. Therefore, all blockchains are aiming to eventually move to a concept called 'proof-of-stake,' a different way of validating transactions and achieving the distributed consensus between all participants. Here, the creator of a new block is chosen depending on the miner's wealth, also defined as stake. Miners receive no block reward, which means that all digital currencies using proof of stake have to be predetermined with a fixed number of tokens. Miners will still need to validate transactions. However, they now just take a set percentage fee of the amount being exchanged. This approach therefore creates a finite amount of the currency which makes it more stable and reduces energy waste. On the other hand, switching to a proof-of-stake consensus brings up risks regarding the potential centralization of the blockchain, since users with more equity are given more power and responsibility. Actual implementation of a proof-of-stake concept will be one of the largest challenges for the long-term validation of blockchain and cryptocurrency.

APPENDIX C: CRYPTO-ECONOMICS

CRYPTOCURRENCIES & TOKENS

Cryptocurrencies and tokens are related but separate concepts. After a miner validates a new block to be added to the network, they get rewarded with a token of the respective cryptocurrency (for example with some Bitcoin or Ether). A blockchain native token, in its simplest form, is just a unit of value, but these native tokens also have a natural utility as they are the meter for using the system. Native Tokens exist only digitally as entries on a blockchain. Essentially, native tokens are wages, equity and employee badges combined to incentivize blockchain usage. The respective protocol – such as Ethereum - only works if there are a number of participants contributing to the decentralization and securitization of the network; therefore, in turn earning Ether. This is a way to compensate people for helping to make the blockchain function, without those people being on an official payroll or owning shares in a corporate entity. This concept allows the database to be distributed and funded.

Larger native tokens like Bitcoin are actual currencies and are fungible stores of value that can be transferred without a bank or middle man. This is the quintessential 'token' model, where focus lies squarely on the speed, cost, and ease of transacting in relation to the status quo. However, there are also non-native tokens that are used

NAVITAS
CAPITAL

on top of the blockchain. For this paper, it is important to understand the difference between cryptocurrencies (native tokens) and non-native tokens.

Today, tokens can represent collateral deals, security dividends, token-based voting systems, currencies for decentralized apps or tokenized assets like gold and real estate. These tokens can have drastically varying purposes, legal statuses, values and utilities. Conceptually, the different tokens on top of the blockchain function like a purchase of a train ticket. Users of the Ethereum platform exchange cash (Ether) for a train ticket (token). This ticket (token) allows you to use the service. The difference is that most "physical world tokens" are traded at a fixed price and have different economics, while most blockchain tokens are scarce and traded on the free market. The following framework provides an overview of the differences and the varying functionality of cryptographic tokens:
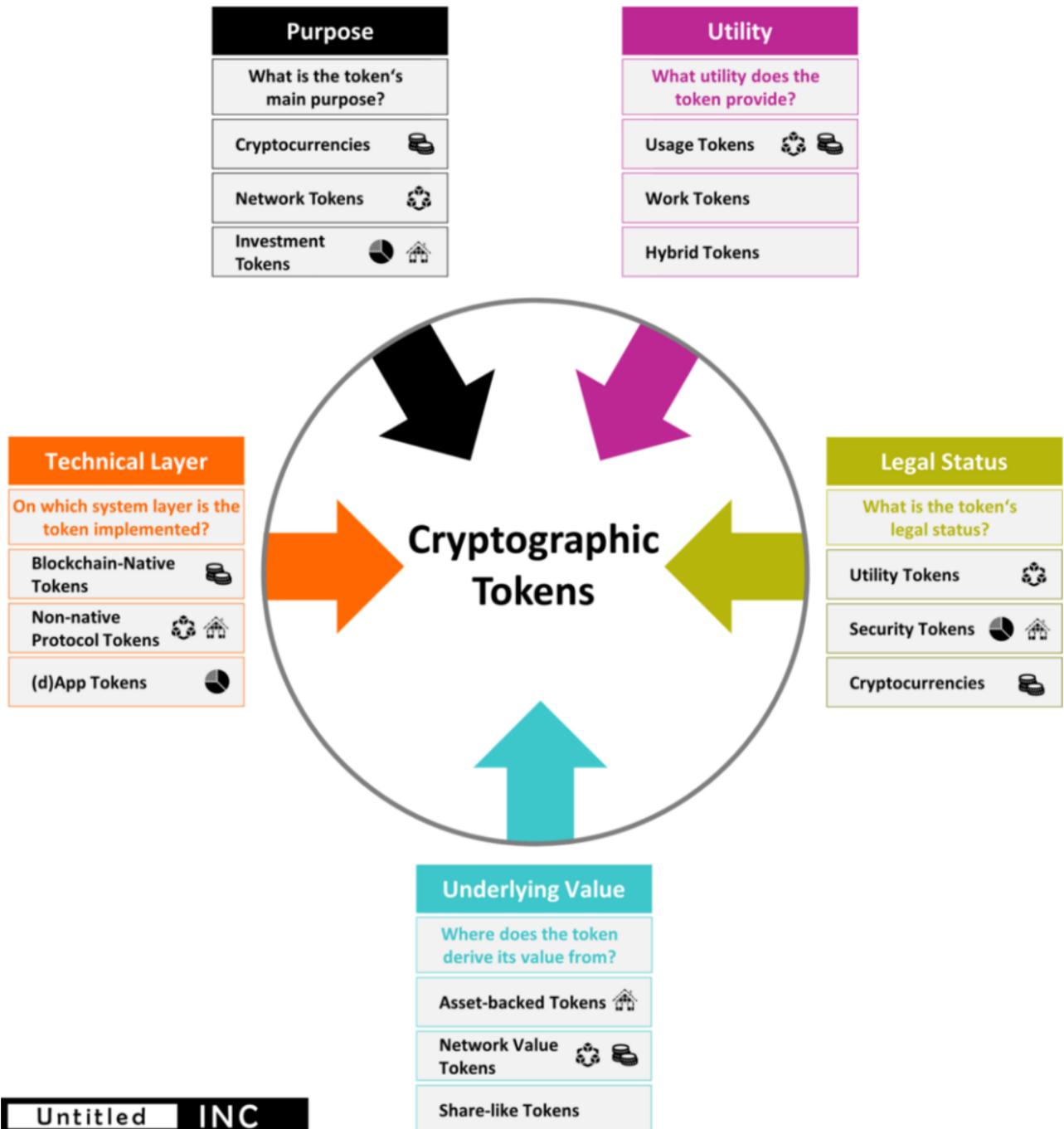
One of the main distinctions between tokens is their varying purpose. Cryptocurrencies are intended as a global medium of value, such as Bitcoins. However, often tokens are meant to enable a specific network. These network tokens, Utility Tokens, are intended for a specific application and only have functionality within the issuers system. The third group of share-like tokens, Security Tokens or Cryptosecurities, are passive investment tokens that have little functionality and provide ownership of an asset that can be traded like gold or real estate.

