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Honors Thesis

STRATEGIC IMPLICATIONS OF BLOCKCHAIN

by
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Submitted to Brigham Young University in partial fulfillment of graduation
requirements for University Honors

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Brigham Young University
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ABSTRACT

STRATEGIC IMPLICATIONS OF BLOCKCHAIN

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Bachelor of Science

This thesis introduces blockchain, the underlying technology of cryptocurrencies such as Bitcoin, and discusses how best to conceptualize it relative to other technologies. Following an explanation of the fundamentals of blockchain, also known as the distributed ledger, I identify the characteristics of the technology. Building upon blockchain's inherent strengths and limitations, I explore potential business applications of blockchain. Finally, I recommend that leaders continue to track the development and adoption of blockchain technology, even if they decide that implementing it does not align with their organization's strategy at present.

ACKNOWLEDGEMENTS

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I. INTRODUCTION

For much of 2016 and 2017, the finance and technology communities were abuzz with the potential of blockchain. Now as the public catches up and blockchain gains the attention of the mainstream media, leaders must quickly grasp the fundamentals of this technology to understand its implications for their businesses.

Following the launch of the cryptocurrency Bitcoin in January 2009, banks and federal regulators moved quickly to understand and possibly harness the power of its underlying technology: the distributed ledger.¹ Since then, words like “ICO,” “mining,” “tokenization,” and “crypto” have become the parlance of newscasters and influencers. And if you have made it this far without needing to look up one of these buzzwords, you are likely among the few who have a general idea of what blockchain is or among the fewer who actually understand this new frontier.

Beneath the noise and away from the allure of the get-rich-quick ICO² schemes, rests a new technology that has the potential to change at least some forms of business. In this paper, I set out to define the jargon of the “crypto space,” explain the fundamentals of blockchain technology, and comment on the appropriateness of various frameworks regarding the growth potential of this nascent technology.

¹ After exploring the technology, the SEC and other regulators have largely taken a passive approach, preferring to let the market run its course. One notable exception to this stance came on July 25, 2017, when the SEC issued guidelines surrounding the use of tokens as a security. See https://www.sec.gov/oiea/investor-alerts-and-bulletins/ib_coinofferings.

² “Initial Coin Offering.” This concept plays off the familiar acronym for “Initial Public Offering” and is essentially a means for a startup built on a blockchain to raise capital by issuing to investors tokens that will have utility within the product once the product is functioning.

II. TECHNOLOGY OVERVIEW

Background

Blockchain is a type of database that allows users to store information in a safe, yet visible way across a network of participants. The theory behind the database was first presented by Satoshi Nakamoto with the publication of “Bitcoin: A Peer-to-Peer Electronic Cash System” in October 2008.³ Bitcoin was to function as a digital, alternative form of currency protected through cryptography, hence “cryptocurrency.” The blockchain technology would allow users to accurately track Bitcoin transactions. Thus through the structure of the database, Nakamoto sought to eliminate the need for intermediaries in digital transactions. The theory became a reality when Nakamoto launched Bitcoin a few months later in January 2009. Competing cryptocurrencies have since followed, until today there are over 1500.⁴

Although Bitcoin was not the first digital currency,⁵ it has gained popularity because of its ability (via the blockchain it’s built upon) to solve the “double-spend” problem that plagued previous digital payment systems.⁶ To understand this problem, contrast the purchasing process in the physical world with its online equivalent. In the physical world, when an individual buys a product or a service—think something as basic as a soda from the convenience store—money is exchanged for the good or

³ Satoshi Nakamoto, “Bitcoin: A Peer-to-Peer Electronic Cash System,” October 2008, <https://bitcoin.org/bitcoin.pdf>.

⁴ Cryptocurrency Market Capitalizations, “All Cryptocurrencies,” accessed February 7, 2018, <https://coinmarketcap.com/all/views/all/>.

⁵ This honor goes to DigiCash, created by David Chaum in 1990. See <https://bitcoinmagazine.com/articles/quick-history-cryptocurrencies-bbtc-bitcoin-1397682630/>.

⁶ It should be noted that Bitcoin’s solution is not the only viable method for addressing double spending. For another decentralized approach, see Stefan Brands, “Untraceable off-line cash in wallet with observers,” *Annual International Cryptology Conference* (August 1993): 302-318.

Traditional payment processors (e.g. banks, credit card companies, PayPal) make their money by auditing transactions to deter potential double-spending. This reliance on third-parties and its associated cost was a major driver of Bitcoin’s development.

service and the transaction is completed. With digital transactions, there is no way for the buyer and the seller to account for the uniqueness of the transaction because the digital representation of the money being exchanged is really just a “digital file that can be duplicated or falsified;”⁷ an “information asymmetry” exists.⁸ In other words, I could order a new t-shirt online with one copy of the digital file and then use another copy of the same digital file to buy shoes on another website.⁹

Blockchains solve the problem through a governance system known as a “proof-of-work” protocol¹⁰ and a process commonly called “mining.”¹¹ Understanding how this protocol and process solve the problem requires further explanation of the blockchain itself.

