

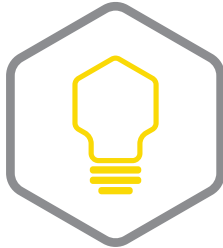
BLOCKCHAIN AND THE CHIEF STRATEGY OFFICER

How Distributed Ledger Technology Will Change Strategy Design and Delivery

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Edivandro Carlos Conforto, and Tahirou Assane Oumarou
Blockchain Research Institute and Brightline Initiative

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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.



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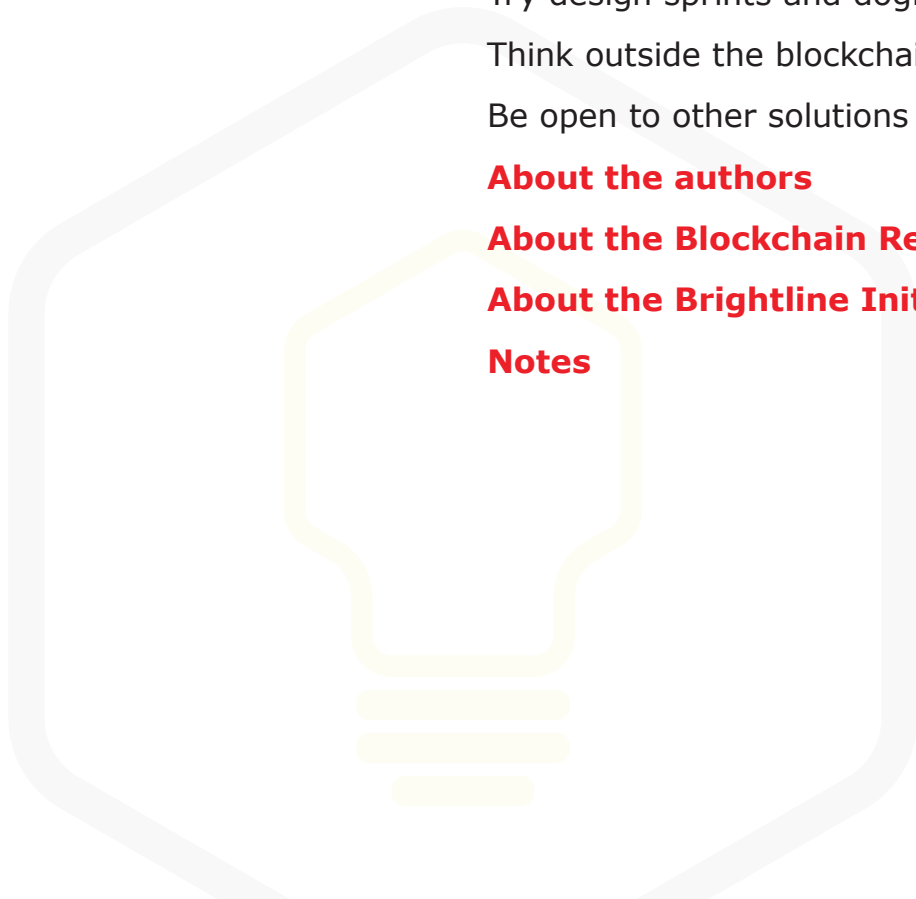
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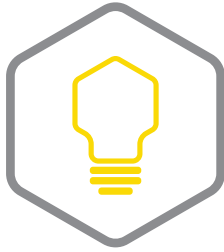


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Foreword

Rarely does the word, *trust*, surface in conversations about strategy. Executives more often talk about implementation risks, information asymmetries, and moral hazard, and they use scenario planning to imagine multiple futures. Yet, if we learned only one thing from the last economic downturn, it was that multiple parties could fail to act with integrity or otherwise perform their fiduciary duties, so that even the best-laid plans were doomed to go awry and without recourse. Blockchain reduces the need to trust other parties in the development and implementation of strategy. It helps to create and align incentives for performance. We see it as an important new platform for the chief strategy officer (CSO) in the design and delivery of strategy.

This research details how blockchain technology supports strategy design and delivery in innovative enterprises.

This research takes on the challenge of describing how blockchain technology supports the CSO in innovative enterprises. It lays out the key challenges facing corporations especially around the areas of trust, describing how blockchain proves to be a useful tool to address deficiencies. It illuminates key concepts such as the shared ledger, smart assets, and smart contracts. It describes how blockchain supports CSO responsibilities such as maintaining collaborative governance, identifying growth opportunities, monitoring long-term trends, and managing the strategic process. It also outlines how blockchain enables important strategic delivery components including cost improvements, business model innovation, new business incubation, and optimizing capital expenditures. Since this paper addresses a forward-thinking organization's goals at the highest level, it is a must-read for all leaders.

We recruited an impressive all-star team for this research. The lead author is Kirsten Sandberg, editor-in-chief of the Blockchain Research Institute. In this role, she deeply influences every one of our research deliverables. I've worked with Kirsten over the years, most recently in the research and writing of *Blockchain Revolution*. For more than a decade, she was an executive editor at Harvard Business School Publishing and has worked with some of the brightest minds in strategy and technology. In this project, I challenged her to move beyond the concept of strategic agility, which tends to depend on organizational culture. Building on ideas of many prescient thinkers in the space, she did the research necessary to define and demonstrate the idea of strategic liquidity, made possible by blockchain technology.

Her collaborators from the Brightline Initiative are equally impressive. They provided valuable feedback throughout the development process. First is Ricardo Viana Vargas, executive director of Brightline and one of the world's leading experts in the field of project management. He has worked as a portfolio manager, has written fifteen books, and hosts the sage *Five Minutes Project Management*



podcast. Dr. Edivandro Carlos Conforto, head of strategy research at Brightline, and a global thought leader on organizational agility, strategy implementation, and agile transformation. Tahirou Assane Oumarou, director of operations at Brightline, was the deputy director of infrastructure and project management group in the United Nations Office for Project Services. In that role, he managed peacebuilding, humanitarian, and development projects globally. It is this diversity of experience and perspective that makes the paper all the more worth reading for members of the Blockchain Research Institute and the Brightline Initiative.



DON TAPSCOTT

*Co-Founder and Executive Chairman
Blockchain Research Institute*

Idea in brief

- » In times of technological disruption, organizations need members of the C-suite to take action in their domains, preparing their people, processes, and practices for change and then leading the transformation. The chief strategy officer has a special role in coordinating the direction of these efforts: where officers of marketing, finance, operations, and human resources are moving over the hill in front of them, the CSO is looking several hills and valleys ahead.
- » Blockchain technology is such a disruptive innovation, one that hinders enterprise strategies that are centrally controlled, designed, and delivered in favor of those that are coordinated with collaborators, automated wherever possible, and distributed across industries, supply chains, and peer-to-peer (P2P) networks.
- » The new distributed building blocks of strategy are shared ledgers, smart contracts, and smart assets—all software, to be coded, plugged, and played across blockchain networks. Used in combination, they instantiate the concept of *strategic liquidity*, the degree to which an enterprise can exploit strategic options to maneuver fluidly in competitive environments.
- » Enterprise leaders are already using blockchain platforms and distributed applications. In strategy design, they're leveraging blockchain to identify growth opportunities, monitor long-term trends, and even manage the strategic planning process itself. In strategy delivery, they're applying blockchain to reduce operational costs, develop new business models, incubate all-new businesses, and reallocate resources more rapidly.
- » Widespread deployment may be a decade away, but those who want to make the leap have much to do between now and then, not to be leapt over. We need more basic and applied

The distributed building blocks of strategy are shared ledgers, smart contracts, and smart assets, which make for greater strategic liquidity.



Implementation challenges include agreement on standards and governance, regulatory clarity, legacy enterprise IT system integration, blockchain interoperability, and network scalability.

research in cryptoeconomics, more education and training, and stronger governance to develop data standards and robust policy. We also need to address such implementation challenges as legacy enterprise information technology (IT) system integration, blockchain interoperability, and network scalability.

- » CSOs have several options to act on, starting with auditing their own enterprise data governance, sharing what their customers and employees already know about and are doing with the technology, and developing enterprise-wide blockchain fluency. They can also think outside the blockchain and look to complementary technologies (i.e., Internet of Things, artificial intelligence, augmented/virtual reality, distributed energy, precision medicine, and mesh networks).

Overview: Solving for trust

Designing and delivering enterprise strategy has rarely been easy. Just as we were wrapping our heads around strategy in an age of information, we faced a crisis of trust—the collapse of global financial markets in 2008. Nobel Laureate Joseph Stiglitz described it as “the fruit of a pattern of dishonesty on the part of financial institutions, and incompetence on the part of policymakers.”¹

The US Financial Crisis Inquiry Commission largely agreed. Relevant to our analysis of strategy were its findings of lax government oversight, lax corporate governance, “excessive borrowing, risky investments, and lack of transparency,” as well as “a systemic breakdown in accountability and ethics,” particularly the “collapsing mortgage-lending standards” and “the failures of credit rating agencies.”²

The impact of trust on strategy

Business strategies depending on such a system were subject to the trustworthiness of those intermediaries—the banks, central banks, and regulators. Former chair of the Federal Reserve, Ben S. Bernanke, studied how enterprise balance sheets influenced not only the corporate response to the credit crisis but also the strategic resilience of companies during the recession.³ He wrote, “[T]he crisis affected investment the most in companies with low cash reserves or high net short-term debt.”⁴ Also hard hit were “smaller or younger firms, which typically require more lender screening and monitoring per dollar of lending,” as “the largest US banks pulled back sharply and differentially from small business lending.”⁵

He found that firms with “higher leverage, less internal cash, [and] less usable collateral ... cut employment significantly more than other firms did, in response to a given decline in local consumer demand.”⁶



These cuts affected strategies hinging on attracting and cultivating key talent. Employee relationships took a hit, especially at small and medium-sized firms.⁷

Likewise, “firms with limited internal liquidity and high operating leverage raised rather than lowered their prices in the face of the 2008 contraction.” Bernanke interpreted “price cuts as investments in maintaining customer relationships” during the downturn, meaning that “financially stressed firms were relatively less able to make such investments” in demand-driven strategies.⁸ So, client relationships also took a hit. The health of “firms’ balance sheets were an essential part of the link between final demand and employment.”⁹

In a global survey of a thousand chief financial officers, executives who described their firms “as credit-constrained during the crisis planned relatively deeper cuts in employment and capital spending, including bypassing otherwise attractive opportunities and cancelling or postponing planned investments.”¹⁰ That meant a freeze on business model innovation and new business incubation. To add insult to injury, those who borrowed from “weaker lenders, borrowed less, paid higher rates when they borrowed, and reduced employment more than other firms.”¹¹ Some large corporations “were able to make up part of the reduction in bank lending through bond issuance, but only by paying high rates.”¹²

The lack of trust among intermediaries had a direct impact on enterprise strategy design and the cost of delivery. Firms that didn't rely as much on global credit markets were better able to navigate the downturn.

So, the lack of trust among intermediaries had a direct impact on enterprise strategy design and the cost of delivery. What really caught our attention was Bernanke’s summary of comparative studies: “Firms in industries more dependent on external finance also reacted more sharply to the crisis” than “firms in industries that are normally more self-sufficient for credit.”¹³ Industries that didn’t rely as much on global credit markets were better able to navigate the downturn.

So how might members of an industry, supply chain, or other economic cluster increase their financial self-sufficiency? How can they depend less on the banks for, say, trade credit or trade finance in the implementation of strategy?

An answer came in the aftershock of the 2008 crisis, when a person or persons named Satoshi Nakamoto released the Bitcoin protocols, calling the invention a “peer-to-peer electronic cash system” as an alternative to the system in place. The problem Satoshi was solving for was trust:

The root problem with conventional currency is all the trust that's required to make it work. The central bank must be trusted not to debase the currency, but the history of fiat currencies is full of breaches of that trust. Banks must be trusted to hold our money and transfer it electronically, but they lend it out in waves of credit bubbles with barely a fraction in reserve. We have to trust them with our privacy, trust them not to let identity thieves drain our accounts. Their massive overhead costs make micropayments impossible.¹⁴



"I'm one of those people who think blockchain is a disruptive technology that will form a new technology platform."

 KEVIN KELLY
Founding Executive Editor
Wired

To the problems of arbitrary inflation and imprudent lending, Satoshi added those of lax cybersecurity and exclusionary business models, where the most basic and lowest priced products and services were still too costly for customers at the bottom of the economic pyramid.

Kevin Kelly, author of *The Inevitable* and founding executive editor of *Wired* magazine, has tweeted, "I'm one of those people who think [Bitcoin] blockchain is a disruptive technology that will form a new technology platform."¹⁵ After reading a former Federal Bureau of Investigation special agent's account of tracing more than 700,000 bitcoins across the Bitcoin blockchain into the wallets controlled by an alleged drug trafficker, Kelly wrote, "I'm telling ya, blockchain technology will be mandated by governments in order to have a fully accounted economy."¹⁶ That'd be an unprecedented push for accountability.

In this research, we look at how distributed ledger technology enables parties who don't know each other—and who may never have held a bank account before—to conduct business legitimately and collaborate online in cryptographically secure environments, increasingly independent of traditional market intermediaries and the resources they control. Because we can't know what we don't know about the future, we develop the idea of *strategic liquidity*, the degree to which an enterprise can maneuver in a competitive environment, learning and unlearning, investing or divesting of strategic positions, accessing the factors of production without using traditional capital markets, and making accessible any underused factors of production at prices greater than or equal to the cost of carrying them on the books. For large multinational firms, this means more liquidity in internal resource reallocation.

Strategic liquidity is the degree to which an enterprise can maneuver in a competitive environment.



Clear Water Drops by Anthony, no date, used under Pexels license, accessed 12 July 2019.

Why the chief strategy officer and why now?

The clear mandate of the chief strategy officer is to future-proof the enterprise, that is, to situate the organization in another place in time, designing the strategy to get there, and securing the commitment and the capital to begin implementation.

Dale Chrystie, business fellow and blockchain strategist at FedEx, said, “It is a peer-to-peer technology. It will change business models, it will change the value we provide, and it’s going to change a lot of companies. If we look at it from a distance, up in our ‘strategy blimp,’ we see the need to change our strategic model.”¹⁷ We agree. The chief strategy officer has an opportunity here to get other executives up in that blimp and help them to see their strategic position in a peer-to-peer world.

In our view, the clear mandate of the chief strategy officer is to future-proof the enterprise. By *future-proofing*, we mean situating the organization in another place in time, designing the strategy to get there, and securing the commitment and the capital to begin implementation. Through a survey, Nicolas Kachaner and Sam Stewart of the Boston Consulting Group identified the main responsibilities of chief strategy officers, which fall into those two categories affected by economic booms and busts:

- » *Strategy design*, including identifying growth opportunities, managing the strategic-planning process, monitoring long-term trends, and maintaining competitive intelligence
- » *Strategy delivery*, including corporate restructuring, portfolio management, shareholder value creation, capital expenditures, vendor relationships, cost improvements, cross-business unit initiatives, post-merger integration, business model innovation, and new business incubation—all hard hit activities on the balance sheet in economic downturns¹⁸

CSOs have an opportunity to educate members of the C-suite on the advantages of blockchain technology in strategy design and delivery. In this research, we first discuss how blockchain solves for trust and the key innovations in the space, which we view as the new elements of strategy. Then we walk through blockchain initiatives that could help reduce enterprise dependence on traditional intermediaries, particularly financial ones, in strategy design and delivery. Finally, we look at implementation challenges as opportunities to participate and learn.

After reading this work, CSOs will have some blockchain-based ideas for bridging the expensive and unproductive gap between strategy design and delivery, especially in times of turbulence and in keeping with the Brightline Initiative’s guiding principles.¹⁹ More important, they will have some immediate actions to take. While we are writing directly to CSOs, we believe that senior vice presidents and executive directors of large enterprises in any sector will find our research useful, as will professionals responsible for managing the execution of strategy within their organization.



How the Bitcoin blockchain solves for trust

Instead of institutional intermediaries, the Bitcoin blockchain relies on miners, the name given to people who've downloaded the software and volunteered their computers and electricity to run it. The software itself does the work.

Blockchain technology is inherently about the direct exchange of value, “an electronic payment system based on cryptographic proof instead of trust, allowing any two willing parties to transact directly with each other without the need for a trusted third party” like a bank or a government agency.²⁰ Instead of institutional intermediaries, the Bitcoin blockchain relies on *miners*, the name given to all the people who've downloaded the software and volunteered their computers and electricity to run it. They're considered “full nodes” on the network. The software itself does the rest: it verifies transactions, assembles blocks of transactions, solves the problem, shows the proof of work—all to win the right to create the next block and receive the bitcoin reward. The nodes reach consensus on the winning solution and maintain a copy of all the chain of blocks, or blockchain. In this case, we can also call it a distributed ledger of transactions.

Satoshi Nakamoto, the pseudonym of whoever wrote the Bitcoin protocols, identified the core challenges of commerce over the Internet. They are the questions of trust-based models of business that we put to so-called “trusted third parties” like banks, universities, or employment agencies to answer. The Bitcoin protocols provide answers directly.

Do these parties own what they claim to own?

That's a two-part question, one of owner identity and one of asset custody. Christian Catalini and Joshua Gans call it the “cost of verification.”²¹ In public key cryptosystems like blockchains, an identity is represented by a unique key pair: the public key we share with parties to transactions, and a private key we use to sign our transactions, generating a digital signature. The Bitcoin protocols use “a framework of coins made from digital signatures, which provides strong control of ownership.”²² Satoshi explained:

We define an electronic coin as a chain of digital signatures. Each owner transfers the coin to the next by digitally signing a hash of the previous transaction and the public key of the next owner and adding these to the end of the coin. A payee can verify the signatures to verify the chain of ownership.²³

So, the owner of the coin is whoever holds the private key that matches the public key to which the coin was last sent. Only a digital signature generated by that private key can transfer the coin to another party, and any of the nodes can confirm this ownership and verify the transaction.

The blockchain start-up Voatz applied this capability to the 2018 midterm election in West Virginia, under the US Uniformed and Overseas Citizens Absentee Voting Act.²⁴ Massachusetts Institute of Technology (MIT), Open University (UK), and other institutions



of higher education applied the blockcerts open standard to issue students digital credentials on the Bitcoin blockchain upon course completion.²⁵ Everledger applied it to provenance of diamonds.²⁶

Will these parties hold up their end of the bargain?

In the strategy behind the Bitcoin blockchain, bitcoin is an incentive for participation in and preservation of the platform.

That's also a two-part question, one of integrity and one of incentives. There are two challenges for dealmakers. The first is reversibility of a deal. In commerce over the Internet, Satoshi acknowledged, "Completely non-reversible transactions are not really possible, since financial institutions cannot avoid mediating disputes" among parties.²⁷ With Satoshi's proof-of-work consensus method, reversing a transaction is "computationally impractical." It also makes hacking a transaction costly.

To undo a deal, a buyer would need to redo the proof of work of the block containing the transaction *and* "all blocks after it and then catch up with and surpass the work of the honest nodes."²⁸ That protects the vendors from fraud in peer-to-peer blockchain commerce, "and routine escrow mechanisms could easily be implemented to protect buyers," should they find the product or service unacceptable.²⁹ Otherwise, the vendor could agree to refund, requiring another transaction, this time from vendor to buyer.

The second challenge is the potential for *double-spending*, the chance that an owner will attempt to spend a bitcoin in two places at once. On the Bitcoin blockchain, the network time-stamps the first transaction where the owner spends a particular coin and rejects subsequent spends of the coin, thus eliminating the possibility of a double spend.

In the strategy behind the Bitcoin blockchain, bitcoin is an incentive for computer owners to participate in running the software in the role of miners. Satoshi wrote, "By convention, the first transaction in a block is a special transaction that starts a new coin owned by the creator of the block. This adds an incentive for nodes to support the network."³⁰ Bitcoin is also a claim on the blockchain, that is, ownership in the platform itself. By owning and using bitcoin, participants are financing the blockchain's ongoing development. If it fails, their bitcoin may be worthless. So, miners and bitcoin users generally want the platform to succeed.

The study of the Bitcoin blockchain is a behavioral economics lesson in designing strategy to reward those delivering it, as they deliver it.

Those who say, "bitcoin bad, blockchain good," are missing the mastery of this incentive structure. Satoshi carefully thought through the incentives required to deliver the strategy, and then codified and programmed them into the design. This is a behavioral economics lesson in designing strategy to reward those *as they deliver it*. It is directly linked to a desired behavior, and it is constant reinforcement of that behavior. That's what tokens help executives to do, when an enterprise incorporates blockchain platforms into strategy implementation.

By solving for trust, Satoshi's Bitcoin protocols instantiated the concept of *digital scarcity*: they created discrete bitcoins, where



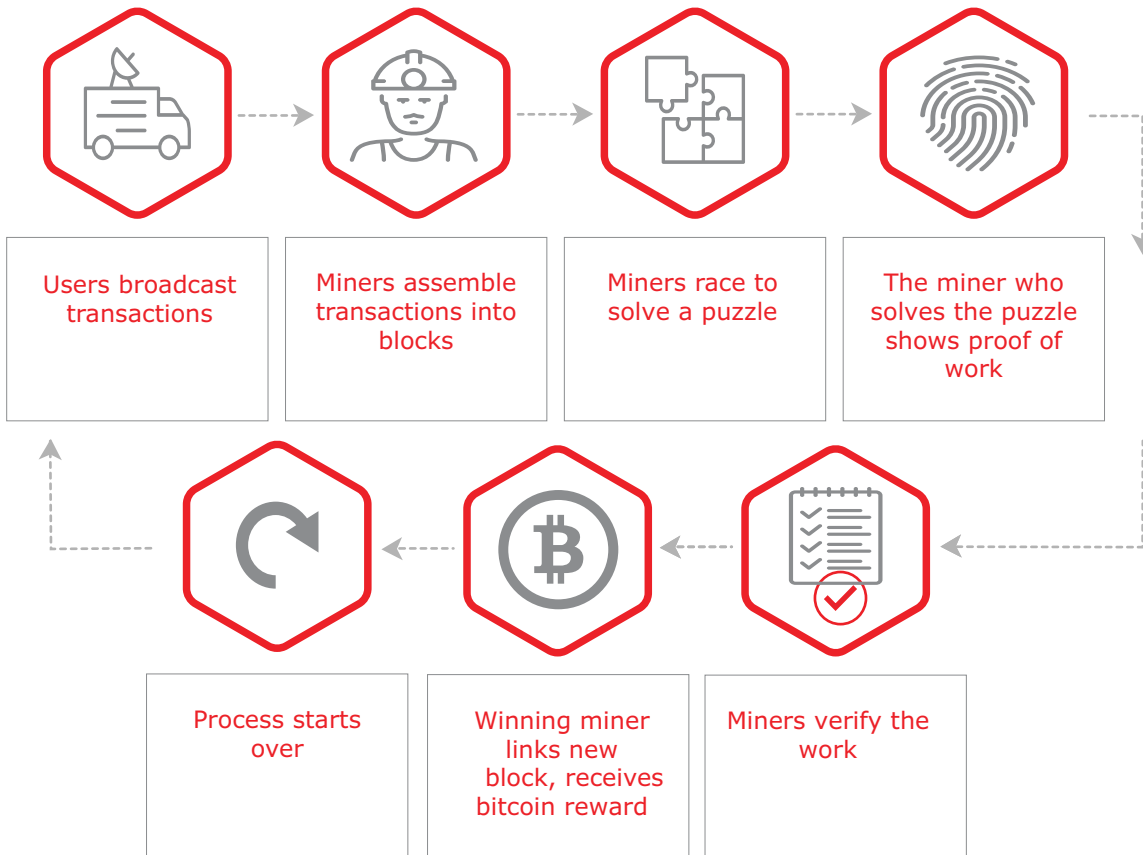
Once launched, the Bitcoin blockchain protocols instantiated the concept of digital scarcity: they created discrete bitcoins, where each unit of value was identifiable and distinct from all other bitcoins in perpetuity and not copiable.

each unit of value was identifiable and distinct from all other bitcoins in perpetuity and not copiable. Those who aren't excited about blockchain, are by no means alone. "The problem with blockchain is that it's boring. It's not fast. It's not the only database. It's not the best database," said Chrystie of FedEx. "But where authenticity is important, where legitimacy matters, it's a game changer."³¹

Blockchain technology provides attestation of claims such as identity, provenance, custody, and ownership. That information is critical for, say, ingredients used in pharmaceuticals and precision parts used in aircraft. It may become critical to more types of marketing claims and product labels, particularly those involving health, environmental impact, fair trade, and ethical sourcing. But it requires everyone in an ecosystem to participate end to end. Otherwise, how are we to isolate quickly the next *E.coli* contaminated food or carcinogen tainted high blood pressure medicine, and identify the source?³²

Figure 1: How the Bitcoin blockchain works

Miners refer to those devices running the full blockchain software stack and competing to solve a difficult mathematical problem and create the next block, in exchange for a cryptocurrency reward. The term also refers to the parties that own those devices.



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Distributed building blocks of strategic liquidity

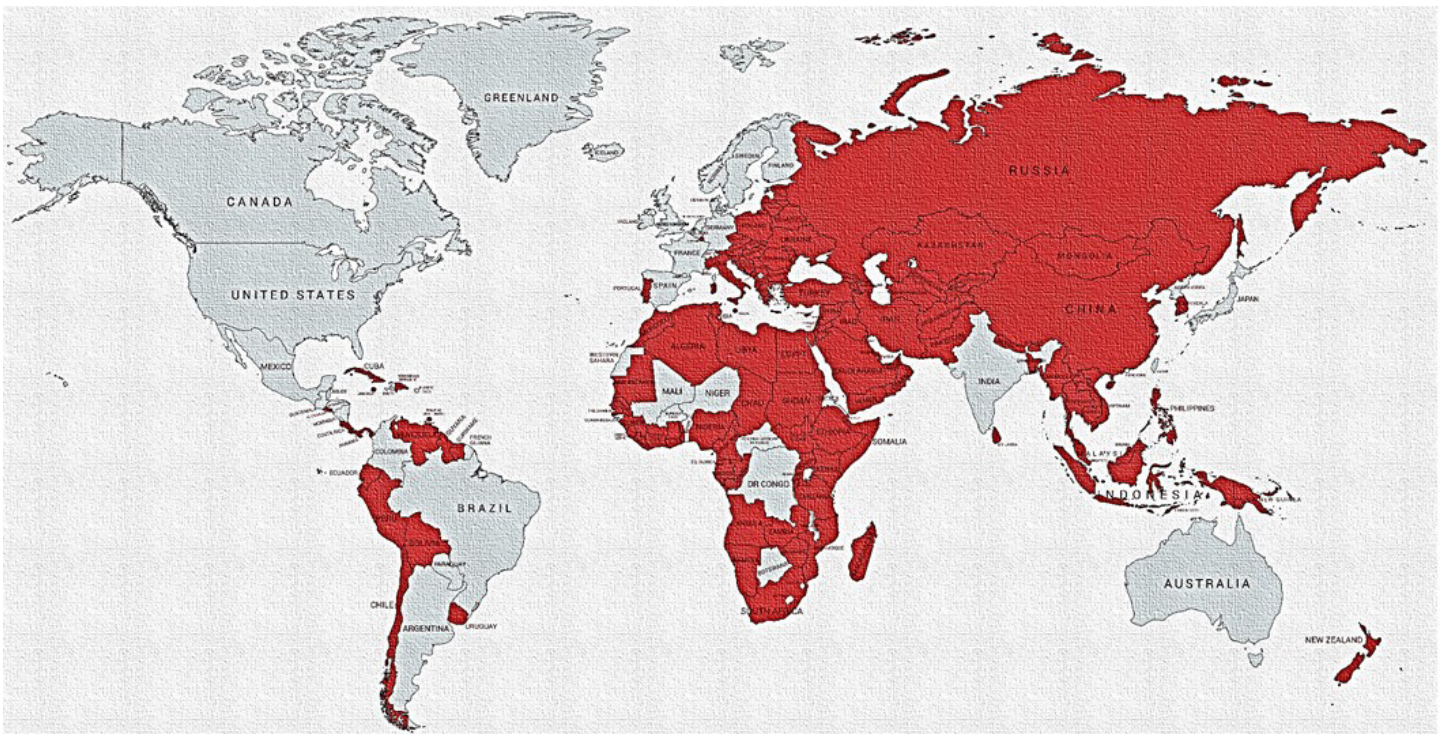
The Belt and Road Consortium is incorporating a shared ledger that is blockchain-based, smart contracts to automate deal terms, and tokenized assets for easier valuation and exchange.