The actual underlying value of a token is closely tied to its purpose. Most tokens are created to have monetary value, but the source of their value can differ significantly. A token can be a note tied to a real-world asset that functions as a claim to the underlying asset. Share-like tokens act like regular shares that are linked to the commercial success of the issuing entity.

Network Value Tokens, i.e. Cryptocurrency and/or Utility Tokens, are tied to the value of the network. Here, instead of owning part of a company, as in the shareholder equity model, people create and get access to tokens and improve the value of the tokens by using and improving the underlying protocol (or network). That means that the lines between founders, investors and customers are far blurrier than in traditional corporate models. All of the incentives are explicitly designed to steer away from winner-take-all outcomes and yet at the same time, the whole system depends on an initial speculative phase in which outsiders are betting on the token to rise in value. In this business model, users have the potential to make money for being early adopters. As a result, these tokens can have a dual role as both a share and an application-specific currency. The blurriness in incentives and value propositions regarding these tokens has led to the SEC introducing measures against ICO's and tokens in general. We expect federal regulators to struggle with these definitions and the resulting regulations for the foreseeable future.

With Utility Tokens, there are two different ways in which these tokens provide utility: 1) they can either give access to a network or service or 2) allow token holders to actively contribute to a system. Utility tokens are similar to the concept of paid API keys. For example, when you buy an API key from Amazon Web Services for a given amount of dollars, you can redeem that API key for time on Amazon's cloud. The purchase of a network value token like Ether is similar, in that you can redeem the token for computing time on the decentralized Ethereum network. This redemption value gives tokens inherent utility. Tokens are similar to API keys in another respect: if someone gains access to your Amazon API keys, they can bill your Amazon account. Similarly, if someone sees the private keys for your tokens, they can take your digital currency. Tokens are inherently useful and tradeable. As such, these tokens have a price.

Tokens also differ in their legal status. This is highly relevant in assessing a tokens potential over time. The general regulative outline is that tokens which aren't clearly utility tokens or pure cryptocurrencies need to be classified as securities. The legal classification is determined by the "Howey Test." In the context of blockchain tokens, the Howey test can be expressed as different elements that all have to be met for the token to be classified as a security. If the token represents an investment of money in a common enterprise with the expectation of profits predominantly from the efforts of others, it is considered as a security. The SEC announced in February 2018 that the vast majority of tokens currently marketed as utilities are actually securities, which led to the steep decline of US based ICOs in the month following the announcement.