Technology

A blockchain is a digital ledger of transactions that are tracked across a distributed network of computers, called nodes (see Figure 1). Members of the network can look back through the ledger and see every transaction. Each new transaction is contained within a block and, once verified by the rest of the network, is added to the chain.

⁷ Usman Chohan, “The Double Spending Problem and Cryptocurrencies” (December 19, 2017): <https://ssrn.com/abstract=3090174> or <http://dx.doi.org/10.2139/ssrn.3090174>.

⁸Erik Bonadonna, *Networks II*, Course Blog for Cornell University INFO 4220, “Bitcoin and the Double-Spending Problem,” March 29, 2013, accessed February 7, 2018, <https://blogs.cornell.edu/info4220/2013/03/29/bitcoin-and-the-double-spending-problem/>.

⁹ Of course, this assumes that both websites accept the digital file as a form of payment.

¹⁰ Due to the high energy and monetary costs of the proof-of-work protocol, some cryptocurrencies, including Ethereum, have begun switching to an alternative “proof-of-stake” protocol. See Amir Rosic, <https://blockgeeks.com/guides/proof-of-work-vs-proof-of-stake/>.

¹¹ The term “mining” is a bit of a misnomer. While a byproduct of the process is that new tokens are brought into circulation and awarded to the “miner,” the coins are really just an incentive for miners to extend the blockchain and process transactions.

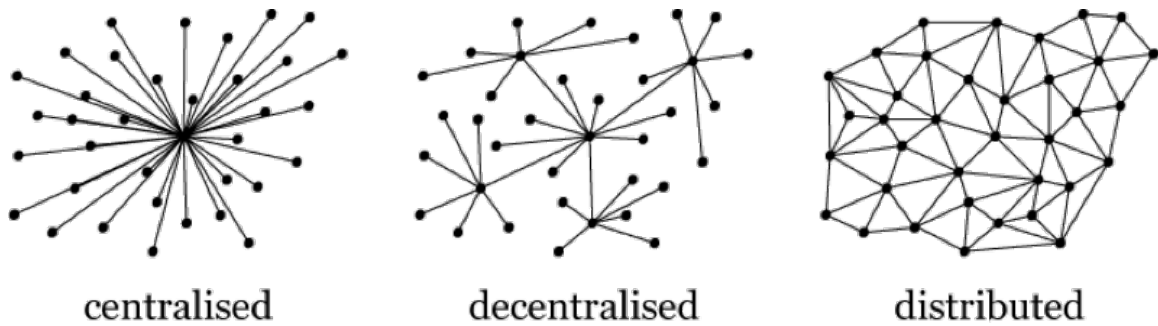


Figure 1: types of networks; each dot is a node in the network. Illustration by 1983, Wikimedia.

I think of blockchain like one of those giant group text message chains I’m occasionally added to. I may not have the number of anyone in the group, but I can see every text message sent. In this example, each text message represents a “block” of information, or the individual transactions of the blockchain.

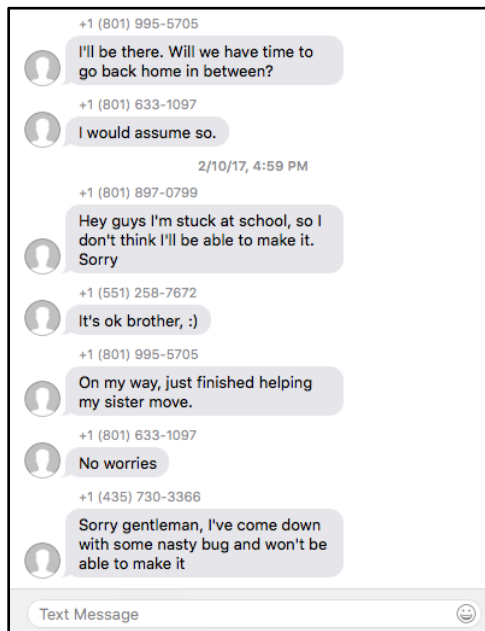


Figure 2: a blockchain is like a group text message chain; even without knowing the identities of the senders, I can still see all the “transactions” or messages by being a part of the “network.”

