

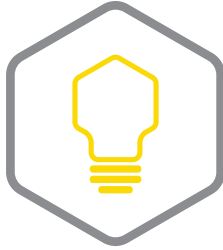
BUILDING A FRAMEWORK FOR BLOCKCHAIN ADOPTION

What CEOs Should Know

Irving Wladawsky-Berger

October 2017





Realizing the new promise of the digital economy

In 1994, Don Tapscott coined the phrase, “the digital economy,” with his book of that title. It discussed how the Web and the Internet of information would bring important changes in business and society. Today the Internet of value creates profound new possibilities.

In 2017, Don and Alex Tapscott launched the Blockchain Research Institute to help realize the new promise of the digital economy. We research the strategic implications of blockchain technology and produce practical insights to contribute global blockchain knowledge and help our members navigate this revolution.

Our findings, conclusions, and recommendations are initially proprietary to our members and ultimately released to the public in support of our mission. To find out more, please visit www.blockchainresearchinstitute.org.



Blockchain Research Institute, 2018

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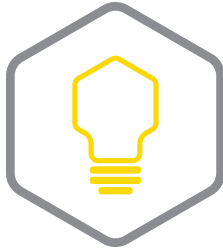
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Foreword

I have known, admired, and collaborated with Irving Wladawsky-Berger for a long time. We were pleased that he wanted to participate in our blockchain research program, and we asked him to take on a challenging and unique deliverable – a polemic that described the state of the blockchain phenomenon and predicted how it will evolve.

Wladawsky-Berger is a well-respected industry observer who also brings the insight of a practitioner with an almost forty-year career focusing on innovation and technical strategy at IBM. In this paper, he provides an annotated history of blockchain including his insights related to how the technology will transcend financial services and impact all aspects of business and society, providing examples related to distributed data, distributed computing, cryptography, game theory, and more.

He complements his insights with those of some of the top industry thinkers including Andy McAfee, Erik Brynjolfsson, David Clark, Primavera De Filippi, Clayton Christensen, and Geoffrey Moore as well as Alex and me. After his thoughtful analysis of the state of blockchain, Wladawsky-Berger describes what CEOs should consider doing to take advantage of it.



DON TAPSCOTT

*Co-Founder and Executive Chairman
Blockchain Research Institute*



Idea in brief

- » There are a number of instructive parallels between the development of blockchain and that of the Internet that should inform executive decision making and the timing of action taking.
- » The capabilities of blockchain as Internet 2.0—enabled by distributed computing, cryptography, and game theory—could help to overcome some of the Internet’s most serious limitations for business and economic activity, namely security, complexity, and trust.
- » Huge volumes of transactions are now taking place online among people, institutions, and things. At the same time, large-scale fraud, identity theft, and data breaches are becoming common.
- » Blockchain has the potential to become the Internet of Transactions, a secure system of record for every transaction that has ever occurred.
- » Blockchain technologies combined with reputation systems and platform strategies could help to manage risk, redistribute economic power, and further transform the nature of the firm.
- » For the technology to transition successfully to the mainstream market achieved by the Internet, the blockchain community must address major stewardship issues at platform, application, and ecosystem levels. Governance of standards is critical.
- » Executives must decide whether their companies should adopt blockchain early and start experimenting now or wait until the technology matures and risk lagging behind more aggressive competitors.



Introduction

I've been writing a weekly blog since May of 2005. Like its namesake, the *ship log*, a *web log* or blog reminds me how my views have evolved over time on the subjects I'm writing about. In this paper, I reflect and expand upon nine different blog entries that I posted between November of 2015 and September of 2017, to emphasize how my view of blockchain has evolved over time.

When I first learned about blockchain, I thought of it as the technology underlying bitcoin and other cryptocurrencies. While important, cryptocurrencies didn't really catch my interest. When people ask my opinion of bitcoin, I usually say that the development of digital money ecosystems is such a complex undertaking that we'd be wise, at least for now, to stick to traditional currencies (e.g., \$, £, €, ¥, ₩) that all the parties involved understand. Introducing new cryptocurrencies into the mix adds all kinds of complications that we might be better able to deal with once the evolution is well underway. But the more I learned about blockchain, the more intriguing I found its technologies—including distributed data, distributed computing, cryptography, and game theory—and its potential applications.

I became convinced that blockchain could potentially be as impactful as the Internet.

By the end of 2015, I was already convinced that blockchain had transcended its original objective as the architecture underpinning bitcoin. In my view, the best indicator that a technology will likely make it is its growing acceptance by the best and brightest and by institutions of all kinds. An increasing number of respected universities such as MIT, financial institutions such as Citigroup and MasterCard, IT companies such as IBM, think tanks like the World Economic Forum, and government agencies such as the Bank of England were taking it quite seriously and exploring its use and impact. I now thought it had the potential to transform not only the finance industry but many other aspects of our emerging digital economy. I explained my thinking in "Why blockchains could transform the economy," the first section of this paper.

Over the next several months, I also became convinced that blockchain could potentially be as impactful as the Internet, a technology I was very familiar with, since I'd been involved with it in one way or another over the past 25 years. While the Internet had been incubating in the research community for a number of years under the sponsorship of the U.S. Defense Advanced Research Projects Agency (DARPA), interest was building up in the general public. Then came the Netscape initial public offering on August 9, 1995. Its very high valuation took the world by storm. In the fall of 1995, Lou Gerstner, then chairman and CEO of IBM, commissioned a task force to recommend what IBM should do. The task force's overriding recommendation was that IBM should commit the resources of the entire company to lead this next wave of computing. Gerstner decided to form a new, cross-IBM group to lead this initiative. In December of 1995, he announced the formation of the IBM Internet Division and the appointment of me as its general manager.



My conviction that blockchain could be framed as Internet 2.0 was significantly strengthened by Don Tapscott and Alex Tapscott's *Blockchain Revolution*, which I wrote about in "Blockchain as another kick at the can," this paper's second section.

A few months later, "The Truth about Blockchain," a *Harvard Business Review* article by Marco Iansiti and Karim Lakhani, further contributed to my understanding of blockchain's long-term potential and similarities to the Internet and inspired the third section of this paper, "The Internet, blockchain, and the evolution of foundational innovations."

Over the next several months I continued to explore how blockchain technologies could help overcome some of the Internet's most serious limitations for business and economic activity, which I wrote about in the fourth section, "Is blockchain the next step in the evolution of the Internet?" Platforms are currently one of the Internet's main market strategies, and the fifth section, "Platforms, blockchains, and the evolution of trust," examines the implications of blockchains for platform strategies.

My hope is that, taken as a whole, the nine sections will help readers appreciate the potential and the value of blockchain, based on what we've all learned from the successful evolution of the Internet over the past two decades.

The next two sections compare the current state of blockchain to that of the Internet. Section six, "Is blockchain ready to 'cross the chasm'?" asks whether blockchain is ready to transition from early adopters to an early majority of users, a transition that the Internet went through in the early to mid 1990s. I based the seventh section, "On the governance of blockchain: Lessons from the Internet," on "Realizing the Potential of Blockchain," a recent report by the Tapscotts for the World Economic Forum that examines the major stewardship issues that blockchain must address to transition successfully to the mainstream market achieved by the Internet.

The eighth section, "Blockchain and the future of the firm," was inspired by Andy McAfee and Erik Brynjolfsson, co-authors of *Machine, Platform, Crowd: Harnessing Our Digital Future*. It explores the question of whether we still need the corporate form of organization in this day and age. The final section, "Should your company get on the blockchain learning curve now or wait," examines whether companies should adopt blockchain early and start experimenting now or wait until the technology matures a bit and risk lagging behind more aggressive competitors. It builds on my experience as general manager of the IBM Internet Division in the 1990s.

My hope is that, taken as a whole, the nine sections will help readers appreciate the potential and the value of blockchain, based on what we've all learned from the successful evolution of the Internet over the past two decades.



1. Why blockchains could transform the economy

In October 2015, *The Economist* featured the blockchain on its cover: "The Trust Machine: How the technology behind Bitcoin could change the world."¹ Its two articles on the subject explained what blockchains were and why we should care about an exotic technology that involved concepts from cryptography (using public/private keys to create a unique identity), game theory (achieving trust and consensus despite the existence of bad actors in the networks), and distributed computing (efficiently propagating transaction updates across the nodes of a large distributed network).

Right up front, the *Economist* distinguished among three related but distinct notions that people often use interchangeably when discussing blockchains:

- » *Bitcoin* is the original, best known, and most widely held cryptocurrency (synonymous with digital currency), whose users can transact directly with each other without a central authority, be it a bank or government agency, to certify the validity of the transactions.²
- » *Blockchain* refers to the architecture underpinning bitcoin, the protocols of which were specifically designed to control the creation and transfer of bitcoins.
- » Blockchain technology as a general concept encompasses any distributed database architecture with the ability to handle peer-to-peer transactions where no party needs to know or trust each other for transactions to complete securely without alteration or delay.

The advanced technologies and architectures underlying blockchains are increasingly accepted as having important implications far beyond bitcoin and other cryptocurrencies.

Bitcoin has had a mixed reputation because of its wild fluctuations in value, links to illicit activities such as drug trafficking, and the early stumbles of the Bitcoin Foundation, culminating in the arrest of a board member for embezzlement. Bitcoin-specific blockchain concepts like *mining*, which describes the process for earning bitcoin as a reward for running the full Bitcoin protocols, might well be perceived as too wasteful of computing power and electricity by all but the most libertarian of bitcoin supporters. The advanced technologies and architectures underlying blockchains are increasingly accepted as having important implications far beyond bitcoin and other cryptocurrencies.

Blockchain's beachhead: Financial services

For starters, the blockchain holds promise for revolutionizing the finance industry by bringing one of its most important and oldest concepts, the ledger, into the Internet age. The earliest ledgers hark back to ancient Mesopotamia, where writing first evolved thousands of years ago and enabled people to keep track of financial records.



The modern ledger arose from the double-entry bookkeeping, developed among the merchants of renaissance Italy as commerce and banking flourished.

A fairly long time often passes between the emergence of a disruptive technology and the development and implementation of the processes that organizations require to leverage the technology properly. Banks first automated each of their individual ledgers, but only now might blockchain truly transform the financial system.

Electricity and manufacturing offer a good analogy. When electric motors were first developed in the late 19th century, they were deployed to replace big steam engines as sources of power. Factory managers took several decades to realize that, instead of having one central source of power, they could now fit small electric motors in each machine on the plant floor, thus leading to far more productive and flexible manufacturing processes.

In the early years of the IT industry, different vendors brought to market their own proprietary networking systems, such as IBM's Systems Network Architecture and Digital's DECnet. These worked quite well as long as all communications occurred within the same company using the same vendor's architecture. But going across companies and vendors was quite unwieldy. Sending an e-mail from an IBM application to another user in a different institution using another vendor's application was quite cumbersome, often requiring extra steps because of the lack of standards.

Once the Internet was widely embraced in the 1990s, sending an e-mail was a breeze. Everyone was using the same standards, including open source implementations of key protocols. Rather than developing their own proprietary networks and struggling to interconnect with those of others, institutions collaborated on developing the common Internet architecture and Internet-based applications like e-mail and the Web, which they all used.

A similar story played out with Unix, developed within AT&T Bell Laboratories in the late 1960s and early 1970s. In the 1980s, Unix became a popular operating system for technical workstations, supercomputers, and other kinds of systems. The problem was that every vendor had developed its own version of UNIX—IBM's AIX, Sun's Solaris, HP's HP-UX, and so on—and they were all somewhat different and incompatible with each other, so that users could not easily port applications across them. Various attempts to unify UNIX failed, mostly because the vendors didn't trust each other. Finally, in the 1990s and informed by an ongoing dialogue with peers, Linus Torvalds' Linux emerged as an open source Unix-like operating system that just about all vendors have embraced over time.³ As was the case with the Internet, the outside-in, collaborative governance of Linux helped it succeed in essentially unifying UNIX where previous efforts failed.

A 2014 report by the Bank of England argued that the time might well have come for *the ledger* to take the collaborative standards-based

Banks first automated each of their individual ledgers, but only now might blockchain truly transform the financial system.



approach of those earlier innovations. The classic ledger—"a process that has not changed since the 16th century," according to the Bank of England—may now be evolving into a blockchain-based distributed ledger, a major technological innovation not only for payment systems but for the finance industry as a whole.

The report went on to describe how modern banking has emerged as a computerized replication of earlier paper-based systems, where intermediaries (i.e., banks) kept master ledgers that served as the authoritative records of each party's holdings. In turn, these intermediaries usually held accounts with central banks. Those keeping the ledgers could bar any transaction they deemed invalid. To use the system, people had to trust these intermediaries to maintain the centralized ledgers with integrity.⁴

The report discussed an alternative approach: decentralize the payment system, share copies of the ledger among all parties, and establish a process whereby participants could agree on any changes to the ledger. If every party could check the validity of a proposed transaction, then no single party would have full power over the system.

The classic ledger—"a process that has not changed since the 16th century," according to the Bank of England—may now be evolving into a blockchain-based distributed ledger, a major technological innovation.

Better risk management

Why should the finance industry embrace such a shared, distributed public ledger that everyone can inspect but no single entity controls? Why not continue to rely on centralized institutions like banks, clearinghouses, and government authorities to certify the trustworthiness of the proprietary ledgers they each manage?

Better risk management is one reason for sharing the ledger. With blockchain-based distributed ledger technologies, we can implement a fully decentralized payment system in which all participants share copies of the ledger. Every participating institution can thus check and validate transactions without a central authority to vouch for the integrity of the system. Beyond the general decline in trust in governments and banks in recent years, the Bank of England cited several risks inherent in our current banking system, which blockchain technology could help to mitigate:

- » Credit risk, where a paying bank goes bankrupt and owes a large sum of money to other members of the system.
- » Liquidity risk, where a fundamentally solvent bank lacks the funds to settle a payment when it is due.
- » Operational risk, where something (such as IT failure) permanently or temporarily interferes with a bank's ability to perform its duty in a payment transaction.

In a distributed financial system, payers make payments directly to payees, thus removing the credit and liquidity risks. The main responsibility of the institutions (such as banks, brokerage houses, and commodity markets) involved is to oversee the trustworthiness,



Such a distributed system should be significantly more resilient than our current banking systems.

security, efficiency, and governance of the distributed ledger system, ensuring that stakeholders have properly implemented the cryptographic technologies and protocols. Like the Internet, such a distributed system should be significantly more resilient than our current banking systems because of the large numbers of redundant blockchains and pathways in the network.