In our sweep of blockchain use cases, we found that companies were designing and delivering strategies that involved three elements—distributed ledgers, smart assets, and smart contracts—that gave them greater degrees of strategic freedom. Among the most ambitious is the work of the Belt and Road Blockchain Consortium (BRBC), founded by Internet pioneer Pindar Wong. He said that its 22 members (as of Nov. 2018) represent “a broad range of sectors, from port operators and logistics, to liquidity providers and professional services including accounting firms,” all dedicated to building out a secure digital infrastructure for China’s bold One Belt One Road Initiative.³³

According to MIT Sloan Fellows, Prema Shrikrishna and Vineet Narula, “China’s Belt and Road Initiative is a project ‘too big to ignore,’ with the potential to transform global trade, if its participants execute its digitization in an equally transformative manner.”³⁴ The goal of the Communist Party of China (CPC) is to connect its economic partners—now 138 of them—by land and sea, and to grease the wheels of China’s global trade, from sourcing to end use.³⁵

Figure 2: Mapping the Belt and Road Initiative

Participating countries appear in red.



Source of data: Office of the Leading Group for the Belt and Road Initiative, “[Country] Profiles,” Belt and Road Portal, State Information Center, as of 29 June 2019. Created with Mapchart.net.



It is a key component of the CPC's foreign policy strategy and among the most audacious economic development programs in human history.

Wong summarized his vision simply "as 'Made in China, Trust in Hong Kong—One Belt, One Road, One Chain.'"³⁶ It builds on Hong Kong's credo, "Public Governance, Private Business."³⁷ The BRBC's goal is to provide speed, transparency, and cybersecurity of transactions

Table 1: Countries in the Belt and Road Initiative

Region	Country (those joining after the initiative's launch appear in <i>italics</i>)
East Africa	<i>Burundi, Djibouti, Ethiopia, Kenya, Rwanda, Seychelles, Somalia, South Sudan, Tanzania, Uganda</i>
Equatorial Africa	<i>Cameroon, Equatorial Guinea, Gabon, Republic of Congo</i>
Northern Africa	<i>Algeria, Chad, Egypt, Libya, Morocco, Sudan, Tunisia</i>
Southern Africa	<i>Angola, Madagascar, Mozambique, Namibia, South Africa, Zambia, Zimbabwe</i>
West Africa	<i>Guinea, Cape Verde, Cote d'Ivoire, The Gambia, Ghana, Mauritania, Nigeria, Senegal, Sierra Leone, Togo</i>
Baltic States	Estonia, Latvia, Lithuania
Eastern Europe	Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Georgia, Hungary, North Macedonia, Moldova, Montenegro, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Ukraine
Europe	<i>Austria, Cyprus, Greece, Italy, Luxembourg, Malta, Portugal, Turkey</i>
Caribbean	<i>Antigua and Barbuda, Barbados, Cuba, Dominica, Dominican Republic, Grenada, Jamaica, Trinidad and Tobago</i>
Central America	<i>Costa Rica, El Salvador, Panama</i>
South America	<i>Bolivia, Chile, Ecuador, Guyana, Suriname, Uruguay, Venezuela</i>
South Pacific	<i>Cook Islands, Fiji, Niue, Samoa, Tonga, Vanuatu</i>
Middle East	Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syria, United Arab Emirates, Yemen
Central Asia	Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan
East Asia	China, Mongolia, Republic of Korea
South Asia	Afghanistan, Bangladesh, Bhutan, Maldives, Nepal, Pakistan, Sri Lanka
Southeast Asia	Brunei, Cambodia, Indonesia, Laos, Malaysia, Micronesia, Myanmar, New Zealand, Papua New Guinea, Philippines, Singapore, Thailand, Timor-Leste, Vietnam

Source of data: Office of the Leading Group for the Belt and Road Initiative, "[Country] Profiles," Belt and Road Portal, State Information Center, as of 29 June 2019.



among the participants. Those require the creation of the essential protocol layers for regulation, identity management, and multistakeholder governance.³⁸ Those are the layers missing from the Internet stack, which the blockchain protocols provide.

The BRBC is incorporating the following three building blocks in the design and delivery of its strategy, to give it maximum liquidity: a shared ledger that is blockchain-based, smart contracts to automate the execution and enforcement of deal terms, and the tokenization of assets so that they're more easily valued and exchanged. Now we look at each of these building blocks in turn.

By shared ledger, we mean blockchain protocols programmed to operate as a ledger, a registry, or other archive, distributed across and updated automatically and simultaneously on the computers of an economic set of actors.

Shared ledger

According to Shrikrishna and Narula, the BRBC "is less about a technology solution [and] more about how companies who have not been able to trust each other in the past can come together and collaborate and share information. The trust shifts to the shared ledger."³⁹

*By shared ledger, we mean blockchain protocols programmed to operate as a ledger, a registry, or other type of archive that is distributed across, shared by, and updated automatically and simultaneously on the computers of an economic set of actors, such as the members of the Belt and Road Initiative. It is a *permissioned ledger*, running on a private distributed network.*

Table 2: General comparison of public and private blockchains

	Private	Public
Participation in network	By invitation or application only, approved by some centralized or decentralized governance body	Open; any party can join
Identity	Every party is known, at least by governance body; many perform know-your-customer processes	Pseudonymous through public key, anonymous through zero knowledge proof protocols
Visibility (Read operation)	Only permissioned users can view data, and only the data they are authorized to view	Any party can view all data
Recording capability (Write and/or commit operation)	Only permissioned users can transact, and fewer may be able to record transaction data	Any party can transact and/or create blocks
Security against malicious tampering	Changing data may be less computationally expensive, but malicious party may be banned from network	All parties can participate in consensus required to change data; doing so is more computationally expensive
Software	Open source or proprietary	Generally open source
Speed	Faster	Slower
Examples	Corda, Hyperledger Fabric	Bitcoin, Ethereum, Stellar



Consortium members can restrict who uses it and who views the data and assets moving across it, and—in this case—they can make sure it complies. That’s in contrast to the Bitcoin and Ethereum blockchains, which are *permissionless ledgers* running on a public network (Table 2, previous page). Anyone can download the protocols, run a full node, and use it to record transactions.

"The data that described the states of supply chains was (and remains) siloed mainly within multiple ERP systems, most of which do not communicate with each other, let alone with advanced supply chain business networks."

 HARRY GOODNIGHT
Executive Advisor
Sweetbridge

Why share a blockchain-based ledger? Because all the stakeholders in such an international consortium have a massive coordination problem. Harry Goodnight, executive advisor to Sweetbridge, put it this way:

The data that described the states of supply chains was (and remains) siloed mainly within multiple ERP [enterprise resource planning] systems, most of which do not communicate with each other, let alone with advanced supply chain business networks.

Problems of data latency, accuracy, and consistency abound for supply chains today, for one simple reason: despite the marketing claims of all of these systems providers, a single source of truth of the state of all supply chain processes simply does not exist.⁴⁰

The benefits of a shared blockchain-based ledger for strategy design and delivery are several.

Strategic benefits of a shared ledger

- » Reduced risk of corporate identity fraud
 - » Maintenance of shared network state
 - » Automated record-keeping
 - » Facilitation of logistics, regulatory compliance, and customs clearance
- » First is “a common blockchain standard for corporate identity along the Belt and Road,” to reduce trade identity risk. “The Belt and Road infrastructure will be an automated way for compliance management for not only know your customer, or know your cow, but, more importantly, know your computer,” Wong told *Accounting and Business*. “Identity is no longer gated by banks; it’s gated effectively by the company registries in each of the [now 138] economies.”⁴¹
 - » A shared ledger also maintains the network state so that artificial intelligence can coordinate the work of smart devices and manage other business functions such as finance, sales, and the deployment of assets, such as patented design files in additive manufacturing anywhere in the world.⁴²
 - » It automates record-keeping, thereby reducing likelihood of human tampering; everyone can see any attempt to cook the share books. “People don’t have to trust someone; they can just trust math to create a win-win situation,” Wong told *China Daily*.⁴³ Dr. Andreas Park of the Rotman School of Management clarified, “Although fraudulent activities are still possible, many of the deals that led, for instance, to the demise of Enron would no longer be possible.”⁴⁴ Executives couldn’t hide leverage or appear to be managing risk when they were actually exacerbating it as Enron’s did.



- » Finally, it facilitates logistics, regulatory compliance, and customs clearance for goods and payments, which is particularly important at border crossings and ports along the Silk Road Economic Belt and the 21st Century Maritime Silk Road.

Design decisions for shared ledgers include the degree of confidentiality and transparency, the range of operations, the type of governance model, and a view of regulations, compliance, and the blockchain network state.

Members of the BRBC have a say in the design decisions of this shared ledger in terms of degree of confidentiality and transparency, range of operations, type of governance model, and a shared view of regulations, compliance, and the state of the Belt and Road blockchain network. The design includes a new model for capital accounting that will support “environmental friendliness, climate resilience, and social inclusiveness.”⁴⁵ According to *China Daily*, Wong sees blockchain as a means of measuring the social impact of investments: “If we can measure it with math, then we can apply science. And once we can apply science, we can then really begin to fix many of the problems ... established by previous generations.”⁴⁶

Semantics matter to Dr. Marek Laskowski, co-founder of blockchain.lab at York University and an adjunct professor at York’s Schulich School of Business.⁴⁷ He cautioned us about the use of the ledger metaphor. Blockchain is more than a ledger or a database. It is a tool for reducing uncertainty in exchanges of value; and, in general, most people understand that idea. In our effort to increase the certainty of value exchange and event coordination (by displacing intermediaries), we may also be increasing enterprise complexity (by taking on the work on those intermediaries), according to Laskowski and his blockchain.lab co-founder, Dr. Henry Kim. Smart contracts are a means of mitigating that complexity.⁴⁸

Smart contracts

“Contracts are the foundation of our economy,” wrote Nick Szabo. “The main inspiration and ideas of smart contracts come from traditional contracts—whence the phrase.”⁴⁹ Szabo is the computer scientist who originated the concept of a smart contract in the early 1990s.

Blockchain is more than a ledger or a database: it is a tool for reducing uncertainty in exchanges of value. In our effort to increase certainty, we may also be increasing enterprise complexity.

He recognized how the Internet had accelerated the deal cycle leading parties to enter into an agreement. Combined with algorithms, big data, and global positioning technology, the Internet matches buyers and sellers, facilitates their negotiations through auctions and take-it-or-leave-it terms, supports online payments and tracking services, aggregates ratings of the parties, and allows for chargebacks.⁵⁰ Those are what users love about Amazon, eBay, and Uber.

What is so smart about a smart contract? Consider Szabo’s definition: a smart contract is an “application that runs in a distributed and trust-minimized manner on a blockchain.” By *distributed*, he means it “runs on a secure consensus protocol across a network of computers rather than on an individual remote computer or centralized server.”



According to Nick Szabo, a smart contract is an "application that runs in a distributed and trust-minimized manner on a blockchain." The contract's execution doesn't rely on any one network node or server owner, and so it is highly resilient and censorship resistant.

By *trust-minimized*, he means the application's "code [runs] properly without [our] having to trust the owners of any of the computers the code runs on."⁵¹

In other words, the contract's execution doesn't rely on any one network node or server owner, and so it is highly resilient amid computer crashes, energy outages, and censorship by centralized authorities. That's not true of commonly used platforms of exchange today. Consider Facebook's ban of advertisements mentioning cryptocurrencies, which we understood indiscriminately included ads for books on blockchain.⁵² A smart contract, if coded carefully, tested rigorously, and debugged thoroughly, could run even on a hacker's computer without being hacked.

So what? Why would we want such capability? One reason is, on average, 10 to 30 percent of contracts fail or underperform.⁵³ Blockchain protocols help to enforce contractual rights and obligations over the Internet without third-party interference. Running on a blockchain, a smart contract can verify the parties' accounts, confirm their capacity, hold assets in escrow, attest to performance, and automate payments—all peer to peer—thereby reducing transaction costs and cutting clearance and settlement times to nearly zero.

For strategies involving the industrial Internet of Things (IoT) and secure machine-to-machine transactions, blockchain platforms should factor into the design for their security and resiliency, and smart contracts should factor into managing, monitoring, and measuring delivery. Szabo recommended looking for these opportunities:



Man wearing Black and White Stripe Shirt Looking at White Printer Papers on the Wall by Startup Stock Photos, no date, used under Pexels license, accessed 12 July 2019.



[P]erformances and conditions that are or might potentially be verified by sensors and computers such as payments and more sophisticated financial arrangements, logistical events, and tasks involving space and time, public arenas such as social networks with observable events, measures, statuses, and status changes.⁵⁴

When we talk about strategy design and delivery, we will increasingly be exploring whether we can ensure strategy delivery by using smart contracts in our strategy design.

The key takeaway is this: when we talk about strategy design and delivery, we will increasingly be exploring whether we can ensure strategy delivery by using smart contracts in our strategy design phase.

For example, according to Shrikrishna and Narula, the Belt and Road Blockchain Consortium platform designers are using smart contracts to “automate capital,” in the sense that the contract “code governs the flow of capital (e.g., automatically pays suppliers upon the delivery and verification of goods), thereby minimizing human intervention and other exigencies.” Likewise, they are doing what they call “‘containerizing risk,’ whereby parties run their businesses through code in self-contained and more predictable environments, thus minimizing risk.”⁵⁵ Shrikrishna and Narula stated:

The smart contract system and the rules engine help ensure consistency between real world contracts and smart contracts in both private and public models because “code is king” does not hold up. In the Internet of Agreements, when technologists deliver machine-to-machine handling of agreements to a high enough standard, it will revolutionize business and international cooperation. The blockchain is the most likely platform to give rise to that world. It is the world that the smart contract ecosystem will create as it matures.⁵⁶

To be clear, smart contracts are software, not legal documents, though they may express in code the terms of legal documents and regulatory requirements. They are also difficult to create and test, and they should be rigorously tested before deployed. Those who excel in smart contracting capabilities will have a formidable competitive advantage.

Smart contracts require expertise to create and must be rigorously tested before deployed. Those who excel in smart contracting capabilities will have a formidable competitive advantage.

Smart assets

People new to blockchain technology sometimes think narrowly, in terms of cryptocurrencies like bitcoin as a digital currency useful for payment or as electronic bullion with the characteristics of gold, where its value could accrue if we held it rather than spent it. By *smart assets*, we mean a whole category of scarce digital units of value that are programmable, trackable, and tradeable on a blockchain-based distributed ledger. It builds on Michael Casey’s concept of “programmable money,” digital coins or tokens we can encode with whatever characteristics and functionality we need, as a strategic lever in a particular business strategy.⁵⁷



By tokenized assets, we mean physical assets cryptographically linked to tokens as a form of digital identity. This type of tokenizing usually involves off-chain processes.

"In 2019, tokens will invade the enterprise in full force. The de-siloing of systems ... will accelerate exponentially across applications."

 AJIT TRIPATHI
Partner
Consensus Systems

For example, CarbonX is a start-up launched to help organizations engage their stakeholders in addressing the climate crisis. CarbonX has recast carbon credits as digital tokens on the Ethereum blockchain and created a market for peer-to-peer or enterprise-to-enterprise trading. According to Tom Baumann, co-founder of ClimateCHECK, governments can use these CarbonX tokens as incentives for carbon-friendly buying and behavior; and enterprises can use them to offset "against excess emissions during the manufacturing 4.0 life cycle, thereby creating carbon-neutral products and services."⁵⁸ Casey wrote, "It's an example of a direct, token-led strategy for promoting conservation of the natural environment. It's also potentially a way for economists to put a price on externalities such as pollution."⁵⁹

Smart assets also relevant to strategy are *tokenized assets*, that is, physical assets cryptographically linked to tokens as a form of digital identity. It extends the idea behind the natural asset token. It represents ownership in (or provides access to or usage of) some assets, be they valuable real estate, office space, fleets of autonomous vehicles, or private jets. This type of tokenizing "always requires the involvement of off-chain processes," according to an excellent "Global Blockchain Benchmarking Study" by the University of Cambridge.⁶⁰ Or they could be more intangible assets such as intellectual property (IP), capacity, computational power, excess electricity that can't otherwise be stored, or enterprise data, 60 to 70 percent of which goes unused for analytics.⁶¹ Or it could be the available time of employees or customers, scheduled and managed through Covee, a blockchain-based version of Gigster or Upwork. For example, consumer packaged goods companies offer their customers *basic attention tokens* (BAT) for attending to company advertisements online. As an incentive, BAT is a component of a strategy for engaging customers and doing A/B testing of ads and messages.

So useful are smart assets to implementing strategy that Ajit Tripathi, a partner at ConsenSys, proclaimed 2019, "the year of enterprise tokens." He expects tokens to "invade the enterprise in full force" as a means of breaking down systems silos, accelerating distributed applications in "securities markets, trade finance, intellectual property, [and] patents and licenses," and rewarding participation.⁶² In April, the Enterprise Ethereum Alliance unveiled its blockchain-neutral Token Taxonomy Initiative, formed specifically "to address the need to develop common definitions and scope for a business-grade standard for tokens with interchangeable currency-like properties or unique assets."⁶³ It's a major endeavor, chaired by Marley Gray of Microsoft, and it should motivate CSOs to understand the strategic potential of tokens in their area of business (Table 3, next page).⁶⁴

Crypto investing experts, Chris Burniske and Jack Tatar, have studied "how exchanges adding a blockchain asset can increase the diversity of the trading pairs used to buy the asset." (In finance parlance, "pair trading" is a market neutral trading strategy, which enables traders to profit under virtually any market conditions. The direction of the market has no apparent [e]ffect on the trade."⁶⁵) Burniske and Tatar



posited, "As an asset grows in maturity and legitimacy, it should have more diversity in its trading pairs, with particularly strong growth in fiat currencies being used to buy the asset."⁶⁶

This might be an argument for China's issuing its own crypto yuan, as it considers the larger portfolio of digital assets that stakeholders will want to use and exchange on its Belt and Road blockchain. According to *MIT Technology Review*, China has been "exploring the technical, logistical, and economic challenges involved in deploying digital money, something that could ultimately have broad implications for its economy and for the global financial system."⁶⁷

According to MIT Technology Review, China has been "exploring the technical, logistical, and economic challenges involved in deploying digital money."

If a crypto yuan were backed by the People's Bank of China with status equal to renminbi, it "would lower the cost of financial transactions, thereby helping to make financial services more widely available [and] be cheaper to operate, and ought to reduce fraud and counterfeiting."⁶⁸ China might also use digital fiat money to facilitate "flow between parties [along the Belt and Road] regardless of any economic sanctions."⁶⁹ Those are both incentives to use it.

Brave New Coin, a blockchain research boutique based in New Zealand, speculated on the broader effects of the current US administration's trade wars with countries in the Belt and Road Initiative and the "backlash against US-dominated systems

Table 3: Cryptoassets are strategic assets: A taxonomy

Type	Description of cryptoasset	Example
Natural asset tokens	This represents such natural assets as grain, oil, or carbon (emissions or reductions).	CarbonX token
Platform tokens	These are designed to support platform-specific decentralized applications, such as initial coin offerings or digital identity commons, which eliminate traditional intermediaries (such as venture capitalists or government agencies) in the platform's ecosystem.	Ether (Ethereum blockchain)
Utility tokens	These are programmed to provide utility in an application such as computing power, manufacturing capacity, or discount on usage. "Think Amazon Web Services without Amazon," Tapscott wrote.	Sweetcoin
Security tokens	These are native digital debt and equity shares that trade peer to peer. These could come in handy in financing One Belt One Road infrastructure buildout.	TheDAO
Digital fiat money	These are cryptocurrencies designed, issued, and governed by a central bank.	Venezuela's Petro
Stablecoins	These are "cryptoassets that maintain a stable value against a target price" such as the US dollar, according to Nathan Sexer of the derivatives trading platform, VariabL. They help to reduce the volatility that "prevents the widespread adoption of cryptocurrencies as a store of value."	Circle, Globcoin, Libra, Tether, TrueUSD

Sources of data: Alex Tapscott, "Cryptocurrency Is Just One of Seven Types of Cryptoassets You Should Know," QZ.com, Quartz Media, Uzabase, 25 July 2018; Nathan Sexer, "State of Stablecoins, 2018," ConsenSys Media, 24 July 2018; and "The Libra Reserve," Libra.org, Libra Association, 18 June 2019, all accessed 29 June 2018.



like the SWIFT [Society for Worldwide Interbank Financial Telecommunication] network,” as positives for China’s crypto yuan strategy:

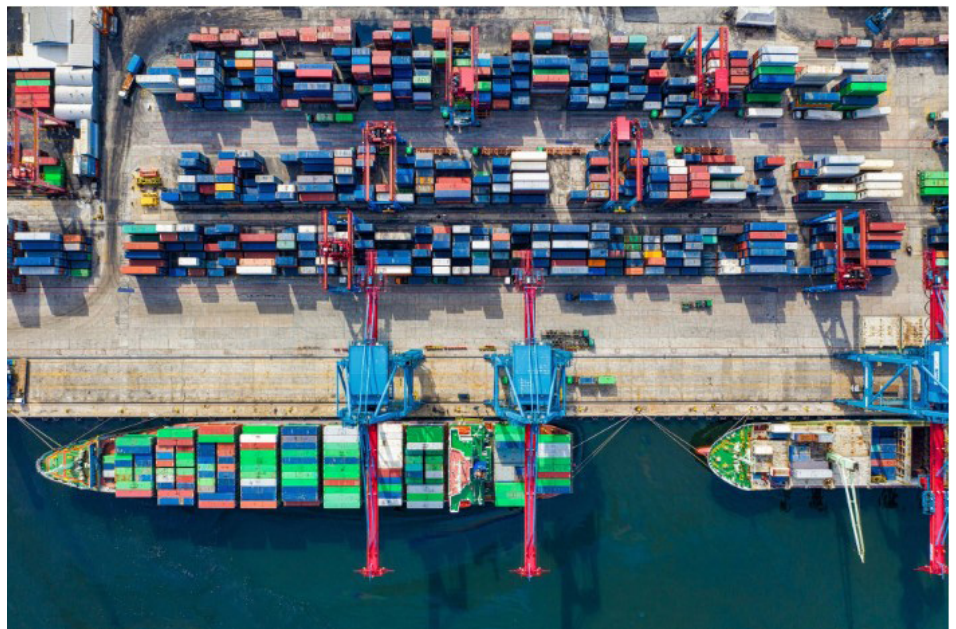
Just as oil and uranium have been used for years as tools of geopolitics, national cryptocurrencies and blockchain will be used in the future arms race to the next global reserve currency. China’s development of a digital renminbi along with its desire to create [an] alternative to the US [dollar] as the global reserve currency suggests the future of blockchain technology will play a role future of superpower rivalry.⁷⁰

For those wondering about the high corporate debt ratios of China’s corporations, its national champions involved in the Belt and Road Initiative have positioned themselves to take over foreign infrastructure assets, should local companies or countries default on their Chinese loans. In 2017, Sri Lanka transferred control of the port of Hambantota to China Merchant Group in a 99-year lease when it fell behind its debt payments to China.⁷¹ Several others—Djibouti, Kyrgyzstan, Laos, the Maldives, Mongolia, Montenegro, Pakistan, and Tajikistan—are also at risk of default, according to the Center for Global Development.⁷² In the future, these assets could be tokenized, with debt serviced by, and controlling interest distributed among, more members of the Belt and Road Initiative, and not just China.

Strategic liquidity

Now we put these three building blocks together to create strategic liquidity, an enterprise’s degree of maneuverability measured by its ease of borrowing against its existing assets, making loans to other parties against their assets, and exploiting any underused factors of

For multinationals and supply chains spanning jurisdictions, strategic liquidity makes the boundaries of the enterprise more porous, more flexible, for realizing interenterprise resource planning capabilities.



Birds Eye View Photo of Freight Containers by Tom Fisk, no date, used under Pexels license, accessed 13 July 2019.



To be clear, strategic liquidity is a collaborative play—it is not something an enterprise can achieve in isolation—but participants must be extremely mindful of antitrust laws and the terms of membership in any alliance or consortium.

production in the system—all without heavy reliance on banks. For multinationals and supply chains spanning jurisdictions, this means more liquidity in ecosystem resource reallocation. It makes the boundaries of the enterprise more porous, more flexible, for realizing *interenterprise resource planning* capabilities.

To be clear, this is a collaborative play—it is not something an enterprise can achieve in isolation—but participants must be extremely mindful of antitrust laws.⁷³ Because of blockchain's transparency and auditability, businesses have incentive to act with integrity and not use blockchain as a mechanism for fixing prices, rigging bids, allocating customers or markets, effecting group boycotts, and so forth.⁷⁴ They must also be extremely careful about the terms of participation, rejecting any restrictions on comparative advertising, member benefits contingent on non-competitive behavior, or anti-competitive constraints masquerading as codes of conduct, to name a few examples.⁷⁵ We look first at what one of the world's largest and most complex supply chains has done, and then at what a blockchain start-up is doing.

Chained Finance

Most of us know the Foxconn Technology Group as manufacturer of Amazon's Kindle, Apple iPhones, Microsoft's Xbox One, Nintendo 3DS, Nokia devices, and Sony's PlayStation. It's ranked 24th on the *Fortune Global 500*.⁷⁶ It happens to anchor a sprawling global supply chain in garment, electronic, and automobile industries, where businesses in emerging markets manage some of the labor and production, and where bank loans for working capital are harder to come by, because of fraudulent invoicing and error-ridden bookkeeping.⁷⁷

Using Chained Finance's shared ledger, members big and small can track the status of orders, the movement of assets, and the flow of money.