These blocks are timestamped so that every node in the network can view the group text message and determine the order of every text. To prevent troublemakers

from tampering with the text messages or blocks, each block is encrypted using a *hash* function, “a mathematical process that takes input data of any size, performs an operation on it, and returns output data of a fixed size.”¹² ›

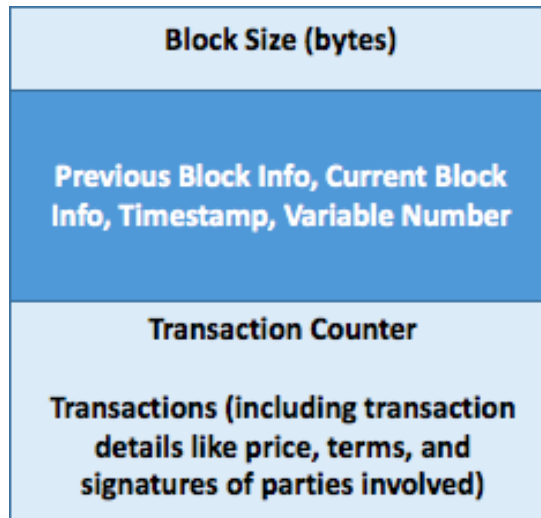


Figure 3: simplified composition of a block. Source: Rob Hennefer, EPA Private Equity.

To add a block to the chain, nodes within the network compete to complete a complex mathematical puzzle.¹³ The solution to the puzzle can only be achieved through sheer computing power as each node tests different potential solutions until one of the nodes cracks the puzzle; hence many nodes within cryptocurrency networks are composed of powerful servers.¹⁴ Once a solution has been found, the solution is broadcast throughout the network and verified. The verification can take “tens of minutes,” which seems like an eternity in the world of computing, but is a significant decrease from the processing time required for transactions through intermediaries.¹⁵ As soon as a majority of the computing power in the network has reached consensus

¹² Corin Faife, Coindesk, “Bitcoin Hash Functions Explained,” February 19, 2017, accessed February 7, 2018, <https://www.coindesk.com/bitcoin-hash-functions-explained/>.

¹³ Not all nodes in the network compete to solve the puzzle, but all nodes will verify the solution to the puzzle once a potential solution has been found.

¹⁴ To date, some of the largest acquisitions in the crypto space have been hardware, not actual cryptocurrencies. See Stan Higgins, Coindesk, “Maker of First Bitcoin Mining ASIC Acquired in What Could Be Industry’s Largest Sale,” June 8, 2016, accessed January 22, 2018, <https://www.coindesk.com/bitcoin-mining-asic-acquired-avalon/>.

¹⁵ Chohan, “Double Spending,” 4. See also Appendix A.

and verified the solution to the puzzle, the block is added to the end of the chain—becoming the most recent text in our metaphorical group text message—and the node that solved the puzzle is awarded a set amount of the cryptocurrency as a transaction fee or bounty. The rules governing this system and the requirement to solve the puzzle before adding the block with the encrypted transaction are collectively the “proof-of-work” protocol.¹⁶ Because the winner of the competition—the node that solved the puzzle—receives tokens that had not previously been in circulation, this entire competition process is referred to as “mining.”¹⁷ Therefore, each of the competing nodes in the network are often called “miners.”

Joining a network and “cashing out”

Individuals can join a public blockchain network such as the Bitcoin blockchain with relatively basic hardware, however the complexity of the software and its intimidating user interface discourages many non-specialists from participating in the network.¹⁸ Yet with a spare laptop (with at least 150GB of storage and 2GB of RAM), anyone can download the code for the public blockchain she would like to join and begin functioning as a node in the network, helping to verify solutions in the proof-of-work

¹⁶ This protocol was first developed in the early 1990s to deter distributed denial of service (DDoS) attacks from flooding email inboxes with spam. See Cynthia Dwork, Naor, Moni, “Pricing via Processing, Or, Combatting Junk Mail, *Advances in Cryptology*,” *CRYPTO ’92: Lecture Notes in Computer Science No. 740*. Springer (1993): 139–147.

¹⁷ The tokens that a miner receives for its work are not in circulation before being mined but had been written into the program and held in reserve so that when a puzzle was solved so many of the “buried” tokens would be released. The number of tokens released for each additional block changes over time. In the case of Bitcoin, there are currently about 18 million in circulation. Ultimately, this number will reach 21 million, at which point miners will no longer “unearth” new Bitcoin, but rather charge a fee for processing the transaction.

¹⁸ Although step-by-step instructions for setting up a node within a blockchain network, beginning to mine a cryptocurrency, or exchanging a cryptocurrency for a fiat currency are all beyond the scope of this paper, I have included general requirements to make the entire system a little more concrete. For further explanation, see <https://99bitcoins.com/step-by-step-guide-firing-up-bitcoin-node/>.

process.¹⁹ If a person is looking to start mining a cryptocurrency, he will need to invest in more powerful, specialized computer servers than the typical “lightweight” verifying nodes.

Like traditional currencies, cryptocurrencies can be exchanged for other cryptocurrencies and for an individual’s own fiat currency. For example, if I’m an American and want to change my Bitcoin into dollars, I can go through an online exchange that will charge me a small fee to exchange my Bitcoin into US dollars. These exchanges are targets for hackers because of their vulnerable position on the border between digital and “concrete” assets but do not have the same security of the immutable ledger.²⁰

Inherent characteristics

With this basic understanding of blockchain technology, we can return to blockchain’s initial value proposition and see how it prevents most cases of double-spending.²¹

Since every transaction is accounted for within the blockchain, anyone within the network can look back through the ledger and trace the movements of each token.