Keep in mind that we use ledgers to keep track of valuable economic assets besides money, and so we will likely use blockchain-based distributed ledgers for more than payment systems. Financial institutions could use them to track stocks, bonds, loans, and similar such assets. Governments could use them to record the ownership of land, houses, cars, and other valuable physical assets as well as the attestation of birth certificates, passports, and other forms of identity. With its rapid growth, the Internet of Things requires the kinds of capabilities offered by blockchain technologies, namely, distributed peer-to-peer architectures, near unlimited scalability, privacy, security, and the ability to handle myriads of trustless transactions with efficiency.⁵

Blockchains enable institutions that don't know or trust each other to build highly secure and scalable ledgers of all sorts. It's a worthy companion to the Internet, with which it shares many architectural characteristics. Like the Internet, it might well lead to many innovative applications that we can barely imagine today.

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Once a major innovation takes hold in the marketplace, it acquires a life of its own. It is truly a brainchild that matures and is co-opted in both expected and quite unexpected ways, which are at times even objectionable. In the 1990s, the Internet was giving rise to all kinds of innovations, particularly applications for communications, content, and commerce. But we couldn't foresee then that, a decade later, the Internet would enable music and video streaming, social media interactions of all kinds, and what became known as "big data," let alone the huge impact the Internet has had more recently on artificial intelligence, machine learning, surveillance, on-demand or sharing platforms, and the very advent of blockchain.

2. Blockchain as another kick at the can

"It appears that once again, the technological genie has been unleashed from its bottle," wrote Don Tapscott and Alex Tapscott in the opening paragraph of their book, *Blockchain Revolution*. "Summoned by an unknown person or persons with unclear motives, at an uncertain time in history, the genie is now at our service for another kick of the can—to transform the economic power grid and the old order of human affairs for the better. If we will it."

Don, whom I've known a long time, has a knack for identifying the next big thing and then quickly writing a book to explain it



to everybody else. In *The Digital Economy*, published in the mid 1990s, Don anticipated the unbundling of vertically integrated companies into business webs, giving rise to the open networked enterprise. In his 2006 book, *Wikinomics*, he predicted the rise of mass collaboration in what has become known as the sharing or on-demand economy.

Blockchain Revolution, his sixteenth book, now explains “How the Blockchain Will Transform Everything from Banking to Government to Our Identities.” The book’s success should reassure early investors in, and early adopters of, the technology that the blockchain is truly reaching a tipping point in terms of big ideas.

The Tapscotts positioned the blockchain as the next generation of the Internet, a means of achieving what many had hoped the Internet would achieve in terms of radically increasing economic opportunity and advancing human rights: “Overall, the Internet has enabled many positive changes—for those with access to it—but it has serious limitations for business and economic activity.”⁶

Foremost among these limitations are privacy, security, and inclusion. “Doing business on the Internet requires a leap of faith,” the Tapscotts wrote, because the infrastructure lacks the necessary protections.

The book’s success should reassure early investors in, and early adopters of, the technology that the blockchain is truly reaching a tipping point in terms of big ideas.

Design choices of the Internet pioneers

Why wasn’t stronger security designed into the original Internet protocols? MIT research scientist and Internet pioneer David Clark addressed this question in a 2016 article about the early design choices that have led to today’s Internet.⁷

Clark wrote that the Internet is fundamentally a general purpose data network supporting a remarkable variety of applications. By *general purpose*, he meant that designers didn’t want to prevent users from developing applications that suited their purposes. That was a major design choice, best appreciated when we consider the alternatives, such as the telephone network designed specifically to carry telephone calls, or payment network designed only to transfer money and settle financial transactions. I think this generality has enabled the Internet to become *one of*, if not, *the* most prolific innovation platforms the world has ever seen.

In the world of computing, *platform* means a product specifically designed to attract an external ecosystem that generates complementary products or service offerings, thus generating much greater potential for innovation and growth. Linux, Windows, Android and iOS are all examples of successful platforms, as are the overall business strategies of Amazon, Facebook, Uber, and Airbnb.

Network effects are a central feature of platforms: the more products and services a platform offers, the more users it will attract. Scale increases the platform’s value and helps it to attract



more complementary offerings, which brings in still more users and potentially leads to a platform's explosive growth.

Over the years, the Internet has faced a number of serious challenges, including running out of IP addresses and lacking the necessary bandwidth to handle the growing requirements for streaming high-quality video. So far, it has been up to its challenges. But, the Internet's success has come at a price: it is good enough but not optimal for any single application.

A major reason for its adaptability is that it has stuck to its basic data-transport mission, that is, just moving bits around. The Internet has no idea what the bits mean or what they're trying to accomplish. Interpreting the meaning and the purpose of the bits is the responsibility of the applications running on top of it. If app users require or expect security as a condition of usage, then the app or the platform on which it runs (e.g., iOS, Windows) is responsible for providing it.

In other words, there's no single or central entity responsible for the overall security of bits traveling across the Internet, which I'd argue is the biggest challenge currently facing the Internet. As Clark pointed out, "the design decisions that shaped the Internet as we know it likely did not optimize secure and trustworthy operation." I hope that's what the blockchain will now help us to do.

The responsibility for Internet security has fallen to the various operating systems, application platforms, and the applications themselves.

Design principles of blockchain era

The design for the blockchain first came to light around 2008, when "a pseudonymous person or persons named Satoshi Nakamoto outlined a new protocol for a peer-to-peer electronic cash system using a cryptocurrency called bitcoin," wrote the Tapscotts.⁸ "This protocol established a set of rules—in the form of distributed computations—that ensured the *integrity* of the data exchanged among these billions of devices *without going through a trusted third party*."

Satoshi had engaged the members of a cryptography listserv to flesh out how the system would operate and why people might want to use it. Insightful people began wrapping their heads around the idea that, to do business directly with total strangers, we could rely on clever code and elegant mathematics instead of society's long established brokers of trust. The Tapscotts described the nature of this breakthrough: "This had never happened before—trusted transactions directly between two or more parties, authenticated by mass collaboration and powered by collective self-interests, rather than by large corporations motivated by profit."

The Tapscotts drew this analogy: *the Internet is to data as the blockchain is to value*. Just as we have the World Wide Web of distributed information, we have "the World Wide Ledger of value...a distributed ledger representing a network consensus of every transaction that has ever occurred."



Satoshi's original vision for the blockchain focused on a single application, a payment system that both minted and used bitcoin, a digital currency. On the Bitcoin blockchain, users could transact directly with each other without a bank or government agency to certify the validity of the transactions. Satoshi hadn't written about creating the next generation of the Internet or fundamentally transforming how the economy works. But, as has been the case with the Internet and World Wide Web, the blockchain has now transcended its original objective.

In the course of researching their book, the Tapscotts talked to a lot of people and read many publications to better understand the potential of blockchain in shaping the evolution of the digital economy. From their research emerged a number of themes, which they distilled into seven blockchain design principles:

On the Bitcoin blockchain, users could transact directly with each other without a bank or government agency to certify the validity of the transactions.

- » **Networked integrity:** "For the first time ever, we have a platform that ensures trust in transactions and much recorded information no matter how the other party acts," they wrote. They called trust as an intrinsic design feature, not extrinsic to a platform or application. That means that integrity is programmed into every step of a process so that it remains decentralized and not vested in any single party.
- » **Distributed power:** "The system distributes power across a peer-to-peer network with no single point of control. No single party can shut the system down." This principle speaks to the shared nature of ledgers and the management of operational risk: the failure of one bank's system, for example, would not interfere with the overall payment ecosystem's performance.
- » **Value as incentive:** "Now we have a platform where people and even things have proper financial incentives to collaborate effectively and create just about anything." The Tapscotts were writing about how the protocols aligned the incentives of all the stakeholders and rewarded participants fairly for their contributions.
- » **Security:** "Safety measures are embedded in the network with no single point of failure, and they provide not only confidentiality, but also authenticity and nonrepudiation to all activity." They were underscoring that, "In the digital age, technological security is obviously the precondition to security of a person in society."
- » **Privacy:** "People should control their own data. Period. People ought to have the right to decide what, when, how, and how much about their identities to share with anybody else," the Tapscotts wrote. Holding vast amounts of other people's data has proven to be both an asset and a liability. What seems more valuable than a large set of data is the organizational capability to analyze it and generate actionable insights. With blockchain technology, corporations may not need to collect



and then protect consumer or even employee information in order to analyze big data or hire the best talent.

- » **Rights preserved:** “Ownership rights are transparent and enforceable. Individual freedoms are recognized and respected.” This design principle covers real and intellectual property rights as well as such basic human rights as free speech and free press. Applied to blockchain-based platforms, it makes owners more discoverable for the purpose of, say, licensing a patent or a copyrighted work.
- » **Inclusion:** “The economy works best when it works for everyone. That means lowering the barriers to participation. It means creating platforms for *distributed capitalism*.” The Blockstream Satellite is a great example of this principle in action. The start-up Blockstream has harnessed a network of satellites not only to broadcast bitcoin transactions in real time everywhere in the world but also to provide free access to the Bitcoin network.⁹

Security is one of the main deficiencies, if not the main deficiency, of the Internet that we’re now trying to address with blockchain, identity management, and related technologies. It’s up to us to continue its evolution.

The Tapscotts saw these seven principles as guides “to designing the next generation of high-performance and innovative companies, organizations and institutions. If we design for integrity, power, value, privacy, security, rights and inclusion, then we will be redesigning our economy and social institutions to be worthy of trust.” I couldn’t agree more.

Given how incredibly successful the Internet has become over the intervening three decades, the Internet pioneers clearly made wise design choices. I really admire what they accomplished. In retrospect, we might wish that they had paid more attention to security back then. Security is one of the main deficiencies, if not the main deficiency, of the Internet that we’re now trying to address with blockchain, identity management, and related technologies. It’s up to us to continue its evolution.

3. The Internet, blockchain, and the evolution of foundational innovations

Last year, a panel of global experts convened by the World Economic Forum selected blockchain as one of the top ten emerging technologies for 2016, based on its potential to fundamentally change how economies work.¹⁰ But, how transformative will blockchain turn out to be? How long is the transformation likely to take? How will it compare with the Internet-based transformation of the past few decades?

Our economic and legal systems rely on contracts and transactions among parties and on records of those transactions. They govern



the interactions among individuals, organizations, and nations. They establish identity, ownership of assets, rights and duties, and the boundaries between entities. But, as Harvard professors Marco Iansiti and Karim Lakhani explain in their *Harvard Business Review* article, "The Truth about Blockchain," if these tools and their administration have not kept up with our increasingly complex, fast-changing digital world, then they have the effect of "rush-hour gridlock trapping a Formula One race car."¹¹ Iansiti and Lakhani nicely provide one of the best descriptions I've seen of the long-term promise of blockchain technology:

With blockchain, we can imagine a world in which contracts are embedded in digital code and stored in transparent, shared databases, where they are protected from deletion, tampering, and revision. In this world every agreement, every process, every task, and every payment would have a digital record and signature that could be identified, validated, stored, and shared. Intermediaries like lawyers, brokers, and bankers might no longer be necessary. Individuals, organizations, machines, and algorithms would freely transact and interact with one another with little friction.¹²

Blockchain is a foundational technology like electricity and the Internet, the transformational impact of which takes decades rather than years.

Such a blockchain-based transformation is still many years away. That's because blockchain is not a *disruptive* technology, whose impact is often quite rapid, once it hits the marketplace. Blockchain is a *foundational* technology like electricity and the Internet, the transformational impact of which takes decades rather than years.

The concept of *technological discontinuities* or disruptions, formulated by Dick Foster of McKinsey in 1986 and popularized by Clayton Christensen of Harvard Business School in 1995, has become widely accepted as a mental model for thinking about innovation-driven growth, but it has been often misunderstood and misapplied in two ways.¹³ First, because the theory has been so broadly disseminated, people often apply *disruptive* to innovations that are more incremental or sustaining in nature. Second, as is the case with blockchain, their full transformational impact might well take decades to play out.

According to Christensen, a *disruptive innovation* is one that successfully challenges a traditional product or business model with a lower cost solution, typically developed by a small company with few resources.¹⁴ What makes disruptive innovations dangerous to incumbent firms is that, if allowed to gain a market foothold, they can get on a learning curve of rapidly improving quality and capabilities while preserving the lower prices and/or ease of use that drove their early acceptance. Consequently, they can end up creating new markets and toppling the incumbents from their leadership position, as has been the case with word processing, digital cameras, and smartphones. Foster called this position the *attacker's advantage*. To neutralize it, incumbents had to stop thinking solely about defending cash flows, usually by doubling down on existing process R&D, and start thinking about identifying new sources of competitive advantage, often by investing in new product R&D.¹⁵



Foundational innovations must overcome many barriers—technological, organizational, governance, political, and social.

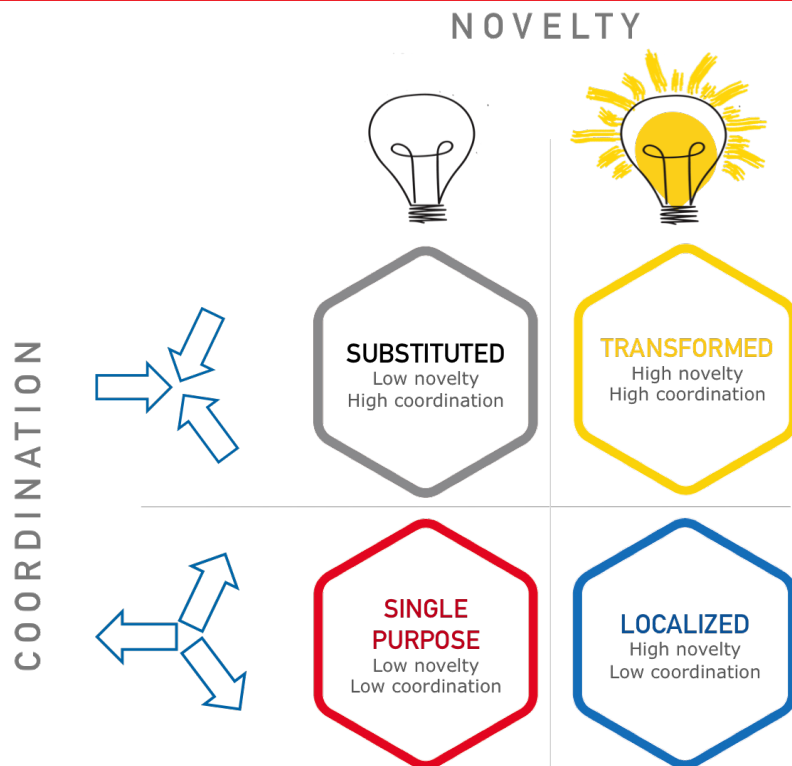
Blockchain has the potential to transform our economic and social systems. But the adoption process of *foundational* technologies like blockchain is gradual, incremental and steady, unlike the hockey stick portion of the adoption S-curve we typically associate with disruptive innovations. Foundational innovations must overcome many barriers—technological, organizational, governance, political, and social. While the impact of blockchain could well be enormous, its full transformational impact may well be decades away.