In March 2017, Foxconn announced that its fintech subsidiary FnConn Financial would be partnering with Dianrong, China's leader in online lending to small and medium-sized enterprises (SMEs). Together, they launched Chained Finance, the first blockchain-based platform for supply chain management (Table 4, next page). It combined procurement, financing, and logistics into a single shared ledger system. It is permissioned and "designed to be technologically (and geographically) agnostic," according to Soul Htite, CEO of Dianrong. "That said, Dianrong is an active participant in the Hyperledger project."⁷⁸ (*Forbes* reported that Chained Finance is using an Ethereum-based blockchain.⁷⁹)

Using Chained Finance's shared ledger, members big and small can track the status of orders, the movement of assets, and the flow of money. To create liquidity, Chained Finance tokenizes the unfinanced accounts payable of Foxconn (the supply chain anchor) and those of its Tier 1 suppliers, converting them into digital assets referred to as "eAPs." Tier 1s can then slice and dice their own eAPs as they'd like, to pay or issue credit to their Tier 2+ suppliers or to get cash from Chained Finance.⁸⁰ Through smart contracts, parties can code rules and regulations into deal terms, so that the movement of assets across jurisdictions is in compliance with local law.⁸¹



Table 4: Comparison of bank-based and blockchain-based finance

	Traditional supply chain finance	Chained Finance
Control	Centralized, anchor dependent	Decentralized but permissioned; nodes have visibility and can record and verify transactions
Process	Manual, with documents to complete	Automated, based on transactional data stored on blockchain
Data transparency	Low; greater risk of tampering	High; low risk of tampering
Risk premium	High	Low
Handling fees	High	Minimal
Average cost of financing	25% for Tier 2+ suppliers (85% if supply chain)	~0% for Tier 1 suppliers <10% for Tier 2+ suppliers
Time to approval	7-10 working days	Same day, if not immediate

Source of data: "High Tech, Low Cost: The Easiest Way to Supply Chain Finance," Chained Finance, FnConn Financial, n.d., accessed 19 Jan. 2019.

The collapse of asset value is a real strategic bugaboo, and so the other component of strategic liquidity is the valuation and tokenization of an enterprise's collateral assets on a distributed ledger without financial intermediaries.

This gives supply chain members greater strategic liquidity, to seize business opportunities or to accelerate the work of others in the chain. A small business that finds itself short of the capital needed to complete an order can get a short-term loan from other members much faster and at a much lower cost because the other members can see the small business' accounts receivable and its other collateral assets within the supply chain.⁸² A member that finds itself needing more manufacturing capacity can more easily find it elsewhere in the system. Htite reported that, in its six-month pilot with FnConn, Chained Finance "originated \$6.5 million in high-quality loans for supply chain operators, many of whom were unable to secure needed financing in the past."⁸³ He declined to disclose the system's credit pricing model or annual percentage rate. His team at Chained Finance has, to some extent, created a private microeconomy run on software, in compliance with Chinese regulations.

Sweetbridge

The other component of strategic liquidity here is collateral asset value. The collapse of asset value is a real strategic bugaboo. As the value of homes fell in the US housing market, mortgage holders had less incentive to pay their monthly debt, because the underlying asset was worth less than what they could otherwise buy with their money—food, utilities, and even rental homes. When they tried to unwind their loans, they couldn't, at least not easily, if their lender had already securitized and moved the loans off the balance sheet. The process wasn't transparent, and the asset wasn't trackable.



Like Satoshi Nakamoto, the founder and executives at blockchain start-up Sweetbridge have thought a lot about decentralized economies with less dependence on the traditional financial system, and the role of collateral. In their view, if an enterprise holds assets of value, then it should be able “to represent this value in a liquid currency without resorting to expensive intermediary services.”⁸⁴

Sweetbridge has designed a blockchain ecosystem with five protocol layers to manage ecosystem risk and increase each participant’s strategic liquidity.

Sweetbridge has designed a blockchain ecosystem with five protocol layers, combined to manage ecosystem risk and, in effect, increase each participant’s strategic liquidity (Table 5). The liquidity layer has three components relevant to our discussion.

Bridgecoin

This cryptoasset functions as a stable cash-like cryptocurrency that users can exchange for fiat currency when they need a loan to use outside the Sweetbridge system, similar to Foxconn’s Chained Finance. Inside the system, they can purchase assets and pay invoices. Users receive these tokens when they transfer custody of collateral assets to Sweetbridge’s “asset vault.” When they return the tokens to the asset vault, they regain custody of their assets. Such a capability could reduce costs and cultivate vendor relationships.

Collateral

Sweetbridge accepts a range of assets as collateral: cryptoassets (e.g., those listed in Table 3), physical assets (e.g., real estate,

Table 5: The Sweetbridge protocol stack: From top to bottom

Layer of stack	Purpose	How it works
Talent/expert optimization (top layer)	Outsiders can access and analyze system data, recommend improvements, and receive rewards (“bounties”) for the system’s improved performance.	Protocols aggregate anonymized data for export through application programming interfaces and other tools. Talent payment mechanism is in development.
Resource sharing	Users can earn profit by making available any underutilized assets such as warehouses, manufacturing facilities, and heavy equipment.	Protocols analyze transaction data and assets held in collateral to track asset usage and availability in the system, a true sharing microeconomy.
Accounting	Users get a complete view of their economic capacity and a permanent record of their transactions, accruing to their reputation.	Protocols timestamp and record all transactions and analyze transaction data to assess financial riskiness of each user.
Settlement	Users reduce or eliminate their counterparty settlement risk.	Protocols reroute payments due the defaulting user directly to the parties owed.
Liquidity (base layer)	Users can borrow working capital more quickly against a wider range of assets at low cost without third-party lenders.	Smart contracts automate the management of money supply (tokens), the transfer of asset custody, and the application of accounting rules.

Source of data: J. Scott Nelson et al., “A Blockchain-Based Protocol Stack for Global Commerce and Supply Chains,” White Paper, Sweetbridge.com, Sweetbridge LLC, 1 May 2018, pp. 11–17, accessed 18 Dec. 2018.



Sweetcoin functions as a software license for using the Sweetbridge system at a discount. It is an incentive for participation in the system, a loyalty program of sorts.

equipment, base metals), fiat currencies and financial instruments (e.g., stocks, bonds, loan guarantees), future cash flows (e.g., accounts receivables, outstanding invoices); value of future products and services; time (of talent and capacity); and intellectual property (e.g., patents, trademarks). This list goes well beyond those accepted by traditional financial intermediaries, giving users more flexibility in raising working capital for strategy delivery.⁸⁵ Sweetbridge is testing the lending capabilities of its system in Arizona, offering credit against consumers' auto titles. According to 2016 US Census survey estimates, US households had 1.8 vehicles on average.⁸⁶ One percent of US adults took out auto title loans from traditional intermediaries at an average interest rate of 300 percent, compared to Sweetbridge's rate of 20 percent.⁸⁷ The start-up will tokenize the value of each participant's car into Bridgecoin. This is a means of incubating a new business by disrupting the old model, and it has the Arizona Attorney General's support.

Sweetcoin

This cryptoasset functions as a software license for using the Sweetbridge system at a discount. Users buy these if they want to borrow money, settle transactions, and do currency conversions on the system with low or even no fees. It is an incentive for participation in the system, a loyalty program of sorts. The aviation industry has already recognized the value of the Sweetbridge system applied to a multi-vendor loyalty program.⁸⁸ Specifically, Lufthansa and SAP awarded Sweetbridge its "traveler challenge" prize for its blockchain-based solution to overhauling the air traveler experience, using Sweetcoin to reward passengers for the value they contribute to the system.⁸⁹ It could similarly serve as an incentive in cross-business unit initiatives within a large global enterprise or in large development projects involving multistakeholders.

Vinay Gupta, founder of the technology start-up Mattereum, said that, in the first quarter of 2019, there has been an uptick in interest in digitally twinning physical assets using the Mattereum protocols.

Since global accounting fraud resulted in \$4.39 trillion in losses in 2016, it is no surprise that Sweetbridge's transparent and synchronized accounting caught the attention of Wincanton, Britain's largest logistics company: "With built-in identity, legal agreements, accounting treatments and payments, the [Sweetbridge] system makes reducing cost to serve, increasing efficiency, and boosting customer loyalty possible, for the first time."⁹⁰ Its accounting protocols should minimize the possibility of bookkeeping shenanigans. Sweetbridge was one of six start-ups chosen from a pool of 152 entrants to participate in Wincanton's W² Labs program in 2019. Wincanton runs W² Labs in partnership with L Marks, a matchmaker between innovators and corporations looking to innovate, and so it must see enterprise potential for the Sweetbridge system. The start-up is definitely one for CSOs to watch.

As CSOs come to understand shared ledgers, smart assets, and smart contracts, they will begin to see the potential for increasing their organization's strategic maneuverability. Vinay Gupta, founder of the technology start-up Mattereum, said that, in the first quarter of 2019, there has been an uptick in interest in digitally twinning



physical assets using the Mattereum protocols. He sees these strategic capabilities rolling out in three phases.⁹¹

- » First, asset owners will tokenize assets via what Mattereum calls an *asset passport*, which is “a unique contractual container (legal and smart contracts together) that records and manages the rights and obligations associated with a given asset [and identifies] property in the same way that URLs identify information.”⁹²
- » Second, owners will automate custodianship, which Mattereum calls “the perfect legal counterparty to a smart contract, ... [becoming] an asset’s legal owner and registrar, maintaining the authoritative register of interests in the asset.”⁹³
- » Third, these automated custodians will publish each asset’s availability and terms of use, rental, or acquisition on a distributed smart property registry, which extends the concept of a real estate registry to all asset classes, “without requiring any changes to the current legal framework in any jurisdiction.”⁹⁴

Blockchain-based platforms like Sweetbridge's provide a means of catalyzing entrepreneurial activity within otherwise well-established large organizations. It is a view of the firm as a dynamic portfolio of property, talent, capital assets, and entrepreneurship.

With these new building blocks of strategy, an enterprise can codify governance over assets and activities, distribute decision rights beyond the enterprise, tokenize and liquefy its assets, and manage more by algorithms, automating more of its strategic response to marketplace information, and minimizing decision biases.

It is a view of the firm as a dynamic portfolio of property, talent, and capital assets with very porous boundaries. In this portfolio, the value of all three asset types could be pegged to a market price at any point in time and optimized in a supply chain or an industry through platforms that support *enterprise entrepreneurship*—the fourth factor integral to production—just as Airbnb, Amazon, eBay, Facebook, TaskRabbit, Uber, and YouTube supported individual entrepreneurs in the first era of the Internet. Such platforms—necessarily blockchain-based, as we have seen in the cases of Foxconn and Sweetbridge—provide a means of catalyzing entrepreneurial activity within otherwise well-established large firms, supply chains, or industries.

CSO responsibilities

Brightline considers strategy design and delivery an intertwined process, in the sense that an enterprise can adjust the design according to what it learns during implementation. The idea is embodied in Brightline principle five, “Be bold, stay focused, and keep it as simple as possible.”⁹⁵ Here we look at how organizations are incorporating the distributed building blocks of strategy into their design and execution.



Strategy design

"We always overestimate the change that will occur in the next two years and underestimate the change that will occur in the next ten. ... Don't let yourself be lulled into inaction."

 WILLIAM (BILL) H. GATES
 Founder and Technical
 Advisor
 Microsoft Corporation

Although CSOs are becoming quite savvy about recognizing a disruptive innovation, they don't necessarily have tools for gauging the rate of change. When it comes to a foundational new technology like the Internet or blockchain, the initial C-suite question is one of timing. Marek Laskowski, co-founder of blockchain.lab at York University, reminded us of a quote that Bill Gates liked to use.⁹⁶ It appears in both of Gates' bestselling books, *The Road Ahead* and *Business @ the Speed of Thought*: "We always overestimate the change that will occur in the next two years and underestimate the change that will occur in the next ten."⁹⁷ Gates framed that comment with an observation as relevant to blockchain today as it was to the Internet in the 1990s: "The social adaptations that have to occur take years, and the infrastructure has to be built out. But when the social and technical changes reach critical mass, the change will be quick and irreversible. ... Don't let yourself be lulled into inaction."⁹⁸

How can we best prepare the enterprise for the tipping point, and not fall forever behind it, as Sears and Kmart did in the age of Amazon.com? Here are four possibilities: participating in blockchain governance, identifying low-hanging growth opportunities, monitoring long-term trends, and widening input into strategic planning.

Stewards of an innovation must reach consensus on several types of issues, but one of them is particularly critical to enterprise strategy and the diffusion of the technology: standards.



Light trails on Highway at Night by Pixabay, no date, used under Pexels license, accessed 13 July 2019.

Collaborating on governance

When we use the term *governance*, we mean *stewardship*, a collaboration of multiple stakeholders in the guiding rather than the ruling of shared resources like the Internet and the environment, ideally to maximize utility and minimize negative externalities.



The Internet boom wouldn't have been possible without the pioneers' ability to compromise. Indeed, in large transformational initiatives, such compromise isn't a sign of weakness; it's a product of real leadership.

Stewards of an innovation must reach consensus on several types of issues, but one of them is particularly critical to the diffusion of the technology: standards. Without agreement on standards, we have stacks of Babel with multiple definitions of common terms: computers can't communicate with each other, and we can't build out interoperable ecosystems.

Too many of us take for granted how well the Internet worked for business in the early 1990s. By the time the National Science Foundation removed commercial restrictions on its use, Tim Berners-Lee had launched the World Wide Web, and Marc Andreessen, the Mosaic Web browser.⁹⁹ Andreessen's start-up Netscape took about a minute to raise \$2.7 billion, which was jaw-dropping at the time for an initial public offering.¹⁰⁰ Thus began the dotcom boom, 30 years in the making. Laskowski pointed to the groundwork of Internet pioneers on open source protocols in the 1960s and 1970s.¹⁰¹ They formed governance groups, many of them voluntary, to steer its development into the 1980s and 1990s. Such an Internet boom wouldn't have been possible without their dedication and, equally important, their ability to compromise. Indeed, in large transformational initiatives, compromise isn't a sign of weakness; it's a product of real leadership.

Those of us, who believe that blockchain is a foundational technology like the Internet, believe that there is comparable foundational work to be done within organizations, industries, and ecosystems, and doing that work is critical to strategy. A great place to start is data standards, said Laskowski, talking about the co-evolution of blockchain and ontologies. CSOs can jump into it themselves, assign someone within the enterprise to dive in, or ask for volunteers and free them up 3M-style, to inform and even influence the timing and direction of the blockchain revolution.¹⁰² Why not participate?


Developing standards requires industry or ecosystem collaboration, and this work is not intuitive for executives, Chrystie of FedEx said. Laskowski of York University agreed and said that, within some firms, different divisions have been "notoriously hostile toward each other," even tinkering with each other's data in internal systems.¹⁰³ He has written extensively on why the typical enterprise mindset has limited the development of shared semantics:

In most enterprise contexts, the assumption that data [are] closed for sharing is the default. Google, Facebook, banks, and others own their data and choose to make some data available to others at their discretion via APIs [application programming interfaces] and Web services. They constrain their data with their own metadata, and so the need for others to define semantics is not compelling. Understandably, they do not expose so much of their data that they lose their information asymmetry and scale of data advantages. So, data sharing is done in very limited way without the need for ontologies within contexts where self-interested intermediaries exist.¹⁰⁴



We're not talking about communicating between our respective data silos through APIs. We're talking about bulldozing some boundaries of the firm and sharing an unprecedented amount of data on a distributed ledger across global supply chains.

"The need for standardization is an inhibitor to the fast development of some technologies, and this creates a social problem for us between our desire to compete and our need to cooperate."

 DR. JOHN R. PIERCE
Distinguished Electrical
Engineer
Bell Labs
Professor of Engineering
California Institute of
Technology

But with blockchain, we're not talking about communicating between our respective data silos through APIs. We're talking about bulldozing some boundaries of the firm and sharing an unprecedented amount of data on a distributed ledger across global supply chains, and we need to agree on which data are important and how we define them, no matter which industry we're in. We're also looking at tokenizing such assets as accounts payable, carbon credits, and diamonds; but we can't create a market, let alone liquidity, if we haven't defined and specified what we're trading. If we want to deploy smart contracts to govern assets and minimize paperwork, then we need to agree on the types of data and data formats these distributed applications must access or contain.

FedEx is devoting time and talent to standards as a member of Blockchain in Transport Alliance (BiTA), and Chrystie was recently elected chair of its standards council. BiTA is a membership-driven standards organization unique among consortia in its focus on the "digitization of freight and transport."¹⁰⁵ To describe what members do, Chrystie prefers the term, *coopetition*, a word coined in 1995 by Barry Nalebuff and Adam Brandenburger in their popular *Harvard Business Review* article on game theory applied to enterprise strategy. It was the same year that the Federal Networking Council agreed unanimously on the term, *Internet*, to describe the network of networks.¹⁰⁶ Nalebuff and Brandenburger were among a handful of management scientists who recognized that, with the convergence of low cost communications, computing, and storage technologies, companies would need to co-evolve their products and services—in hardware, software, and connectivity—competing head-on in some markets, and complementing each other in others, mutually benefitting from the network effects of technological standards.

Otherwise, the technology would stall. The late Dr. John R. Pierce, distinguished electrical engineer of Bell Labs and professor of engineering at the California Institute of Technology, observed, "The need for standardization is an inhibitor to the fast development of some technologies, and this creates a social problem for us between our desire to compete and our need to cooperate."¹⁰⁷ That's why *coopetition* is such a great word here. That's ostensibly what members of the Belt and Road Blockchain Consortium are doing: they're collaborating on matters of blockchain governance, stewarding this new technology so that it complies with regulations, generally accepted accounting principles, and best practices of an industry or jurisdiction, and defining standards for global trade as needed, so that they can scale the competition for business within the Belt and Road Initiative.

The challenge is sizeable, and Chrystie uses a canyon metaphor to help people visualize it: "We're all standing on this side of the canyon, looking through our telescopes to the other side, and seeing the promised land, the pot of gold. We need a global village to build a bridge to the other side."¹⁰⁸ Chrystie identified several areas where BiTA members could agree on data formats such as delivery addresses, invoicing, contracting, advertising, financial compliance, and regulatory audits.¹⁰⁹ These are design elements of the bridge.



Having a seat at the table during blockchain standards setting is critical. We need to agree on which data are important and how we define them across our industry or supply chain.



Birds Eye View of a Man on Grand Canyon Mountain by Noelle Otto, no date, used under Pexels license, accessed 13 July 2019. Cropped to fit.

Having a seat at the table during the designing of the bridge—the blockchain standards setting—is critical.

In a presentation on its website, BiTA's statement of purpose is straightforward: "Leveraging talent and resources from the world's most influential companies, BiTA is producing open source and royalty free data standards that will allow for interoperability between participants in the global supply chain."¹¹⁰ Its council has issued two standards already, one "a model to track events which are generated by various processes within a transportation network" known as "BiTAS Tracking Data Framework Profile," and the other a definition of a location component, titled "BiTAS Std 120-2019: Location Component Specification," with such use cases as global positioning, national postal standards, and electronic exchange formats and consideration of variations (e.g., which address format, which door or dock).¹¹¹

Whether to go the open standards route or the patent-and-licensing route is a key governance decision around the ownership of an enterprise's or a consortium's intellectual property.

To those enterprise executives interested in joining a blockchain consortium but reluctant to do so because of antitrust concerns, Chrystie was emphatic: as with trade and industry association gatherings, BiTA begins every meeting with the reading of an antitrust statement, which proscribes any discussion of pricing, products, or customers. The World Wide Web Consortium and the Hyperledger Project also emphasize adherence to their antitrust policies during working group meetings.¹¹² If, in the course of a meeting, anyone hears anything that smacks of trust talk, then he or she must "draw a hardline, make it known, and exit the room," Chrystie said, and the meeting minutes must reflect the person's objection and departure. He added that corporate representatives are generally well schooled by their legal counsel on what not to discuss with competitors. There's still time to be in the room where it happens, and CSOs need to find it.



Identifying growth opportunities

Watch for "knowledge creating companies" that learn how to do something better than everyone else and then codify their new know-how in software. This kind of enterprise could become formidable in the blockchain space.

When it comes to learning quickly, Amazon is worth watching in the blockchain space, because it epitomizes what Professors Ikujiro Nonaka and Hirotaka Takeuchi called a "knowledge creating company," an enterprise set up to learn how to do something better than everyone else and to capture and codify its new know-how, usually in software.¹¹³ Amazon excels at studying the problems its customers are trying to solve, through their behavior and feedback on its sites, and then creating the best software services to solve them. It does this so well that, when it announced its acquisition of Whole Foods, the market value of all Whole Foods competitors dropped by \$35 billion.¹¹⁴

So here we are in 2019, marking the tenth anniversary of the release of the Bitcoin blockchain protocols. Only recently did Amazon announce its two ledger-related services, one a centralized solution called Amazon Quantum Ledger Database, and the other a distributed one, Amazon Managed Blockchain supporting Ethereum and Hyperledger Fabric protocols. These shouldn't be a surprise to the market: in November 2017, Amazon Web Services CEO Andy Jassy told attendees of AWS' annual re:Invent conference in Las Vegas that he was interested in what customers were trying to do with blockchain.¹¹⁵

Here's a snapshot of what AWS learned: financial institutions were working on P2P payments, small businesses were trying to transact directly with suppliers and distributors, mortgage lenders were looking to process syndicated loans, and retailers wanted to streamline customer loyalty rewards.¹¹⁶ While they recognized the value of blockchain technology, they were finding blockchain frameworks "difficult to set up, hard to scale, complicated to manage, and expensive," as new infrastructure investment can be.¹¹⁷ Unlike the Internet, the blockchain disrupts the deep structures of enterprise architecture, like accounting and finance, and so we should expect such challenges. Amazon worked to address them in its two new offerings, both growth opportunities for Amazon.

Unlike the Internet, the blockchain disrupts the deep structures of enterprise architecture. We should expect incumbents to face challenges in implementing what is essentially a new operating platform for the enterprise.

Contrast that with one of Amazon's competitors, Overstock.com. In January 2014, Overstock became the first global retailer to accept bitcoin. Jonathan "JJ" Johnson, chair of Overstock's board, reflected upon the innovation as essential to the brand:

Overstock is a technology company at its core. We built our brand around leveraging technologies to provide our customers with the best possible shopping experience. Because of this, we constantly experiment with new technologies across a variety of applications. Bitcoin was no exception.¹¹⁹

Overstock's senior management decided that "bitcoin as a payment method was a good idea." He immediately discovered what executives in other companies were discovering: that his technology team not only knew about the Bitcoin blockchain, but wanted to



Jonathan "JJ" Johnson, chair of Overstock, quickly discovered what executives in other companies were discovering: that the company's future had already arrived but wasn't evenly distributed to the C-suite.

make the bitcoin payments project a priority. Forty of the company's best developers volunteered to isolate themselves over the year-end holidays and integrate the new technology into Overstock's website. As it turned out, the company's future had already arrived but wasn't evenly distributed to the C-suite.

Overstock integrated its website with the digital currency exchanges, Coinbase and ShapeShift, to manage the risk of cryptocurrency price volatility. The strategy did result in growth. Johnson wrote:

When we began accepting bitcoin, we accessed a new demographic of customers with plenty of bitcoin to spend, but few places to spend it. The bitcoin community is a loyal and engaged one, and we believed they would return Overstock's faith in the currency with continued patronage. We were right.¹²⁰



Men Going Around a Warehouse by Alexander Isreb, no date, used under Pexels license, accessed 13 July 2019.

Overstock's experience with bitcoin opened the C-suite's eyes to its potential. It was the beginning of a strategic pivot for the enterprise, from the retail shopping sector to the blockchain development space.

While bitcoin comprised less than one percent of Overstock's annual revenue, the experience opened the C-suite's eyes to its potential. It was the beginning of a strategic pivot for the company, from the retail shopping sector to the blockchain development space. Brittain Ladd, an expert in e-commerce and retail strategy, wasn't surprised when Overstock founder Patrick Byrne announced that Overstock's retail operations were for sale: "Simply put: blockchain is the future in the eyes of Byrne and Overstock is the past."¹²¹ Customers and employees were both touchpoints in this pivot.

Monitoring long-term trends

For decades, Professor George Day, founder of the Mack Institute for Innovation Management at the Wharton School, and his long-



time collaborator Dr. Paul Schoemaker, a pioneer in decision sciences and behavioral economics, have studied the challenge of seeing and seizing the future sooner than everyone else. In a forthcoming MIT Press book, *See Sooner, Act Faster: How Vigilant Leaders Navigate Digital Turbulence*, Day and Schoemaker identify many practical methods for monitoring long-term and potentially fast-moving trends.

One method is tapping the wisdom of a truly diverse crowd through prediction markets, popularized by the Iowa Electronic Markets (IEM) launched as a teaching tool at the University of Iowa.¹²² Participants invest money in and trade on contracts representing some aspect of the future—the outcome or timing of an event—and receive a payout based on the actual outcome.¹²³ These markets have also been described as *oracles* and *event derivatives*.¹²⁴ Circle analyst Ria Bhutoria explained, “Participants are incentivized to act on private information (and reap the benefits) without needing to publicly disclose the actual secrets or information. Also, participants have real money at stake, which provides a financial incentive over surveys and polls.”¹²⁵ The relative prices of the contracts represent the aggregate opinion of participants at any given moment, and their collective view tends to outperform traditional opinion polls. For example, IEM’s election forecasts have beaten the major pollsters 451 out of 596 times.¹²⁶

Prediction markets are one method for monitoring trends. Participants buy or receive tokens representing votes on the probability of an event or outcome. Those who predict what actually happens receive some portion of the tokens of those who didn’t.

Here’s where blockchain comes in. Participants buy or receive (as part of their compensation package) tokens representing votes on the probability of an event or outcome. Those who predict what eventually happens receive some portion of the tokens of those who didn’t. There are several blockchain protocols—Augur, Gnosis, and Stox, all Ethereum-based—that users can download and use to create decentralized prediction markets. Let’s look at Augur, since it’s live, it’s open to the public, and it has examples of each type of question suitable for prediction markets:

- » *Binary*, with only two choices—will this or won’t this happen within this time frame?—where payout goes to those who hold tokens representing what happened. For example, “Will a SpaceX Starship test vehicle have a successful test flight before 2 March 2019?” When we checked in mid-February, the “ayes” had only 18 percent of market share; they grew to 19 percent—and were wrong.¹²⁷ In a related question, 25 percent believe SpaceX will land a manned or unmanned craft successfully on the Martian surface before 2023.¹²⁸
- » *Categorical*, with multiple choices—which of all these candidates will win?—where payout goes to those who hold tokens representing the outcome. “Will Apple and Google reduce their App Store fees below 30 percent by end of March 2019?” (one, both, neither). By 31 March 2019, 69 percent believed that neither would, 24 percent said both would, and seven percent said only one of them would. The majority appears to be right, with no official announcement of a rate cut coming from either press office in the period.¹²⁹

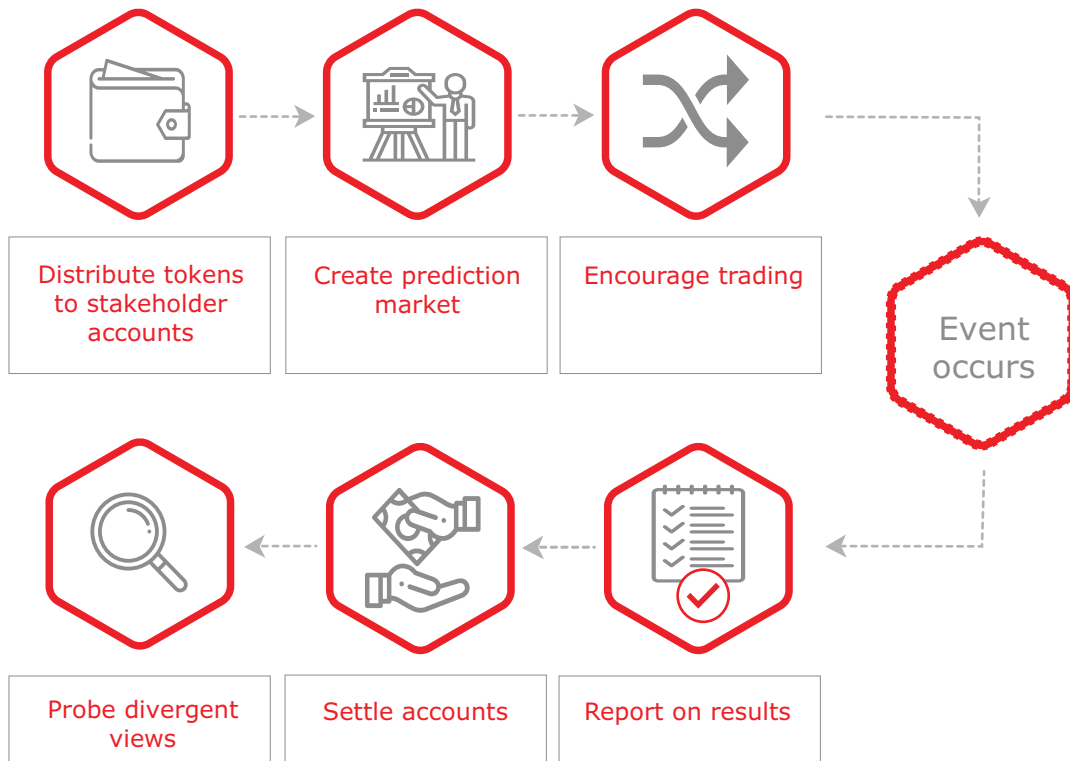


The real work of extrapolating long-term trends from shorter-term predictions comes after the prediction market closes. The chief strategy officer's job is to probe the results further.