Blockchain is a particularly secure form of database for two reasons: 1) every node in the network has a copy of every transaction in the ledger, and 2) each block contains a portion of the information from the previous block. If hackers were to attempt to

¹⁹ Bitcoin Core, “What is a full node?”, accessed March 13, 2018, <https://bitcoin.org/en/full-node#what-is-a-full-node>.

²⁰ Emma Dunkley, “Problems at two cryptocurrency exchanges raise security concerns,” Financial Times, December 20, 2017, accessed March 13, 2018, <https://www.ft.com/content/aa9fdd64-e536-11e7-97e2-916d4fbacoda>. Yuji Nakamura, Tan, Andrea, “Massive Cryptocurrency Heist Spurs Call for More Regulation,” Bloomberg, updated January 29, 2018, accessed March 13, 2018, <https://www.bloomberg.com/news/articles/2018-01-28/massive-cryptocurrency-heist-puts-spotlight-on-exchange-security>, see also <https://blog.sqreen.io/cryptocurrency-exchanges-security/>.

²¹ Some forms of double-spending attacks still work, but in order to work both transactions must occur before the network has time to verify the first transaction. For this reason, blockchain is not optimal for instances when transactions need to be instantaneous or nearly instantaneous. For examples of this potentially harmful double-spending, see Chohan and Bonadonna.

change the data, they would need to control over 50 percent of the network's computing power and alter the block with the information they wanted to change, in addition to all the subsequent blocks in the chain.

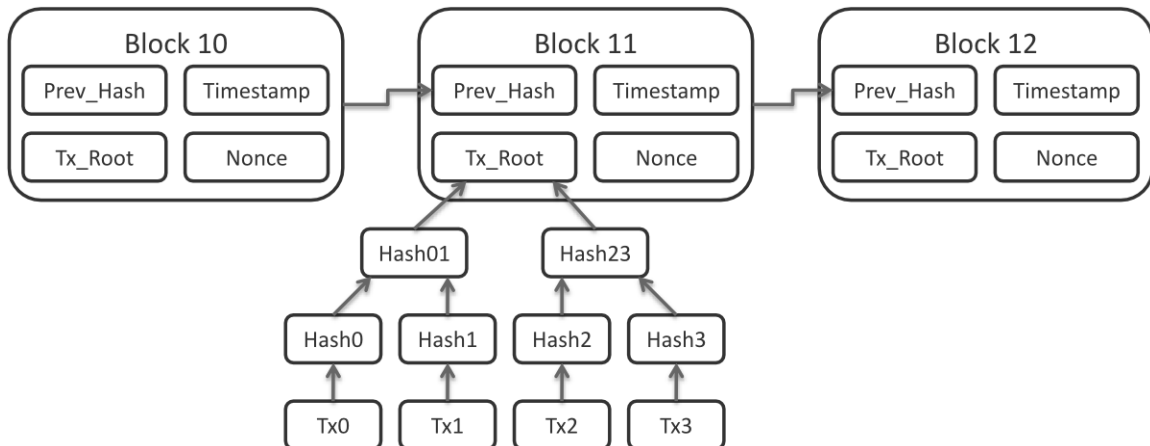


Figure 4: simplified composition of a blockchain.²² Illustration by Matthäus Wander, Wikimedia.

The characteristics of blockchain translate to three inherent strengths for the technology: transparency, security, and relative efficiency. These strengths, in turn, lead to an important result: they establish trust, or a proxy for trust, where trust otherwise doesn't exist. In other words, they eliminate the need for an intermediary. This outcome worries rent-seeking intermediaries, chief among them the federal government and banks, who currently benefit from the status quo and are threatened by the implications of blockchain.²³ In an early move to stem the threat of

²² The Tx_Root, or the Merkle Root, "is a reduced representation of the set of transactions that is confirmed with the block." The Nonce are arbitrary digits added on to the block to make the proof-of-work more difficult to solve. See <https://bitcoin.stackexchange.com/questions/12427/can-someone-explain-how-the-bitcoin-blockchain-works>.