What's the likely adoption process for foundational technologies like blockchain? Iansiti and Lakhani explored this question by examining the decades-long evolution of a highly successful foundational technology we're all familiar with—the Internet—and then developed an adoption framework consisting of four phases. They defined each phase by the degree of novelty—low or high—of the applications supported and by the complexity required to coordinate the various elements of the application. Let's look at these four phases as they apply to the Internet (Figure 1).

Single use (low-novelty, low-coordination)

The Advanced Research Projects Agency Network (ARPAnet), the precursor of the Internet, first gained traction in the 1970s as the basis for e-mail among a relatively small number of researchers involved in its development. Its packet switching architecture didn't

Figure 1: Four phases of technology adoption



See Marco Iansiti and Karim Lakhani, "The Truth about Blockchain," *Harvard Business Review*, January-February 2017.



require pre-established connections as existing circuit switching networks did.

This first step should be simple, as it's essentially a way of testing the new technology with an easy-to-implement, low-novelty, low-coordination application, to see whether it will lead to a less costly, simpler solution. We often cannot differentiate between disruptive and foundational innovations in their early stages because their objectives look so similar.

Bitcoin put blockchain on the map, just like e-mail did for transmission control protocol/Internet protocol (TCP/IP).

Bitcoin has played a similar role for blockchain. Introduced in 2008, it offers an alternative peer-to-peer payment method that enables a relatively small number of users around the world to transact with each other directly, without a financial or government intermediary. Bitcoin put blockchain on the map, just like e-mail did for transmission control protocol/Internet protocol (TCP/IP).

Localization (high-novelty, low-coordination)

In the 1980s, the use of ARPAnet was expanded, and IBM worked closely with the National Science Foundation and other collaborators in developing NSFNET, an Internet-based network that linked together universities, supercomputing centers, and other research communities. These TCP/IP networks were deployed within their respective institutions but operated across institutions through the use of common protocols, giving rise to the network of networks that became known as the Internet. Commercial users were still not allowed to participate at this stage.

Beyond e-mail, use of the Internet expanded to include the transfer of files, access to computers, voice and video connections, and other applications, all of which demonstrated that TCP/IP was a general purpose architecture that could, over time, replace existing computer and telecommunication networks.

Blockchain is now entering this second phase. Private blockchain-based prototypes are now taking place, mostly involving small number of firms in the financial services industry.¹⁶ "We anticipate a proliferation of private blockchains that serve specific purposes for various industries," noted Iansiti and Lakhani.

Substitution (low-novelty, high-coordination)

The advent of the World Wide Web in the early to mid 1990s brought the Internet to its third phase, its adoption by the much larger commercial world. It was in this phase that IBM made the decision to embrace the Internet across the whole company. The emphasis was now on scalability and coordination, that is, the ability to support a fast growing number of users, content, and applications. Given that the Internet and Web were now reaching a large, new user audience, companies realized that their early third phase applications had to be relatively intuitive and easy to use.

"We anticipate a proliferation of private blockchains that serve specific purposes for various industries."



MARCO IANSITI
David Sarnoff Professor of
Business Administration
Harvard Business School

KARIM R. LAKHANI
Professor of Business
Administration
Harvard Business School



Internet-based platforms have given rise to ecosystems and network effects, also referred to as network externalities or demand-driven economies of scale, whereby a network reaches a cost-value tipping point and starts paying off as it adds new members.

In my opinion, customer self-service was the killer app of the early commercial Internet. In fact, outsourcing to the customer was considered one of the design principles for unleashing killer apps in the mid to late 1990s.¹⁷ These kinds of apps were simple, yet quite useful. They made it easy to do for ourselves what many ordinary activities previously required a trip to a store or a phone call during business hours. We could access the latest sports results, check the weather of any city in the world, track the status of FedEx and UPS packages, or buy a book or compact disc online with nothing more than a browser, an Internet connection, and a credit card or bank account. Users could now easily access for themselves whatever information they wanted any time, day or night.

Transformation (high-novelty, high-coordination)

A decade later, the Internet moved into its fourth phase. By this phase, IBM no longer needed a separate Internet division to coordinate Internet activities across the company. The Internet had become integrated into all aspects of IT and was thus part of every unit's strategy. Along with smartphones, cloud computing, social media, big data analytics, and related technologies, the Internet has been systematically transforming one industry after another.

Internet-based platforms have given rise to ecosystems and network effects, also referred to as *network externalities* or *demand-driven economies of scale*, whereby a network reaches a cost-value tipping point and starts paying off as it adds new members.¹⁸ The more products or services a platform offers, the more users it will attract, helping it then to attract more offerings, which in turn brings in more users, which then makes the platform even more valuable. Moreover, the larger the network, the more data are available to customize offerings to user preferences and better match supply and demand, further increasing the platform's value.

The Internet protocol suite took three decades to move through these four phases. Iansiti and Lakhani drew parallels between the TCP/IP and the Bitcoin protocols. Where the former enabled the sending of information in the form of e-mail from one person to another without going through an intermediary institution such as a post office, the latter enables the sending of value in the form of Bitcoin from one person to another without going through a trusted third party like a bank or wire service. The development and maintenance of both the Internet and the blockchain are open, shared, and distributed among volunteers around the world. The blockchain promises to reduce those transaction costs—particularly around contracting and preserving rights—that the Internet has not yet been able to reduce.

How long will this all likely take? "If bitcoin is like early e-mail, is blockchain decades from reaching its full potential?" Iansiti and Lakhani asked. Their answer was a qualified yes. The blockchain transformation of the economy will require some global consensus around standards and processes across institutions as well as major

"If bitcoin is like early e-mail, is blockchain decades from reaching its full potential?"



MARCO IANSITI
David Sarnoff Professor of
Business Administration
Harvard Business School

KARIM R. LAKHANI
Professor of Business
Administration
Harvard Business School



social, legal, and political change. It's very hard to predict how long this will take.

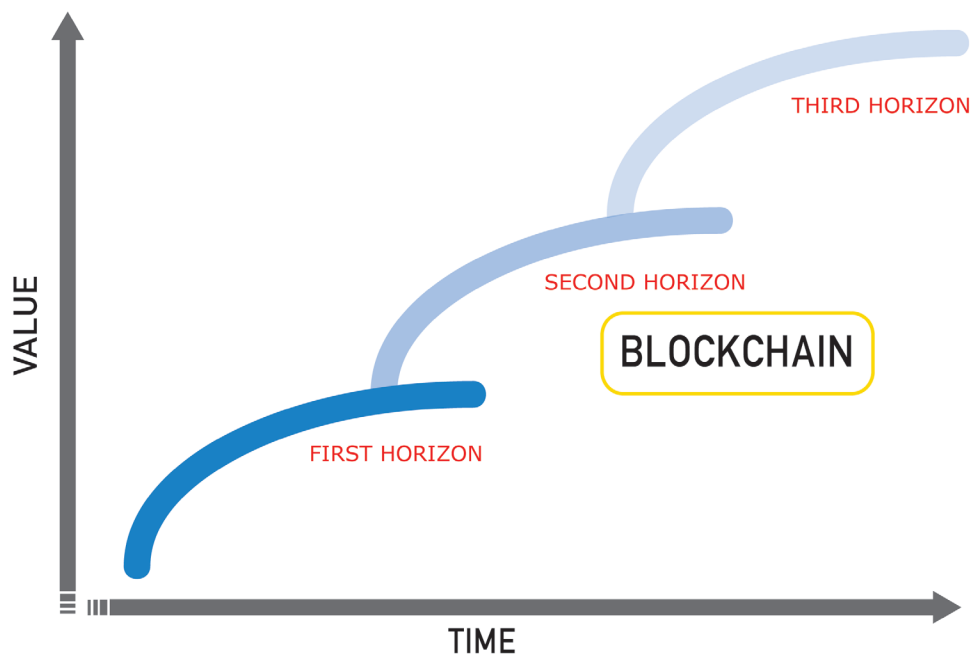
Some companies use the "three horizons framework" to manage their investment strategies and assess opportunities for growth.¹⁹ The first horizon includes the existing core business of the company, which provides the greatest profits and cash flow. The second horizon encompasses emerging opportunities that start-ups and competitors are already pursuing and that could require substantial investments. The third horizon includes potentially transformative projects still in the research stage, where their overall impact and timeframes are still difficult to predict.

We're seeing a growing number of established companies whose leaders are willing and ready to experiment with blockchain.

At this point, I would put blockchain some place between the second and third horizons (Figure 2). Its potential is enormous, but we still have lots of questions as to when and how we will realize this potential. However, we're seeing a growing number of established companies whose leaders are willing and ready to experiment with blockchain. We're also seeing the formation of a diverse set of start-ups. This activity is beginning to move blockchain into the early second horizon timeframe.

Building on and leveraging the Internet will be a great help. "In addition to providing a good template for blockchain's adoption, TCP/IP has most likely smoothed the way for it," Iansiti and Lakhani wrote. "TCP/IP has become ubiquitous, and blockchain applications are being built on top of the digital data, communication, and computation infrastructure, which lowers the cost of experimentation and will allow new use cases to emerge rapidly."

Figure 2: Blockchain on the three horizons framework



See Mehrdad Baghai, Stephen Coley, and David White, *The Alchemy of Growth* (New York: Perseus Books, 1999).



4. Is blockchain the next step in the evolution of the Internet?

Like the Internet, the blockchain is an open, global infrastructure upon which other technologies and applications can be built. And like the Internet, it allows people to bypass traditional intermediaries in their dealings with each other, thereby lowering or even eliminating transaction costs.

In the fall of 1995, IBM made the decision to embrace the Internet as the centerpiece of its strategic directions. As the general manager of the newly formed IBM Internet division, I spent a lot of time thinking how best to articulate the promise of the Internet. Looking back, I often described that promise using some variation of “The Internet has the potential to transform the economy, society, and our personal lives.”

A few additional innovations—such as smartphones, social media, cloud computing, big data, and the Internet of Things—have significantly expanded the Internet’s historical impact. By now, most everyone agrees that the Internet has become one of the most transformative technologies the world has ever seen—right up there with electricity, cars, and airplanes.

In its report on the top emerging technologies of 2016, the World Economic Forum compared the blockchain to the Internet, noting that, “Like the Internet, infrastructure upon which other technologies and applications can be built. And like the Internet, it allows people to bypass traditional intermediaries in their dealings with each other, thereby lowering or even eliminating transaction costs.”²⁰

I wholeheartedly agree. For the past two years, I’ve read lots of articles on blockchain technologies, and written over 15 entries in my blog on the subject. When discussing the long-term potential of blockchain, I once more find myself saying something like, “Blockchain has the potential to transform the economy, society and our personal lives.” To help me better understand how such a transformation might evolve over the years, I’ve found it quite useful to compare the current state of blockchain to that of the Internet in its early years.

We shouldn’t view the Internet and blockchain as two distinct foundational technologies, but together as a multi-decade evolution of the global development of a twenty-first century digital infrastructure.

Remember, blockchain is a *foundational* technology like the Internet, whose full transformational impact will take time—decades rather than years. The adoption process of *foundational* technologies like the Internet and blockchain is gradual, incremental, and steady, because they must overcome many different kinds of barriers—technological, organizational, governance, political, and social.

We shouldn’t view the Internet and blockchain as two distinct foundational technologies, but together as a multi-decade evolution of the global development of a twenty-first century digital infrastructure. The Tapscotts reminded us that the Internet “has enabled many positive changes—for those with access to it—but it has serious limitations for business and economic activity....Doing business on the Internet requires a leap of faith.”²¹ To take its major next step, the Internet must overcome three such serious limitations: security, complexity, and trust. Here’s where blockchain comes in. Let’s briefly discuss each of these.



Companies are finding that cyber-attacks are costly to prevent and recover from. Blockchain technologies should help us enhance the security of digital transactions and data by developing the required common services for secure communication, storage, and data access.

As firms now rely on ecosystem partners for many of the functions once done in-house, one of their major organizational challenges is how best to manage their increasingly complex operations across a network of interconnected companies.

Security

Over the past few decades, we've been moving to a world where information of all kinds is digital, and where many different kinds of online transactions are now taking place between people, institutions, and things. At the same time, large-scale fraud, data breaches, and identity thefts are becoming more common, and companies are finding that cyber-attacks are costly to prevent and recover from. Blockchain technologies should help us enhance the security of digital transactions and data by developing the required common services for secure communication, storage, and data access, along with open source software implementations of these standard services. As was the case with key Internet protocols, we would expect such standard blockchain services to be supported by all blockchain platforms such as Hyperledger and Ethereum.

Security standards are necessary but not sufficient. Identity is the key that determines the particular transactions in which individuals, institutions, and the exploding number of devices can rightfully participate, as well as the data they're entitled to access. But, our existing methods for managing digital identities are far from adequate.

As explained in this excellent 2016 World Economic Forum report, "A Blueprint for Digital Identity," identity is essentially a collection of information or attributes associated with a specific individual, institution or device.²² In general, the needed attributes to validate an identity are siloed within different private and public sector institutions, each using its data for its own purposes. To reach a higher level of privacy and security, we need to establish a trusted data ecosystem, which requires the interoperability and sharing of data across the various institutions involved.²³ The more data sources a trusted ecosystem has access to, the higher the probability of detecting fraud and identity theft.

But gathering all the needed attributes in a central data warehouse is not only highly unsafe but also totally infeasible. Few institutions will let their critical data out of their premises. MIT Connection Science—a research initiative led by MIT professor Sandy Pentland—has been developing a new identity framework that would enable the safe sharing of data across institutions.²⁴ Instead of copying or moving the data, the agreed upon queries are sent to the institution owning the data, executed behind the firewalls of the data owners, and only the encrypted results are shared. MIT Connection Science is implementing such an identity framework in its OPAL and Enigma projects, both of which make extensive use of cryptographic and blockchain technologies.²⁵

Complexity

As firms now rely on ecosystem partners for many of the functions once done in-house, one of their major organizational challenges is how best to manage their increasingly complex operations across a network of interconnected companies. Distributed operations can



make firms more efficient, but they can also lead to increased risks, unanticipated consequences and large transaction costs.

"The long history of human progress has been a steady march against friction," noted a 2016 IBM report. "From the introduction of money to replace barter and the gradual replacement of wax seals by digital signatures, we have seen steady progress facilitated by digital innovations. The Internet primed friction for a free-fall. Since then, some frictions fell while others rose."²⁶

Enterprises, supply chains, and global ecosystems have scaled in recent years. But "the added complexity of operations has grown exponentially while revenue growth has remained linear. The result? At a certain point, organizations face diminishing returns. Blockchains have the potential to eradicate the cost of complexity and ultimately redefine the traditional boundaries of an organization."²⁷

Professors Iansiti and Lakhani made a similar point in their *Harvard Business Review* article, "The Truth about Blockchain":

*TCP/IP unlocked new economic value by dramatically lowering the cost of connections. Similarly, blockchain could dramatically reduce the cost of transactions. It has the potential to become the system of record for all transactions. If that happens, the economy will once again undergo a radical shift, as new, blockchain-based sources of influence and control emerge.*²⁸

Blockchains hold the promise to bring the ledger into the Internet age.