» *Scalar*, within possible ranges or magnitudes—will price rise or fall, by how much?—where payout could be relative, divided between the two sets of token holders. “EOS Market Cap Tracker Year-End 2019” is open now.¹³⁰ “US Congress, Power in the House” closed in November 2018. Its market creator, Poyo, explained the payout as follows: if Republicans (GOP) outnumbered Democrats (Dem) by 60 seats, then buyers would get no reward, and sellers would get all of it. If GOP outnumbered Dems by 20, then buyers would get 33 percent, and sellers, 67 percent. The opposite would be true if Dems outnumbered the GOP by 60 or 20 seats. If the number of seats ended up equal, then the payout would be fifty-fifty.¹³¹

The enterprise goal in using such a method is not only to benefit from the individual knowledge of the group but also to counter groupthink by surfacing as many alternative or contrarian views as possible. According to Schoemaker and his Wharton colleague, Dr. Philip Tetlock, “What is paramount ... is not just how best to aggregate diverse opinions but to first delve deeply into the root causes of divergent opinions.”¹³² So, the real work of extrapolating long-term trends from shorter-term predictions comes *after* the prediction market closes (Figure 3). The CSO’s job is to probe the results further, “decompose them into differences about facts [versus] values, then discuss each source of conflict, and lastly, recombine the pieces into a better judgment overall.”¹³³

Figure 3: How a prediction market could inform strategy



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The US Central Intelligence Agency uses prediction markets to complement traditional methods of “avoiding strategic surprise.”¹³⁴

The benefits to using blockchain-based tools are several:

- » Cryptographically secured decentralized markets are generally more inclusive, more global, and more censorship resistant across jurisdictions.
- » Trades are transparent, trackable while the market is open, and auditable when the market is closed.
- » The reward system is built-in, and payout can be fairly quick and direct, if there is no dispute over the reported outcome.
- » Fees are potentially lower than those charged by commercial vendors.¹³⁵

The US Central Intelligence Agency uses prediction markets to complement traditional methods of “avoiding strategic surprise.”

Some words of caution for CSOs who’d like to experiment with this tool, from professional trader and market maker, Zvi Mowshowitz. He argues that they work best under these conditions:

- » The creator clearly and precisely defines the outcome, and participants are quite confident they’ll be able to collect if they win. There was a dispute over the wording of an Augur-based market, “Which party will control the House after 2018 US Midterm Election?” closing on 10 December 2018, a month after the elections. Those who bet on a Democratic takeover on Election Day were upset when they came to understand that, technically, Republicans would control the House into the New Year. The market went through at least four rounds of dispute in January.¹³⁶ It appears to have been resolved in the Dem’s favor.¹³⁷
- » The resolution and payout come quickly, so that participants are very engaged between the creation of the market and the realization of the outcome, and greater engagement may have greater network effects on participation. Otherwise, interest may drop off, and people will no longer apply their best information regularly to the market. So CSOs could set a long-term horizon on the market—like the one about SpaceX’s reaching Mars by 2023—but see too little participation in the short-term to inform any direction.
- » A resolution is probable, not conditional, and without the likelihood of a tie. “Trading in a prediction market ties up capital, creates risk, and requires optimization pressure,” Mowshowitz explained. Participants “need to pay attention to the market, both to decide what fair value is and then to go about maximizing and making good trades.” If trades are valid only if certain conditions are met, then participants end up wasting “time, money, and risk capacity, [to get] nothing in return.”¹³⁸

CSOs who set a long-term horizon on the market may see too little participation in the short-term to inform any direction.



- » The outcome can't be controlled by participants. "While the individual trades of insiders make the market more efficient, they punish others trying to share their information and analysis with the market."¹³⁹ No one wants to bet against insiders, and so insider trading kills participation. The Augur markets above, involving specific questions about Apple, Google, and SpaceX, might very well have company insiders as participants. The average user can't tell by the user addresses.
- » There must be some source of disagreement or opposition, such as natural buyers and sellers. "What traders need, more than anything else, is *the ability to tell a story for why their trade is a good idea*," Mowshowitz wrote. "To do that, they need to know why they have the opportunity to make this trade. What do they know, that others don't know? What mistake do they think people are making?"¹⁴⁰ Those are the questions worth probing and discussing when the market has closed.

Managing the strategic planning process

According to a recent Brightline Initiative survey of over 1,600 executives worldwide, 44 percent of strategy implementation leaders believe that the process of developing and delivering strategic initiatives is dynamic and continuous, whereas it isn't so for followers (35%) or laggards (23%). Quite the opposite: nearly one-third (31%) of laggards revisit their strategic aims only every two years versus 10 percent of implementation leaders.¹⁴¹

Strategy gurus, from Henry Mintzberg to Roger Martin, have been pointing out the flaws of using this linear approach to developing strategy for thirty years: CSOs end up focusing on what is knowable and controllable, like costs and capabilities.¹⁴² To factor in the unknowable outside their control, CSOs have adapted "by increasing the scope and complexity of their roles."¹⁴³ They have changed their function rather than make the case for change, be it in organization process, design, culture, or other dimension.

So, rather than widening the scope of their function, CSOs can widen the scope of input in the strategic planning process. That can include getting grassroots ideas from employees and customers as well as enlisting broader participation in evaluating the feasibility and potential of strategic options. Alan Todd, CEO of CorpU, makes the case and offers advice:

*Savvy CEOs are launching idea tournaments and encouraging problem swarming. Instead of an occasional town hall, post your strategy online and ask for responses from all your employees. Ask if they believe in the strategy and if they are committed to the changes being made. Set aside time to have these conversations and to course correct if need be. Once a strategy is implemented, continue to seek out your employees' feedback.*¹⁴⁴

To factor in the unknowable outside their control, CSOs can widen the scope of input in the strategic planning process, getting ideas from employees and customers as well as enlisting broader participation in evaluating the feasibility and potential of strategic options.



"Organizations should be democratizing input to strategy and incentivizing the sharing of data."

 JERRY CUOMO
IBM Fellow
Vice President Blockchain
Technologies
IBM Blockchain

"Many customers are interested in developing new business models through co-creation that cross the barriers of organizations and industries."

 TATSUYA TANAKA
President
Fujitsu Limited

Mark van Rijmenam, founder and CEO of Datafloq, sees roles for blockchain in open innovation, "especially when there is need for verifying data and the identities of participants, tracking the provenance and progress of ideas, and rewarding participation."¹⁴⁵

Gennaro "Jerry" Cuomo of IBM says, "Organizations should be democratizing input to strategy and incentivizing the sharing of data."¹⁴⁶ As noted, IBM is partnering with major food suppliers to ensure food safety using its Food Trust blockchain solution. The key to success in this (and similar sustainability and environmental initiatives) is enlisting all the players—growers, suppliers, processors, distributors, retailers, regulators, and consumers—to participate in standards setting and share data and ideas for improvement.¹⁴⁷

Tatsuya Tanaka, president of the global information and communications technology (ICT) company Fujitsu, said, "With the expansion of ICT, no one can do everything themselves."¹⁴⁸ He told some 12,000 attendees of a recent Fujitsu event, "Many customers are interested in developing new business models through co-creation that cross the barriers of organizations and industries." That would require Fujitsu to "break away from the 'not-invented-here' syndrome" that often limits strategy design.¹⁴⁹

Supporting the creation of incentives for collaboration, participation, and open innovation are such blockchain-based tools as Sweetbridge's Sweetcoin as a user discount or a reward for customer loyalty, Augur's reputation (REP) token for accurate reporting of outcomes, and the ether awarded in Ethereum-based prediction markets. Such incentives are in keeping with Brightline's guiding principle ten, about recognizing those who have contributed good work.¹⁵⁰ Finding ways to incentivize people in alignment with strategy delivery is part of every leader's role. The benefits of such decentralized systems apply, if an enterprise wants to collect input across many jurisdictions and enterprise boundaries with less risk of censorship and greater auditability of data.

Strategy delivery

In our research, we explored how blockchain technology might help close the gap between the design and the delivery of strategic initiatives in organizations across industry sectors. According to a 2017 Brightline survey conducted by the Economist Intelligence Unit (EIU), only one in ten organizations successfully reaches all of its strategic goals. On average, organizations fail to deliver 20 percent of their strategic projects, and almost two-thirds of respondents admitted that their organizations struggle to bridge the strategy-implementation gap.¹⁵¹

Throughout implementation, perhaps the most critical responsibility of the CSO is that of communicator or evangelist among key stakeholders. In the transformation of IBM, Irving Wladawsky-Berger's communications strategy had to be deliberate, and his messaging clear. "We came up with what became known as *e-business*, a strategy that we succinctly defined as *Web + IT*." He explained:



Throughout implementation, perhaps the most critical responsibility of the CSO is that of communicator or evangelist among key stakeholders—not just designing a company’s strategy but communicating it clearly and loudly.

We had to figure out how to best communicate, in the simplest way possible, why every company 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.¹⁵²

His message to CEOs and their CSO delegates was straightforward: a company’s blockchain strategy—not just designing it but communicating it clearly and loudly inside and outside the enterprise—was “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.”¹⁵³

Today, we see IBM’s blockchain team doing what Wladawsky-Berger did back then: establishing IBM’s blockchain brand in the marketplace by telling its success 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.”¹⁵⁴ Most executives interested in blockchain have heard of IBM’s pilot projects with Walmart to track the provenance of pork in China and mangos in the Americas.¹⁵⁵

IBM has built on the success of its pilots, launching what it calls its Food Trust solution, a permissioned blockchain that gives members visibility into the supply chain, with better ability to identify and sequester contaminated produce (e.g., romaine lettuce tainted by *E. coli*) in the system.¹⁵⁶ Walmart and Sam’s Club have required their US leafy greens suppliers to join.¹⁵⁷ Dole, Driscoll’s, Golden State Foods, Kroger, McCormick, McLane, Nestlé, Tyson Foods, and Unilever have signed on as well. IBM has also attracted the retailers Carrefour, Topco, and Wakefern and such suppliers as Beefchain, Dennick Fruit Source, and Smithfield.¹⁵⁸



Salad Green Leaf Lettuce Garden In The Garden by Pezibear, 2016, used under Pixabay license, accessed 14 July 2019.

CSOs need a hand in explaining what doing business in the age of blockchain will mean for their enterprise. It is an opportunity for B2B brands to revitalize and reposition themselves.

HSBC's blockchain project, "FX Everywhere," showed that the technology worked to automate manual processes, decrease the bank's reliance on technology vendors, and cut foreign exchange transaction fees.

CSOs need a hand in explaining what doing business in the age of blockchain will mean. It is an opportunity for B2B brands to revitalize and reposition themselves, if they are truly serious about participating in what Don Tapscott calls "the second era of the Internet." When it comes to strategy delivery, there are several areas worth exploring: cost control, business model innovation, new business incubation, and capital allocation.

Cost improvements

"The long history of human progress has been a steady march against friction," according to IBM. "The Internet primed friction for a free-fall."¹⁵⁹ Traditional businesses that provided information and consulting services or managed intellectual property in such industries as music, media, pharmaceuticals, and retail banking, all consolidated assets under massive global organizations, even as media and payments start-ups emerged such as Facebook, Netflix, PayPal, and Square. Global enterprise and supply chains have both scaled in complexity in recent years. But, according to IBM:

[T]he 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.¹⁶⁰

Overstock's board chair, JJ Johnson, wrote that the online retailer's bet on the bitcoin payment option paid off: "Fiscally, the decision made a great deal of sense. ... We eliminated credit card transaction costs on bitcoin purchases, thus increasing our profit within the tight margins of e-commerce." That included currency exchange processing and costs in cross-border sales.¹⁶¹

For example, HSBC experimented with blockchain to synchronize payments across the balance sheets of its operations in multiple countries. The project, "FX Everywhere," was designed specifically to process foreign exchange transactions. HSBC ended up processing three million trades valued at \$250 billion in the yearlong pilot. Executives could see for themselves how funds moved from execution to settlement. The pilot demonstrated that the technology worked to automate manual processes, decrease HSBC's dependence on technology vendors, and cut foreign exchange transaction fees to the Continuous Linked Settlement (CLS) service system. Richard Bibbey, acting global head of currencies at HSBC, told the *Financial Times*, "FX Everywhere uses distributed ledger technology to drastically increase the efficiency of these internal flows."¹⁶² HSBC plans to offer this platform to companies that conduct large volumes of cross-border transactions.

It's not just about eliminating costs. In a world where 783 million people live on only \$1.90 a day, 821 million people are chronically malnourished, and 2.1 billion people lack access to safe water at home, Vinay Gupta suggested that we ought to be thinking in terms



In a world where 783 million people live on \$1.90 a day, we ought to be thinking in terms of minimizing needless waste as much as we think about maximizing shareholder value, as equal goals of enterprise strategy.



Person Paying by Francesco Paggiaro, no date, used under Pexels license, accessed 13 July 2019.

of minimizing needless waste as much as we think about maximizing shareholder value, as equal goals of enterprise strategy.¹⁶³

Business model innovation

The IBM Institute for Business Value, in collaboration with the Economist Intelligence Unit, surveyed 200 financial services institutions in 16 countries, and found that between 60 and 86 percent of them expected to introduce blockchain-enabled business models in the areas of “clearing and settlements, wholesale payments, and equity and debt issuance” with blockchains.¹⁶⁴

Aigang's insurance for things is low cost, because the smart contract assesses and verifies claims; there is no third-party assessor.

In markets for risk and insurance, the start-up Aigang is positioning its blockchain protocols to become the decentralized autonomous insurance provider of the Internet of Things. For consumers, that means not just phones and computers but fitness trackers, drones, televisions, gaming consoles, and Wi-Fi-enabled home appliances. For entrepreneurs and small business owners, that means a suite of business equipment. Aigang has prototyped, tested, and launched smart insurance contracts that can interface with the device's diagnostic software and alert the owner of any issue, such as a failing battery. The device manufacturing one-year warranty has expired, but the smart insurance contract covers the battery for three years, and so the contract can issue a payment or order a replacement battery. The insurance is low cost, because the smart contract assesses and verifies claims; there is no third-party assessor.¹⁶⁵

In markets for valuables, the start-up Everledger has created a business model around provenance and transparency, recording data about off-chain assets such as diamonds onto its blockchain ledger and providing a clear chain of custody and asset verification at any



Companies are innovating new blockchain-based business models around provenance and transparency, collaborative manufacturing, insurance managed by smart contracts, IP file licensing, and peer-to-peer energy markets.

Collaborative manufacturing business models align the interests of manufacturers and customers, shift part of the operational risk to the manufacturer, and alter the cost structure, as customers incur only operating expenses.

checkpoint. It can tailor these capabilities to a range of precious property. The costs of its services are offset by the reduction of fraud and risk in its customers' supply chains.¹⁶⁶

In manufacturing, since blockchain solves the problem of attribution and ordering of events within an ecosystem, it can facilitate the exchange of digital assets in transactions triggered by human or machine, and links enterprise systems—such as manufacturing execution systems (MES) and enterprise resource planning (ERP)—with those of collaborators, making end-to-end horizontal integration possible. This unleashes what Dr. Stefan Hopf of Nunatak called, “collaborative manufacturing 4.0” business models. He expects manufacturing business models to evolve beyond the transactional contract sale of products and aftersales service contracts into product-service systems and product-as-a-service models. Rolls-Royce pioneered the latter model when it began selling engine hours on a fixed-cost-per-flying-hour basis.¹⁶⁷ Hopf explained how it differs from renting:

The business model aligns interests between a manufacturer and customer, as both parties are incentivized to maintain an operational asset, minimize downtime, and reduce waste. Part of the operational risk thereby shifts to the manufacturer. A product-as-a-service business model also alters the cost structure, as customers do not incur fixed capital costs for buying a piece of equipment, but only operating expenses with the opportunity to optimize capital expenditures.¹⁶⁸

One node in such a manufacturing network is Moog, a precision parts manufacturer operating in a highly regulated industry segment. Its leaders expect its business model to shift from traditional contract manufacturing to design licensing, as more of its components are exchanged directly on the blockchain in the form of secured design files sent to 3D printing facilities.¹⁶⁹ The value previously generated from the traditional model will shift to other areas. With a network of highly specialized designers, Moog could adopt a software-as-a-service and license its designs to aircraft assembly lines, depending on the location of customers and raw materials in the supply chain.¹⁷⁰

In energy, the dropping costs and technological innovations in renewables and *distributed energy resources* (DERs) are reminiscent of the convergence of computing and communications. “These advances have driven a steady trend toward decentralization in electricity markets, with larger and more diverse participation than ever before,” according to the nonprofit Energy Web Foundation. Consumers are better equipped “to produce, store, and manage electricity on their own terms at prices competitive with conventional utility tariffs.”¹⁷¹ Neither patching up aging energy infrastructure in developed economies nor building out new ones based on fossil fuel in emerging markets is prudent during our climate crisis. Blockchain supports decentralized models.

The Brooklyn Microgrid is a case in point. Developed by LO3 Energy, it is a blockchain-based microgrid in Brooklyn, New York City. More



than fifty residents can use their own devices to trade photovoltaic-generated energy, directly and securely with neighbors. The devices use a *transactive grid* (TAG) meter, to “tag” units of energy produced locally, offer these units to neighbors with TAG meters, and record these interactions on the blockchain.¹⁷² “Such microgrids, off-grid community installations, and other configurations that break from the traditional grid will make up a significant portion of tomorrow’s energy market,” according to Lawrence Orsini, founder and CEO of LO3 Energy. “The microgrids market alone is estimated to reach \$23 billion by 2021.”¹⁷³



Solar Panel on Straw Hut Roof by Teresa Cotrim (cotrim), 2005, used under Pixabay license, accessed 16 July 2019.

Blockchain technology is making markets for “validated machine data, smart-contract-based product and service liability insurance, automated predictive micro-maintenance contracts, pay-per-use smart-contract-based asset sharing, provenance-based marketing, or dispute management.”

 DR. STEFAN HOPF
Senior Consultant
The Nunatak Group

The energy grid is just one of several aging infrastructures, among them healthcare, water utilities, and telecommunications networks whose providers can’t afford to upgrade or overhaul without charging consumers or taxing citizens more. For example, mesh networks—where individuals share the connectivity of their devices with each other—would be less expensive to implement than 5G networks, which could cost the big telcos an estimated \$872 billion to build out.¹⁷⁴ Start-ups such as Nodle, OmniMesh, Open Garden, and RightMesh are using blockchain to incentivize and organize the formation of such ad hoc mobile networks, as platforms for new peer-to-peer business models.¹⁷⁵ Disruption is in order.

To sum up the business model innovation underway, Hopf said that blockchain technology is making markets for “validated machine data, smart-contract-based product and service liability insurance, automated predictive micro-maintenance contracts, pay-per-use smart-contract-based asset sharing, provenance-based marketing, or



dispute management.”¹⁷⁶ These are essential to the Fourth Industrial Revolution, comprised of the Internet of Things, some of them autonomous, and many of them managed by artificial intelligence or improved by machine learning.

New business incubation

Japan’s Fujitsu kicked off its blockchain journey some time ago. What began as service innovation is transforming the company into a business incubator of sorts. It started with what Fujitsu calls a *virtual private digital exchange* (VPX), a proprietary platform for its enterprise customers to share data among them, to trace the data’s origin and track how they’re used, and to receive a portion of the value they help to generate.¹⁷⁷ Fujitsu’s goal was to spark open innovation and to support collaborative business models among clients across diverse industries, and it founded a blockchain research center for that purpose.¹⁷⁸ It called on enterprise crowdsourcing platform Topcoder to help generate use cases for the platform.¹⁷⁹ It has since announced cooperations with Sony on education and ENERES on energy and has joined the Open Radio Access Network Alliance (O-RAN) to develop products for commercial 5G networks.¹⁸⁰

“Expecting the SEC to accept a legal distinction between an investment contract that pre-sells the tokens and the sale of the actual tokens once they have acquired ‘utility’ requires [a] leap in logic.”

 COALITION OF AUTOMATED
LEGAL APPLICATIONS

Anyone watching the blockchain space in the last 24 months will be aware of *initial coin offering* (ICO) mania, where start-ups raised insane amounts of money for projects based on white papers. So is the ICO an option for incubating new businesses for an enterprise? Consider Overstock.com’s foray. It decided to launch its own blockchain subsidiary, named tZERO, a security token trading system as an alternative to traditional capital markets. Prior to staging its ICO—which it intended to be a utility token, needed to use the system—it filed with the US Securities and Exchange Commission (SEC) for classification under Regulations D and S, which meant that it didn’t consider the token a traditional security. It used what is called a *simple agreement for future equity* (SAFE), where issuers pre-sell tokens classified as a security under the Regulation D exemption so that, if they never held an ICO, they could convert the value of the pre-sold tokens into equity in their start-ups. In December 2017, tZERO went ahead with its ICO and raised \$100 million in the first half-day of trading.¹⁸¹

In March 2018, the SEC announced a probe into tZERO’s potential violations of federal securities laws, and the value of the token began to plummet. By then, the cryptocurrency market was already in a decline.¹⁸² As analysts at the Coalition for Automated Legal Applications pointed out, “Expecting the SEC to accept a legal distinction between *an investment contract* that pre-sells the tokens and *the sale of the actual tokens* once they have acquired ‘utility’ requires [a] leap in logic.”¹⁸³ As far as we could determine, the SEC found no reason to suspend the offering. It closed in August 2018, and the company reported raising \$134 million total. It also announced that the Chinese private equity firm, GSR Capital, was putting down as much as \$270 million for an 18 percent stake in the start-up.¹⁸⁴ The question now is whether it can distinguish itself from





Accomplished Achievement Agreement Assistant by rawpixel, 2018, used under Pixabay license, accessed 13 July 2019.

Staging an ICO is not an easy strategy for incumbents to incubate new businesses. Co-creating services with customers or investing in and learning from blockchain start-ups may be more prudent growth strategies than acquiring any start-up outright.

other cryptoasset exchanges (e.g., Quadency, Quantatex, ProBit, Xena Exchange). While Overstock's leadership no doubt learned a lot about the challenges of creating and running an ICO, it's not an easy strategy for new business incubation. KODAKCoin, associated with the image rights management platform KODAKOne, was launched with the assistance of ICOx Innovations, as the cryptomarket started to collapse; and its value doesn't appear among cryptocurrency listings.¹⁸⁵ Facebook's stablecoin Libra faces scrutiny by US Senate Committee on Banking, Housing, and Urban Affairs this month.¹⁸⁶

Shifting gears, Overstock.com formed another subsidiary, Medici Ventures, to invest in blockchain start-ups. Its portfolio of companies enables Overstock's executives to monitor advances in core distributed applications and blockchain services, from cryptowallets and P2P payments and asset trading to digital identities, smart contracts, and governance (Table 6, next page).¹⁸⁷

Investing in blockchain start-ups, learning from them, and integrating relevant capabilities over time may be a more prudent growth strategy than acquiring them outright. Overstock's portfolio is quite diverse, with stakes in core areas of a blockchain-enabled economy; and so its leadership has a view under the hood of these operations.



Table 6: Medici Venture's investment portfolio

Capability	Start-ups
Banking, payments, and wallets	<ul style="list-style-type: none"> » Bankorus, a regulatory-compliant blockchain banking platform » Bitsy, a digital currency wallet, acquired at end of 2018 and renamed tZERO Crypto, released its digital wallet and exchange services mobile app » Bitt, digital wallet and currency exchange, piloted a digital Eastern Caribbean dollar with Eastern Caribbean Central Bank to aid peer-to-peer transactions between merchants and consumers via mobile apps
Data integrity	<ul style="list-style-type: none"> » Factom, a blockchain-as-a-service platform for data provenance and integrity, to "preserve evidence, demonstrate compliance, increase process transparency, streamline audits, reduce cost, and automate transactions ... without cryptocurrency exposure or costly infrastructure" » PeerNova, an immutable ledger for digital record-keeping with built-in audit for ensuring the integrity of data
Enterprise services	<ul style="list-style-type: none"> » Chainstone Labs, a "technical advisory and investment company" » Mint, an enterprise middleware provider for creating new distributed applications or integrating blockchain technologies into existing enterprise applications, processes, or products » Symbiont, a smart contracts platform for enterprise applications of blockchain technology
Financial inclusion	<ul style="list-style-type: none"> » FinClusive, a global "blockchain-architected" banking, routing, and payments platform for those underserved or excluded by the incumbent financial system » Medici Land Governance, a platform for low cost property registration and land administration; Teton County, Wyoming, used it to record warranty deeds, mortgages, release of liens, and other documents going back to 1996 » Ripio, digital wallet for bitcoin currency exchanges, P2P payments, and lines of credit in the form of paying by installment in Argentina
Governance	<ul style="list-style-type: none"> » Voatz, a blockchain-based mobile elections platform, used successfully for absentee voting in West Virginia's 2018 elections and in Denver's May 2019 city elections » Votem, a now-defunct blockchain enabled mobile voting platform for individuals to cast their votes securely and privately, and to verify that their vote was counted as cast in a public or private sector election
Identity	<ul style="list-style-type: none"> » IdentityMind, a digital identity platform to help businesses reduce fraud, comply with anti-money laundering/know-your-customer rules, and build risk scores for each identity » Netki, global ID validation service for onboarding online customers, which works with Bitt
Peer-to-peer markets	<ul style="list-style-type: none"> » GrainChain, a P2P agriculture commodities trading platform for suppliers and buyers, where farmers can receive payment quickly » tZERO, blockchain-based trading system, so that capital market users would be "less beholden to traditional, institutional market structures, " with bond » Vinsent, a blockchain based wine marketplace that connects wineries directly with fine wine buyers, eliminating intermediaries in distribution while ensuring provenance
Project management	<ul style="list-style-type: none"> » Spera, comprehensive project management platform for independent contractors and project management, which includes a cryptocurrency payment option and ProPay, a method for encrypting and tokenizing payment data to reduce identity theft
Social media	<ul style="list-style-type: none"> » Minds, a decentralized social network that rewards users with cryptotokens for their contributions to the community. It is a study of aligning incentives in a creative commons


Source of list: "Medici Ventures Portfolio Companies: Harnessing the World-Changing Power of Blockchain," n.d., accessed 25 Jan. 2019.