²³ This concern may explain Jamie Dimon's criticism of Bitcoin: if he could persuade people to walk away from a new entrant threatening his firm's position while offering them a comparable alternative, he could possibly avoid being disrupted. Hence his condemnation of Bitcoin and his simultaneous endorsement of blockchain. See Polina Marinova, "Jamie Dimon: Bitcoin Bad, Blockchain Good," *Fortune*, <http://fortune.com/2017/09/13/jamie-dimon-bitcoin-blockchain/>. Since this statement, he has retreated somewhat, while still emphasizing the underlying blockchain technology: Tae Kim, "Jamie Dimon says he regrets calling bitcoin a fraud and believes in the technology behind it," CNBC, January 9, 2018, accessed February 6, 2018, <https://www.cnbc.com/2018/01/09/jamie-dimon-says-he-regrets-calling-bitcoin-a-fraud.html>. See also Julia La Roche, "JPMorgan's Farooq: Blockchain will have a radical impact on some of our businesses," Yahoo Finance, February 7, 2018, accessed February 7, 2018,

cryptocurrencies, over 40 financial institutions have backed their own distributed ledger.²⁴ The federal government has protested the cryptocurrency advances by dragging its feet. Ironically, such opposition may prove to be to the advantage of cryptocurrency—regulation too early may stymie innovation, even if it creates a “Wild West” landscape for the time being.

Understanding the technology also reveals under which conditions blockchain is not ideal. Some examples include 1) when no intermediary is involved, 2) when transactions are immediate and cannot be verified across the network quickly enough, 3) when data does not need to be redundant, and 4) when outsiders do not need information stored in the database. Finally, blockchain technology is susceptible to one weakness every database faces: if the data originally entered into the database is incorrect, the data generated will also be corrupted—garbage in, garbage out.²⁵ For blockchain, the immutability of transactions based on incorrect data is irrelevant.

These strengths and limitations inherent in the technology are central to the discussion of where blockchain belongs relative to other technologies. They also indicate which applications of the technology are most likely to succeed.

<https://finance.yahoo.com/news/jpmorgans-farooq-blockchain-will-radical-impact-businesses-220312432.html/>.

²⁴ Joel Dudley, “R3 secures record-breaking \$107m investment from 40 institutions,” Corda.net, May 23, 2017, accessed February 7, 2018, <https://www.corda.net/2017/05/r3-secures-largest-ever-investment-distributed-ledger-technology-usd-107-million-40-institutions/>.

²⁵ See Christian Catalini, “How Blockchain Applications Will Move Beyond Finance,” *Harvard Business Review*, March 2, 2017, accessed November 16, 2017, <https://hbr.org/2017/03/how-blockchain-applications-will-move-beyond-finance>.

III. TECHNOLOGY LOCATION

Because of its three primary strengths, blockchain has widespread appeal in industries outside cryptocurrency (e.g. finance, healthcare, logistics, real estate, insurance, etc.) as those industries scramble to see if or how blockchain's strengths influence them.

Locating blockchain in relation to other technologies allows us to consider historical analogies that may prove helpful in forecasting blockchain's impact across the economy. I refute the common conception that blockchain is a disruptive technology, and instead identify two broad technology categories, examining how well blockchain fits within each.

Disruptive technology

Almost daily, we see headlines claiming that blockchain will disrupt one industry or another. While these articles seek to express the potential impact of blockchain by employing the popular verb, *disrupt*, such use is sloppy. A technology isn't intrinsically disruptive: rather it can enable disruption as it can enable a company to sustain its competitive advantage. Technology is a component of disruptive innovation, as are the specific business model, resources, process, and priorities of the company built around the new disruption-enabling technology relative to the resources, process, and priorities of the incumbents.²⁶ Therefore, it is more precise to consider blockchain an enabling technology that may allow startups or established firms to succeed, depending on how they respond to and choose to incorporate or ignore it. This all may seem like splitting semantic hairs, but the implications are important: simply having a

²⁶ Correspondence with Aticus Peterson, Associate at Rose Park Advisors (<https://www.roseparkadvisors.com/>). Rose Park is the investment firm founded by Clayton Christensen, the father of "disruptive innovation."

cutting-edge technology infrastructure will not equate to market success; more important is how the technology is used.

Blockchain also does not fit the traditional model of disruptive innovation because it doesn't undercut and replace an incumbent as much as it eliminates the need for an intermediary altogether. In traditional cases of disruptive innovation, such as Toyota, the new entrant offers a lower-end product that attracts the customers least attractive to the incumbent (thus the incumbent cedes this group of customers to the entrant to retain the more desirable customers, those who pay for the higher-end products). As the entrant's technology and processes improve, the company attracts more and more of the incumbent's customer base until it has effectively "disrupted" the status quo of the industry. Toyota did not eliminate the intermediary (the car salesman), rather it gave the intermediary a better alternative by not overshooting customer needs.²⁷

A similar pattern exists with sharing economy companies, such as Airbnb and Uber (whose status as disruptors is debated, but for our purposes will be considered). While they did employ new technology to disrupt hotels and taxi services initially, they have not eliminated the need for intermediaries, but may have begun to replace them by offering the same service through different means. This brings us to our first great paradox of the blockchain: if someone owns it, they in essence become the intermediary, in which case the inherent strengths of the technology become moot and

²⁷ Clayton M. Christensen, Matt Verlinden, and George Westerman, "Disruption, disintegration and the dissipation of differentiability," *Industrial and Corporate Change*, vol. 11, no. 5, 955-993.

the company is better off with a traditional database because trust already exists within the owner organization.²⁸

Foundational technology

With this dilemma in mind, one solution is to build a product on a public infrastructure rather than attempting to create an independent ecosystem. Imagine, for example, if every website or company tried to create its own Internet. The reason the Internet works is because everyone agrees to use it, a classic example of the network effect. Currently, one major obstacle facing blockchain adoption is no single cryptocurrency or blockchain platform has hit a critical mass of users—how many people do you know who pay for things with Bitcoin?