Trust

Ledgers constitute a permanent record of all the economic transactions an institution handles, whether it's a bank managing deposits, loans, and payments; a brokerage house keeping track of stocks and bonds; or a government office recording births and deaths, the ownership and sale of land and houses, or legal identity documents like passports and driver licenses.

Starting over fifty years ago, institutions have been transforming their paper-based ledgers into highly sophisticated IT applications and databases. While most ledgers are now digital, their underlying organization has not changed. Each institution continues to own and manage its own ledger, synchronizing its records with those of other institutions as appropriate—a cumbersome process that often takes days. By contrast, we can share and update blockchain-based distributed ledgers in near real-time across a group of participants.

Blockchains hold the promise to bring the ledger into the Internet age. *The Economist* noted that blockchain "offers a way for people who do not know or trust each other to create a record of who owns what that will compel the assent of everyone concerned. It is a way of making and preserving truths."²⁹



5. Platforms, blockchains, and the evolution of trust

"In primitive economies, people traded mostly with members of their village and community," wrote David Brooks in a *New York Times* OpEd, "Trust was face to face. Then, in the mass economy we've been used to, people bought from large and stable corporate brands, whose behavior was made more reliable by government regulation. But now there is a new trust calculus, powered by both social and economic forces."³⁰

Brooks' article focused on the rise of the on-demand economy—also known as the collaborative, sharing, and peer-to-peer economy—and in particular on the surprising success of Airbnb. Rooms for rent in boarding houses and child and pet care services are nothing new. What's new is the impact of technology, especially platforms and blockchain, on the growing on-demand economy. Companies are being disrupted by consumers who can now deal with each other bypassing traditional hotels and taxi services at an unprecedented scale and scope. All kinds of new on-demand products and services are coming to market.³¹

In the digital economy, our online reputations follow us everywhere, whether we are the renters or the ones renting, the service providers or the service consumers.

Reputation systems

The on-demand economy is a direct result of our twenty-first century digital economy. It would not be possible without the social networks that enable peer-to-peer transactions matching supply with demand; the mobile devices and cloud-based platforms that let individuals conduct such transactions anywhere, anytime; and the digital payment systems that reliably and securely broker the transactions between buyers and sellers. Social reputation systems such as eBay where people rank buyers and sellers, and Uber where riders and drivers rate each other, are critical to the smooth functioning of collaborative markets like Airbnb. In the digital economy, our online reputations follow us everywhere, whether we are the renters or the ones renting, the service providers or the service consumers.

The competitive advantage of on-demand companies is their ability to aggregate lots of resources from their suppliers and integrate them with the trust needed to attract customers. The classic hotel business model is based on integrating property with trust, that is, the rooms the hotel makes available to customers with the trust created through its brand and reputation that attracts customers to come stay in the hotel. Trust (and, in some places, local regulation) is the hotel's key barrier to entry from individual competitors with rooms to let.

Airbnb and similar companies have totally shifted this dynamic. Lodgings have now been commoditized. Airbnb offers more than three million listings in over 65,000 cities in almost 200 countries around the world. Airbnb's competitive advantage is its Internet-based reputation systems for trust between hosts and guests,



New firms continue to enter the market in segment after segment, bringing together consumers and providers of goods and services with their highly scalable platforms and innovative applications.

based on the ratings of over 200 million guests. By integrating its reservation and trust management systems, Airbnb has been able to achieve an extraordinary global scale in less than a decade.

Despite its original grass-roots nature, the on-demand economy is now mostly owned by venture capitalists and other investors. New firms continue to enter the market in segment after segment, bringing together consumers and providers of goods and services with their highly scalable platforms and innovative applications. This new class of on-demand companies relies on a large freelance or independent contractor workforce instead of on a classic company or unionized workforce.

Should we bemoan the fact that some of these on-demand start-ups have joined the ranks of billion-dollar *unicorns*, or should we just accept that capitalism has always worked this way and celebrate their innovative business models? Is this just another manifestation of progress in the historical transition from an industrial to a digital economy?

On-demand communities “have been delving deep into what it means to be running a collaborative business model within a capitalist framework,” according to a 2015 *Financial Times* article. It questions whether the two are even compatible: “Is there a fundamental conflict at the heart of an industry that preaches collaboration but, [because of radical commercialization] by venture capital money from Silicon Valley, also needs to profiteer from the goodwill of others if it’s to remain viable?”³²

“Most models focus either on leveraging networks of existing resources, capital and volunteers then charging rents for platform use, or on forging platform monopolies that lock-in users so that their data can then be monetised,” Izabella Kaminska wrote. “For now, the uncomfortable truth is that the sharing economy is a rent-extraction business of the highest middle-man order.” Incumbents that can rigorously police and ruthlessly defend their territory can extract the most rents.

Dominant on-demand companies are likely to trap their freelance workers and asset owners in a kind of *digital serfdom* because their all-important digital reputation is only associated with the platform of a specific company. Instead, these independent contractors should have fully portable digital credentials and reputations so that they needn’t start from square one, each time they change territory or platform.

“For now, the uncomfortable truth is that the sharing economy is a rent-extraction business of the highest middle-man order.”

 IZABELLA KAMINSKA
Alphaville
Financial Times

Imbalance of power in platforms

These fast growing on-demand companies represent but a relatively small fraction of the overall platform economy, a winner-take-most economy that’s dominated by Seven Samurai of the Internet—Alibaba, Alphabet (Google), Amazon, Apple, Facebook, Microsoft, and Tencent—whose combined valuation is around \$3.5 trillion. We’ve already looked at how network effects drive the economies of scale



of successful platform companies. Until recently, users of these platforms have been consuming rather than producing value.

"Over the past 20 years the economy has progressively moved away from the traditional model of centralized organizations, where large operators, often with a dominant position, were responsible for providing a service to a group of passive consumers," wrote Primavera De Filippi in a recent *Harvard Business Review* article.³³ De Filippi is a researcher at the National Center of Scientific Research (CNRS) in Paris and faculty associate at Harvard's Berkman Klein Center for Internet and Society.³⁴ She's also a co-founder of COALA, the Coalition of Automated Legal Applications, a multidisciplinary initiative focused on the impact of blockchain technologies on society.³⁵

She observed, "We are moving toward a new model of increasingly decentralized organizations, where large operators are responsible for aggregating the resources of multiple people to provide a service to a much more active group of consumers." In most cases, however, the total value created by the crowd does not flow to its members according to their individual contributions. Instead, the few large platform operators rather than the many platform users capture the profits generated by this model.

De Filippi explained how blockchain technology could correct this imbalance: "Blockchain facilitates the exchange of value in a secure and decentralized manner, without the need for an intermediary." Large numbers of value creators could organize themselves through blockchain-based applications running on peer-to-peer networks without the help of a platform operator per se. She summed up the potential: "Blockchain technology is ultimately a means for individuals to coordinate common activities, to interact directly with one another, and to govern themselves in a more secure and decentralized manner."

The platform cooperative

De Filippi noted that blockchain can support a new kind of *platform cooperativism*—"where users qualify both as *contributors* and *shareholders* of the platforms to which they contribute. Since there is no intermediary operator, the value produced within these platforms can be more equally redistributed among those who have contributed to the value creation." Her article cited a few such recent start-ups in social networks, marketplaces, and transportation.

"There's nothing new about that, you might say—haven't we heard these promises before?" she added in conclusion.

Wasn't the mainstream deployment of the Internet supposed to level the playing field for individuals and small businesses competing against corporate giants? Yet, as time went by, most of the promises and dreams of the early Internet days faded away, as big giants formed and took control over our digital landscape.

"Blockchain technology is ultimately a means for individuals to coordinate common activities, to interact directly with one another, and to govern themselves in a more secure and decentralized manner."

 PRIMAVERA DE FILIPPI
Faculty Associate
Berkman Klein Center for
Internet and Society
Harvard University



Will large blockchain giants form and come to dominate whole categories of value creation, just as the Seven Samurai of the Internet have done?

As of this writing, large amounts of venture capital continue to pour into the blockchain space. Will large blockchain giants form and come to dominate whole categories of value creation, just as the Seven Samurai of the Internet have done? Those seven seem indestructible at the moment. But, as I've seen over and over in my long career, the force of innovation chips away at the economic structure of industries from within and frees up resources for entrepreneurially minded leaders to redeploy more efficiently elsewhere.

That's the essence of what economist Joseph Schumpeter called *creative destruction* over 70 years ago. Creative destruction rejuvenates economies by replacing industry leaders that can no longer outperform the market with fast-growing start-ups. I experienced this displacement firsthand in the late 1980s, when advances in microprocessing technology enabled new competitors to attack IBM's mainframe business with less expensive client-server solutions. IBM barely survived its near death encounter. Today we see yesterday's pioneers—Blackberry, Barnes & Noble, and Sun Microsystems, for example—slipping into the dust bin of brand history. Few elephants can dance.

The question is whether and which incumbents will be able to transform themselves through blockchain technology at the scale and pace of the capital markets without spinning out of control. Or will the creativity of the crowd, mobilized through a new generation of blockchain-based innovations, be able to reorganize and redeploy their talents more quickly and on a larger scale than any huge incumbent without a peer-to-peer market collapse so that—at long last—those who create value will be fairly and promptly compensated for it time and time again?

"If we, as a society, really value the concept of a true sharing economy," de Filippi argued, then "it behooves us all to engage and experiment with this emergent technology, to explore the new opportunities it provides and deploy large, successful, community-driven applications that enable us to resist the formation of blockchain giants."

Creative destruction rejuvenates economies by replacing industry leaders that can no longer outperform the market with fast-growing start-ups.

6. Is blockchain ready to "cross the chasm"?

Earlier this year, IBM conducted the largest study to date on the state of adoption of blockchain.³⁶ Researchers interviewed almost 3,000 C-suite executives from over 80 countries and 20 industries to learn about their company's blockchain plans. Survey responses were classified into three groups: explorers, investigators, and passives.³⁷

Explorers were already involved in blockchain pilots and experiments. They made up an average of eight percent across all industries, with



higher activity in certain industries like financial services; 25 percent of organizations were *investigators*—considering but not yet ready to deploy blockchains; and 67 percent were *passives*—not considering blockchains so far.³⁸

These survey results are not surprising for a technology as new and complex as blockchain. With such technologies, relatively small number of early adopters. A larger number of followers are waiting to learn from the early adopters' experiences, while the laggards are not yet sure what the technology is about or whether it applies to them.

The IBM study analyzed the responses of the explorers, in an attempt to figure out what was driving them to embrace blockchain at this early stage. Their responses suggest that they viewed blockchain as a kind of *trust accelerator*, helping to build trust in several ways: by increasing transactional transparency, ensuring higher data quality and accuracy, increasing trust in transaction reliability, and improving security against fraud and cybercrime.

Traditionally, intermediaries such as banks and government bodies have taken on the role of trust keepers, adding costs, delays, and complexity to the processing of transactions. Sometimes they add risk, too, as we witnessed during the last economic downturn. Or they drain value, as through hyperinflation of fiat currency. Explorers expect blockchain to reduce transaction costs by eliminating intermediaries that add no value; increase transaction speed by reducing clearing time; increase security by encrypting both the asset data and the means of access; and simplify and automate business processes, especially processes that deal with interactions across companies, governments, and borders.

They also see blockchain as enabling the creation of platforms for business model innovation and new ways of working. Platforms are all about scale and network effects, where the whole is much greater than the sum of its parts. Platforms require the formation of multi-sided ecosystems, including partners and developers on the supply-side, and customers and end users of services (e.g., search, navigation) and information (e.g., web sites) on the demand side. The greater trust, security, and efficiencies inherent in blockchain platforms could be competitive differentiators in the formation of such multi-sided ecosystems.

As a foundational innovation, blockchain has the potential to transform our economic and social systems over decades rather than years, because such innovations must overcome many barriers—technological, organizational, governance, political. Their adoption process is thus gradual, incremental, and steady. It won't blast off like a disruptive technology (e.g., PCs, smartphones, digital photography, social media, streaming media) but it will gain momentum. The impact of blockchain could well be enormous, but its full transformational impact will take considerable time.

With such technologies, we typically have a relatively small number of early adopters. A larger number of followers are waiting to learn from the early adopters' experiences.



The IBM survey study reminded me of *Crossing the Chasm*, Geoffrey Moore's 1991 bestseller, now in its third edition.³⁹ In *Crossing the Chasm*, Moore adapted Everett Rogers' diffusion of innovations model to the development of high-tech markets.⁴⁰ Rogers had defined *diffusion* as the process by which members of a social system communicated about an innovation through certain channels over time. He mapped the distribution of adoption statistically in a bell curve and categorized the adopters in five segments according to their characteristic response to innovation.⁴¹

Moore made two important observations. The first was that anyone looking at S-curve of technology adoption might mistake the diffusion of innovation as a steady and continuous process from one set of adopters to the next. It wasn't. There were gaps between each segment, gaps that could jeopardize the cultivation of any high-tech market (Figure 3).

"The point of greatest peril," according to Moore, "lies in making the transition from an *early market* dominated by a few *visionary* customers to a *mainstream market* dominated by a large block of customers who are predominantly *pragmatists* in orientation." He viewed this gap as so formidable and perilous that he called it a chasm. "Crossing this chasm must be the primary focus of any long term high-tech marketing plan," he said. "A successful crossing is how high-tech fortunes are made; failure in the attempt is how they are lost."⁴²

The second observation was that the type of marketing needed to reach one group would not work to engage the next group, nor would the type of manager needed on one side of the chasm be the type of management needed on the other side. A company would need to change, and change quickly, both its strategy and its operations as it went further mainstream.

"Crossing this chasm must be the primary focus of any long term high-tech marketing plan."

 GEOFFREY A. MOORE
Author
Crossing the Chasm

Figure 3: Blockchain's challenge: Crossing the chasm



See Geoffrey A. Moore, *Crossing the Chasm*, 3rd ed. (New York: HarperBusiness, 2014).

What will blockchain need to cross this chasm—to leap from the explorers and early-adopters who are already involved in blockchain pilots, over to the investigators and pragmatic followers who are considering blockchain but waiting for results and assurances before jumping in? How long will it likely take?