ICO's

Initial Coin Offerings (ICOs) are in a lot of ways similar to an IPO - but for tokens. Speculators can buy- in during the offering, but unlike an IPO, they are not buying an ownership stake in a public company. Instead, the tokens even after the ICO will continue to be created in exchange for labor. ICOs allow companies to sell tokens that give access to a network, rather than giving away equity. Essentially, ICOs provide a way to jump-start a new decentralized platform via a crowdfunding model. This means that token launches provide a way to fund

NAVITAS
CAPITAL

previously un-fundable shared infrastructure projects, like open-source or implementing new databases for any assets that were previously siloed.

Imagine an amusement-park operator, promoting the blueprints for innovative roller coasters, sells tokens in exchange for discounts to future rides, and then devoting the proceeds to the construction of a park—one that would eventually be overseen, maintained, and updated by its own visitors.[45] Interestingly, this is also one of the biggest selling points of Ethereum blockchain, as it makes it easy to build customized rides with customized tokens compared to other blockchain networks.

ICOs also entail the risk that an unsavory ICO might sell meaningless chips for a fake ride or park nobody ever planned to build. ICOs have been fueled by a gold-rush mentality around cryptocurrency and optimized to raise the maximum amount of capital upfront, rather than creating a sustainable business model. They have been deployed in irresponsible ways that are damaging the ecosystem of developers and organizations as legal, technical, or normative controls are not yet set up.

It is a common misconception that each application requires its own individual token. This is largely because most blockchain companies developing projects created their own tokens in response to the large capital raised by other ICOs. Companies that are building applications on top of the blockchain are typically offering a platform token for sale because every interaction on the blockchain has a transaction cost associated with it. For example, companies that are using Ethereum blockchain for their platform are essentially creating tokens to convert to blockchain native tokens to pay for using the underlying technology.

As of June 2018, $12B+ has been raised through ICOs globally.[46] One of the biggest ICO successes has been the Ethereum blockchain which sold its own tokens via an ICO and raised ~$18M. Since then the network has come to be worth, on its best day in January 2018, ~$135 billion.

[45] Gideon Lewis-Kraus, Inside the Crypto World's Biggest Scandal, Wired Magazine, 06/2018
[46] https://www.coindesk.com/ico-tracker/

NAVITAS
CAPITAL

Date	Company	Description	Round	Investors	Investment	Investment to Date
	Aperture	RE investment company using blockchain to issue tokenized investment and record property ownership	Private		N/A	N/A
8/14/2018	Baya	Blockchain platform announced by Knotel that allow users to access verified data for CRE	Series B	Newmark Knight Frank, The Moinian Group, Wolfson Group, Wainbridge Capital, The Sapir Organization, Alrai Capital	$70M	$95M
1/25/2017	Bitfury	Full service blockchain technology company that provides blockchain services (Exonum)	Series C	Credit China FinTech Holdings	$30M	$90M
	Bitland	Real estate land title registration in Ghana	Private		N/A	N/A
	BitRent	Blockchain real estate platform that xonnects developers with investors.	ICO		$180M	$180M
	BlockStone	Real estate asset tokenization platform	Pre-ICO		N/A	N/A
4/18/2018	Blocksquare	Tokenization platform for buying or selling fractional commercial real estate properties	ICO		$0.3M	$0.3M
2/7/2017	Bloq	Delivers enterprise grade blockchain technology to leading companies worldwide	Seed	SixThirty, CMT Digital Ventures	N/A	N/A
10/1/2017	Bloquid	Enables tokenization of reverse mortgages	ICO Pre Sale		$1M	N/A
5/8/2018	Brickblock	Platform to connect cryptocurrencies with real world assets	Series A	Finch Capital	$6M	$6M
6/11/2018	Brickschain	Blockchain for construction and facilities management	Seed		N/A	N/A

NAVITAS
CAPITAL

	Buildin	Property transaction management for brokers and agents using blockchain	Private		N/A	N/A
12/1/2017	Caviar	Combines investments in crypto-assets with income-generating short-term loans, backed by real estate in the United States	ICO Pre Sale		$1.5M	$1.5M
	Chromaway	Blockchain platform for creating smart contracts and digital assets for financial applications	Private		N/A	N/A
6/22/2017	Civic	Platform allowing businesses and individuals control their digital blockchain identities	ICO		$33M	$35.8M
7/1/2018	CPROP	Transaction management system	ICO		Min $2M	N/A
	Deedcoin	Real estate token to lower commission costs for homebuying	Pre-ICO		N/A	N/A
9/2/2016	Enigma	Shares and analyzes encrypted data for decentralization	Seed	Plug and Play Insurtech, Flybridge Capital Partners	$800k	$800k
	Elea Labs	Creates blockchain-based digital property identities to eliminate costs associated with acquiring, operating and selling real estate.	Private		N/A	N/A
	Epigraph	Blockchain solution to build transparent, tamper proof title registration solution.	Private		N/A	N/A
4/20/2018	Etherty	Real estate blockchain platform for buying investment properties from around the globe	ICO		$5.3M	$5.3M
3/1/2018	Evareium	Real estate investment token designed to capitalize on Dubai's full integration of blockchain for real estate transactions	ICO		N/A	N/A