Nevertheless, the potential is there for one of these platforms to emerge as the public ledger of choice, at which point blockchain could become the foundation of future economies.²⁹ Hence in Marco Iansiti and Karim R. Lakhani's January/February 2017 article for *Harvard Business Review*, they categorize blockchain as a foundational technology like the electrical grid or the Internet, one with “the potential to create new foundations for our economic and social systems.”³⁰ This opinion is well supported; others have made similar comparisons, most notably the TCP/IP protocol that made email possible.³¹

²⁸ The takeaway: when companies say they are exploring utilizing blockchain, dig a little to see if they are actually rebuilding their products on top of a platform like Ethereum, or if they are simply converting their current database to another.

²⁹ Steps have already been taken in this direction: Overstock.com accepts Bitcoin as a form of payment while IBM and Microsoft Azure have coalesced around Ethereum.

³⁰ Marco Iansiti and Lakhimi, Karim R., “The Truth about Blockchain,” *Harvard Business Review*, 95, no. 1 (January/February 2017): 120.

³¹ Steven Johnson, “Beyond the Bitcoin Bubble,” *The New York Times Magazine*, January 16, 2018.

The attempts to label blockchain as foundational come with the acknowledgement that laying such a foundation will take at least years, if not decades to achieve. Additionally, advocates of this label also admit that “the potential power of this would-be revolution is being actively undercut by the crowd it is attracting, a veritable goon squad of charlatans, false prophets and mercenaries.”³² That is to say, cryptocurrency is experiencing a bubble that is hindering the meaningful growth of the entire blockchain sector and that meaningful growth won’t come until after the bubble pops.

Niche technology

Classifying blockchain as a niche technology drastically limits the scope of its impact. If blockchain is a niche technology, it likely fits a few, specific use cases but will not see the massive adoption so many are predicting. If this is the right category for blockchain, once its bubble bursts, we will see it consistently used in only a handful of industries.

Surprisingly, one of the pioneers of the “blockchain revolution” classifies blockchain as a niche technology. Medici Ventures, a wholly owned subsidiary of Overstock.com, oversees “the company’s investments in firms building solutions leveraging and servicing blockchain technologies.”³³ The firm anticipates that blockchain will have a significant impact in a few key areas and restricts its investments accordingly: capital markets, money and banking, identity, voting, land, and underlying tech.

³² Ibid.

³³ Medici Ventures, “Our Story,” accessed October 20, 2017, <http://www.mediciventures.com/bio/>.

Medici Framework

Steve Hopkins, General Counsel and Chief Operating Officer at Medici, relies on a simple, two-question framework for assessing potential blockchain investments:

1. Is the idea actually a business?
2. Does the business need blockchain?

Many entrepreneurs are excited about blockchain's potential, but do not consider if their use of blockchain will result in a viable, revenue-generating venture or if the business would be successful even without blockchain. Instead, as entrepreneurs and established firms join in the pursuit of blockchain's white whale, many are quick to think up solutions that are economically infeasible or to bolt on the technology to a structure that fails to optimize blockchain's intrinsic strengths.

With regards to the first question in the framework, Hopkins gives the example of browser/micropayment platforms like Brave. Such platforms grant users access to an ad-reduced web surfing experience.³⁴ With the ad-reduced browser, verified advertising partners make micropayments recorded on the platform's blockchain to ensure that only precisely targeted ads reach the users most likely to benefit from the ad. While the concept sounds compelling by addressing a real user pain point, and although Brave is being developed by Brendan Eich of Mozilla Firefox fame, the numbers may not work out. Like many potential blockchain applications, Brave requires a critical mass before it sees success. Competing against Google, Brave seeks to employ blockchain to displace Google as the intermediary of web services, but

³⁴ Brave.com, "What is Brave Ad Replacement?", accessed March 14, 2018, <https://brave.com/about-ad-replacement/>.