As with similar such questions, let's look at the lessons learned from the decades-long evolution of the Internet for inspiration and guidance, starting with the packet switching Advanced Research Projects Agency Network (ARPAnet). The precursor of the Internet, ARPAnet was developed by a small number of researchers in the 1960s and 1970s. It adopted TCP/IP in the early 1980s, evolving through the decade into interconnected networks that became known as the Internet. The Internet's early adopters arrived in two phases. First came universities, supercomputing centers, and other research communities in the early and mid 1980s. Then came commercial early adopters who were allowed to use the Internet only toward the end of the 1980s. Their numbers grew rapidly over the next few years; and, by the mid-1990s, the Internet was being embraced by a much larger number of mainstream users. It had successfully crossed its chasm.

How the Internet crossed the chasm

What will blockchain need to cross this chasm? How long will it likely take?

What helped take the Internet from early adopters to mainstream users? While a company's approach to marketing and management is important, three technology-wide reasons stand out for me: collaboration in the development of standards, applications, and governance.

Standards

By its very nature, the Internet put a premium on collaborations and partnerships. Through the 1980s, an increasing number of university, government, and research networks embraced TCP/IP as their networking standard. The advent of routing technologies enabled these various TCP/IP networks to eventually coalesce into one Internet or *network of networks*. E-mail was the Internet's first major application. Its protocols—such as simple mail transfer protocol (SMTP), multipurpose internet mail extensions (MIME), post office protocol (POP), and internet message access protocol (IMAP)—were standardized in the mid-1980s, enabling its users to communicate easily with each other. A few years later, the Web's open standards—hypertext markup language (HTML), hypertext transfer protocol (HTTP), and uniform resource locators (URLs)—made it possible for any PC connected to the Internet to access information on any web server anywhere in the world. Released in 1993, the easy-to-use, graphical Mosaic web browser played a major role in the popularization of the Internet.



Applications

A *killer app* is an IT application whose value is easy to explain, because while relatively mundane in nature, it turns out to be unexpectedly useful in business and/or everyday life. E-mail and the Web are great examples of killer apps and helped to accelerate mainstream adoption of the Internet. Everybody could appreciate the ability to communicate easily with anyone, or to access information anywhere in the world, both from one's desktop. Many other applications quickly followed across a variety of industries. Time to market pressures, along with the fast pace introduction of new market innovations forced companies to partner with friend and foe alike. For example, instead of building its own, IBM embraced the open source Apache http server and built its successful WebSphere family of offerings around it. At the same time, IBM embraced Java, even though the technology had been developed by Sun Microsystems, one of its major system competitors. Given that the developers and earliest users of the Internet came from research labs and universities, IBM had to work closely with them in the continuing evolution of Internet applications and architecture.

Governance

Time to market pressures, along with the fast pace introduction of new market innovations forced companies to partner with friend and foe alike.

Much of the success of the Internet and World Wide Web is due to the international organizations created to steward their evolution, including the Internet Engineering Task Force (IETF) under the auspices of Vint Cerf and Bob Kahn's Internet Society, the Internet Corporation for Assigned Names and Numbers (ICANN), the predecessor of which was shepherded by Jon Postel and Joyce Reynolds, and the World Wide Web Consortium (W3C) with Tim Berners-Lee's stewardship. In addition to developing standards and organizing technical, industry, and policy initiatives, these various organizations make available open source implementations of their software releases, thus encouraging collaborative, open innovation.

Where blockchain stands: On the brink

Is blockchain ready to transition from its early adopters to a more mainstream market? Let's look at where we stand with blockchain in each of the three areas that helped the Internet across.

Standards

There are already a number of blockchain platforms in the marketplace, with more in development. All are generally based on the original design released in 2009 by Satoshi Nakamoto; but the platforms differ, depending on the applications they are designed to support. I see two fairly distinct blockchain design points. One focuses primarily on blockchain as the underlying platform for bitcoin and other cryptocurrencies; the second focuses on blockchains as a general purpose platform for transaction applications—a kind of Internet 2.0.



The space urgently needs blockchain standards, at least at the fabric level, the equivalent of the TCP/IP layer.

The cryptocurrency-oriented platforms are mostly based on public, permissionless blockchains and proof-of-work systems. The more general purpose platforms—such as Hyperledger—are aimed at supporting business applications and are mostly based on private or permissioned blockchains, akin to the Internet’s encompassing private Intranets. Some blockchain designs straddle both camps, such as Ethereum (with its inventor Vitalik Buterin), which includes support for the ether cryptocurrency and for distributed applications (“dapps”) like smart contracts.

The space urgently needs blockchain standards, at least at the fabric level, the equivalent of the TCP/IP layer. “While these groups attack the problem from different angles and with different agendas, each shares a common goal to make this technology ready for prime time—by building infrastructure, developing standards and making it scalable,” the Tapscotts wrote.

Applications


Since blockchain is all about the creation, exchange, and management of valuable assets, its applications are likely to be considerably more complex to develop than Internet applications. “Launching this type of application requires massive collaboration among companies, governments and other entities,” the Tapscotts observed.

Similarly, this resource will need constant care and tending to onboard more and more users over time. It illustrates the profound differences between managing information creation versus value creation activities. The latter require deep negotiation, contractual, and jurisdictional understandings, and the ongoing stewardship of application-level ecosystem.

Governance

The Tapscotts expect this second generation of the Internet to disrupt revenue streams, upend business models, and transform industries or obsolesce those that refuse to embrace change. They see blockchain’s potential for ushering in a new era of openness, one that is decentralized and inclusive of people long excluded from the global economy and civic participation. “However, this extraordinary technology may be stalled, sidetracked, captured or otherwise suboptimized depending on how all the stakeholders behave in stewarding this set of resources—that is, how it is governed,” they added a strong cautionary note in their WEF report. “How we govern the Internet of information as a global resource serves as a model for how to govern this new resource: through a multi-stakeholder approach using what we call *global governance networks*.”

“How we govern the Internet of information as a global resource serves as a model for how to govern this new resource: through a multi-stakeholder approach using what we call global governance networks.”

 DON TAPSCOTT
ALEX TAPSCOTT
Authors
“Realizing the Potential of
Blockchain”

I totally agree. Is blockchain ready to cross the chasm from its early adopters into a wider marketplace? Not quite yet. Much remains to be done. Given all the attention and activity, this important transition



should be able to take place in the not too distant future. But, as Geoffrey Moore reminds us, crossing this chasm is “the point of greatest peril” for a high-tech innovation.

7. On the governance of blockchain: Lessons from the Internet

In the 1980s, getting different IT systems to talk to each other was quite difficult. In the 1990s, the Internet and World Wide Web brought a badly needed culture of collaboration and standards to the IT industry. The general IT marketplace began embracing the open Internet protocols—TCP/IP—making it possible to interconnect systems and applications from any vendors. Internet e-mail protocols—the aforementioned SMTP, MIME, POP, and IMAP—enabled people to communicate easily with anyone on any system. At the same time, the Web’s open standards—HTML, HTTP, and URLs—enabled any PC connected to the Internet to access information on any web server anywhere in the world.

Much of the success of the Internet and Web is due to the aforementioned international organizations (IETF, ICANN, W3C) as well as the Internet Architecture Board (IAB) and the Internet Research Task Force (IRTF), created to oversee their evolution.⁴³ Similarly, the Linux Foundation, formed by Torvalds and lead maintainer Greg Kroah-Hartman, has successfully stewarded the evolution of Linux since 2000.⁴⁴ In addition to developing standards and organizing technical, industry, and policy activities, these various organizations invite open debate, and they make available open source implementations of their software releases, thus encouraging collaborative, open innovation. Torvalds went so far as to say, “Talk is cheap. Show me the code.” According to *Wired*, Torvalds’ attitude has served the software well: “[Linux has] managed to grow up on the Internet by fostering an online community—thousands of developers strong—where people worry much more about the technical merits of an argument than someone’s marketing plan.”⁴⁵

“[Linux has] managed to grow up on the Internet by fostering an online community—thousands of developers strong—where people worry much more about the technical merits of an argument than someone’s marketing plan.”

Blockchain is in its early stages, perhaps akin to the Internet in the 1980s, when somewhat different versions of TCP/IP networks were in use by research communities, government labs and universities, and the Internet or *network of networks* was still self-organizing. For blockchain to succeed, it will similarly require the stewardship of international organizations to oversee its evolution. Let’s discuss how that might come about, all the while returning to the lessons from the Internet for inspiration and guidance.

The WEF report on blockchain governance stated that the blockchain required stewardship at three different levels: platform, application, and overall ecosystem.⁴⁶

 ROBERT MCMILLAN
Wired.com



Platforms

Innovators such as Satoshi Nakamoto and Vitalik Buterin have already launched a number of blockchain platforms (e.g., Bitcoin and Ethereum) and more are in development, many of them funded by initial coin offerings (ICOs) that are raising astronomically large sums in short periods of time with (thus far) minimal regulatory interference.⁴⁷ However, as the *New York Times* reported, the US Securities and Exchange Commission has started looking into ICOs and warning investors to be wary of the potential for scams. “[M]any lawyers in the industry have been warning entrepreneurs that just because a coin is intended to serve as a payment method does not mean that it cannot also be categorized as a security.”⁴⁸

All platforms are generally based on Satoshi’s original design, but with wide variations and limited interoperability. In their WEF report, the Tapscotts pointed out that we lack a shared taxonomy or categorization of platforms in the space: “Does blockchain refer to the bitcoin blockchain or the technology in general? Is it big ‘B’ Blockchain or little ‘b’ blockchain? Is it a currency, commodity or technology? Is it all of these things or none of them?”⁴⁹ For example, some feel that permissioned (private) blockchains aren’t true blockchains, but rather selectively distributed ledgers, where parties need permission to view and use.

There seem to be two fairly distinct blockchains camps—one primarily focused on blockchain as the underlying platform for cryptocurrencies, the other on blockchain as the next major step in the evolution of the Internet.

There seem to be two fairly distinct blockchains camps—one primarily focused on blockchain as the underlying platform for cryptocurrencies, the other on blockchain as the next major step in the evolution of the Internet. The cryptocurrency camp—best characterized by Bitcoin—is mostly based on public, permissionless blockchains and proof-of-work systems, which consume energy as a means of platform security. The Internet 2.0 camp—best characterized by Hyperledger—is mostly interested in the business applications of blockchain technologies, and embraces private blockchains, much as the Internet embraced private Intranets. Some blockchains such as Ethereum straddle both camps: Ethereum features the ether cryptocurrency and provides a software platform that supports dapps.

The authors closely examined the top two cybercurrency platforms, bitcoin’s and ether’s. The problem facing the Bitcoin network was that, with increased participation, the platform had become slow. Its block size was limited to one megabyte of data, but the volume of transactions was increasing and a backlog of unblocked transactions had started to form.⁵⁰ The processing speed of bitcoin was only seven transactions per second, a capacity far short of Visa’s 56,000 transactions per second.⁵¹ For the Bitcoin blockchain to compete with incumbent payment platforms, it needed to scale.

But how? Without a board of directors or steering committee, its many stakeholders and volunteers have to collaborate and reach consensus in order to solve platform problems. Although several developers have emerged from time to time as core to the maintenance and advancement of these protocols—hence, the



phrase, “core developers” (a.k.a. “core devs”)—they cannot impose anything upon the community. Members have the option not to implement a change in the protocols that their machines are running.

In April 2017, two different camps of core devs proposed two different scaling solutions to the protocols. In August 2017, the Bitcoin blockchain hard-forked—that is, it split into two distinct cryptocurrencies, bitcoin and bitcoin cash—because the two camps could not agree on a solution. The split exemplified the challenges of governance by consensus in the second era of the Internet.

It was not unlike the challenge faced by the Ethereum platform in 2016. Ethereum’s stakeholders debated whether and how to resolve the hack of one of Ethereum’s first decentralized autonomous organizations (the DAO, for short) embodied in a smart contract. They voted strongly in favor of a hard fork to prevent the hacker from controlling much of the ether in circulation. With the hard fork came the formation of a second cryptocurrency, ethereum classic. The WEF report quoted the co-founder of the Ethereum Project, Joseph Lubin: “I don’t think the verdict is in on whether it was good governance, but it was quite decentralized governance.”⁵²

The WEF report also featured two of what I’d call more general purpose platforms—Hyperledger, a project of the Linux Foundation, and Cosmos, an initiative of Tendermint. Hyperledger borrows from the Linux tradition in that it is enterprise grade, open-source code developed by a community of technical volunteers. It also borrows from the Linux governance framework in that it provides neutral territory for debate and collaboration.⁵³ It also provides for a technical steering committee to keep ahead of market needs, an end user technical advisory board to educate new adopters, and a marketing committee to communicate with adopters and prospects—all efforts to gain momentum as it ramps up to the chasm. One of Hyperledger’s members commented on the sheer force of collaboration.⁵⁴ For a platform to reach mainstream adoption, those who are building on it need to collaborate.

I think the secure interoperability of platforms will be another key factor in the technology’s crossing the chasm, and Tendermint is developing its new Cosmos Network to ensure just that.⁵⁵ Its website refers to Cosmos as “a heterogeneous network of proof-of-stake blockchains that can interoperate with one-another.” The Tapscotts’ analysis helped me better appreciate the design objectives and organizational cultures of the various blockchain camps, as well as the key governance challenges each faces going forward.

“I don’t think the verdict is in on whether it was good governance, but it was quite decentralized governance.”

 JOSEPH LUBIN
Co-founder
Ethereum Project

Applications

E-mail in the mid-late 1980s and the Web a few years later played a crucial role in the widespread commercial adoption of the Internet. Subsequently, Internet applications took off in many different directions—e-commerce, finance, entertainment, social media, IoT, digital money, government services—and have continued to do so. Similarly, bitcoin and other cryptocurrencies first put blockchain on



However, since blockchain is all about the creation, exchange, and management of valuable assets, its applications are likely to be considerably more complex to develop than Internet applications.

the map; start-ups, large companies, and NGOs have more recently started to experiment with blockchain applications in a variety of industries.

However, since blockchain is all about the creation, exchange, and management of valuable assets, its applications are likely to be considerably more complex to develop than Internet applications. “Launching this type of application requires massive collaboration among companies, governments and other entities. Similarly, this resource will need constant care and tending to onboard more and more users over time,” the Tapscotts wrote. I read their commentary as further evidence of the distinction between the Internet and the blockchain. “It illustrates the profound differences between managing *information creation* versus *value creation* activities. The latter require deep negotiation, contractual and jurisdictional understandings, and the ongoing stewardship of application-level ecosystem.” To my mind, that’s what this new technology needs to gain traction, and that’s what incumbents such as Google, Microsoft, and IBM as well as key industry consortia in, for example, finance, supply chain, manufacturing, and transportation can bring to the table.

“As blockchain applications have evolved from potential to actual use cases, we can see that particular use cases will raise specific governance questions best answered at the level of each use case (e.g., payments, smart contracts, securities clearance, insurance, etc.),” the Tapscotts concluded.