Burniske and Tatar have a word of caution about going another step, acquiring one of the companies in a corporate portfolio:

While the ... takeover strategy has been a go-to for incumbents trying to avoid disruption, it is rarely as effective as hoped. Once the big company swallows the start-up, or begins meddling, it is often hard for the start-up to retain its fast-moving and flexible culture. Nimble cultures are key to succeeding in the early stages of a disruptive technology, and if the start-up is tainted by corporate bureaucracy, then it will quickly lose its edge.¹⁸⁸

"Nimble cultures are key to succeeding in the early stages of a disruptive technology, and if the start-up is tainted by corporate bureaucracy, then it will quickly lose its edge."

 *Chris Burniske and Jack Tatar*
Authors
Cryptoassets: The Innovative Investor's Guide to Bitcoin and Beyond

Dynamic deployment of resources and project portfolios

According to a Brightline global survey conducted by the EIU, among the top three barriers to successful strategy implementation are cultural attitudes, insufficient resources such as money and time, and insufficient agility in changing plans when needed.¹⁸⁹ The same EIU survey revealed that successful organizations promptly and effectively reallocate funding among strategy implementation initiatives when needed. Blockchain technology can help this process become even more effective, responsive, and reliable.

One of the best-known examples of such a dynamic deployment of resources is the DAO, for *decentralized autonomous organization*, a concept articulated by Vitalik Buterin in a series of opposite editorial pieces, formalized by Christoph Jentzsch in a white paper, and launched on the Ethereum blockchain in 2016.¹⁹⁰ Jentzsch described what became "the first implementation of [DAO] code to automate organizational governance and decision-making."¹⁹¹ He wrote that, if registered corporations could codify their corporate bylaws and regulatory requirements in smart contracts, then they could use the DAO framework for automating formalized rules of governance.¹⁹²

As deployed, the DAO operated as an investor-directed venture capital fund that gave each token holder a say in the allocation of its assets, primarily the 12 million ether raised through its ICO, worth around \$150 million at the time.¹⁹³ Token holders could submit proposals. A panel of curators vetted the coding of the proposals, to make sure they did what they claimed to do, and then green-lighted them for all token holders' consideration and potential investment. The curators also served as a code oversight board.

An attacker exploited a bug in the DAO's code, and a majority of stakeholders voted to unwind the fund and get their money back. Still, it was an instantiation of strategic liquidity, where token holders could reallocate their tokens, as projects unfolded and the more promising ones gained traction and required resources. It was also an example of the complexity of smart contracts, the need to test rigorously for a period, and the need for more top quality contract coders, debuggers, and testers.

The DAO's failure did not deter Siemens from conducting its own experiment, the Hutten-DDO.¹⁹⁴ Siemens wanted to find a way for

Blockchain technology could make resource allocation even more effective, reliable, and responsive to changes in internal and external markets.



Siemens' Hutten-DDO, a decentralized digital organization running on a private Ethereum-based blockchain, was a successful experiment in decentralized allocation of resources and management of project portfolios.

employees to work on projects without a central coordinator or manager to oversee their contributions. It decided to launch Hutten-DDO, a *decentralized digital organization* running on a private Ethereum-based blockchain and named after the location of Siemens' gas turbine plant in Berlin, Hutten Street.

In the first phase of the experiment, Siemens invited all employees to vote on one of three possible purposes of the DDO: they could (1) support a social initiative, (2) build a creative lab, or (3) leave the purpose of the DDO open. They had two weeks to vote, and voting took place off-chain. Employees chose the social option, to support a nongovernmental organization dedicated to caring for and protecting disadvantaged children. Had they voted for either of the other options, the following phases would still have applied.

In the next phase, employees exchanged Euros for the Hutten-DDO's native tokens, Hutten-Coins, which were not tradeable with other cryptocurrencies. They represented the exact value of the Euros exchanged, and that value would never change. In the third phase, those who wanted to become Hutten-DDO shareholders converted their Hutten-Coins into Hutten-Shares, initially at the rate of three shares per one coin—an early donor discount—and eventually at a one-to-one rate.

In the final phase, only Hutten-Shareholders could submit proposals for projects suitable to the children's nonprofit, and many of them did, proposing the purchase of musical instruments and the funding of a field trip to the Berlin Zoo. All Hutten-Shareholders could vote on each submission, with votes weighted according to the number of Hutten-Shares held.

Ultimately, the Hutten-DDO served to educate Siemens employees on the potential uses of shared ledgers, tokens, and smart contracts—not just crowdsourcing funds and ideas, but choosing among options and deploying funds for approved proposals, all without a central administrator and negligible administrative costs. It was a useful lesson for decentralized allocation of resources and management of project portfolios.¹⁹⁵

Conclusion and challenges

How far along are we in this blockchain revolution? How near are we to creating viable adaptive cryptoeconomic systems in which strategic liquidity is possible? Consider all that the BNP Paribas Group has accomplished in the blockchain space (see screened insert).

One enterprise's efforts: BNP Paribas

BNP Paribas prides itself in its culture of innovation, characterized by incentives for leading bold initiatives and digital transformation while controlling for risk, resulting in new corporate know-how, better operational performance, and new business models.¹⁹⁶



Snapshot of BNP Paribas efforts

- » Joined R3 consortium
- » Engaged in standards setting
- » Engaged in public policy research
- » Partnered with SmartAngels
- » Staged a hackathon
- » Prototyped "Cash Without Borders."
- » Launched ClimateSeed
- » Formed LiquidShare
- » Participated in R3's Voltron and Corda
- » Launched PlanetFunds

2014: Preparing for disruption

Johann Palychata, a research analyst at BNP Paribas Securities Services, and Nathalie Doré, then CEO of L'Atelier BNP Paribas–North America, were among the group's employees who saw the disruptive potential of blockchain technology.¹⁹⁷ The international banking group was singled out for its foresight.¹⁹⁸

2015: Industry consortium, standards

To learn all it could about blockchain technology, the bank invested in Digital Assets Holdings led by CEO Blythe Masters and joined the R3 financial services blockchain consortium engaged in industry standard setting.¹⁹⁹ It also joined the Caisse des Dépôts et Consignations (CDC) innovation laboratory for public policy and impact research, which was set up to run scenarios and design sprints.²⁰⁰

2016: Letters of credit, collateral, Cash Without Borders

The bank's securities services group partnered with SmartAngels, a crowdfunding platform for investing in the equities or bonds of start-ups and growth-oriented SMEs. They wanted to co-create a blockchain-based system for private companies to issue shares on the primary market, with the possibility of trading them in the secondary market.

Its transaction banking team staged a hackathon to hack its own business model and surface ideas worth developing into proof-of-concept (POC) tests. There was the smart letter of credit POC, which replaced paper-based documentation with blockchain-based processing of credit in trade finance.²⁰¹ There was the collateral management POC, which used blockchain to provide a shared view of asset custody in international trades so that the parties to a deal could coordinate actions.²⁰² There was the transborder transfers POC, dubbed "Cash Without Borders."

Similar to HSBC's FX Everywhere, Cash Without Borders was a means of facilitating transborder transfers between BNP Paribas bank accounts in different jurisdictions but within the bank's own system. It invested about €50,000 to prototype a system, using the Nxt protocols similar to Bitcoin's but with a proof-of-stake consensus mechanism. As with Overstock, six employees volunteered on top of their day jobs to join the team, along with two institutional customers—global packager Amcor and the Panini Group of trading card fame. They worked with blockchain coders to co-develop the software. In December, the team tested the system with great success for the bank and its two customers.

2017: Treasury management, LiquidShare

Elsewhere in the bank, there was the internal treasury management POC, co-developed by the BNP Paribas asset/liability management and treasury group and Ernst & Young. They tested it internally over the summer, also with success. The pilot demonstrated how the bank could use a private blockchain to integrate cash management across business units, which gave the bank around-the-clock flexibility.²⁰³ Also that summer, there was a successful test of the



The ClimateSeed project is a voluntary carbon offsetting system launched to address the climate crisis. Project developers are already promoting and selling carbon credits on the platform.

system for managing private stocks, co-developed by SmartAngels, and they began the next phase of development.²⁰⁴ And there was the ClimateSeed project, a voluntary carbon offsetting system in keeping with BNP Paribas's commitment (as the first carbon-neutral bank in Europe) to address the climate crisis.²⁰⁵

With a group of other firms in July, BNP Paribas formed a jointed venture, called LiquidShare, to develop a blockchain-based post-trade infrastructure, primarily for SMEs. LiquidShare describes itself as "the output of a consortium gathering nine strategic investors collaborating to build the first community workflow of the financial industry."²⁰⁶ Other members include CACEIS Investor Services, the asset servicing banking group of Crédit Agricole; the public policy group, CDC; Euroclear; Euronext; Société Général; and S2iem gérée par OFI AM, with support from Paris Europlace, an advocate of the City of Lights as a leading financial marketplace.²⁰⁷

LiquidShare's board of directors represents each of these members, including Philippe Ruault, head of digital transformation at BNP Paribas Securities Services, and Eric Massart, an expert on renewable energy from CDC. Its advisors also represent the members in such areas as strategy and knowledge management.²⁰⁸ It is decidedly a Paris-centric European venture, with members who have complementary know-how and points of view and an understanding of the role of policy in the broad adoption of innovation.

2018: Voltron, PlanetFunds, Stratumn, and ClimateSeed

The year was a full one. BNP Paribas participated in the first-ever successful blockchain-based syndicated loan pilot, Fusion LenderComm, on R3 Corda.²⁰⁹ It also participated in the launch of R3's Voltron trade finance platform for letters of credit.²¹⁰ The securities services team took over the start-up financing project with SmartAngels and announced PlanetFunds, a platform for the distribution of digital funds that it would co-develop with its clients. PlanetFunds would incorporate blockchain technology, smart contracts, and big data analytics so that clients could manage their funds securely and efficiently end to end.²¹¹

It also invested in fintech start-up of the year, Stratumn, to learn more about blockchain traceability.²¹² Stratumn joined Carrefour at the French National Assembly to push for European Union directives that would "validate the legality of a digital signature rather than electronic signature, recognize blockchains as a proof register, and foster dematerialization of processes by removing the need for paper audit trails." Finally, ClimateSeed went live, with the support of Grameen's Creative Lab and "19 project developers promoting and selling carbon credits representing eight million tonnes of carbon dioxide equivalents on the platform."²¹³

2019: Cybersecurity, asset protection

Blockchain has touched enough of the bank's client work that Florent Bronès, chief investment officer for the wealth management group, included it in his top ten investment themes for 2019, as a mean of protecting clients' assets and providing cybersecurity.



From an enterprise perspective, blockchain technology is not yet ready for prime time. Given what they have learned, the folks at BNP Paribas see 2030 as a more likely horizon for wider adoption and deployment.

BNP Paribas has done its homework, built institutional knowledge across business units, and positioned itself as a first mover, to move when the technology is ready for prime time adoption. *And that's just it—it's not yet ready for prime time.* Given what they have learned, the folks at BNP Paribas see 2030 as a more likely horizon for wider adoption and deployment. Philippe Denis, head of the BNP Paribas blockchain lab, told a team of scientists at MIT Sloan's Center for Information Systems Research (CISR), "We will have blockchains in products before 2030, but the first implementations will mainly concern niche products."²¹⁴

The implementation challenges are several.²¹⁵ We've already discussed the first—the lack of standards—as an opportunity to participate. In the words of Dr. John R. Pierce of Bell Labs and CalTech fame, "Competition and monopoly solve many problems, not all. To achieve maximum growth in the technology, we need standardization, and to achieve standardization, we need cooperation."²¹⁶ Joichi "Joi" Ito, director of MIT Media Lab, made this comparison in 2017: "We're investing in blockchain like it's 1998, but I think we're at 1989 in terms of the level of standardization."²¹⁷ Stephan Tual, chief operating officer (COO) of the start-up Slock.it and former COO of Ethereum, was more conservative on the timing. He told Alan Majer of Good Robot, "People say, 'Oh, it's like the Internet in 1993.' Well, I don't think so. I think it's more like the Internet in 1968 when Douglas Englebart was presenting the mouse, collaborative editing, hypertext—all that stuff was right in his head."²¹⁸

Unlike the Internet, blockchain technology was born commercial, competitive from the get-go. Upon its release in January 2009, the Bitcoin blockchain was literally minting value. By October 2009, New Liberty Standard decided to buy and sell it at an exchange rate of one dollar for 1,309.03 bitcoins.²¹⁹ By April 2013, one bitcoin was worth \$135.58.²²⁰ So, in fewer than five years, the price of bitcoin had increased by over 17 million percent. It's no wonder it got people's attention, and the attention only fueled bitcoin's price, peaking near \$20,000 a coin in December 2017. As of 10 July 2019, bitcoin's price stood at \$12,311.²²¹

Blockchain was thrust into the regulatory spotlight at a tender age. There was no real gestation period, no scientific research and testing as there was for the Internet within government and academia.

It was thrust into the regulatory spotlight at a tender age, thanks to crooked early adopters trading illicit goods on the darknet as well as corrupt or incompetent initial coin offerers.²²² But there was no real gestation period, no scientific research and testing as there was for the Internet within government and academia. In 1968 or even in 1989, average shareholders weren't investing in the initial public offerings of dotcoms, and institutional investors weren't asking corporate executives about their Internet strategies. Nor were Nobel Laureates in economics appearing on television to say the Internet was a really bad idea, as they've said about bitcoin.²²³

The need for more basic and applied research

Joi Ito was concerned enough about the lack of fundamental research that he rallied corporate sponsors to fund the MIT Media





Adults Analysis Brainstorming by rawpixel.com, 2018, used under Pexels license, accessed 13 July 2019.

Lab's Digital Currency Initiative in 2015.²²⁴ Research is underway at three levels: the protocol layer of blockchain operators where some cryptocurrencies like bitcoin reside; the distributed application layer, where smart contracts run and smart assets like those created through ICOs are managed; and the ecosystem level, where multiple parties decide to join—or not.

In discussions with BNP Paribas leaders, the CISR team at the MIT Sloan School of Management surfaced concerns about governance that many C-suites share.²²⁵ For example, various open source codebases continue to evolve, but none has emerged as a dominant protocol. Will it be truly open, distributed, and managed by the stakeholding-many, as in Ethereum? Or will it be private, permissioned, and controlled by a corporate few, as in Chained Finance? Or some combination of these?

Cryptoeconomics is an emerging field where insights into user behavior are beginning to be captured and communicated so that they can inform software development. It studies the effects of protocol design choices and economic incentives.

Scientists such as Christian Catalini and Catherine Tucker, both professors at MIT Sloan, have been studying *cryptoeconomics*, an emerging field where insights into user behavior are beginning to be captured and communicated so that they can inform software development. Catalini, Tucker, and their colleagues at the MIT Cryptoeconomics Lab are looking to understand the economic design choices encoded in software by the creators, relative to their stated goals (e.g., "solving for trust") and the economic choices of the people actually using it. Once creators have identified the problem to be solved and the goals of the system, they may discover that the goals are at odds—such as high security and no latency—and so they must make trade-offs based on what is most important to them, to their values (Table 7, next page). A blockchain enshrines in code the creator's vision of a system, and then the blockchain takes on a social life of its users' making, within the context of that original vision. Creators are discovering unintended consequences that, unlike a corporate or city charter and bylaws, become difficult to



Table 7: Consensus mechanisms: A comparison of design trade-offs

Name	Goals	Advantages	Disadvantages	Type	Examples
Proof of work (PoW)	Provide a computationally difficult barrier to publishing blocks. Enable transactions between untrusted participants.	Difficult to flood network with bad blocks (denial of service attack). Open to anyone with hardware to solve the puzzle.	Computationally intensive by design, high power consumption, hardware arms race. Potential for 51% attack by obtaining enough computational power.	Permissionless cryptocurrencies	Bitcoin, Ethereum, many others
Proof of stake (PoS)	Enable a less computationally intensive barrier to publishing blocks. Enable transactions between untrusted participants.	Less computationally intensive than PoW. Open to anyone who wishes to stake cryptocurrencies. Stakeholders control the system.	Stakeholders control the system. Nothing prevents formation of a centralized pool of stakeholders. Potential for 51% attack by obtaining enough financial power.	Permissionless cryptocurrencies	Ethereum Casper, Krypton
Delegated PoS	Enable a more efficient consensus model through "liquid democracy." Support crypto-signed messages for electing and revoking rights of delegates to validate and secure the blockchain.	All delegates are known. Elected delegates are economically incentivized to remain honest. More computationally efficient than PoW.	Less node diversity than PoW or pure PoS consensus implementations. Constrained set of operating nodes presents greater security risk for node compromise. Block producers may have incentive to collude and accept bribes	Permissionless cryptocurrencies; permissioned systems	BitShares, Cardano, EOS, Steem
Round robin	Provide a system for publishing blocks among approved/trusted publishing nodes	Low computational power. Straightforward to understand.	Requires large amount of trust among publishing nodes.	Permissioned systems	MultiChain
Proof of authority (PoA) Proof of identity (PoI)	Create a centralized consensus process. Minimize block creation and confirmation rate	Fast confirmation time. Dynamic block production rates. Good for sidechains to networks using other consensus models.	Assumes that the current validating node has not been compromised Vulnerable to central points of failure: a node's reputation is subject to high tail-risk as it could be compromised at any time.	Permissioned systems, hybrid (sidechain) systems	Ethereum Kovan testnet, POA Chain, various private systems using Parity
Proof of elapsed time (PoET)	Enable a more economic consensus model for blockchain networks.	Less computationally expensive than PoW. Lacks deeper security guarantees associated with PoW.	Required hardware clock used to derive time could be compromised. Given speed-of-light latency limits, true time synchronicity is impossible in distributed systems.	Permissioned networks	Hyperledger Sawtooth

Source: Dylan Yaga, Peter Mell, Nik Roby, and Karen Scarfone, "Blockchain Technology Overview," NISTIR 8202, 3 Oct. 2018, accessed 18 Jan. 2019. Adapted courtesy of the National Institute of Standards and Technology, US Department of Commerce. Not copyrightable in the United States.



address without robust governance. For example, Catalini and Tucker analyzed blockchain from an antitrust perspective and described how the technology could “be used to facilitate the creation of extremely efficient and competitive digital markets, as well as to facilitate collusion and make antitrust enforcement more difficult.”²²⁶ Consider the first antitrust lawsuit involving blockchain: the case of United American Corporation (UAC), a diversified technology company, against the largest bitcoin mining pool, Bitmain, and others, which allegedly colluded to amass mining power in favor of a fork against UAC’s proposed protocol upgrade and, in the process, manipulated market prices.²²⁷

Governance

Blockchain technology emerged in an explosion of open source software (OSS) projects, where market consensus has the potential to turn popular technical choices into de facto standards in the absence of governance.²²⁸ David Ward, chief technology officer of engineering and chief architect at Cisco Systems, pointed out that OSS cycle times are double the pace of the typical standards development organization’s processes, and that standard specification without code generation may be a “road to irrelevance.”²²⁹ Without agreement on decision rights and processes for change—such as software upgrades and modifications to code—we may find ourselves also dealing with capacity constraints, loss of users, environmentally unsustainable networks, the data equivalent of gated communities, understaffed or underfunded maintenance, and other unexpected twists of invention.

Open source software cycle times are double the pace of the typical standards development organization’s processes; standard specification without code generation may be a “road to irrelevance.”

 **DAVID WARD**
Chief Technology Officer
of Engineering and Chief
Architect
Cisco Systems

For example, the code Satoshi Nakamoto used to achieve the design goals of increased security and pseudonymity, distributed decision rights, and incentives to participate (mining rewards) has in fact attracted miners and secured the Bitcoin blockchain thus far from attack. That’s great. But, according to Catherine Barrera of the MIT Cryptoeconomics Lab, it has also consolidated control over mining in huge pools with specialized mining equipment, raised the energy costs of maintaining it, and made the platform more suitable for storing value rather than conducting payment transactions.²³⁰ Also, with no inherent governance mechanism, the Bitcoin network has been unable to agree upon a path for increasing block size and has instead forked into additional chains, as some users adopt a proposed change to the codebase and others don’t.²³¹

Another well-known example of governance in action was the aforementioned hack of the DAO, the distributed application launched on the Ethereum blockchain in May 2016.²³² In June that year, an attacker exploited a bug in the DAO’s code and siphoned off about \$50 million from the DAO’s holdings.²³³ Ethereum governance kicked in, giving stakeholders 28 days to debate, vote on, and execute a plan of counteraction. A hard fork was proposed that would, in effect, unwind the DAO and reverse funds into stakeholders’ accounts. Those in favor of the fork wanted to bar the hacker from capturing such a huge quantity of ether in circulation and gaining greater



We need to think about governance of blockchain protocol's applications, and ecosystems. Enterprise stakeholders need a mechanism for agreeing on which changes need to be made, when, how, and by whom.

For distributed ledger technologies to deliver the most value, we need to integrate current enterprise ICT systems with blockchain-based ones, create connections among those systems, and scale them up to handle more transactions of many types.

control over Ethereum itself. Those opposed to the fork viewed the code as the law: the terms of the DAO contract should stand, for the greater good of Ethereum's reputation as a censor-proof blockchain. By an 89 percent majority vote, stakeholders decided to reverse the funds through the hard fork, thereby undoing the DAO. But few were happy about fixing an application-level problem with a protocol-level solution.²³⁴

Finally, some cryptographic algorithms used to secure blockchains and wallets (or the clouds they run in) are not resistant to attackers with quantum computers.²³⁵ For example, public keys generated with Rivest-Shamir-Adleman (RSA) encryption technology, elliptic curve (EC-DSA) or finite field (DSA) cryptography will be vulnerable if used in a quantum environment; and those relying on advanced encryption standards (AES) or secure hash algorithms (SHA-2, SHA-3) may need larger key sizes and larger output.²³⁶ Switching to a quantum-proof hashing algorithm and migrating large numbers of users will be a huge governance challenge for the most used blockchains and might obsolete specialized mining equipment.²³⁷



Asphalt Balance Blur Close Up by Pixabay, no date, used under Pexels license, accessed 14 July 2019.

So we need to think about the three layers of blockchain governance—protocol, application, and ecosystem. Enterprise stakeholders need a mechanism for agreeing on which changes need to be made, when, how, and by whom. Do we need *on-chain* rules, coded directly into the infrastructure, *off-chain* rules implemented by a governance body like the Ethereum Foundation, or some combination of the two? We also need to keep in mind that the operations of a blockchain system are defined not solely by these on-chain and off-chain rules. According to Primavera De Filippi and Greg McMullen of the Coalition of Automated Legal Applications, they are also defined by the underlying layers of Internet infrastructure, which have some features of a decentralized system but are often



Design principles behind interoperable blockchain architecture

- » Survivability of transactions
- » Variety of services
- » Diversity of systems
- » Reachability of nodes end to end
- » Convertibility of one unit of value into another
- » Portability of applications
- » Survivability of the crypto fittest

centrally controlled or administered by an Internet service provider, government authority, or other intermediary.²³⁸ Getting those parties to the table may be worthwhile, too.

Integration, interoperability, and scale

For distributed ledger technologies (DLTs) to deliver the most value, data need to flow across enterprise blockchains as they do across the many networks that form the Internet. That means integrating current enterprise ICT systems with blockchain-based ones, creating connections among those blockchain systems, and scaling them up to handle more transactions of many types.

Let's start with perhaps the most pressing, the integration of such ICT systems as Web services, messaging protocols, software as a service, legacy MES or ERP, and even mainframe computing with DLTs.²³⁹ Deloitte has pointed to the possible use of blockchain APIs, written in such languages as JavaScript and Python to read and write data at different programming layers, that integrate with middleware to interact with legacy systems.²⁴⁰ Such interfaces will need rigorous testing before deployment. We need more research here.

For interoperability, Sandy Pentland's team at MIT Connection Science offered this working definition, with an emphasis on semantics:

An interoperable blockchain architecture is a composition of distinguishable blockchain systems, each representing a distributed data ledger, where transaction execution may span multiple blockchain systems, and where data recorded in one blockchain is reachable and verifiable by another possibly foreign transaction in a semantically compatible manner.²⁴¹

Vitalik Buterin described three types of rudimentary mechanisms for connecting blockchains.²⁴² First are *notary schemes* such as Ripple's protocols for interledger payments, where parties agree to act on one chain after an action on another chain occurs.²⁴³ Second are *sidechains* or relays within a chain that can validate events in other chains, as through a *two-way peg* that leverages a chain's established network and hardware infrastructure without diminishing its security features.²⁴⁴ Third is *hash locking*, where one event triggers an event simultaneously on two blockchains, which enable *atomic swaps*, set up to trade different native cryptocurrencies concurrently peer to peer rather than through cryptoexchanges.²⁴⁵ These are areas for more research and development. Several start-ups—Aion, Cosmos, and Polkadot, to name a few—are taking different approaches to addressing this implementation challenge.²⁴⁶ We're far from there yet. For a different perspective, Pentland's team adapted and applied the design philosophy of the Internet to that of the blockchain space, worth considering as we probe each proposed new solution:

- » Survivability in the sense of the system's ability to complete an application-level transaction.



Members of Ripple's University Blockchain Research Initiative

- » Australian National University
College of the Law
- » Berkeley Haas School of Business
- » Carnegie Mellon University
- » Cornell Information Science
- » Delft University of Technology
- » Duke Fuqua School of Business
- » Fundação Getulio Vargas
- » Georgetown University
- » Indian Institute of Technology, Bombay
- » International Institute of IT, Hyderabad
- » Korea University
- » Massachusetts Institute of Technology
- » McCombs School of Business
- » Morgan State University
- » National University of Singapore
- » Northeastern University
- » Princeton University
- » Stanford University
- » Tsinghua University
- » University College London
- » University of Kansas, Engineering
- » University of Luxembourg
- » University of Michigan
- » University of Nicosia, Cyprus
- » University of North Carolina, Chapel Hill
- » University of Oregon
- » University of Pennsylvania
- » University of São Paulo
- » University of Waterloo

Source: ubri.ripple.com, as of 19 May 2019.

- » Variety of services to facilitate speed, confirmation, directionality, and the strength of consensus.
- » Variety of systems with a semantically shared minimal assumption of transaction units but potentially different degrees of permissionability and anonymity.
- » Capabilities similar to those provided by ISPs peering agreements, which permit ISPs to push Internet traffic to competing ISPs, to ensure reachability of nodes end to end.²⁴⁷
- » Interconnectors that can convert value from one currency to another, “[separate] from the transaction mechanics of the underlying blockchain systems.”²⁴⁸
- » Portable smart contracts, where these distributed applications share some “minimal common syntax” so that, should the blockchain on which they were running come under attack, parties could copy them from nodes in one blockchain to nodes in another one, which could execute the contract identically or with semantic equivalence in both technical and legal terms.²⁴⁹
- » Crypto survivability, in what Pentland’s team describes as a Darwinian process where each hack yields lessons for the next design and only the fittest combination of proven and unproven technical components will survive over time.