NAVITAS
CAPITAL

Date	Company	Description	Stage	Investors	Amount	Total
4/18/2018	Factom	System for securing real-time records on the blockchain	Series A	Plug and Play, Peeli Ventures, Medici Ventures, Harvest Equity, Draper Associates	$8M	$9.5M
3/20/2018	Finhaven	Blockchain-powered investment banking platform.	Seed	Medici Investment	$1M	$1M
8/1/2018	Foam.Space	Mapping service powered by blockchain	Pre-ICO		N/A	N/A
1/3/2018	FundPlaces	Cryptocurrency real estate investment platform	Seed	Global Yellow Pages	$1.5M	$1.5M
4/17/2018	Harbor	Tokenizes private securities by automating regulatory compliance	Series A	Craft Ventures, Founders Fund, Andreessen Horowitz, Vy Capital, Valor Equity Partners, Signia Venture Partner, 1confirmation, Pantera Capital, Abstract Ventures, Future Perfect Ventures, Fifth Wall, Navitas Capital	$28M	$38M
12/1/2017	Imbrex (formerly Rex)	Real estate data marketplace	ICO		$3.8M	$3.8M
10/10/2017	LAToken	Tokenizes and makes tradable fractions of assets ranging from real estate and loans to artworks.	ICO		$18M	$18M
	Meridio (formerly Pangea)	ConsenSys Platform to create, manage, and trade fractional ownership shares in real estate assets	Private		N/A	N/A
1/25/2018	Polymath	Helps companies create their own securitized tokens	ICO		$59M	$59M
7/27/2018	Primalbase	Office rental platform using blockchain tokens	ICO		$24M	$24M
8/1/2016	Propify	Real estate marketing powered by blockchain	Seed	Porte Cave	$150k	$150k
11/21/2017	Proof Suite	Open-source blockchain technology	ICO		$3.1M	$3.1M

NAVITAS
CAPITAL

		company creating smart contracts for financial transactions.				
9/18/2017	Propy	Blockchain platform for buying and selling real estate and digitizes title deeds issuance for properties	ICO	RenGe, Crunch Fund & 6,597 contributors	$15M	$15M
10/26/2017	RealBlocks	Real estate capital markets platform utilizing blockchain	Seed	Techstars, Barclays Accelerator	$120k	$120k
11/25/2017	Realisto	Marketplace for tokenized investment properties	ICO		$1.5M	$1.5M
	Remme	Blockchain authentication system for humans and devices protecting company's data from cyber attacks	Private		N/A	N/A
2/28/2018	Rentberry	Rental platform that streamlines negotiations between landlords and tenants	ICO	Zing Capital & 2,673 contributors	$30M	$34M
	Securitize	Platform for creating asset-backed security tokens.	Private		N/A	N/A
	ShelterZoom	Blockchain online renting platform integrable with real estate websites	Private		N/A	N/A
	SMARTRealty	Smart contract technology for everyday real estate transactions such as rental, purchase, and sale.	ICO		N/A	N/A
3/1/2018	SPiCE VC	Tokenized VC fund using security tokens	ICO		$152M	$152M
	StreetWire	Blockchain network for real estate data management	ICO		N/A	N/A
10/31/2017	Swarm	Blockchain for private equity via a decentralized capital marketplace	ICO		$5.5M	$5.5M

NAVITAS CAPITAL

Date	Company	Description	Round	Investors	Raised	Total
5/4/2018	Symbiont	Smart contracts platform for institutional applications of blockchain technology	Series A	Medici Ventures, Wicklow Capital, Fenbushi Capital	$15M	$15.4M
7/18/2018	TrustToken	Creates asset-backed tokens that can be used for buying and selling properties around the world	ICO	Andreessen Horowitz, Zhen Ventures, Slow Ventures, Jump Capital, Foundation Capital, BlockTower Capital	$20M	$21.7M
8/10/2018	tZERO	Blockchain platform for security tokenization of digital assets including bonds, equity & real estate	ICO	GSR Capital	$462M	$462M
6/6/2017	Ubitquity	Blockchain-secured platform for real estate transactions	Private		N/A	N/A
	uPort	Identity and user-centric data platform utilizing blockchain	Private		N/A	N/A
	Velox.RE	Transaction and asset management platform built on blockchain	Pre-ICO		N/A	N/A

NAVITAS
CAPITAL