Ecosystems

Organizing blockchain’s overall ecosystem requires the development of legal and regulatory frameworks, along with considerable social and economic research.

Organizing blockchain’s overall ecosystem requires the development of legal and regulatory frameworks, along with considerable social and economic research. These frameworks—which have evolved over many decades in the physical world—now have to be brought over and adapted to our increasingly digital world. Moreover, unlike technologies and applications, such frameworks can vary considerably from country to country. For example, where the US Security and Exchange Commission remains open to initial coin offerings, provided that their issuers follow SEC rules and regulations, the Chinese government has banned them as a means of fundraising in China and has asked its local regulatory agencies to investigate sixty ICO platforms there.⁵⁶ Developing them will likely take considerable time. With the blockchain as with the Internet, “Proper legal and regulatory frameworks also favor long-term, more sustainable and more technically sound business models over short-term high-risk ones.”⁵⁷

In a previous research project, the Tapscotts surveyed the governance of the Internet and found that “diverse stakeholders, loosely organized in seven types of open networks that operate by consensus, could effectively steward a global resource.” Could we apply a similar consensus-based ecosystem to the governance of blockchain? Why not?



Over the past few decades, the Internet has become one of, if not, the most prolific innovation platform the world has ever seen. But its evolution must continue.

Standards networks: We urgently need clear processes and/or good leaders for guiding standards at both the platform and application levels, since we have now seen how consensus mechanisms can stall adoption and development. We also need non-state, non-profit organizations to work on the infrastructure required for mass adoption.

Networked institutions: These are not state-based but true multistakeholder networks that cultivate serendipitous meetings among participants so that they can hear each other's positions and concerns.

Policy networks: The Internet Policy Research Initiative at the MIT Computer Science and Artificial Intelligence Lab is a good example of a network of technologists and policy-makers who are collaborating to increase the integrity of interconnected digital systems. The goal is to inform, if not shape, the policy-making process of institutions so that it is more transparent.

Advocacy networks: These strive to influence the actual policies and strategies of governments, corporations, and other institutions with respect for their interests and constraints. The goal is to forestall any decision or action that would jeopardize responsible experimentation and wider participation. Among them is the Chamber of Digital Commerce.

Watchdog networks: Blockchain is in its blue ocean phase. People are experimenting because they can, some are making extraordinary claims, and a few may ultimately prey on those who are in over their heads. Watchdogs patrol the space to ensure that the players behave appropriately and to hold them accountable when they don't.

Knowledge networks: Considerable experimentation is absolutely necessary, because we barely understand the scale of the long-term transformation that blockchain will usher in. Pilot projects can support this iterative learning approach, while providing evidence-based information to developers and advocates.

Delivery networks: These implement what a new technology needs to attract participation, such as interoperability and incentives. We need international organizations that will deliver the essential functions to enable distributed mass collaboration.

Over the past few decades, the Internet has become one of, if not, the most prolific innovation platform the world has ever seen. But its evolution must continue. The Internet continues to have serious limitations for business and economic activity—including security, complexity, and trust.



"This second era of the Internet promises to create new opportunities for a more prosperous world. This is the promise of the blockchain."

 DON TAPSCOTT
ALEX TAPSCOTT
Authors
"Realizing the Potential of
Blockchain"

"This second era of the Internet promises to create new opportunities for a more prosperous world," Don and Alex Tapscott concluded. "This is the promise of the blockchain." However, blockchain is still in its toddler stage. For this toddler to achieve its long-term potential, we must carefully oversee its evolution toward an increasingly complex and unpredictable future.

8. Blockchain and the future of the firm

In the latter chapters of *Machine, Platform, Crowd*, authors Andy McAfee and Erik Brynjolfsson raise a few provocative questions such as, "In this era of powerful new technologies, do we still need companies?" How are firms likely to evolve given the continuing advances of Internet-based technologies, as well as emerging blockchain-based technologies such as distributed ledgers and smart contracts? "Are companies passé" in an increasingly decentralized economy?

Following the Great Depression and World War II, the United States welcomed the stability promised by corporate capitalism. Big, multinational companies dominated most industries—General Motors, Ford, and Chrysler in automobiles, Citibank, American Express, and Morgan Stanley in finance, and Esso/Exxon, Mobil, and Texaco in oil and gas. It was an era characterized by bureaucratic corporate cultures—not unlike military hierarchies—focused on organizational power and orderly prosperity.

A few decades later, with the advent of a more innovative, fast moving entrepreneurial economy, these top down structures began to change. The 1980s saw the rise of young, high-tech companies such as Microsoft, Apple, Oracle, and Sun Microsystems, and Silicon Valley became the global hub for innovation, emulated by regions around the world. Black turtlenecks and jeans replaced blue suits, white shirts, and ties.

The commercialization of the Internet and online retail pushed all these trends into hyperdrive in the 1990s. With the Internet, companies could more easily transact with each other around the world. Vertically integrated firms evolved into virtual enterprises, increasingly relying on supply chain partners for many of the functions once performed in house and giving rise to what Don Tapscott called the open, networked enterprise.⁵⁸ Management experts noted that large firms were no longer necessary and would in fact be at a disadvantage in this emerging Internet era when competing against agile, innovative, and smaller companies.

More recently, we've seen another major evolution of the digital economy with the rise of the on-demand or collaborative economy, based on the exchange of goods and services between individuals instead of between companies and consumers or the intermediaries



between the two. The on-demand economy would not be possible without the mobile devices and platforms that enable peer-to-peer transactions among individuals any time and place such as Freelancer, Taskrabbit, Upwork, and WeGoLook; the digital payment systems such as PayPal that reliably and securely brokers the transactions between buyers and sellers; and the online reputation systems (often embedded in the platforms), where people rank buyers and sellers, a critical requirement for the smooth functioning of collaborative markets.⁵⁹

But not only are large companies alive and well, the stars are becoming superstars in the firmament of international business. According to *The Economist*, “the most striking feature of business today is not the overturning of the established order. It is the entrenchment of a group of superstar companies at the heart of the global economy.”⁶⁰ *The Economist* suggested that such megastars jeopardize competition and the legitimacy of enterprise.

The on-demand economy would not be possible without the mobile devices and platforms that enable peer-to-peer transactions among individuals any time and place; the digital payment systems that reliably and securely brokers the transactions between buyers and sellers; and the online reputation systems, a critical requirement for the smooth functioning of collaborative markets.

The big keep getting bigger

The growth of large companies has been most evident in North America. *The Economist* analyzed almost 900 industries across a number of sectors and found that the weighted average share of the top four US firms in each sector rose from 26 percent to 32 percent between 1997 and 2012. In addition the share of US GDP generated by the 100 biggest companies rose from 33 percent to 46 percent between 1994 and 2013, and the five largest banks now account for 45 percent of all banking assets, up from 25 percent in 2000.

While the Internet, blockchain, and other technology advances would seem to support the decentralization of the economy away from big companies, the data indicate that, at least so far, their demise is not evident. In fact, the economy has been moving in the opposite direction. To understand this seeming paradox, let’s turn to “The Nature of the Firm,” Ronald Coase’s 1937 seminal paper, among the achievements that earned him the 1991 Nobel Prize in economics.

Why do firms exist? Professor Coase provided a simple, elegant answer to this question. Firms came into being to make it easier and less costly to get work done. In principle, a firm should be able to find the cheapest, most productive goods and services by contracting them out in an efficient, open marketplace. However, markets are not perfectly fluid. Transaction costs are incurred in obtaining goods and services outside the firm, such as searching for the right partners and prices; coordinating an ecosystem of partners; negotiating, monitoring, and enforcing contracts; and so on.


A firm will keep expanding, adding people and layers of management and staff as long as doing so is less expensive than securing the additional services in the marketplace. But, there are limits to how big a firm can get and still remain competitive against faster moving companies. The additional layers of management and staff can cause the organization to become bureaucratic, significantly affecting its ability to embrace new ideas and technologies quickly when market



Nevertheless, big companies keep growing instead of shrinking as the economy becomes more digitized.

We could make all decisions in a purely decentralized market with no need for firms, bankers, lawyers, or other intermediaries.

"It's pretty clear that a large movement is under way to take much of the work that used to be done within the single hierarchy of the firm and move it to the market."

 ANDY MCAFEE
ERIK BRYNJOLFSSON
Authors
Machine, Platform, Crowd
Wired.com

conditions change. A well-managed company strives to achieve an optimal balance between what work gets done within and outside its boundaries.

Advances in IT systems and networks have had a big impact on the nature of firms over the past few decades. The Internet has significantly reduced external transaction costs, giving rise to global supply-chain ecosystems. Nevertheless, big companies keep growing instead of shrinking as the economy becomes more digitized.

Blockchain technologies—distributed ledgers for replicated, shared, non-revocable data; self-executing, self-enforcing smart contracts; mathematical models to enable cooperation among non-trusted parties—could further redefine the balance between companies and markets over time. "It's pretty clear that a large movement is underway to take much of the work that used to be done within the single hierarchy of the firm and move it to the market," McAfee and Brynjolfsson wrote. "It's also clear, however, that firms are still going strong, and that in many ways, their economic influence is growing, not shrinking."

Transaction cost economics

The reason, they argue, is based on *transaction cost economics* (TCE), built on Coase's path-breaking work as well as that of other prominent economists. Let me attempt to summarize their argument.

An important TCE concept is that "if every possible contingency for use of a building, machine, or patent were spelled out in contracts, then labeling one party the owner of the asset would confer no additional rights. However," according to McAfee and Brynjolfsson, "when contracts are incomplete, owners have the residual rights of control, meaning they can do whatever they want with the asset except for what's in the contract."⁶¹

If we could write a complete contract, embed it in software as a smart contract, and store it in a blockchain-based distributed ledger, then we could handle transactions with no need to worry about who owned which assets because a comprehensive, tamper-proof smart contract would be adjudicating all future decisions. In such a case, we could make all decisions in a purely decentralized market with no need for firms, bankers, lawyers, or other intermediaries. However, when we needed to make a decision about an asset not specified in the contract, only the party that owned the asset—that is, that held residual control rights to the asset in TCE terms—could make such decisions.

Virtually every economist believes that, in practice, complete contracts aren't possible. No matter how smart contracts get, they'll still be incomplete. The reasons are fairly straightforward. The world is very complicated, the future is largely unknowledgeable, and *homo sapiens* can be a fickle species. "These and other factors combine to make it prohibitively difficult, and most likely actually impossible, to



write a complete contract—one that truly does away with the need for ownership—for any realistic business situation.”⁶²

McAfee and Brynjolfsson concluded that firms exist because “it’s just not possible for market participants to get together and write complete contracts—ones that specify who does what, and who gets what, in all possible contingencies: all the ways the real world could unfold.”⁶³

What about the future? Could advances in computers, artificial intelligence, blockchain, prediction markets, quantum computing, and other technologies enable us to anticipate future possible contingencies and outcomes? McAfee and Brynjolfsson noted that, like the Red Queen in *Alice in Wonderland*, machines would have to run ever faster to keep up with an increasingly complex and unpredictable world. “In the end, contracts would still be incomplete,” they concluded.

In addition to providing a good set of lessons for blockchain’s adoption, the Internet is smoothing the way for the development of blockchain platforms, applications, and ecosystems.

9. Should your company get on the blockchain learning curve now or wait?

Earlier in this paper, I wrote about the current state of blockchain. In particular, I asked whether blockchain is ready to *cross the chasm* from its early adopters—who are already involved with blockchain in one way or another—to the considerably larger set of mainstream users who may be considering blockchain but are waiting for results and assurances before jumping in.

I explored this question by comparing blockchain today to the Internet in the early-mid 1990s, which is roughly when the Internet made its own transition from early adopters to mainstream users. My conclusion was that blockchain isn’t quite ready for this important transition. It’s still in its *early adopters* stage—perhaps akin to the Internet in the late 1980s. Much remains to be done in key areas, including standards, applications, and governance. Blockchain has the potential to make our digital infrastructures much more secure, efficient and trustworthy, but it will take time.

The Internet in the early-mid 1990s was clearly more advanced than blockchain is today. On the other hand, the business environment in 2017 is quite different from the one back then. The Internet and associated technologies like smartphones and cloud computing have significantly lowered the costs of collaboration and experimentation, enabling innovations to emerge more rapidly. In addition to providing a good set of lessons for blockchain’s adoption, the Internet is smoothing the way for the development of blockchain platforms, applications, and ecosystems.

What should your company do? Get on the blockchain learning curve now or wait until the technology is more mature before jumping



in? Become an early adopter of this potentially transformative technology, or run the risk of being left behind by more aggressive competitors? How should your company decide when and how to best embrace a foundational new technology like blockchain?

A good way to explore these questions is by once more examining the lessons from the decades-long evolution of the Internet—lessons I’m quite familiar with given my role as general manager of the IBM Internet Division in the 1990s. Let me share my experiences and lessons learned in three major areas—strategy formulation, marketplace execution, and organizational and cultural issues—and see if and how they might now apply to blockchain.

Strategy formulation

Several factors convinced IBM to embrace the Internet in the fall of 1995. Market interest in the Internet and its economic potential was taking off, especially following Netscape’s highly successful IPO. Start-ups were appearing right and left. Some IBM competitors had already embraced the Internet, especially Sun Microsystems. A number of IBM’s clients were among the early adopters, and had already started Internet prototypes working with Sun, Netscape and other vendors. Our clients were clearly embracing the Internet with or without IBM.

The Internet was ushering a new model of computing. The universal reach and connectivity of the Internet were enabling access to information and transactions of all sorts for anyone with a browser and an Internet connection, making existing business processes more efficient, as well as enabling all kinds of new business models.

Start-ups were experimenting with many new applications—some of which turned out to be quite innovative, and some rather silly. Part of the buzz in the air was that in the Internet-based *new economy*, start-ups had an inherent advantage over existing businesses. The legacy assets of older companies were like a noose around their neck. They couldn’t possibly compete in the fast moving digital world and were therefore headed for extinction.

Our point of view was quite different. We came up with what became known as *e-business*, a strategy which we succinctly defined as *Web + IT*, based on integrating the industrial-strength IT infrastructures being widely used in business and government with the new Internet capabilities. Any institution, by integrating its existing databases and applications with a web front end, could now reach its customers, employees, suppliers and partners at any time, day or night, no matter where they were. The Internet was the beginning of a profound business and societal revolution with the potential to alter the shape of businesses, industries, and economies. But, it wouldn’t be a rip-and-replace revolution; it would take place as a series of incremental steps over time.

Given how new all this was, we had to figure out how to best communicate, in the simplest way possible, why every company

The universal reach and connectivity of the Internet were enabling access to information and transactions of all sorts for anyone with a browser and an Internet connection, making existing business processes more efficient, as well as enabling all kinds of new business models.



should embrace the Internet and become an e-business. This was one of the key responsibilities of the IBM Internet Division and a major part of my personal responsibilities as its general manager.