Users may insist on mechanisms for preserving transaction histories and transferring assets and contracts to more robust chains—no system lock-in.

Research across industries

The good news is that we have ten years of largely commercial activity to study, some of it public and auditable, on real outcomes of different blockchain designs. That’s something CSOs can explore, because that’s at the heart of designing strategy so that the people charged with delivering it actually deliver it. Complementary basic and applied research centers have also opened their doors, these in 2018 alone, and these present opportunities for enterprise engagement:

- » IBM partnered with Columbia University to open a center for blockchain and data transparency, which will draw on the university’s strengths in data science, engineering, business, law, international and public affairs, and technology ventures.²⁵⁰⁷
- » China Internet Nationwide Financial Services partnered with Tsinghua University to found a blockchain research center focused on building out industry architecture and enterprise applications in Beijing.²⁵¹



- » Mount Sinai Hospital’s medical school opened its center for biomedical blockchain research in New York City.²⁵²
- » Stanford University launched its center for blockchain research, dedicated to education and research on technical challenges, sponsored by Ethereum Foundation and Protocol Labs among others.²⁵³
- » University College Oxford established its blockchain research center, sponsored initially by the start-up Blockhouse Technology and interested in green blockchains for mainstream use.²⁵⁴

“A process is well underway that will lead to the migration of most financial data to blockchain-based organizations. Students will benefit greatly by studying this area.”

 DR. DAVID YERMACK
Chair, Finance Department
New York University

The need for foundational education at all levels

There’s more good news here. New educational programs on blockchain have also sprouted up under demand. The digital currency exchange Coinbase analyzed *US News and World Report’s* rankings of the top universities and found that, as of August 2018, 42 percent were now offering courses on cryptocurrencies and blockchain technology, even in light of the steady decline in value of cryptocurrencies.²⁵⁵ David Yermack, chair of the finance department at New York University, explained: “A process is well underway that will lead to the migration of most financial data to blockchain-based organizations. Students will benefit greatly by studying this area.”²⁵⁶ He told Coinbase that enrollment in his own course on blockchain and financial services had grown by over 600 percent in four years.²⁵⁷

Platforms for massive open online courses (MOOCs) such as Coursera and edX are also expanding their offerings in blockchain and cryptocurrencies, with at least 26 courses underway in spring 2019, and some of them free. Coursera reported that Princeton University’s MOOC on Bitcoin and Cryptocurrency Technologies was among the platform’s most popular in 2018, along with Stanford University’s Machine Learning and McMaster University’s Learning How to Learn.²⁵⁸ More than ever, the enterprise will need people and things that can learn and inform the nature of change within an enterprise and its ecosystem.

The need for policy development and regulatory clarity

The third implementation challenge, especially for highly regulated and closely watched industries, is regulatory uncertainty around blockchain technology. Several financial regulators around the world have weighed in on the definition of an initial coin offering as a likely security issuance. Jacques Levet, head of transaction banking at BNP Paribas, pointed out that “global regulations” really means “local regulations applied globally.” He gave an example: “The US dollar is regulated by the US federal government. Wherever in the world you use the US dollar, you have to respect that regulation.”²⁵⁹ It encodes US social values. But there needs to be a clear regulation in place



Fortune 500 members of blockchain consortia

Company (Consortium)

- » Aetna (Hyperledger)
- » American Express (Hyperledger)
- » Bank of NY Mellon (EEA)
- » Cisco (Hyperledger, EEA)
- » Citi bank (Hyperledger)
- » Conduent (EEA)
- » Dell (Boomi) Tech. (EEA)
- » Eli Lilly (Hyperledger)
- » FedEx (Hyperledger)
- » Hewlett Packard (EEA)
- » Honeywell (Hyperledger)
- » IBM Corp. (Hyperledger)
- » Intel (EEA)
- » Intercontinental Exchange (EEA)
- » JPMorgan (Hyperledger, EEA)
- » Marsh & McLennan (EEA)
- » Microsoft (EEA)
- » Oracle (Hyperledger)
- » Pfizer (EEA)
- » State Farm (Hyperledger)

Sources: Fortune 500 list, Enterprise Ethereum Alliance, and Hyperledger, as of 30 April 2019.



Whiteboard Sketching Design Planning by Startup Stock Photos, no date, used under Pexels license, accessed 14 July 2019.

to respect. Regulators have a hard time providing clarity around something not in use widely enough by residents of a jurisdiction to understand how it differs and how people will abuse it, and so the tendency has been to apply existing rules or leave inventors in a fog.

To the challenge of creating a solution that will comply with freight and transport regulations around the world, Chrystie of FedEx said that truly global companies like FedEx do business daily in some 200 countries and are on top of regulatory requirements. They have a long history of working with customs and borders agencies, food and drug administrations, aviation agencies, and so forth. The Enterprise Ethereum Alliance includes such global veterans as the Foxconn Group, Hewlett Packard, HCL Technologies, Microsoft, and Shell Global Solutions. Hyperledger lists among its “premier members” Airbus, Baidu, Cisco, Daimler, Fujitsu, Intel, and SAP to name a few.²⁶⁰ BiTA has not only FedEx but also British Petroleum, Google, Salesforce, UPS, and other well-known brands. We might expect consortia with such membership to be able to identify areas of regulatory uncertainty around the deployment of blockchain and to engage with regulators through existing channels such as the World Customs Organization, an independent intergovernmental body.²⁶¹

Recommendations

Chrystie described what we’ve found to be a common experience among enterprise executives as they wrap their heads around blockchain technology. He was talking with an executive of a \$130 million company about the P2P nature of the technology and its potential for disintermediation. All of a sudden, the executive blurted out, “I’m a middleman! What do I do now?” In itself, that’s a hugely



For organizations, industries, and supply chains in the early stages of digital transformation, blockchain presents a digital leap in enterprise architecture, much as the mobile Internet did in the telecommunications infrastructure of developing economies.

valuable realization, a critical first step. In response, Chrystie said, “Learn everything. Your staff is still your staff.”²⁶² Engage their expertise. To keep on top of developments, start a C-suite book of the month club, where everyone reads and discusses the latest authoritative book or definitive report.

Laskowski of York University said there may be lower hanging fruit with greater benefits for those organizations, industries, and supply chains in the early stages of digital transformation—such as insurance, construction and project management, customs and global trade, and others where leaders are “quietly embarrassed by their fax machines”—with processes that are still paper-bound and human-dependent, with multiple stakeholders and differing points of view.²⁶³ For them, blockchain presents a digital leap in enterprise architecture, much as the mobile Internet did in the telecommunications infrastructure of developing economies. He said blockchain technology helps to solve the political problems of shared resources such as who owns data, who pays for it, who hosts it. He sees it as the next evolution of cloud computing, where everyone can run nodes. CSOs have several options to move the ball forward.

Take a hard look at enterprise data governance

Prerequisite to blockchain efforts is a tough audit of *data governance*—how the enterprise defines and formats data, who has which decision rights over which data, and whether there is an accountability framework in place to promote acceptable use of these data.²⁶⁴ Dr. Elizabeth M. Pierce, a program chair for the International Conference on Information Quality hosted by MIT in 2015, makes an important distinction between data governance and data management: “Governance is about determining who inputs and makes the decisions and how. Management is the process of making and implementing the decisions.”²⁶⁵



Six Women Standing and Sitting Inside the Room by Christina Morillo, no date, used under Pexels license, accessed 14 July 2019.

Blockchain will touch all functions of the enterprise, and a cross-unit team of employees who hold cryptocurrencies or have studied blockchain's potential impact on their career could help to monitor developments in the space.

Watch for what the late Andy Grove called "strategic inflection points," those order-of-magnitude changes in the blockchain space.

If enterprise leaders discover a hodgepodge of data definitions and formats, then Laskowski of York University recommended that they sit down, discuss, and agree on the meanings, formats, and value of information to the enterprise, which will greatly inform participation in data standards bodies.²⁶⁶ Which data are proprietary and ought never be shared on a blockchain? Which might be shared among ecosystem, supply chain partners, or regulators on a permissioned blockchain? Which off-chain data will be critical to the operation of smart contracts?

Share what the enterprise already knows

Talk with employees, find out how they view the technology. Look what Overstock executives learned when they finally shared their ideas with their software developers. Cast a wide net. Pindar Wong "views blockchain as essentially an accounting innovation" and believes that "accountants will play a crucial role in its implementation," particularly in system design. He told *Accounting and Business* that accounting professionals "might make the best blockchain programmers, given their deep understanding of how to manage, and contain, business risk."²⁶⁷ Blockchain will touch all functions of the enterprise, and a cross-unit team of employees who hold cryptocurrencies or have studied blockchain's potential impact on their career could help to monitor developments in the space.

Consider a thoughtful global survey to indicate patterns, surface anomalies, and highlight common areas of interest and expertise could make for a live C-suite discussion of results. Survey those at the edges of the firm who work directly with customers and suppliers, to learn more about what the enterprise ecosystem is doing with blockchain. Remember, this is an ecosystem play. Generating strategic liquidity is extremely difficult going it alone. Collaborating with supply chain partners is also necessary in developing industry standards and practices, especially around smart contract templates. Finally, make sure the leaders of POCs have a mechanism for capturing and sharing what they learn in the prototyping and testing phases with others doing the same.

Develop enterprise blockchain fluency now

The online developer community site, Stack Overflow, reported a 500-percent increase in blockchain-related job postings over the last year.²⁶⁸ According to LinkedIn, the job with the most growth in 2018 was that of "blockchain developer," with hiring notices up 33 times over last year (Table 8, next page).²⁶⁹ That's one of those order-of-magnitude changes that the late Andy Grove warned us about, in terms of what he called "strategic inflection points."²⁷⁰ So there is a dearth of skilled blockchain developers and engineers, even though cryptocurrency market capitalization declined throughout the year.²⁷¹ To combat this talent shortage, Consensus Systems—one of the premier blockchain development studios—has created several MOOCs and is sponsoring blockchain hackathons and boot camps. What a great way to screen for qualified coders!



CSOs who recommend putting their people through training now will at least be cultivating some in-house blockchain knowledge.

Those CSOs who recommend a wait-and-see approach to blockchain may find their companies fighting for a very small, exclusive, and expensive pool of talent or choosing from the also-rans. An enterprise's best engineers may already be preparing to leap to more exciting and lucrative job opportunities. For example, *The Washington Post's* top engineer, Jarrod Dicker, left to take on the role of CEO at Po.et, a blockchain-based publishing attribution platform.²⁷² (He has since returned to the *Post* to take on the new role of vice president of commercial technology and development.²⁷³) CSOs who recommend putting their people through training now—say, blockchain coding, software development, and smart contracting languages such as Solidity—will at least be cultivating some in-house blockchain knowledge.

Kick the tires *with* customers

CSOs must understand the underlying problem a protocol or application solves for, the economic goals, design choices, and the trade-offs made of blockchain protocols and applications as well as the on-chain and off-chain governance of the software. Fujitsu and BNP Paribas found that collaborating with customers to define problems, design solutions, and test implementations was as equally valuable as, if not more so than, working with industry competitors, potentially more likely to reward the desired behavior.

Table 8: Top job growth in emerging technologies

The market for talent is one signal of enterprise interest in blockchain, but there are complementary technologies to leverage. CSOs who seek to learn more quickly from their blockchain systems, manage more by algorithms, and automate more of their operations through the Internet of Things will need talent with the skills on this list.

Job title	Growth	Knowledge/skills	Hiring
Blockchain developer	33x	Cryptocurrency, blockchain, Ethereum, Node.js, Solidity	Chainyard, ConsenSys, IBM
Machine learning engineer	12x	Deep learning, natural language processing, Apache Spark, TensorFlow	Apple, Intel, NVIDIA
Machine learning specialist/researcher	4-6x	Algorithms, artificial intelligence, deep learning, Python, TensorFlow	Amazon, Apple, Google, Microsoft
Assurance	5x	Auditing, accounting, financial reporting, internal controls	EY, Moss Adams, Plante Moran
Data science specialist/manager	4-5x	Machine learning, Apache Spark, Python, R	Capital One, Facebook, IBM, McKinsey & Co., Microsoft

Source of data: Economic Graph Team, "LinkedIn 2018 Emerging Jobs Report," introduction by Guy Berger, LinkedIn Economic Graph, LinkedIn Corp., Microsoft, 13 Dec. 2018, accessed 18 Jan. 2019.



Consider doing design sprints and putting your own solutions into production for internal use (“eating your own dogfood”) to get firsthand experience with the implementation challenges.

BNP Paribas prefers to use the verb, *co-creating* the future with customers and suppliers, rather than *aligning* interests, because interests can be in alignment but implementations can be widely apart. It also found that giving POC ownership to employees closest to customer pain points was the best way to generate the energy and commitment needed to drive projects forward. Alain Verschueren, head of DLT for trade and treasury solutions at BNP Paribas, underscored the bank’s primary criterion for assessing the outcomes of POCs: “Success depends on the value proposition for our clients—which will drive their interest and approval—and for the bank. We see that clients are very eager to get involved.”²⁷⁴

Try design sprints and dogfood

Design sprints are a hyper-efficient means of prototyping products and services that are ready for user testing.²⁷⁵ BNP Paribas does one- or two-day idea jams involving more people to generate ideas, followed quickly by one-week design sprints with fewer people and user experience designers so that the ideas and the enthusiasm don’t grow stale. The sprints usually result in mockups that the enterprise can test with customers.²⁷⁶ Nathalie Doré, chief digital and acceleration officer at BNP Paribas Cardiff, prefers the lean start-up approach: “Sometimes there is no immediate ROI. What I try to do is start small. Think big but start small. So we’re not asking for millions to fund a project. We start with one use case in one country, and we demonstrate the benefits. Then we replicate and go bigger.”²⁷⁷ It is a very swift and deliberate process. “We test one assumption after another,” she said. “But we are not talking about huge projects that are costly and long. It’s really something that I took back from [Silicon Valley]—the ability to fail fast. It gives us room to work with deep tech by starting small with the ambition to go bigger if it’s working.”²⁷⁸

Hands-on use also helps to transform enterprise culture, which otherwise “eats strategy for breakfast.”

BNP Paribas developed a portfolio of projects in two categories: those yielding new business models and those would enhance current performance and security, especially of internal information systems. That’s a great representative sample for understanding the nature of blockchain implementation challenges. Laskowski suggests that leaders of such enterprise blockchain projects adopt Silicon Valley’s practice of “dogfooding,” that is, putting their own solutions into production for internal use (“eating their own dogfood”) and building interfaces among those projects, as HSBC and BNP Paribas did with their FX pilots.²⁷⁹ The benefits are several: the enterprise gets firsthand experience on the challenges of scaling these solutions, integrating them with other enterprise systems, and interoperating with distributed ledger technologies beyond enterprise boundaries. As Doré noted, hands-on use also helps to transform enterprise culture, which otherwise “eats strategy for breakfast.”²⁸⁰

Think outside the blockchain

Table 8 (previous page) also emphasizes the other emerging technologies that will be integral to the Fourth Industrial Revolution and the Internet of Things, such as machine learning, artificial



Look for your blue ocean in such complements as gaming, mobile devices, data analytics, artificial intelligence, augmented and virtual reality, and the Internet of Things.

intelligence, and data science. Bettina Warburg and Tom Serres of the innovation agency Animal Ventures have speculated that machines may be the next largest class of consumers, and we don't have the infrastructure needed for robots to participate in the economy.²⁸¹ There's more white space there, fewer legacy systems to displace, more services for autonomous things to imagine. Our climate crisis makes clean energy and renewables a priority, and BNP Paribas has made it one. What does it mean for a product or service to be blockchain-ready and environmentally neutral? What complements will blockchain ecosystems needs? How will we run our business if consumers take control over their data, and we can no longer harvest online? There's work to be done on protocols and standards in those areas, to prepare them for a blockchain future.



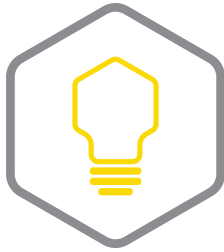
Two Women Sitting in Chairs Using Laptop Computers by Visual Tag Mx, no date, used under Pexels license, accessed 14 July 2019.

Be open to other solutions

Blockchain may not be the best solution for the problems in front of you, but its qualities may inspire one.

Management consultant Matt Higginson and his colleagues reminded us, "A key to finding the value is to apply the technology only when it is the simplest solution available. ... Occam's razor is the problem-solving principle that the simplest solution tends to be the best."²⁸² For example, Amazon's new offering, Amazon Quantum Ledger Database, is not blockchain technology per se. It's aimed at customers who want some of what blockchain technology offers—the immutability and verifiability of changes to data—but they want these features within their existing applications, without all the switching costs or the scaling constraints of blockchain.²⁸³ It's for apps that don't "involve multiple, untrusted parties." All that to say, blockchain may not be the best solution for the problems in front of you, but its qualities may inspire one.





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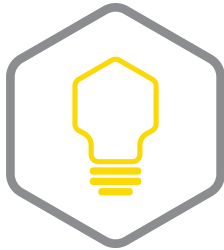
Disclosures

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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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About the Brightline Initiative

Brightline is a Project Management Institute initiative together with leading global organizations dedicated to helping executives bridge the expensive and unproductive gap between strategy design and delivery. Brightline delivers insights and solutions that empower leaders to successfully transform their organization's vision into reality through strategic initiative management. Learn more at www.brightline.org.

Notes

1. Joseph Stiglitz, "The Financial Crisis Is the Fruit of Dishonesty on the Part of Financial Institutions," *The Guardian*, Guardian News and Media, 15 Sept. 2008. www.theguardian.com/commentisfree/2008/sep/16/economics.wallstreet, accessed 18 Dec. 2019. By 6 May 2019, this article had been retitled, "The Fruit of Hypocrisy."
2. Financial Crisis Inquiry Commission, chaired by Phil Angelides, *The Financial Crisis Inquiry Report: Final Report of the National Commission on the Causes of the Financial and Economic Crisis in the United States*, official government ed. pursuant to Public Law 111-21, Jan. 2011, updated 25 Feb. 2011, pp. xvii, xxv. www.gpo.gov/fdsys/pkg/GPO-FCIC/pdf/GPO-FCIC.pdf, accessed 12 Jan. 2019. The other two credit rating agencies held culpable were Standard & Poor's and the Fitch Group.
3. Ben S. Bernanke, "The Real Effects of the Financial Crisis," *Brookings Papers on Economic Activity Conference Drafts*, Brookings Institution, 13-14 Sept. 2018. www.brookings.edu/wp-content/uploads/2018/09/BPEA_Fall2018_The-real-effects-of-the-financial-crisis.pdf, accessed 19 Jan. 2019. Also titled, "The Real Effects of Disrupted Credit: Evidence from the Global Financial Crisis."
4. Bernanke, "The Real Effects of the Financial Crisis," p. 21, citing the work of Ran Duchin, Oguzhan Ozbas, and Berk A. Sensoy, "Costly External Finance, Corporate Investment, and the Subprime Mortgage Credit Crisis," *Journal of Financial Economics: The 2007-8 Financial Crisis: Lessons from Corporate Finance* 97, no. 3 (2010): 418-35. doi.org/10.1016/j.jfineco.2009.12.008.
5. Bernanke, "The Real Effects of the Financial Crisis," pp. 20, 22, citing the work of Brian S. Chen, Samuel G. Hanson, and Jeremy C. Stein, "The Decline of Big-Bank Lending to Small Business: Dynamic Impacts on Local Credit and Labor Markets," Working Paper 23843, National Bureau of Economic Research, 2017. doi.org/10.3386/w23843.
6. Bernanke, "The Real Effects of the Financial Crisis," p. 20, citing the work of Xavier Giroud and Holger M. Mueller, "Firm Leverage, Consumer Demand, and Employment Losses During the Great Recession," *The Quarterly Journal of Economics* 132, no. 1 (2017): 271-316. doi.org/10.1093/qje/qjw035.
7. Bernanke, "The Real Effects of the Financial Crisis," p. 24.
8. Bernanke, "The Real Effects of the Financial Crisis," p. 21, citing the work of Simon Gilchrist, Raphael Schoenle, Jae Sim, and Egon Zakrajšek, "Inflation Dynamics during the Financial Crisis," *American Economic Review* 107, no. 3 (2017): 785-823. doi.org/10.1257/aer.20150248.
9. Bernanke, "The Real Effects of the Financial Crisis," p. 20, citing the work of Giroud and Mueller, "Firm Leverage, Consumer Demand, and Employment Losses."



10. Bernanke, "The Real Effects of the Financial Crisis," p. 21, citing the work of Murillo Campello, John R. Graham, and Campbell R. Harvey, "The Real Effects of Financial Constraints: Evidence from a Financial Crisis," *Journal of Financial Economics, The 2007-8 Financial Crisis: Lessons from Corporate Finance* 97, no. 3 (2010): 470–87. doi.org/10.1016/j.jfineco.2010.02.009.
11. Bernanke, "The Real Effects of the Financial Crisis," p. 24, citing the work of Gabriel Chodorow-Reich, "Employment Effects of Credit Market Disruptions: Firm-Level Evidence from the 2008-9 Financial Crisis," *Quarterly Journal of Economics* 129, no. 1 (2014): 1–59.
12. Bernanke, "The Real Effects of the Financial Crisis," p. 24, citing the work of Tobias Adrian, Paolo Colla, and Hyun Song Shin, "Which Financial Frictions? Parsing the Evidence from the Financial Crisis of 2007-9," *National Bureau of Economic Research Macroeconomics Annual* 27 (Aug. 2012): 159–214.
13. Ben S. Bernanke, "The Real Effects of the Financial Crisis," p. 21.
14. Satoshi Nakamoto, "Bitcoin Open Source Implementation of P2P Currency," Discussion, P2P Foundation, Ning Platform, 11 Feb. 2009. p2pfoundation.ning.com/forum/topics/bitcoin-open-source, accessed 11 Jan. 2019.
15. Kevin Kelly (@kevin2kelly), Twitter post, 25 Nov. 2014 (4:40 PM). twitter.com/kevin2kelly/status/537360078412595200, accessed 19 March 2019.
16. Kevin Kelly (@kevin2kelly), Twitter post, 31 Jan. 2015 (5:00 PM). twitter.com/kevin2kelly/status/561645237056311296; and Andy Greenberg, "Prosecutors Trace \$13.4M in Bitcoins from the Silk Road to Ulbricht's Laptop," *Wired*, Condé Nast, 3 June 2017. www.wired.com/2015/01/prosecutors-trace-13-4-million-bitcoins-silk-road-ulbrichts-laptop, both accessed 19 March 2019.
17. Dale Chrystie, interviewed via telephone by Kirsten Sandberg, 12 March 2019.
18. Nicolas Kachaner and Sam Stewart, "Understanding the Role of the Chief Strategy Officer," *www.bcg.com*, Boston Consulting Group, 19 Dec. 2013. www.bcg.com/publications/2013/strategic-planning-understanding-role-chief-strategy-officer.aspx, accessed 17 June 2018.
19. "About Brightline," *Brightline Initiative*, Project Management Institute, 28 Feb. 2017. www.brightline.org/about, accessed 1 Oct. 2018. "Guiding Principles," *Brightline Initiative*, Project Management Institute, 26 Sept. 2017. s3.us-east-2.amazonaws.com/brightline-website/downloads/workshop/brightline_workshop_guiding_principles_brochure.pdf, accessed 12 May 2019.
20. Satoshi Nakamoto, "Bitcoin: A Peer-to-Peer Electronic Cash System," White Paper, *www.bitcoin.org*, 1 Nov. 2008, p. 1. www.bitcoin.org/bitcoin.pdf, accessed 7 June 2017.
21. Christian Catalini and Joshua S. Gans, "Some Simple Economics of the Blockchain," Working Paper No. 22952, National Bureau of Economic Research, June 2018. www.nber.org/papers/w22952, accessed 19 Jan. 2019.
22. Satoshi Nakamoto, "Bitcoin: A Peer-to-Peer Electronic Cash System," White Paper, *www.bitcoin.org*, 1 Nov. 2008, p. 8. www.bitcoin.org/bitcoin.pdf, accessed 5 Jan. 2019.
23. Satoshi Nakamoto, "Bitcoin: A Peer-to-Peer Electronic Cash System," p. 2.
24. Robert Hackett, "Denver and West Virginia Deserve Praise for Voting on Blockchain," *Fortune*, *Fortune Media*, 23 March 2019. fortune.com/2019/03/23/blockchain-vote-election-denver-west-virginia-voatz, accessed 31 March 2019.
25. Gary W. Matkin et al., "The Present and Future of Alternative Digital Credentials (ADCs)," *Report of the ICDE Working Group*, International Council for Open and Distance Education, Jan. 2019, pp. 36, 52. icde.memberclicks.net/assets/ICDE-ADC%20report-January%202019%20%28002%29.pdf, accessed 31 March 2019.
26. Anthony D. Williams, "Diamonds on the Blockchain: Building a Global Digital ledger for Valuable Assets," foreword by Don Tapscott, Blockchain Research Institute, 22 Dec. 2017.
27. Satoshi Nakamoto, "Bitcoin: A Peer-to-Peer Electronic Cash System," p. 1.
28. Satoshi Nakamoto, "Bitcoin: A Peer-to-Peer Electronic Cash System," p. 3.
29. Satoshi Nakamoto, "Bitcoin: A Peer-to-Peer Electronic Cash System," p. 1.
30. Satoshi Nakamoto, "Bitcoin: A Peer-to-Peer Electronic Cash System," p. 4.
31. Dale Chrystie, interviewed via telephone by Kirsten Sandberg, 12 March 2019.
32. Alex Keown, "Tainted Blood Pressure Drugs Causes FDA to Issue Recall Alert," *BioSpace*, BioSpace, 1 Nov. 2018. www.biospace.com/article/tainted-blood-pressure-drugs-causes-fda-to-issue-recall-alert, accessed 31 March 2019.