Google earns in excess of \$95 billion from advertising.³⁵ Therefore, it is unlikely to cede this core element of its business. Google has maintained such dominance because of its reasonable pricing for advertisers³⁶ and general reliability for users.³⁷

An extreme example of the second question of the framework was the December 21, 2017 name change of Long Island Iced Tea to Long Blockchain.³⁸ Here is a company in the non-alcoholic drink space whose business model has no real use for a distributed ledger, yet relied on a bit of wordplay to see a temporary jolt in its price. The company hasn't made its intentions clear whether it would use blockchain to oversee its logistics and distribution, or if the name change indicates a more dramatic change in direction, a "long-jump" as described by Daniel A. Levinthal in "Adaptation on Rugged Landscapes,"³⁹ but statements from the executive team hint towards the latter option: "Our ultimate goal is to build a portfolio of investments that touch multiple points in the blockchain ecosystem."⁴⁰

Talk of an "internal blockchain" to be used for back office work in large organizations and major banks is a less subtle example of the second case. These businesses do not rely on a third party to validate a transaction and in many cases

³⁵ Alphabet Inc., Form 10-K fiscal year ended December 31, 2017, accessed March 14, 2018, <https://www.sec.gov/Archives/edgar/data/1652044/000165204418000007/goog10-kq42017.htm>.

³⁶ Google offers an extremely flexible pricing model: see Google AdWords, "Pay only for results," accessed March 14, 2018, https://www.google.com/adwords/costs/?channel=ha&subid=us-en-ha-g-aw-c-bk_mv_exa_1102-201167645-237671285912-kwd-32200984791.

³⁷ One notable exception was the YouTube child exploitation scandal, a scenario Brave could potentially avoid through its partner verification platform. See Lucy Handley, "Multiple advertisers put global YouTube ads on hold in wake of child exploitation scandal," November 27, 2017, accessed March 14, 2018, <https://www.cnn.com/2017/11/27/advertisers-put-youtube-ads-on-hold-after-child-exploitation-scandal.html>.

³⁸ Arie Shapira and Leinz, Kailey, "Long Island Iced Tea Soars After Changing Its Name to Long Blockchain," Bloomberg, December 21, 2017, accessed February 7, 2018, <https://www.bloomberg.com/news/articles/2017-12-21/crypto-craze-sees-long-island-iced-tea-rename-as-long-blockchain>.

³⁹ Daniel A. Levinthal, "Adaptation on Rugged Landscapes." *Management Science* 43, no. 7 (1997): 934-50, <http://www.jstor.org/stable/2634336>.

⁴⁰ Long Blockchain Corp., "Long Blockchain Corp. Enters into Letter-of-Intent with Stater Blockchain, UK-Based Business that is Building Blockchain Solutions for the Global Financial Markets," Corporate Information, Press Releases, January 16, 2018, <https://investors.longislandicedtea.com/>.

adding the hash algorithm and mining/proof of work features may slow down the process rather than increase efficiency. Following the slew of high-profile hacking incidents in 2017, blockchain may appeal to large data storers, but the security they seek in blockchain—the distributed and encrypted element—could be achieved without full-on blockchain. Companies pursuing a “blockchain strategy” who match the profile I’ve described are more than likely dressing up their security initiatives to capitalize on the crypto craze.

One use case that appears to meet both Medici’s requirements is that of remittance. Startups such as Circle and Abra have started to successfully disrupt legacy providers like Western Union and to challenge the previous upstarts like Xoom.⁴¹ These newcomers allow users to make mobile payments or money transfers across borders by using a blockchain infrastructure behind the scenes. By giving users a simple interface, Circle and Abra make sending money simple. But unlike other peer-to-peer money transfer platforms like Venmo, these companies do not collect interest on money in users’ accounts. Rather, a user texts the amount he or she wants to send, the transaction is recorded on the blockchain, and the recipient gets the money deposited in a digital wallet or account that the recipient can then withdraw in the local currency. Circle, for example, can offer this service at such low cost (virtually free) because its real business comes from its Circle Invest product, which allows users to invest in a range of cryptocurrencies.⁴²

⁴¹ Western Union has recently announced its own blockchain initiative based on the Ripple cryptocurrency as a measure to stem the adoption of blockchain-backed remittance services, but it remains to be seen if Western Union can successfully maintain its control on the market. See Josiah Wilmoth, “Western Union Taps Ripple for Blockchain Trial,” *ccn.com*, February 14, 2018, accessed February 14, 2018, <https://www.ccn.com/western-union-taps-ripple-for-blockchain-trial/>.

⁴² Circle, “How does Circle Invest make money?,” accessed March 14, 2018, <https://support.invest.circle.com/hc/en-us/articles/360000204286-How-does-Invest-make-money>.

IV. CONCLUSIONS AND FURTHER RESEARCH

A blockchain database, or distributed ledger, allows users to store information in a safe, yet visible way across a network of participants. Since virtually any information can be stored in the database, the possible use cases for blockchain appear to be limitless. Nevertheless, given certain characteristics of the technology: its transparency, security, and relative efficiency, some applications do not make sense currently.