The e-business strategy became a way of proving that IBM *got it*, and of associating the IBM brand with the future, rather than with its once glorious past. It worked. We successfully established the e-business brand in the marketplace by consistently telling our e-business stories over a variety of communication channels, including press interviews, conferences around the world, IT and financial analyst meetings, Web articles, and lots of client engagements. We worked closely with our marketing agency Ogilvy & Mather, which created a very effective e-business campaign, including memorable, award-winning TV ads that explained the value of e-business in a series of short vignettes. These communication and marketing efforts helped to explain what it meant to do business in the Internet age and closely associated IBM with the Internet. They also helped to revitalize and reposition IBM's brand.

Marketplace execution

We had to develop our strategy by getting in the marketplace, figuring out what was going on, and working closely with clients around the world. As we did so, the fog of the future began to lift.

Having a clear, compelling strategy is a necessary, but far from sufficient condition. We could not wait until we had a well defined strategy to establish a market presence because neither our competitors nor our customers were waiting. We had to develop our strategy by getting in the marketplace, figuring out what was going on, and working closely with clients around the world. As we did so, the fog of the future began to lift and we started to see more clearly that the Internet was going to have a profound impact on business, and every company needed to consider how to leverage the Internet for business value and become an e-business.

Time-to-market was critical. We couldn't wait until we figured things out or developed a whole new set of products because by then the train was likely to have already left the station. We had to work closely with clients around the world, understand their key requirements and come up with innovative solutions that we could start prototyping and experimenting within months rather than years.

One major example is the development of the 1996 Atlanta Olympics website. IBM was an official sponsor of the Olympics from 1960 to 2000 and was its overall technology provider. Having recently launched our Internet initiative, we were hoping to establish IBM as a major Internet player by developing the first official Olympics website. The site offered near-instantaneous results for all sporting events, schedules, news, photographs, and information about athletes. We publicized the website extensively and invited the world to come use it.

This open invitation was a risky venture because, at the time, the Atlanta Olympics website was one of the largest Internet projects anyone had undertaken. We didn't know how many people would show up and how well our website would handle very high volumes.



Would it crash in front of the whole world on one of the world's biggest stages? As it turned out, our website worked quite well, except for some unduly slow response times when traffic got very heavy. We learned a lot about the requirements for building and operating large, complex websites. All in all, it was a very successful experiment.

That same year we worked closely with L.L.Bean to develop and launch our first major e-commerce application. L.L.Bean had a very successful catalogue business, where people would call on the phone to order items from the catalogue. They now wanted to put their catalogue online and enable customers to now order and pay for items over the Internet. The application had to be ready for the 1996 Christmas shopping season, and so we had to lock and test everything by early November, a significant challenge since we started developing the application only a few months earlier. Once more, we didn't know how many people would now buy online. It was a pretty heroic effort, but we made it. After the holidays, our L.L.Bean partners kindly sent us a bottle of champagne in appreciation.

Equally important, we captured these customer references and wrote up these case studies to solidify and fortify IBM's position as a major Internet player. A lot of our work in the early months of IBM's Internet initiative involved conducting market experiments with clients and partners across a variety of industries.

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Organization and culture

Established companies cannot possibly compete with start-ups on focus and speed. Instead, they need to figure out how to best integrate the new disruptive innovations with their key core assets. This will make it easier to embrace the innovation as a way of rejuvenating and transforming the company and its various offerings, processes, business models, and culture. If properly done, it can be a major competitive advantage over both established competitors and fast moving start-ups.

Top management support is absolutely essential for disruptive initiatives to have any serious chance of success. Much of what needs to be done in an entrepreneurial initiative involves taking risks and breaking glass. The initiative must be carefully nurtured and protected until it has enough concrete results and marketplace successes to stand on its own. There's no question in my mind that IBM's Internet strategy would not have succeeded, had it not received the strong and visible support from CEO Lou Gerstner and other senior executives.

IBM, like many large businesses in the pre-Internet era, used to be very inward-looking, preferring to do everything by itself if at all possible. Embracing the Internet, its open standards, and its overall outside-in approach turned out to be much more than a technology and strategy change—it required a major transformation of the very culture of the company.




Leaders may decide to declare blockchain as their moonshot, their "galvanizing mission."

"The winning strategy does not just change as we move from stage to stage [in the technology adoption life cycle], it actually reverses the prior strategy."

 GEOFFREY A. MOORE
Author
Inside the Tornado

"This is clearly no game for anyone who has one way of doing things and sticks to it."

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Gerstner saw the Internet as an all-important catalyst for change. "I decided to declare e-business as our moon-shot, our galvanizing mission, an equivalent of the System/360 for a new era," he wrote in his excellent book, *Who Says Elephants Can't Dance?* "We infused it into everything. It provided a powerful context for all of our businesses. It gave us both a marketplace-based mission and a new ground for our own behaviors and operating practices—in other words, culture."⁶⁴

One of Geoffrey Moore's insights in *Inside the Tornado*, his sequel to *Crossing the Chasm*, was that "the market is a conservative institution, and it presses back against the new changes" until "there comes a flash point...when the entire marketplace, under the pressure of continually escalating disequilibrium in price/performance, shifts its allegiance from the old architecture to the new."⁶⁵ Companies that have been plugging away on new categories of products and services—and these are offerings that use the breakthrough technology to deliver unprecedented user benefits—suddenly find themselves in a tornado of market demand on the mainstream side of the chasm. It is a spectacular time.

Here is Moore's other key insight: "The winning strategy does not just change as we move from stage to stage [in the technology adoption life cycle], it actually reverses the prior strategy."⁶⁶ Everything that got a company's or a consortium's product across the chasm—such as customizing use cases or targeting a niche or a vertical—needs to reverse and shoot for wider distribution, mass or horizontal applications, and even commoditization. Power shifts from product suppliers to service providers and back again. Leaders and followers both enjoy periods of advantage as a technology rolls out. Positioning becomes an assertion of influence within an ecosystem of relationships. Moore put it bluntly: "This is clearly no game for anyone who has one way of doing things and sticks to it."⁶⁷

From an organizational leadership perspective, then, Moore wrote that executive teams need to be stating the challenge clearly and confronting each situation as it arises. They also need to "assess each other's strengths and weaknesses, and do their best to move the reins of power into the right hands at the right time."⁶⁸ This is not about executive turnover; this is about strong teams at the top, a C-suite of diverse skills and talents, so that the organization can call on the individual strengths of each executive when needed.

Getting back to our original question, should your company get on the blockchain learning curve now or wait and run the risk of being left behind by more aggressive competitors? There is no easy answer. In the end, it all comes down to your leadership aspirations and your appetite for change and uncertainty.



Conclusion and recommendations

Gartner included blockchain among the technologies in its report, "2017 Hype Cycle for Emerging Technologies." While warning its clients that "blockchain technologies are extremely hyped, evolving at different trajectories," they most definitely should not be ignored. "They offer the potential for substantial change in technology development and delivery as well as in how the economy, business and society operates."⁶⁹

Navigating this balance between hype and promise is a key responsibility of a company's senior management team. We lived through it in IBM in the 1990s amid the initial public offering frenzy, the hype associated with the dotcom bubble, and the bursting of that bubble, and we were able to realize the incredible potential of the Internet that so many of us believed in.

Do any of these lessons learned apply to blockchain today? I think so. There are both differences and similarities. Let me briefly summarize the current state of blockchain.

Navigating this balance between hype and promise is a key responsibility of a company's senior management team.



Blockchain is nowhere near as mature as the Internet in the early-mid 1990s, perhaps more akin to the Internet in the late 1980s. But marketplace interest has considerably picked up in the past few years. Universities and research labs have launched blockchain-based projects, and there is serious interest on the part of governments.



A number of large companies and start-ups have blockchain prototypes underway, though the amount of such activity is still relatively small, with a few prominent exceptions such as financial services and supply chain management. A recent IBM survey of almost 3,000 C-suite executives found out that fewer than 10 percent of companies are actively involved in blockchain activities, while 25 percent are considering but not yet ready to deploy blockchains.



IT companies are starting to offer consulting and blockchain-based services to their clients, including IBM, Microsoft, and Amazon, as have a number of new blockchain start-ups such as Blockstream and Consensus Systems. Some have started offering "blockchain as a service" (BaaS), similar to "software as a service" (SaaS) or cloud computing.



Blockchains are generally multi-institutional and mission critical, and thus fairly complex. On the other hand, the Internet's global infrastructure greatly facilitates the development and deployment of blockchain-based platforms and applications.



Despite the increasing number of articles, reports, and books on blockchain, most people have little idea what blockchain is about and why we're so excited about it. It's all



still very new. Many still associate blockchain primarily with bitcoin and other cryptocurrencies.

Will blockchain have a profound long-term impact—like the Internet—on companies, industries, and economies? I think it will, but it's too early to tell how big the impact will be and how long it will take. I've spent my life studying very complex systems, and nothing is ever black and white. Technology is very important, but so are market readiness and good financial results, including cash flow and profits.

Technology is very important, but so are market readiness and good financial results, including cash flow and profits.

In the end, a successful strategy must be executable in the marketplace. With the Internet, the action was mostly in the marketplace, not in the labs. There was no single technology or product that we could develop in the labs that would ensure our success in the marketplace. That said, we did need to get on the learning curve with proof-of concept pilots ready to reap blockchain's long term benefits.

We sometimes forget that disruptive innovations are indeed *disruptive*, not only in the marketplace but also for individuals and organizations. Much as we often talk about embracing change as a positive experience, change is in fact very difficult, even painful for many people. We are asking them to move into unknown, perhaps even uncharted territory. What will be the impact on their jobs? Do they have the required skills for whatever is ahead? How well will they personally do in the new environment?

Effective marketing and communications is essential. I've written a lot about marketing to external audiences—customers, investors, educators, and the press. Blockchain leaders also need to devote communications efforts on internal audiences. If the employees of the company do not understand the new initiatives, then they struggle to support them. Managers must pay considerable attention to internal messages, education, and incentives so people understand the overall strategy, their own role, and the role of their unit in helping it succeed. Often, one of the most effective ways of explaining the strategy to employees is through outside communications. People will believe what they read in newspapers, magazine articles, and other external sources more than they will be in internal company communications.

I've witnessed a Wild West mentality, where leaders send the message "the rules don't apply to us," whether they're talking about the principles of economics or the codes of conduct in a civil society. For these organizations or their leaders, it almost never ends well. So I'll say it for the record: these rules do apply.

A communications strategy is absolutely critical to a new, disruptive initiative from the very beginning. We need to be able to explain what it is that we are doing in simple terms, something that is easier said than done especially when talking about a new and potentially disruptive initiative. Often, the people leading the venture underestimate how important it is to develop clear, simple messages and how much work it takes to do so. They are then frustrated that many of their key constituencies do not understand what the new venture is about.

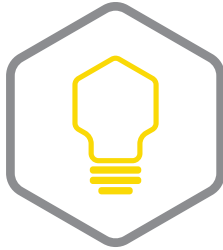
I've also witnessed a Wild West mentality, where leaders send unproductive messages to the effect of "the rules don't apply to us," whether they're talking about the principles of economics—"it's



all about eyeballs, not revenues”—or the codes of conduct in a civil society, such that sexual harassment, for example, becomes normalized. For these organizations—or at least for some of their leaders—it almost never ends well. So I’ll say it for the record: *these rules do apply*.

Finally, we need to avoid unrealistic expectations. Blockchain initiatives are mostly in the alpha or beta stage. As Geoff Moore observed, “For a long time, although much is written about the new paradigm, little of economic significance happens. Indeed, sometimes the innovation is never embraced, falling back into some primordial entrepreneurial soup.”⁷⁰ But sometimes it emerges from that soup and evolves so quickly that incumbents of the old paradigm don’t know what hit them. Vigilance is in order.





About the author

Dr. Irving Wladawsky-Berger is visiting lecturer at MIT's Sloan School of Management, a fellow of MIT's Initiative on the Digital Economy and of MIT Connection Science and adjunct professor at the Imperial College Business School, and member of the advisory board of its Data Science Institute.

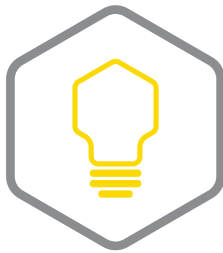
In May 2007, he retired from IBM after a 37-year career with the company, where his primary focus was on innovation and technical strategy. He led a number of IBM's companywide initiatives including the Internet, supercomputing, and Linux. He's been a strategic adviser on digital strategy and innovation at Citigroup, HBO, and Mastercard.

Since 2005, Dr. Wladawsky-Berger has been writing a weekly blog, irvingwb.com, which the *Wall Street Journal* has published in its *CIO Journal* since April 2012. He is a member of the board of trustees of Manhattanville College, the advisory board of USC's Annenberg Innovation Lab, the board of directors of inno360, and the Corporation for National Research Initiatives. He is a distinguished associate at the Energy Futures Initiative.

He was co-chair of the President's Information Technology Advisory Committee as well as a founding member of the Computer Sciences and Telecommunications Board of the National Research Council. He is a former member of the University of Chicago Board of Governors for Argonne National Laboratories, the Fermilab Board of Overseers, and the BP Technology Advisory Council. He is a fellow of the American Academy of Arts and Sciences and the Royal Society of Arts. A native of Cuba, he was named the 2001 Hispanic Engineer of the Year.

Dr. Wladawsky-Berger received an M.S. and a Ph. D. in physics from the University of Chicago.





About the Blockchain Research Institute

Co-founded in 2017 by Don and Alex Tapscott, the Blockchain Research Institute is a knowledge network organized to help realize the new promise of the digital economy. It builds on their yearlong investigation of distributed ledger technology, which culminated in the publication of their critically acclaimed book, *Blockchain Revolution* (Portfolio|Penguin).

Our syndicated research program, which is funded by major corporations and government agencies, aims to fill a large gap in the global understanding of blockchain technology and its strategic implications for business, government, and society.

Our global team of blockchain experts is dedicated to exploring, understanding, documenting, and informing leaders of the market opportunities and implementation challenges of this nascent technology.

Research areas include financial services, manufacturing, retail, energy and resources, technology, media, telecommunications, healthcare, and government as well as the management of organizations, the transformation of the corporation, and the regulation of innovation. We also explore blockchain's potential role in the Internet of Things, robotics and autonomous machines, artificial intelligence, and other emerging technologies.

Our findings are initially proprietary to our members and are ultimately released under a Creative Commons license to help achieve our mission. To find out more, please visit www.blockchainresearchinstitute.org.