33. Peta Tomlinson, "Blockchain Technology Is Set to Be the Driving Force behind the Belt and Road Initiative," *ACCA Global*, Association of Chartered Certified Accountants, 1 Nov. 2018. www.accaglobal.com/my/en/member/member/accounting-business/2018/11/insights/blockchain-technology.html, accessed 19 Jan. 2019. This article first appeared in the Chinese edition of *Accounting and Business*, Nov. 2018.
34. Prema Shrikrishna and Vineet Narula, "Belt and Road Blockchain Consortium: Building Digital Trust for Cross-Border Trade," foreword by Don Tapscott, Blockchain Research Institute, 24 May 2018.
35. Office of the Leading Group for the Belt and Road Initiative, "[Country] Profiles," *Belt and Road Portal*, State Information Center, as of 29 June 2019. eng.yidaiyilu.gov.cn/info/iList.jsp?cat_id=10076, accessed 29 June 2019.
36. Pindar Wong, "Blockchain: The Way Forward," *Hong Kong Means Business*, Hong Kong Trade Development Council, 14 June 2018. hkmb.hktdc.com/en/1x0ae8fx/first-person/blockchain-the-way-forward, accessed 8 Oct. 2018.
37. Pindar Wong, "Blockchain's Killer App? Making Trade Wars Obsolete," *CoinDesk*, Digital Currency Group, 22 May 2018. www.coindesk.com/blockchains-killer-app-making-trade-wars-obsolete, accessed 15 May 2019.
38. Prema Shrikrishna and Vineet Narula, "Belt and Road Blockchain Consortium: Building Digital Trust for Cross-Border Trade," foreword by Don Tapscott, Blockchain Research Institute, 24 May 2018.
39. Prema Shrikrishna and Vineet Narula, "Belt and Road Blockchain Consortium."
40. Harry Goodnight, "Managing Supply Chains on the Blockchain: A Primer," *Medium*, A Medium Company, 10 July 2017. medium.com/sweetbridge/managing-supply-chains-on-the-blockchain-a-primer-1f7dc293e3d9, accessed 19 Jan. 2019.
41. Peta Tomlinson, "Blockchain Technology Is Set to Be the Driving Force behind the Belt and Road Initiative," *ACCA Global*, Association of Chartered Certified Accountants, 1 Nov. 2018. www.accaglobal.com/my/en/member/member/accounting-business/2018/11/insights/blockchain-technology.html, accessed 19 Jan. 2019. This article first appeared in the Chinese edition of *Accounting and Business*, Nov. 2018.
42. Tom Serres and Bettina Warburg, "Introducing Asset Chains: The Cognitive, Friction-free, and Blockchain-enabled Future of Supply Chains," foreword by Don Tapscott, Blockchain Research Institute, 28 Nov. 2017.
43. Pamela Lin, "Making Impact Investment Measurable," *China Daily*, Hong Kong Edition, China Daily Information Co., State Council Information Office, 16 Jan. 2019. www.chinadailyhk.com/articles/96/124/74/1547621012863.html, accessed 19 Jan. 2019.
44. Andreas Park, "Managing Blockchain Transparency: Strategies for a Private/Open World," foreword by Don Tapscott, 10 Nov. 2018. He explained,

Enron had founded numerous "special purpose entities" (SPE), ... (legally) founded for limited time horizons to allow the management of a particular risk. Usually, these SPEs are funded by separate equity investors. Enron had used its own equity, thereby fully exposing Enron shareholders to the risk that the SPE allegedly hedged. This activity would be visible if the SPE transactions were recorded on a blockchain.
45. Shouqing Zhu and Sha Song, "Three Ways China Can Make the New Silk Road Sustainable," *Annual Meeting of the New Champions*, World Economic Forum, 15 Sept. 2018. www.weforum.org/agenda/2018/09/three-ways-china-can-make-the-belt-and-road-initiative-sustainable, accessed 8 Oct. 2018.
46. Pamela Lin, "Making Impact Investment Measurable," *China Daily*, Hong Kong Edition, China Daily Information Co., State Council Information Office, 16 Jan. 2019. www.chinadailyhk.com/articles/96/124/74/1547621012863.html, accessed 19 Jan. 2019.
47. Marek Laskowski, interviewed via telephone by Kirsten Sandberg, 26 Feb. 2019.
48. Henry Kim and Marek Laskowski, "A Perspective on Blockchain Smart Contracts: Reducing Uncertainty and Complexity in Value Exchange," Elsevier, RELX Group, 10 May 2017. SSRN, ssrn.com/abstract=2975770, accessed 27 Feb. 2019.
49. Nick Szabo, "Winning Strategies for Smart Contracts," foreword by Don Tapscott, Blockchain Research Institute, 4 Dec. 2017. See "The deal cycle: Innovations of the Internet era" and Table 1.
50. Nick Szabo, "Winning Strategies for Smart Contracts." See "The deal cycle: Innovations of the Internet era" and Table 1.
51. Nick Szabo, "Winning Strategies for Smart Contracts."
52. Kurt Wagner, "Facebook Is Reversing Its Ban on Some Cryptocurrency Ads," *Recode*, Vox Media, 26 June 2018. www.recode.net/2018/6/26/17505876/facebook-cryptocurrency-ads-bitcoin-ico-ban-reversed, accessed 9 Oct. 2018.



53. Tim Cummins, "Why Contracts Fail," *IACCM Blog*, International Association for Contract & Commercial Management, 19 July 2017. blog.iaccm.com/commitment-matters-tim-cummins-blog/why-contracts-fail, accessed 1 Dec. 2018.
54. Nick Szabo, "Winning Strategies for Smart Contracts." See "Strategies and best practices for the organization."
55. Prema Shrikrishna and Vineet Narula, "Belt and Road Blockchain Consortium: Building Digital Trust for Cross-Border Trade," foreword by Don Tapscott, Blockchain Research Institute, 24 May 2018.
56. Prema Shrikrishna and Vineet Narula, "Belt and Road Blockchain Consortium."
57. Michael J. Casey, "The Token Economy: When Money Becomes Programmable," foreword by Don Tapscott, Blockchain Research Institute, 28 Sept. 2017, rev. 28 March 2018.
58. Tom Baumann, "Blockchain for Planetary Stewardship: Landscape of Initiatives in Climate and Sustainability," foreword by Don Tapscott, Blockchain Research Institute, 30 Jan. 2018.
59. Michael J. Casey, "The Token Economy," rev. 28 March 2018.
60. Garrick Hileman and Michel Rauchs, "2017 Global Blockchain Benchmarking Study," University of Cambridge Judge Business School, Elsevier, RELX Group, 22 Sept. 2017. SSRN, papers.ssrn.com/sol3/papers.cfm?abstract_id=3040224, accessed 1 Dec. 2018.
61. Mike Gualtieri, "Hadoop Is Data's Darling for a Reason," *Forrester.com*, Forrester Research, 21 Jan. 2016, electronically published 10 July 2017. go.forrester.com/blogs/hadoop-is-datas-darling-for-a-reason, accessed 1 Dec. 2018.
62. Ajit Tripathi, "RIP ICOs: 2019 Will Be the Year of Enterprise Blockchain Tokens," *CoinDesk*, Digital Currency Group, 7 Jan. 2019. www.coindesk.com/r-i-p-icos-2019-will-be-the-year-of-enterprise-blockchain-tokens, accessed 23 Jan. 2019.
63. "Enterprise Ethereum Alliance Launches Blockchain-Neutral Token Taxonomy Initiative to Accelerate a Token-Powered Blockchain Future," Press Release, Enterprise Ethereum Alliance, Ethereum Foundation, 17 April 2019. entethalliance.org/enterprise-ethereum-alliance-launches-blockchain-neutral-token-taxonomy-initiative-to-accelerate-a-token-powered-blockchain-future, accessed 29 June 2019.
64. For more information, see "Help Accelerate the Token Taxonomy," Token Taxonomy Initiative, n.d. tokentaxonomy.org. For more on the Facebook-led blockchain initiative, see "Libra," White Paper, *Libra.org*, Libra Association, 18 June 2019. libra.org/en-US/white-paper, both accessed 29 June 2019.
65. Jeff Donaldson, Donald Flagg, and Ashley Northrup, "Pair Trading with Options," LV14042, *aabri.com*, Academic and Business Research Institute, 17 Sept. 2014, p. 3. www.aabri.com/LV2014Manuscripts/LV14042.pdf, accessed 1 Dec. 2018.
66. Chris Burniske and Jack Tatar, *Cryptoassets: The Innovative Investor's Guide to Bitcoin and Beyond* (New York: McGraw-Hill Education, 19 Oct. 2017): 188-189.
67. Will Knight, "China's Central Bank Has Begun Cautiously Testing a Digital Currency," *MIT Technology Review*, Massachusetts Institute of Technology, 23 June 2017. www.technologyreview.com/s/608088/chinas-central-bank-has-begun-cautiously-testing-a-digital-currency, accessed 8 Oct. 2018.
68. Will Knight, "China's Central Bank Has Begun Cautiously Testing a Digital Currency."
69. Genson C. Glier, "An Overview of Government Backed Cryptocurrencies and How They Will Change the Blockchain Landscape," *BlockToken*, Medium, 13 Aug. 2018. medium.com/blocktoken/an-overview-of-government-backed-cryptocurrencies-and-how-they-will-change-the-blockchain-landscape-c3ccffbf66af, accessed 8 Oct. 2018. As of 12 May 2019, that page was no longer available on Medium. See Lucas Mearian, "JP Morgan to Launch a US Dollar-Backed Cryptocurrency," *Computerworld*, IDG Communications, 14 Feb. 2019. www.computerworld.com/article/3340373/jp-morgan-to-launch-a-us-dollar-backed-cryptocurrency.html; and Robert Kirkby, "Cryptocurrencies and Digital Fiat Currencies," *Australian Economic Review* 51, no. 4 (Dec. 2018): 527-539. SSRN, ssrn.com/abstract=3293188, both accessed 12 May 2019.
70. Andrew Gillick, "How Digital Currencies Will Shape the Future of Geopolitics," *Brave New Coin*, A Techemy Company, 15 Nov. 2018. bravenewcoin.com/insights/how-digital-currencies-will-shape-the-future-of-geopolitics, accessed 13 Dec. 2018.
71. James Kyngé, "A Tale of Two Harbors Tells Best and Worst of China's 'Belt and Road,'" *Financial Times*, Nikkei, 25 Sept. 2018. www.ft.com/content/7699d13a-806a-11e8-af48-190d103e32a4, accessed 19 Jan. 2019.
72. John Hurley, Scott Morris, and Gailyn Portelance, "Examining the Debt Implications of the Belt and Road Initiative from a Policy Perspective," CGD Policy Paper 121, Center for Global Development, William and Flora Hewlett Foundation and the Lakeshore Foundation, March 2018. www.cgdev.org/sites/default/files/examining-debt-implications-belt-and-road-initiative-policy-perspective.pdf, accessed 18 Jan. 2019.



73. OECD Secretariat, "Blockchain Technology and Competition Policy," DAF/COMP/WD(2018)47, Organisation for Economic Cooperation and Development, 26 April 2018. [one.oecd.org/document/DAF/COMP/WD\(2018\)47/en/pdf](https://one.oecd.org/document/DAF/COMP/WD(2018)47/en/pdf); and Directorate for Financial and Enterprise Affairs Competition Committee, "Blockchain and Competition Policy Roundtable," *OECD.org*, Organisation for Economic Cooperation and Development, 8 June 2018. www.oecd.org/daf/competition/blockchain-and-competition-policy.htm, both accessed 29 June 2019.
74. Federal Trade Commission, "Dealing with Competitors," *Guide to Antitrust Laws*, FTC.gov, n.d. www.ftc.gov/tips-advice/competition-guidance/guide-antitrust-laws/dealings-competitors, accessed 18 March 2019.
75. Federal Trade Commission, "Other Agreements among Competitors," *Guide to Antitrust Laws*, FTC.gov, n.d. www.ftc.gov/tips-advice/competition-guidance/guide-antitrust-laws/dealings-competitors/other-agreements-among, accessed 18 March 2019.
76. "Hon Hai Precision Industry," known as Foxconn Technology Group, *Fortune Global 500*, Fortune Media, July 2018. fortune.com/global500/hon-hai-precision-industry, accessed 28 Jan. 2019.
77. Vidhi Choudhary, "Reebok India: Fake Sales and Secret Depots," *LiveMint*, HT Media, 20 Nov. 2012. www.livemint.com/Companies/vkpTgJ1M39TbRHvG1nZGsk/Reebok-India-fake-sales-and-secret-depots.html; "Mahindra and IBM to Develop Blockchain Solution for Supply Chain Finance," Press Release, IBM Corporation, 16 Nov. 2016. www-03.ibm.com/press/us/en/pressrelease/51147.wss, both accessed 19 Jan. 2019. The Mahindra Group is also aiming to address the problems of invoice discounting.
78. Bernard Lunn, "Interview with Soul Htite of Dianrong to Understand the Intersection of Supply Chain Finance and Blockchain," *DailyFintech.com*, Daily FinTech Advising, 3 April 2017. dailyfintech.com/2017/04/03/interview-with-soul-htite-of-dianrong-to-understand-the-intersection-of-supply-chain-finance-and-blockchain, accessed 6 Feb. 2018.
79. Michael del Castillo, "Blockchain Goes to Work at Walmart, Amazon, JPMorgan, Cargill and 46 Other Enterprises," *Forbes*, Forbes Media LLC, 16 April 2019. www.forbes.com/sites/michaeldelcastillo/2019/04/16/blockchain-goes-to-work/#322612cf2a40, accessed 29 June 2019.
80. "Fast and Safe Financing," *Chained Finance*, FnConn Financial, n.d. www.chainedfinance.com/index, accessed 19 Jan. 2019.
81. Tom Serres and Bettina Warburg, "Introducing Asset Chains: The Cognitive, Friction-free, and Blockchain-enabled Future of Supply Chains," foreword by Don Tapscott, Blockchain Research Institute, 28 Nov. 2017.
82. "Allow Account Payables to Be Traded Safely and Efficiently," *Chained Finance*, FnConn Financial, n.d. www.chainedfinance.com/index, accessed 19 Jan. 2019.
83. Bernard Lunn, "Interview with Soul Htite of Dianrong to Understand the Intersection of Supply Chain Finance and Blockchain," *DailyFintech.com*, Daily FinTech Advising, 3 April 2017. dailyfintech.com/2017/04/03/interview-with-soul-htite-of-dianrong-to-understand-the-intersection-of-supply-chain-finance-and-blockchain, accessed 6 Feb. 2018.
84. Michael Zargham, Aleksandr Bulkin, Hui Huang, and J. Scott Nelson, "Sweetbridge Liquidity Protocol: Mathematical Specifications," Publication Version 1.0, *Sweetbridge.com*, Sweetbridge LLC, Desert Heritage Financial Partners, 31 Jan. 2018, p. 5. sweetbridge.com/assets/docs/Sweetbridge-WP-LiquidityProtocolMath-v1-01.pdf, accessed 18 Dec. 2018.
85. J. Scott Nelson et al., "A Blockchain-Based Protocol Stack for Global Commerce and Supply Chains," White Paper, *Sweetbridge.com*, Sweetbridge LLC, Desert Heritage Financial Partners, 1 May 2018, p. 23. sweetbridge.com/assets/docs/Sweetbridge-Whitepaper-20180529.pdf, accessed 18 Dec. 2018.
86. "Vehicle Ownership in US Cities Data and Map," *Governing: The States and Localities*, Governing Institute, n.d. www.governing.com/gov-data/car-ownership-numbers-of-vehicles-by-city-map.html, accessed 6 Feb. 2019. Estimates are based on 2016 American Community Survey results published by US Census Bureau.
87. "Auto Title Loans: Market Practices and Borrowers' Experiences," project director Nick Bourke, *www.pewtrusts.org*, The Pew Charitable Trusts, March 2015. www.pewtrusts.org/~media/assets/2015/03/autotitleloansreport.pdf; Office of Mark Brnovich, "Two More Participants Join Arizona's FinTech Sandbox First Arizona-Based Company Enters Program," Press Release, Arizona Attorney General, State of Arizona, 2019. www.azag.gov/press-release/two-more-participants-join-arizonas-fintech-sandbox-first-arizona-based-company, both accessed 6 Feb. 2019.
88. Sweetbridge, "Sweetbridge Wins World's First 'Aviation Blockchain Challenge' Hosted by SAP and Lufthansa," *Sweetbridge Blog*, A Medium Company, 6 Nov. 2018. blog.sweetbridge.com/sweetbridge-wins-worlds-first-aviation-blockchain-challenge-hosted-by-sap-and-lufthansa-72d96a76b8de, accessed 19 Jan. 2019.



89. Christina Walke, "Lufthansa and SAP Announce Winners of 'Aviation Blockchain Challenge,'" Press Release, Lufthansa Group, 31 Oct. 2018. [preview.theweekend.com/Previews/LUFT/DocumentAssets/524542.pdf](https://www.theweekend.com/Previews/LUFT/DocumentAssets/524542.pdf), accessed 19 Jan. 2019.
90. Jim Gee and Mark Button, "The Financial Cost of Fraud 2017: The Latest Data from Around the World," Centre for Counter Fraud Studies, Institute of Criminal Justice Studies, University of Portsmouth; and Crowe Clark Whitehill LLP, Crowe Horwath International, 13 Feb. 2017. www.accountant.nl/globalassets/accountant.nl/diversen/crowe-the-financial-cost-of-fraud-2017.pdf; "Shortlisted Start-Ups Announced for Wincanton's W2 Labs Programme," Press Release, Wincanton Plc, 10 Jan. 2019. www.wincanton.co.uk/news/press-releases/shortlisted-start-ups-announced-for-wincanton-s-w2-labs-programme, both accessed 18 Jan. 2019.
91. "Tokenize Everything with Mattereum: Interview with CEO Vinay Gupta," *YouTube*, Crypto Rich, 3 April 2019. www.youtube.com/watch?v=dc-fBZhf9xA, accessed 5 April 2019.
92. "Mattereum Protocol: Turning Code into Law," Summary White Paper, *Mattereum*, MTRM Industries, 30 Oct. 2018, p.5. mattereum.com/upload/iblock/784/mattereum-summary-white_paper.pdf, accessed 29 Feb. 2019.
93. "Mattereum Protocol: Turning Code into Law," Summary White Paper, *Mattereum*, MTRM Industries, 30 Oct. 2018, p.3.
94. "Mattereum Protocol: Turning Code into Law," Summary White Paper, *Mattereum*, MTRM Industries, 30 Oct. 2018, p.6.
95. Brightline Initiative, "Guiding Principles: Principle 5," *Bridging the Gap between Strategy Design and Delivery*, Brightline Initiative, Project Management Institute, 12 June 2018. www.brightline.org/principles, accessed 12 May 2019.
96. Marek Laskowski, interviewed via telephone by Kirsten Sandberg, 26 Feb. 2019.
97. Bill Gates, *Business @ the Speed of Thought Using a Digital Nervous System* (New York: Warner Books, 1999): Ch. 4, "Ride the Inflection Rocket."
98. Bill Gates, *Business @ the Speed of Thought Using a Digital Nervous System* (New York: Warner Books, 1999): Ch. 4, "Ride the Inflection Rocket."
99. "A Brief History of NSF and the Internet," Fact Sheet, *NSF.gov*, National Science Foundation, 13 Aug. 2003. www.nsf.gov/news/news_summ.jsp?cntn_id=103050, accessed 9 March 2019. Berners-Lee collaborated with his colleagues at CERN, and Andreessen worked with fellow students at the University of Illinois to release the browser through the National Center for Supercomputing Applications.
100. Shane Greenstein, "Commercialization of the Internet: The Interaction of Public Policy and Private Choices or Why Introducing the Market Worked So Well," *Innovation Policy and the Economy*, Vol. 1, eds. Adam B. Jaffe, Josh Lerner, and Scott Stern (Cambridge, MA: MIT Press: Jan. 2001): 151–186. National Bureau of Economic Research, www.nber.org/chapters/c10779; "NCSA Mosaic of Marc Andreessen and Eric Bina," *History of Computers: Hardware, Software, Internet*, Georgi Dalakov, last updated 6 March 2019. history-computer.com/Internet/Conquering/Mosaic.html; and W. Joseph Campbell, "The 'Netscape Moment,' 20 Years On," *Poynter.org*, Poynter Institute, 3 Aug. 2015. www.poynter.org/reporting-editing/2015/the-netscape-moment-20-years-on, all accessed 9 March 2019.
101. Marek Laskowski, interviewed via telephone by Kirsten Sandberg, 26 Feb. 2019.
102. 3M's president and longtime chair, William McKnight, believed in cultivating employee initiative. 3M has its now-legendary "15% culture," wherein employees (in consultation with their managers) can devote 15% of their time to "pursue innovative ideas that excite them," from "3M's 15% Culture," *About 3M*, 3M Company, n.d. www.3m.com/3M/en_US/careers-us/culture/15-percent-culture, accessed 30 March 2019. As of 12 May 2019, that page was no longer available on 3M's site. We found a reference to the program here: "15% Program," *2018 Sustainability Report*, 3M Company, 2018. www.3m.com/3M/en_US/sustainability-report/all-stories/full-story/~15-percent-time-innovation/?storyid=c871812b-1aec-45c3-9b1f-79104cf82f78, accessed 12 May 2019.
103. Marek Laskowski, interviewed via telephone by Kirsten Sandberg, 26 Feb. 2019.
104. Henry M. Kim, Marek Laskowski, and Ning Nan, "A First Step in the Co-Evolution of Blockchain and Ontologies: Toward Engineering an Ontology of Governance at the Blockchain Protocol Level," Elsevier, RELX Group, 6 Jan. 2018. SSRN, ssrn.com/abstract=3097443, accessed 27 Feb. 2019.
105. "Digitization of Freight and Transport," BiTA deck, March 2019, p. 1. static1.squarespace.com/static/5aa97ac8372b96325bb9ad66/t/5c8282517817f71a490f8759/1552056920257/BiTA+Deck+%28March+2019%29.pdf, accessed 20 March 2019.
106. Barry M. Leiner, Vinton G. Cerf, David D. Clark, Robert E. Kahn, Leonard Kleinrock, Daniel C. Lynch, Jon Postel, Larry G. Roberts, and Stephen Wolff, "Brief History of the Internet," Internet Society, 1997. www.internetsociety.org/internet/history-internet/brief-history-internet, accessed 17 March 2019.



107. John R. Pierce, *What Futurists Believe*, eds. Joseph F. Coates and Jennifer Jarratt (Mount Airy and Bethesda, MD: Lomond Publications and World Future Society, 1989): Ch. 4, "Strengths, Weaknesses, and Gaps in Current Futures Thinking," p. 54.
108. Dale Chrystie, interviewed via telephone by Kirsten Sandberg, 12 March 2019.
109. Brian Behlendorf and Dale Chrystie, "The Future of Enterprise Blockchain," panel, mod. Don Tapscott, *Blockchain Research Institute All-Member Summit*, Thomson Reuters, New York, 13 June 2018.
110. "Digitization of Freight and Transport," BiTA deck, March 2019, p. 2. static1.squarespace.com/static/5aa97ac8372b96325bb9ad66/t/5c8282517817f71a490f8759/1552056920257/BiTA+Deck+%28March+2019%29.pdf, accessed 29 June 2019.
111. For more, see the standards text here: Ben Kothari, "BiTAS Tracking Data Framework Profile," Blockchain in Transport Alliance Standards Council, last revised 27 Feb. 2019. static1.squarespace.com/static/5aa97ac8372b96325bb9ad66/t/5c7e88397817f73e6c60a967/1551796284047/BiTAS+Tracking+Data+Framework+Profile+v9_IStO.pdf; Pratik Soni, "BiTAS Std. 120-2019: Location Component Specification," Blockchain in Transport Alliance Standards Council, last revised 27 Feb. 2019. static1.squarespace.com/static/5aa97ac8372b96325bb9ad66/t/5c7e8882f9619a98a55ec24d/1551796355748/BiTAS+Location+Component+Specification+v4.pdf, both accessed 13 March 2019.
112. "Antitrust and Competition Guidance," edited by Wendy Seltzer, *W3C*, World Wide Web Consortium, 1 March 2017. www.w3.org/Consortium/Legal/2017/antitrust-guidance; "World Wide Web Consortium Process Document," edited by Natasha Rooney and Florian Rivoal, *W3C*, World Wide Web Consortium, 1 March 2019. www.w3.org/2019/Process-20190301; "Antitrust Policy," amended by Board of Directors, The Linux Foundation, 27 Oct. 2017. www.linuxfoundation.org/antitrust-policy; and Karen Ottoni, "Anti-Trust Policy Notice," *Hyperledger.org*, The Linux Foundation, 25 June 2019. wiki.hyperledger.org/display/SISIG/Anti-trust+Policy+Notice, all accessed 29 June 2019.
113. Ikujiro Nonaka and Hirotaka Takeuchi, "The Knowledge-Creating Company," *Harvard Business Review* 69, no. 9 (1991): 96-104, published electronically 1 Aug. 2014. Harvard Business School Publishing, hbr.org/2007/07/the-knowledge-creating-company, accessed 6 Jan. 2019. Dr. Vijay Gurbaxani, director of the Center for Digital Transformation, Paul Merage School of Business, University of California at Irvine, has studied a number of companies including Amazon that have codified their enterprise know-how in software.
114. Vijay Gurbaxani, "Amazon Is Showing Us the Way," *VijayGurbaxani.com*, 12 May 2018. vijaygurbaxani.com/2018/05/12/amazon-is-showing-us-the-way, accessed 6 Jan. 2019.
115. Frederic Lardinois, "Don't Expect AWS to Launch a Blockchain Service Anytime Soon," *TechCrunch*, Oath Tech Network, 29 Nov. 2017. techcrunch.com/2017/11/29/dont-expect-aws-to-launch-a-blockchain-service-anytime-soon, accessed 4 Jan. 2019.
116. Asha McLean, "AWS Goes Blockchain: The Cloud Giant Announces Two Distributed Ledger Services," *ZDNet*, CBS Interactive, 28 Nov. 2018. www.zdnet.com/article/aws-and-blockchain-the-cloud-giant-announces-two-ledger-services, accessed 6 Jan. 2019. Jassy presentation slide, "Common Customer Use Cases."
117. McLean, "AWS Goes Blockchain," Jassy presentation slide, "Common Customer Use Cases."
118. Jonathan Johnson, "'Into the War Room': Overstock Looks Back on Bitcoin Embrace," *CoinDesk*, Digital Currency Group, 13 April 2017, last updated 16 May 2017. www.coindesk.com/into-the-war-room-overstock-looks-back-on-bitcoin-embrace, accessed 23 Jan. 2018. In 2013, Amazon introduced the Amazon Coin for Kindle Fire owners to use in the Amazon Appstore, but it is not a cryptocurrency per se; it operates like a digital gift card. Also, as of 12 May 2019, Amazon.com did not accept cryptocurrency directly; through eGifter, a corporation could use bitcoin, bitcoin cash, ether, and litecoin to buy eGifter Rewards Choice Cards for a corporate reward or incentive program, and the recipients of these cards could redeem them for Amazon gift cards. See Jordan Crook, "Amazon Launches 'Amazon Coins' In Its First Move Into Virtual Currency, Targets Apps And Games On Kindle Fire," *TechCrunch*, Verizon Media, 5 Feb. 2013. techcrunch.com/2013/02/05/amazon-to-launch-virtual-currency-amazon-coins-in-its-appstore-in-may; Sean Ross, "When Will Amazon Accept Bitcoin?" *Investopedia*, Dotdash, 12 March 2019. www.investopedia.com/articles/company-insights/090216/when-will-amazon-accept-bitcoin-amzn.asp; and eGifter terms of service for buying Amazon cards, specifically the pop-up that states, "Amazon.com Gift Cards are available ONLY when eGifter Points are used as payment in full [and] you are redeeming an eGifter Rewards Choice Card as part of a corporate reward/incentive program." www.egifter.com/giftcards, all accessed 12 May 2019.
119. Jonathan Johnson, "'Into the War Room': Overstock Looks Back on Bitcoin Embrace," *CoinDesk*, Digital Currency Group, 13 April 2017, last updated 16 May 2017. www.coindesk.com/into-the-war-room-overstock-looks-back-on-bitcoin-embrace, accessed 24 Jan. 2019.