Serious players in the space have started with the most obvious applications of the technology (e.g., speculation, capital markets, money and banking, land titles, and computer storage), but these may not prove to be the most profitable in the long run. Further research is needed to determine when specific companies, given their business model could actually benefit from blockchain, should adopt a blockchain infrastructure. This conversion is likely to occur once regulators have established clearer guidelines and more people have migrated to the crypto space.

Finally, since blockchain is likely in a pre-bubble period, an analysis of previous bubbles, particularly the dotcom bubble, would be helpful for predicting which blockchain-based companies are most likely to survive once the bubble bursts.

For now, leaders should be aware of blockchain and understand the basics of how the technology works. Blockchain has the potential to impact many industries, as we've seen as we have tried to classify it. But blockchain's major hurdle is the network effect: a critical mass of users needs to coalesce around one or two platforms and potential users need to understand its benefits. Until the technology can overcome these barriers, leaders are best off keeping an eye on blockchain from a distance.

When adopting blockchain makes sense.		
	Use blockchain	Find other option
Does trust already exist between parties?	No	Yes
Does the transaction need to be instantaneous?	No	Yes
Does everyone using the database need access to every transaction?	Yes	No
Is anonymity essential?	Yes	No

Table 1: When should a company consider implementing blockchain? When the technology aligns with its unique value proposition. These questions can help determine just that.

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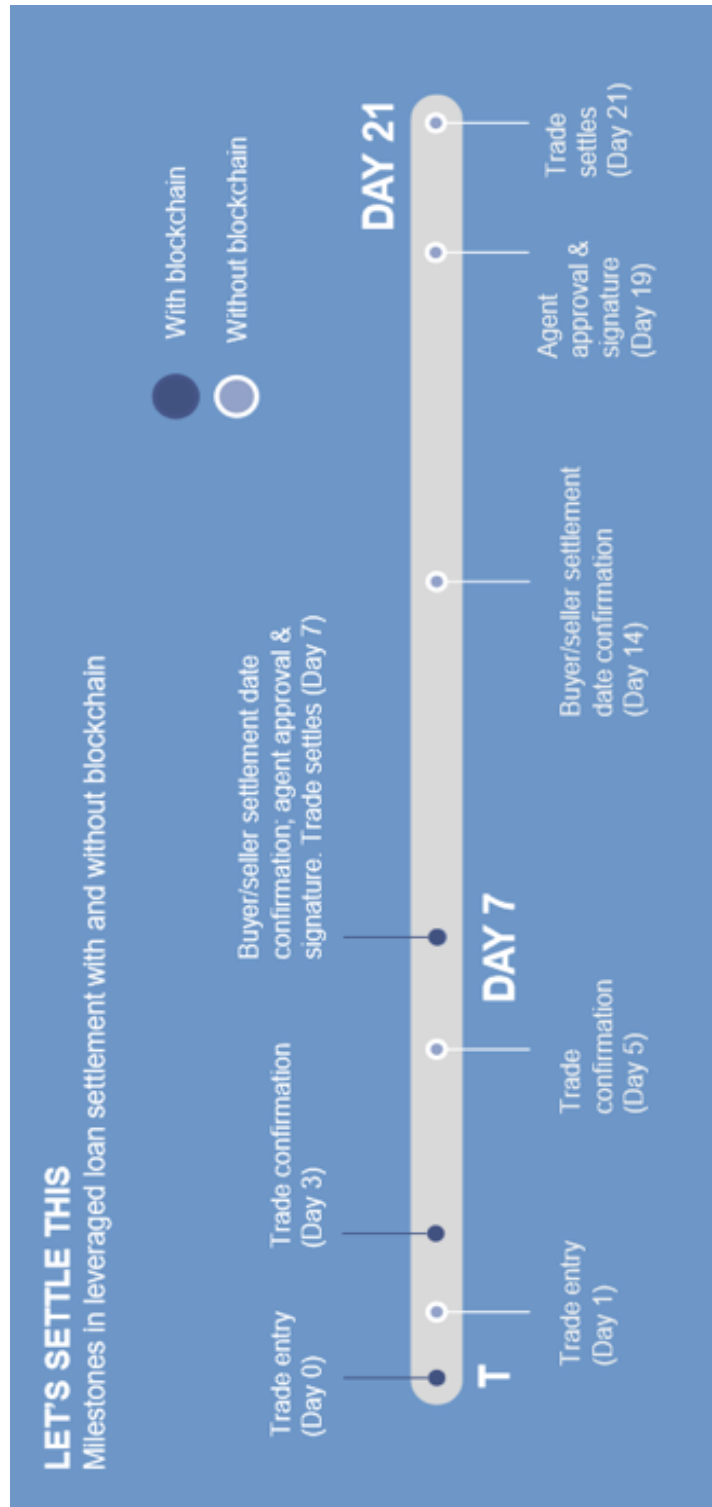
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APPENDIX



Decrease in transaction time with blockchain relative to traditional system.
 Source: Goldman Sachs GIR