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Notes

1. "The Trust Machine," *The Economist*, 31 Oct. 2015. <http://www.economist.com/printedition/covers/2015-10-29/ap-e-eu-la-me-na-uk>, accessed 22 Sept. 2017.
2. Its inventor, Satoshi Nakamoto defined "the electronic coin as a chain of digital signatures." Satoshi Nakamoto, "Bitcoin: A Peer-to-Peer Electronic Cash System," www.bitcoin.org.
3. Linus Torvalds, "Linux's History," Alan W. Black's faculty page, Language Technologies Institute, Carnegie Mellon University, 31 July 1992. <https://www.cs.cmu.edu/~awb/linux.history.html>, accessed 14 Sept. 2017.
4. Robleh Ali, John Barrdear, Roger Clews, and James Southgate, "Innovations in payment technologies and the emergence of digital currencies," *Quarterly Bulletin* Q3 (2014): 1-14, Bank of England. <http://www.bankofengland.co.uk/publications/Documents/quarterlybulletin/2014/qb14q3digitalcurrenciesbitcoin1.pdf>, accessed 22 Sept. 2017.
5. Veena Pureswaran and Paul Brody, "Device democracy Saving the future of the Internet of Things," IBM Institute for Business Value, July 2015. <http://www.the-blockchain.com/docs/IBM%20-%20Blockchain%20and%20IoT.pdf>, accessed 16 Oct. 2017.
6. Don and Alex Tapscott, *Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World* (New York: Penguin Portfolio, 2016).
7. David D. Clark, "The Contingent Internet," *Daedalus*, Vol. 145, Issue 1, Winter 2016, pp. 9-17. http://www.mitpressjournals.org/doi/pdf/10.1162/DAED_a_00361, accessed 11 Sept. 2017. Ten years earlier, Clark contributed to a 2006 MIT Technology Review article, "The Internet is Broken," in which he cited costs, impediments to innovation, and national security threats as challenges. He called for a "clean slate approach" to fixing it.
8. Don and Alex Tapscott, *Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World* (New York: Penguin Portfolio, 2016).
9. Adam Back, "Announcing Blockstream Satellite," Blockstream, Inc., 15 Aug. 2017. [Blockstream.com/2017/08/15/announcing-blockstream-satellite.html](http://blockstream.com/2017/08/15/announcing-blockstream-satellite.html), accessed 19 Sept. 2017.
10. Meta-Council on Emerging Technologies, "Top Ten Emerging Technologies of 2016," World Economic Forum, June 2016. http://www3.weforum.org/docs/GAC16_Top10_Emerging_Technologies_2016_report.pdf, accessed 22 Sept. 2017.
11. Marco Iansiti and Karim Lakhani, "The Truth about Blockchain," *Harvard Business Review*, Jan.-Feb. 2017. <https://hbr.org/2017/01/the-truth-about-blockchain>, accessed 21 Aug. 2017.
12. Iansiti and Lakhani, "The Truth about Blockchain," *HBR*, Jan.-Feb. 2017.
13. Richard Foster, *Innovation: The Attacker's Advantage* (New York: Summit, 1986); Clayton M. Christensen, Michael E. Raynor, and Rory McDonald, "What Is Disruptive Innovation?" *Harvard Business Review*, Dec. 2015. <https://hbr.org/2015/12/what-is-disruptive-innovation>, accessed 21 Aug. 2017.
14. Christensen, Raynor, and McDonald, "What Is Disruptive Innovation?" *HBR*, Dec. 2015.
15. Foster, *Innovation*, 1986.
16. Nathaniel Popper, "Wall Street Clearinghouse to Adopt Bitcoin Technology," *New York Times*, 9 Jan. 2017. <https://www.nytimes.com/2017/01/09/business/dealbook/wall-street-clearing-house-to-adopt-bitcoin-technology.html>, accessed 22 Sept. 2017.



17. Larry Downes and Chunka Mui, *Unleashing the Killer App: Digital Strategies for Market Dominance*, foreword by Nicholas Negroponte (Boston: Harvard Business School Press, 1998).
18. Bob Briscoe, Andrew Odlyzko, and Benjamin Tilly, "Metcalfe's Law Is Wrong," *IEEE Spectrum: Technology, Engineering, and Science News*, IEEE Spectrum, 1 July 2006. spectrum.ieee.org/computing/networks/metcalfes-law-is-wrong, accessed 22 Aug. 2017.
19. Mehrdad Baghai, Stephen Coley, and David White featured the three horizons framework in their book, *The Alchemy of Growth* (New York: Perseus Books, 1999), published when they were at McKinsey & Company.
20. Meta-Council on Emerging Technologies, "Top Ten Emerging Technologies of 2016," World Economic Forum, June 2016. http://www3.weforum.org/docs/GAC16_Top10_Emerging_Technologies_2016_report.pdf, accessed 22 Sept. 2017.
21. Don and Alex Tapscott, *Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World* (New York: Penguin Portfolio, 2016).
22. "A Blueprint for Digital Identity the Role of Financial Institutions in Building Digital Identity," foreword by R. Jesse McWaters, Future of Financial Services Series, World Economic Forum, Aug. 2016. http://www3.weforum.org/docs/WEF_A_Blueprint_for_Digital_Identity.pdf, accessed 22 Sept. 2017.
23. Alex Pentland, David Shrier, Thomas Hardjono, and Irving Wladawsky-Berger, "Towards an Internet of Trusted Data: A New Framework for Identity and Data Sharing," *Input to the Commission on Enhancing National Cybersecurity*, Aug. 2016. https://www.nist.gov/sites/default/files/documents/2016/09/16/mit_rfi_response.pdf, accessed 22 Sept. 2017.
24. MIT Connection Science. <http://connection.mit.edu/>; Pentland et al, "Towards an Internet of Trusted Data," *Input to the Commission on Enhancing National Cybersecurity*, Aug. 2016. https://www.nist.gov/sites/default/files/documents/2016/09/16/mit_rfi_response.pdf, accessed 22 Sept. 2017.
25. OPAL project, 2016-2017, <http://opalproject.org/> and Project Enigma, Massachusetts Institute of Technology, School of Architecture + Planning. <https://www.media.mit.edu/projects/enigma/overview/>, both accessed 22 Sept. 2017.
26. "Fast forward: Rethinking enterprises, ecosystems and economies with blockchains," IBM Institute for Business Value, June 2016. <https://public.dhe.ibm.com/common/ssi/ecm/gb/en/gbe03757usen/GBE03757USEN.PDF>, accessed 26 Sept. 2017.
27. "Fast forward," IBM Institute for Business Value, June 2016.
28. Iansiti and Lakhani, "The Truth about Blockchain," *HBR*, Jan.-Feb. 2017.
29. "The great chain of being sure about things," *The Economist*, 31 Oct. 2015. <http://www.economist.com/news/briefing/21677228-technology-behind-bitcoin-lets-people-who-do-not-know-or-trust-each-other-build-dependable>, accessed 22 Sept. 2017.
30. David Brooks, "The Evolution of Trust," *The New York Times*, 30 June 2014. <http://www.nytimes.com/2014/07/01/opinion/david-brooks-the-evolution-of-trust.html>, accessed 26 Sept. 2017.
31. Jeremiah Owyang, "TED: When Cars Become Alive (my 3 min speech)," Web Strategy LLC, 19 Sept. 2017. <http://www.web-strategist.com/blog/>, accessed 22 Sept. 2017.
32. Izabella Kaminska, "The sharing economy will go medieval on you," *Alphaville*, *Financial Times*, 21 May 2015. <http://ftalphaville.ft.com/2015/05/21/2130111/the-sharing-economy-will-go-medieval-on-you/>, accessed 19 Sept. 2017.



33. Primavera De Filippi, "What Blockchain Means for the Sharing Economy," *Harvard Business Review*, 15 Mar. 2017. <https://hbr.org/2017/03/what-blockchain-means-for-the-sharing-economy>, accessed 19 Sept. 2017.
34. French National Center for Scientific Research (Centre national de la recherche scientifique or CNRS). <http://www.cnrs.fr/index.php>, accessed 22 Sept. 2017.
35. Primavera De Filippi, Constance Choi, and Amore Sexton, Coalition of Automated Legal Technologies (COALA). <http://coala.global/>, accessed 22 Sept. 2017.
36. IBM press release, "IBM Study", IBM, 18 May 2017. <https://www-03.ibm.com/press/us/en/pressrelease/52418.wss>, accessed 22 Sept. 2017.
37. IBM IBV, "Forward Together," May 2017. <https://www-935.ibm.com/services/studies/csuite/pdf/GBE03835USEN-00.pdf>, accessed 22 Sept. 2017.
38. IBM IBV and the Economist Intelligence Unit, "Blockchain rewires financial markets: Trailblazers take the lead," IBM Institute for Business Value, Sept. 2017. <https://www-01.ibm.com/common/ssi/cgi-bin/ssialias?htmlfid=GBP03469USEN&>, accessed 22 Sept. 2017.
39. Geoffrey A. Moore, *Crossing the Chasm: Marketing and Selling Technology Products to Mainstream Customers*, foreword by Regis McKenna (New York: HarperBusiness, 1991).
40. Everett M. Rogers, *Diffusion of Innovations*, 3rd ed. (New York: The Free Press, 1983). Moore adapted Rogers' Figure 7-2, "Adopter categorization on the basis of innovativeness," p. 247.
41. Rogers, *Diffusion of Innovations*, 3rd ed., p. 10.
42. Moore, *Crossing the Chasm*, pp. 5-6.
43. Henning Schultzrinne, IAB Executive Director, "A Brief History of the Internet Advisory / Activities / Architecture Board," Internet Architecture Board. <https://www.iab.org/about/history/>, accessed 14 Sept. 2017. Internet Research Task Force, 29 Aug. 2017. <https://irtf.org/>, accessed 23 Sept. 2017. The IRTF is managed by IRTF chair in consultation with the Internet Research Steering Group.
44. The Linux Foundation. <https://www.linuxfoundation.org/about/>, accessed 14 Sept. 2017.
45. Robert McMillan, "The Legacy of Linus Torvalds: Linux, Git, and One Giant Flamethrower," *Wired.com*, 19 Nov. 2012. <https://www.wired.com/2012/11/linus-torvalds-isoc/>, accessed 14 Sept. 2017.
46. Don and Alex Tapscott, "Realizing the Potential of Blockchain," World Economic Forum. http://www3.weforum.org/docs/WEF_Realizing_Potential_Blockchain.pdf, accessed June 2017.
47. "ICOs, Token Sales, Crowdsales," Smith+Crown, n.d. <https://www.smithandcrown.com/icos/>, accessed 14 Sept. 2017.
48. Nathaniel Popper, "Despite S.E.C. Warning, Wave of Initial Coin Offerings Grows," *The New York Times*, 7 Aug. 2017. <https://www.nytimes.com/2017/08/07/business/dealbook/initial-coin-offerings-sec-virtual-currency.html>, accessed 15 Sept. 2016. It should be noted that, as of this writing, the Chinese government has banned ICOs as a means of fundraising.
49. Tapscott, "Realizing the Potential of Blockchain," WEF, June 2017.
50. Grace Caffen, "What is the Bitcoin Block Size Debate and Why Does It Matter," *Coindesk.com*, 21 Aug. 2015. <https://www.coindesk.com/what-is-the-bitcoin-block-size-debate-and-why-does-it-matter>, accessed 16 Sept. 2017.
51. Jack Crosbie, "When will Bitcoin Fork, and What's It Mean for Crypto's Future?" *Inverse.com*, 26 July 2017. <https://www.inverse.com/article/34693-bitcoin-hard-fork-soft-fork-explained-august-1>, accessed 16 Sept. 2017.



52. Tapscott, "Realizing the Potential of Blockchain," WEF, 11 Sept. 2017.
53. "Hyperledger Project Charter," The Linux Foundation, 22 Jan. 2016. www.hyperledger.org/about/charter, accessed 17 May 2017.
54. Casey Kuhlman, "Why We're Joining Hyperledger," *Monax*, Monax Industries, 28 Feb. 2017. <https://monax.io/blog/2017/02/28/why-were-joining-hyperledger/>, accessed 17 May 2017.
55. Rebecca Campbell, "Tendermint Wins Innovation Award and Announces Cosmos at International Blockchain Week," *Bitcoin Magazine*, 23 Sept. 2016. <https://bitcoinmagazine.com/articles/tendermint-wins-innovation-award-and-announces-cosmos-at-international-blockchain-week-1474657507/>, accessed 13 Sept. 2017.
56. Saheli Roy Choudhury, "China Bans Companies from Raising Money Through ICOs, Asks Local Regulators to Inspect 60 Major Platforms," CNBC, 4 Sept. 2017, updated 5 Sept. 2017. www.cnbc.com/2017/09/04/chinese-ICOs-china-bans-fundraising-through-initial-coin-offerings-report-says.html, accessed 15 Sept. 2017.
57. Tapscott, "Realizing the Potential of Blockchain," WEF, June 2017.
58. "Tapscott: Success Will Come from Trust, Shared Information," interviewed by Debra D'Agostino, CIO Insight, 5 Oct. 2005. <http://www.cioinsight.com/c/a/Expert-Voices/Tapscott-Success-Will-Come-From-Trust-Shared-Information>, accessed 23 Sept. 2017.
59. Simon Elstad, "Top 10 Gig Economy Platforms," *Casual Capitalist*, Glenn Carter, 10 April 2017. <https://thecasualcapitalist.com/the-sharing-economy/gig-economy-platforms-top-ten>, accessed 15 Sept. 2017.
60. "A Giant Problem: The Superstar Company," *The Economist*, 17 Sept. 2016. www.economist.com/news/leaders/21707210-rise-corporate-colossus-threatens-both-competition-and-legitimacy-business, accessed 23 Sept. 2017.
61. Andrew McAfee and Erik Brynjolfsson, "No Matter How Smart They Get, Contracts Will Still Be Incomplete," *Machine, Platform, Crowd* (New York: W.W. Norton & Company, 2017).
62. McAfee and Brynjolfsson, *Machine, Platform, Crowd*, 2017.
63. McAfee and Brynjolfsson, *Machine, Platform, Crowd*, 2017.
64. Louis V. Gerstner, *Who Says Elephants Can't Dance? Leading a Great Enterprise Through Dramatic Change* (New York: HarperCollins Publishers, 2002), p. 213.
65. Geoffrey A. Moore, *Inside the Tornado: Marketing Strategies from Silicon Valley's Cutting Edge* (New York: HarperCollins Publishers, 1995), p. 4.
66. Moore, *Inside the Tornado*, p. 10.
67. Moore, *Inside the Tornado*, p. 12.
68. Moore, *Inside the Tornado*, p. 12.
69. David Furlonger, Ray Valdes, and Rajesh Kandaswamy, "Hype Cycle for Emerging Technologies, 2017," *Gartner, Inc.*, 31 July 2017. <https://www.gartner.com/doc/3775165/hype-cycle-blockchain-technologies>, accessed 15 Sept. 2017.
70. Moore, *Inside the Tornado*, p. 4.







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