120. Jonathan Johnson, "Into the War Room': Overstock Looks Back on Bitcoin Embrace."
121. Brittain Ladd, "Overstock.Com: What's Next?" *Forbes*, Forbes Media LLC, 28 Nov. 2018. www.forbes.com/sites/brittainladd/2018/11/23/the-ceo-of-overstock-com-doesnt-care-what-you-think-about-him-or-bitcoin/#1cef5a5a7c92, accessed 23 Jan. 2019.
122. "What is the IEM?" Iowa Electronic Markets, 2018. iemweb.biz.uiowa.edu/media/summary.html; Gary Stix, "When Markets Beat the Polls," *Scientific American* 298, no. 3 (March 2008): 38–45. www.scientificamerican.com/article/markets-predict-outcome-better-than-polls, both accessed 10 Feb. 2019. In the first market, IEM participants accurately forecasted the outcome of the 1988 US presidential election—George H.W. Bush over Michael Dukakis—better than such major polls as CBS/*New York Times*, Gallup, Harris, and three others.
123. Will Kenton, "Prediction Market," *Investopedia.com*, Dotdash, last updated 23 April 2018. www.investopedia.com/terms/p/prediction-market.asp, accessed 10 Feb. 2019.
124. Lukas Schor, "Explained: Predication Markets," Argon Group, A Medium Company, 20 June 2018. medium.com/@schor/decentralized-prediction-markets-explained-d9f0425d331c, accessed 15 May 2019. In event derivatives, "the value of the derivative will almost perfectly reflect the probability of an outcome materializing."
125. Mrinalini Bhutoria, "Prediction Markets," Report, Circle Research, Circle Internet Financial, updated 13 Nov. 2018. research.circle.com/crypto-reports/prediction-markets, accessed 20 Dec. 2018.
126. Mrinalini Bhutoria, "Prediction Markets."
127. "Will a SpaceX Starship test vehicle have a successful test flight before March 2nd?" *Predictions.global*, Veil Inc., as of 5 March 2019. predictions.global/augur-markets/0x8499fca0a811ede100c36a438dca755bc89c1fc3, accessed 5 March 2019.
128. "Will Elon Musk get to Mars before 2023?" *Predictions.global*, Veil Inc., as of 11 Feb. 2019. predictions.global/augur-markets/will-elon-musk-get-to-mars-before-2023-0xa8d4e415205ad8396f1f7100299e2b74030ecc78, accessed 11 Feb. 2019.
129. "Will Apple and Google reduce their App Store fees below 30% by end of March 2019?" *Predictions.global*, Veil Inc., as of 8 April 2019. predictions.global/augur-markets/0xf226fa2ff9096323ee7c55fcf386617e03e4ef65, accessed 8 April 2019.
130. "EOS Market Cap Tracker Year-End 2019," *Predictions.global*, Veil Inc., as of 11 Feb. 2019. predictions.global/augur-markets/eos-market-cap-tracker-year-end-2019-0x203f2ca6a47241ff7f1f22e25cebba1428be570a, accessed 11 Feb. 2019.
131. "US Congress, Power in the House," *Predictions.global*, Veil Inc., as of 11 Feb. 2019. predictions.global/augur-markets/-u-s-congress-power-in-the-house-scalar-0x3742d0e02d10483f9804f2baa33ecbd3d6e7eaa8, accessed 11 Feb. 2019.
132. Paul Schoemaker and Philip Tetlock, "How to Take the Conflict Out of Conflicting Advice," Decision-Making Blog, *Inc. Magazine*, Manseuto Ventures, 29 Nov. 2018. www.inc.com/paul-schoemaker/taking-the-conflict-out-of-conflicting-advice.html, accessed 15 April 2019. See also George S. Day and Paul J.H. Schoemaker, *See Sooner, Act Faster: How Vigilant Leaders Navigate Digital Turbulence* (Cambridge: MIT Press, 2019).
133. Paul Schoemaker and Philip Tetlock, "How to Take the Conflict Out of Conflicting Advice."
134. Puong Fei Yeh, "Using Prediction Markets to Enhance US Intelligence Capabilities: A 'Standard & Poors 500 Index' for Intelligence," *CIA.gov*, Central Intelligence Agency, 26 June 2008. www.cia.gov/library/center-for-the-study-of-intelligence/csi-publications/csi-studies/studies/vol50no4/using-prediction-markets-to-enhance-us-intelligence-capabilities.html, accessed 12 May 2019.
135. Mrinalini Bhutoria, "Prediction Markets," Report, Circle Research, Circle Internet Financial, updated 13 Nov. 2018. research.circle.com/crypto-reports/prediction-markets, accessed 20 Dec. 2018.
136. Ryan Youngjoon Yi, "Trolling with REP: How the Augur Dispute Resolution Mechanism Is Facing Its Biggest Test Yet," *CoinFund Blog*, A Medium Company, 16 Jan. 2019. blog.coinfund.io/trolling-with-rep-c5b6e1e0461, accessed 18 Jan. 2019.
137. Binance Research, "A Look at Irregularities Discovered on Augur: Design Flaws Plague Augur's Prediction Markets," Market Research, *Binance.com*, 1 April 2019. info.binance.com/en/research/marketresearch/augur-design-flaws.html; and "Which Party Will Control the House after 2018 U.S. Midterm Election?" *Reporters.Chat*, 30 Jan. 2019. reporters.chat/markets/0xbbbc0a8baa03535e0a680ee2f057162aaaaafd570, both accessed 29 June 2019.
138. Zvi Mowshowitz, "Prediction Markets: When Do They Work?" *Don't Worry About the Vase*, WordPress.com, Automattic Inc., 30 July 2018. thezvi.wordpress.com/2018/07/26/prediction-markets-when-do-they-work, accessed 6 Feb. 2019.
139. Zvi Mowshowitz, "Prediction Markets: When Do They Work?"



140. Zvi Mowshowitz, "Prediction Markets: When Do They Work?" Emphasis added.
141. "Testing Organizational Boundaries to Improve Strategy Execution," Research Report, *Harvard Business Review* Analytic Services, Brightline Initiative, 8 April 2019. s3.us-east-2.amazonaws.com/brightline-website/downloads/reports/HBR_Research-Report_Brightline.pdf, accessed 10 April 2019.
142. See Henry Mintzberg, "Crafting Strategy," *Harvard Business Review* 65, no. 4 (July-Aug. 1987): 66–75; and Roger L. Martin, "The Big Lie of Strategic Planning," *Harvard Business Review* 92, no. 1/2 (Jan. 2014): 78–84.
143. Michael Birshan, Emma Gibbs, and Kurt Strovink, "Rethinking the Role of the Strategist," *McKinsey Quarterly*, McKinsey & Company, Nov. 2014. www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/rethinking-the-role-of-the-strategist, accessed 1 Oct. 2018.
144. Alan Todd, "Leadership Is a Movement, Not a Mandate," Corp/U, 2018. www.corpu.com/blog/leadership-movement-not-mandate, accessed 8 Oct. 2018.
145. Mark van Rijmenam, interviewed via telephone by Robert Morison, 14 May 2018.
146. Jerry Cuomo, interviewed via telephone by Robert Morison, 3 April 2018.
147. "Blockchain: An Insider's Guide," TechRepublic/CBS Interactive, 2018, pp. 3-8. www.techrepublic.com/resource-library/whitepapers/blockchain-an-insider-s-guide, accessed 8 Oct. 2018.
148. Kenny MacIver and Maxine-Laurie Marshall, "Fujitsu Shines the Spotlight on Services as the Key to Co-Creating with Customers," *I-Global Intelligence for the CIO*, Fujitsu by Seven, Nov. 2018. www.i-cio.com/innovation/human-centric-innovation/item/fujitsu-shines-the-spotlight-on-services-as-the-key-to-co-creating-with-customers, accessed 25 March 2019.
149. Kenny MacIver and Maxine-Laurie Marshall, "Fujitsu Shines the Spotlight on Services as the Key to Co-Creating with Customers."
150. "Brightline's Guiding Principle 10," *YouTube*, TED and the Brightline Initiative, 5 July 2018. www.youtube.com/watch?v=ceocXNfDez4, accessed 15 April 2019.
151. "Closing the Gap: Designing and Delivering a Strategy that Works," Brightline Initiative and Economist Intelligence Unit, 2017.
152. Irving Wladawsky-Berger, "Building a Framework for Blockchain Adoption: What CEOs Should Know," foreword by Don Tapscott, Blockchain Research Institute, 26 Oct. 2017.
153. Irving Wladawsky-Berger, "Building a Framework for Blockchain Adoption: What CEOs Should Know."
154. Irving Wladawsky-Berger, "Building a Framework for Blockchain Adoption: What CEOs Should Know."
155. Reshma Kamath, "Food Traceability on Blockchain: Walmart's Pork and Mango Pilots with IBM," *Journal of the British Blockchain Association* 1, no. 1, British Blockchain Association and Blockchain Research Institute, 12 June 2018. jbba.scholasticahq.com/article/3712-food-traceability-on-blockchain-walmart-s-pork-and-mango-pilots-with-ibm, accessed 18 Dec. 2018.
156. "IBM Food Trust: Adding Trust and Transparency to Our Food," *IBM Blockchain Solutions*, International Business Machines Corporation, n.d. www.ibm.com/blockchain/solutions/food-trust, accessed 5 Feb. 2019.
157. "Fresh Leafy Greens: New Walmart Food Traceability Initiative: Questions and Answers," Walmart Food Safety and Health, Walmart and Sam's Club, 10 Sept. 2018. corporate.walmart.com/media-library/document/leafy-greens-food-safety-traceability-requirements-faq/_proxyDocument?id=00000166-0c8e-dc77-a7ff-4dff95cb0001, accessed 24 March 2019. Walmart's Q&A referred to the definition under its "leafy greens marketing agreement," which covers conventional and organic arugula, baby leaf lettuce, butter lettuce, cabbage, chard, endive, escarole, green leaf lettuce, iceberg lettuce, kale, red leaf lettuce, romaine lettuce, spinach, and spring mix.
158. Lucas Mearian, "IBM Launches Blockchain-Based, Global Food Tracking Network," *Computerworld*, IDG Communications, 8 Oct. 2018. www.computerworld.com/article/3311464/blockchain/ibm-launches-blockchain-based-global-food-tracking-network.html, accessed 18 Dec. 2018.
159. "Fast Forward: Rethinking Enterprises, Ecosystems, and Economies with Blockchains," IBM Institute for Business Value, June 2016. public.dhe.ibm.com/common/ssi/ecm/gb/en/gbe03757usen/GBE03757USEN.PDF, accessed 25 Sept. 2017.
160. "Fast Forward," IBM Institute for Business Value, June 2016.
161. Abhishek Punia, "The Future of Retail Payments: How Merchants Are Adapting to the Age of Crypto," foreword by Don Tapscott, Blockchain Research Institute, 30 Jan. 2018.



162. Eva Szalay, "HSBC Banks on Blockchain to Finesse Forex Trades," *Financial Times*, Nikkei, 14 Jan. 2019. www.ft.com/content/60d5a48c-17fa-11e9-9e64-d150b3105d21, accessed 19 Jan. 2019.
163. "Ending Poverty," United Nations, 2019. www.un.org/en/sections/issues-depth/poverty/; "Know Your World: Facts about World Hunger & Poverty," *The Hunger Project*, The Global Hunger Project, last updated Nov. 2017. www.thp.org/knowledge-center/know-your-world-facts-about-hunger-poverty/; and "Tokenize Everything with Mattereum: Interview with CEO Vinay Gupta," *YouTube*, Crypto Rich, 3 April 2019. www.youtube.com/watch?v=dc-fBZhf9xA, all accessed 5 April 2019.
164. Keith Bear, Nick Drury, Peter Korsten, Veena Pureswaran, James Wallis, and Likhit Wagle, "Blockchain Rewires Financial Markets: Trailblazers Take the Lead," *Hyperledger.org*, IBM Institute for Business Value, IBM Corporation, Sept. 2016. www.hyperledger.org/wp-content/uploads/2016/10/Blockchain-rewires-financial-markets.pdf, accessed 23 Jan. 2019.
165. Augustas Staras, "One of Three Evolutionary Ideas for the Insurance Industry," *Aigang*, A Medium Company, 12 Oct. 2017. medium.com/aigang-network/one-of-three-revolutionary-ideas-for-the-insurance-industry-47165fa01584, accessed 1 Oct. 2018.
166. Anthony D. Williams, "Diamonds on the Blockchain: Building a Global Digital Ledger for Valuable Assets," foreword by Don Tapscott, Blockchain Research Institute, 22 Dec. 2017. See this case study for details.
167. Stefan Hopf, "Blockchain, the Emerging Platform for Manufacturing 4.0: Major Use Cases and Implementation Challenges," foreword by Don Tapscott, Blockchain Research Institute, 29 Jan. 2018. See this excellent white paper for more examples.
168. Stefan Hopf, "Blockchain, the Emerging Platform for Manufacturing 4.0."
169. Vineet Narula and Prema Shrikrishna, "Additive Manufacturing and Blockchain: Moog Creating Efficient Global Supply Chains," foreword by Don Tapscott, Blockchain Research Institute, 28 Sept. 2017. See this case study for details.
170. Tom Serres and Bettina Warburg, "Introducing Asset Chains: The Cognitive, Friction-free, and Blockchain-enabled Future of Supply Chains," foreword by Don Tapscott, Blockchain Research Institute, 28 Nov. 2017.
171. Claire Henly, Sam Hartnett, Sam Mardell, et al., "Energizing the Future with Blockchain," *Energy Law Journal* 39 (14 Nov. 2018): 197-232. Energy Bar Association, www.eba-net.org/assets/1/6/14-197-232-Blockchain_FINAL.pdf, accessed 18 Jan. 2019.
172. Ray Adler, "LO3 Energy: Distributed Grid Solutions Bringing People, Tech and Energy Together," *CleanTech Alliance*, 7 July 2017. www.cleantechalliance.org/2017/07/07/lo3-energy-distributed-grid-solutions-bringing-people-tech-and-energy-together, quoted in Lawrence Orsini, "Distributed Power: How Blockchain Will Transform Global Energy Markets," foreword by Don Tapscott, Blockchain Research Institute, 11 Oct. 2018.
173. "Microgrids, Update 2017: Global Market Size, Competitive Landscape, and Key Country Analysis to 2021," *GlobalData*, *GlobalData UK Ltd.*, June 2017. www.globaldata.com/store/report/gdpe1024emr--microgrids-update-2017-global-market-size-competitive-landscape-and-key-country-analysis-to-2021, quoted in Lawrence Orsini, "Distributed Power: How Blockchain Will Transform Global Energy Markets," foreword by Don Tapscott, Blockchain Research Institute, 11 Oct. 2018.
174. "For Investors, Could 5G Stream Higher Share Prices?" Morgan Stanley Research, Morgan Stanley, 25 Feb. 2019. www.morganstanley.com/ideas/5g-telecoms-share-price-drivers, accessed 29 June 2019.
175. Charlie Morris and Dieter Fishbein, "Using Blockchain to Power the 5G Bypass: The Disruptive Potential of Mesh Networks," foreword by Don Tapscott, Blockchain Research Institute, 21 May 2019.
176. Stefan Hopf, "Blockchain, the Emerging Platform for Manufacturing 4.0: Major Use Cases and Implementation Challenges," foreword by Don Tapscott, Blockchain Research Institute, 29 Jan. 2018.
177. "Fujitsu Develops Technology to Improve Reliability of Data Distribution across Industries," Press Release, *Fujitsu Global*, Fujitsu Laboratories Ltd., 20 Sept. 2018. www.fujitsu.com/global/about/resources/news/press-releases/2018/0920-02.html, accessed 25 March 2019.
178. "Blockchain Innovation Center, Brussels," Media Backgrounder, Fujitsu Technology Solutions, March 2018. www.fujitsu.com/be/microsite/blockchain/resource-center, accessed 25 March 2019.
179. Fujitsu Laboratories, "Service Ideation for Digital Co-Creation Using Blockchain-Based Decentralized Digital Resource Exchange Technology," Topcoder, 12 Sept. 2018. www.topcoder.com/challenges/30069914, accessed 25 March 2019.



180. "Fujitsu and Sony Global Education Initiate Blockchain Field Trials for Course Records and Transcript Management," Press Release, *Fujitsu Global*, Sony Global Education Inc. and Fujitsu Research Institute, 27 Feb. 2019. www.fujitsu.com/global/about/resources/news/press-releases/2019/0227-01.html; and "Mobile Industry Leaders to Develop O-RAN Fronthaul-Compliant Products and Drive Multi-Vendor Radio Access Networks," Press Release, *Fujitsu Global*, Fujitsu Ltd., 22 Feb. 2019. www.fujitsu.com/global/about/resources/news/press-releases/2019/0222-01.html, both accessed 25 March 2019.
181. Sarah Hansen, "Overstock Blockchain Subsidiary tZERO Raises \$134 Million in ICO," *Forbes*, Forbes Media LLC, 9 Aug. 2018. www.forbes.com/sites/sarahhansen/2018/08/09/overstock-blockchain-subsidiary-tzero-raises-134-million-in-ico/#49ded4d462cf, accessed 7 Feb. 2019.
182. Michael del Castillo, "Overstock Defends tZERO ICO: SEC Subpoenaed 'Everyone Else,'" *CoinDesk*, Digital Currency Group, 1 March 2018. www.coindesk.com/overstock-exec-calls-tzero-sec-inquiry-welcome-voluntary, accessed 7 Feb. 2019.
183. Fennie Wang, Primavera De Filippi, Alexis Collomb, and Klara Sok, "Financing Open Blockchain Ecosystems: Toward Compliance and Innovation in Initial Coin Offerings," foreword by Don Tapscott, Blockchain Research Institute and Coalition of Automated Legal Applications, 16 March 2018.
184. Michael del Castillo, "Chinese Private Equity Firm To Invest \$270 Million In Overstock Blockchain Subsidiary," *Forbes*, Forbes Media LLC, 12 Aug. 2018. www.forbes.com/sites/michaeldelcastillo/2018/08/09/chinese-private-equity-firm-to-invest-270-million-in-overstock-blockchain-subsidiary/#21f8524c7361, accessed 7 Feb. 2019.
185. Jimmy Aki, "Report: Contractors Threaten to Sue KodakOne over Outstanding Fees," *CCN, Hawfish AS*, 26 Nov. 2018. www.ccn.com/report-contractors-threaten-to-sue-kodakone-over-outstanding-fees; see also a fuller account of next steps by David Z. Morris, "Exclusive: KodakCoin, One of the Biggest Punchlines of the ICO Mania, May Have the Last Laugh," *BREAKERMAG*, SingularDTV LLC, 8 Jan. 2019. breakermag.com/exclusive-kodakcoin-one-of-the-biggest-punchlines-of-the-ico-mania-may-have-the-last-laugh, both accessed 5 March 2019.
186. Mike Crapo and Sherrod Brown, "Facebook's Extensive Data Collection Practices and Whether Any of the Data Collected by Facebook Is Being Used for Purposes That Do or Should Subject Facebook to the Fair Credit Reporting Act," to Mark Zuckerberg, Facebook, One Hacker Way, Menlo Park, CA 94025, 9 May 2019. www.banking.senate.gov/imo/media/doc/5.9.19%20Facebook%20Letter.pdf; "Banking Committee Schedules Hearing on Facebook Digital Currency, Data Privacy for 16 July 2019," Press Release, *Sherrod Brown, US Senator for Ohio*, US Senate, 19 June 2019. www.brown.senate.gov/newsroom/press/release/banking-committee-schedules-hearing-on-facebook-digital-currency-data-privacy-, both accessed 29 June 2019.
187. Sources of data for Table 6: Bankorus, n.d. www.bankorus.com; Bitsy, "How it work," n.d. bitsy.com/how-it-works; Bitt, n.d. www.bitt.com; Chainstone Labs, "About," n.d. chainstone.com/about; Factom, "About us," n.d. www.factom.com/company/about-us; Finclusive, "About," n.d. www.finclusivecapital.com/about; GrainChain, n.d. www.grainchain.io; IdentityMind, "About," n.d. identitymindglobal.com/about; Medici Land Governance, "Mission," n.d. www.mediciland.com/index.html#mission; "Minds: The Crypto Social Network," by Bill Ottman, Mark Harding, John Ottman, and Jack Ottman, white paper V4.0, n.d. cdn-assets.minds.com/front/dist/assets/documents/Whitepaper-v0.4.pdf; Mint, n.d. settlemint.com/about; Netki, n.d. netki.com/tos; PeerNova, n.d. peernova.com/about-peernova; Ripio, n.d. www.ripio.com/en; Spera, n.d. spera.io/faqs; Symbiont, n.d. symbiont.io/solutions; Vinsent, "The Oldest Business Needs Innovation," by Jacob Ner David, Vinsent blog, 9 Jan. 2019. www.vinsent.wine/post/blog; Voatz, n.d. voatz.com/faq.html; Votem, n.d. votem.com/our-story; and tZERO, n.d. www.tzero.com, all accessed 24 Jan. 2019. *Overstock.com*, "Overstock.com and Medici Ventures Celebrate the Launch of tZERO Crypto Wallet Mobile App," Press Release, *GlobeNewswire Inc.*, 27 June 2019. www.globenewswire.com/news-release/2019/06/17/1869648/0/en/Medici-Land-Governance-Makes-Teton-County-Wyoming-the-First-County-in-the-USA-with-Blockchain-Registered-Land.html; *Overstock.com*, "Medici Land Governance Makes Teton County, Wyoming the First County in the USA with Blockchain-Registered Land," Press Release, *GlobeNewswire Inc.*, 17 June 2019. www.globenewswire.com/news-release/2019/06/17/1869648/0/en/Medici-Land-Governance-Makes-Teton-County-Wyoming-the-First-County-in-the-USA-with-Blockchain-Registered-Land.html; and *Overstock.com*. "Overstock.com Blockchain Portfolio Company Voatz to Support Smartphone Voting for Upcoming Municipal Elections in Denver, Colorado," Press Release, *GlobeNewswire Inc.*, 3 March 2019. www.globenewswire.com/news-release/2019/06/17/1869648/0/en/Medici-Land-Governance-Makes-Teton-County-Wyoming-the-First-County-in-the-USA-with-Blockchain-Registered-Land.html, all accessed 29 June 2019.
188. Chris Burniske and Jack Tatar, *Cryptoassets: The Innovative Investor's Guide to Bitcoin and Beyond* (New York: McGraw-Hill Education, 19 Oct. 2017): 388-389.



189. "Closing the Gap: Designing and Delivering a Strategy that Works," Brightline Initiative and Economist Intelligence Unit, 3 Oct. 2017. www.brightline.org/resources/eiu-report, accessed 15 April 2019.
190. Vitalik Buterin, "Bootstrapping a Decentralized Autonomous Corporation: Part I," *Bitcoin Magazine*, 19 Sept. 2013. bitcoinmagazine.com/articles/bootstrapping-a-decentralized-autonomous-corporation-part-i-1379644274; and Christoph Jentzsch, "Decentralized Autonomous Organization to Automate Governance," final draft, *Slock.it Website*, Slock.it GmbH, 30 April 2016. download.slock.it/public/DAO/WhitePaper.pdf, both accessed 12 Dec. 2018.
191. Christoph Jentzsch, "Decentralized Autonomous Organization to Automate Governance," final draft, *Slock.it Website*, Slock.it GmbH, 30 April 2016, p. 1. download.slock.it/public/DAO/WhitePaper.pdf, accessed 12 Dec. 2018.
192. Christoph Jentzsch, "Decentralized Autonomous Organization to Automate Governance," final draft, 30 April 2016, p. 1.
193. Christoph Jentzsch, "The History of the DAO and Lessons Learned," *Slock.it Blog*, *Slock.it GmbH*, 24 Aug. 2016. blog.slock.it/the-history-of-the-dao-and-lessons-learned-d06740f8cfa5, accessed 12 Dec. 2018.
194. Steffen Kux, Heiko Burkhardt, and Stephan Tual, "Siemens AG Hutten-DDO: The First Fortune 500 Company Using the DAO Framework," *Slock.it Blog*, Slock.it GmbH, 15 Aug. 2017. blog.slock.it/siemens-ddo-the-first-fortune-500-company-using-the-dao-framework-2fd970b0b138, accessed 1 Dec. 2018.
195. Steffen Kux, Heiko Burkhardt, and Stephan Tual, "Siemens AG Hutten-DDO."
196. BNP Paribas, 2017 Annual Report, p. 503. invest.bnpparibas.com/sites/default/files/documents/ddd2017_bnp_paribas_gb.pdf, accessed 6 Feb. 2019.
197. Editorial team, "BNP Paribas: The Five Ways Bitcoin Can Shake up the Financial Services World," *Finextra.com*, Finextra Research, 12 Nov. 2014. www.finextra.com/news/fullstory.aspx?newsitemid=26689; and Nathalie Doré, Eliane Hong, and Arthur de Villemandy, "Tech News: The Innovations of Silicon Valley," *Les Echos*, 5 Dec. 2014. www.lesechos.fr/2014/12/lactu-tech-de-la-silicon-valley-une-montre-connectee-pour-prevenir-les-crises-depilepsie-315019, both accessed 29 June 2019.
198. Chris M. Skinner, "Will Bitcoin Replace SWIFT?" *TheFinanser.com*, Financial Services Club Blog delivered by Newstex, 12 Oct. 2014. thefinanser.com/2014/11/will-bitcoin-replace-swift.html, accessed 29 June 2019.
199. "BNP Paribas Confirms Its Commitment to Blockchain," Press Release, BNP Paribas, 2 Feb. 2015. group.bnpparibas/en/press-release/bnp-paribas-confirms-commitment-blockchain; and "BNP Paribas Joins the R3 Blockchain Initiative," Group News, BNP Paribas, 23 Nov. 2015. group.bnpparibas/en/news/bnp-paribas-joins-r3-blockchain-initiative, accessed 7 Feb. 2019.
200. "Launch of a Market Initiative on the Block Chain with 11 Partners," Press Release, Caisse Des Dépôts Group, 16 Dec. 2015. www.caissedesdepots.fr/en/launch-market-initiative-block-chain-11-partners, accessed 7 Feb. 2019.
201. "BNP Paribas in Co-Development Mode with Clients for Applications Based on Blockchain Technology," Group News, BNP Paribas, 23 Sept. 2016. group.bnpparibas/en/press-release/bnp-paribas-co-development-mode-clients-applications-based-blockchain-technology, accessed 6 Feb. 2019.
202. "BNP Paribas in Co-Development Mode with Clients for Applications Based on Blockchain Technology," Group News, BNP Paribas, 23 Sept. 2016. group.bnpparibas/en/press-release/bnp-paribas-co-development-mode-clients-applications-based-blockchain-technology, accessed 6 Feb. 2019.
203. "BNP Paribas and EY explore private blockchain to optimize the bank's global internal treasury operations," Group News, BNP Paribas, 17 Oct. 2017. group.bnpparibas/en/press-release/bnp-paribas-ey-explore-private-blockchain-optimize-bank-s-global-internal-treasury-operations, accessed 7 Feb. 2019.
204. "BNP Paribas Securities Services and SmartAngels finalize first phase of their blockchain partnership," Group News, BNP Paribas, 5 July 2017. securities.bnpparibas.com/news/smartangels-finalise-first-phase.html, accessed 7 Feb. 2019.
205. "BNP Paribas Launches Three Initiatives to Fight Global Warming," Group News, BNP Paribas, 11 Dec. 2017. group.bnpparibas/en/news/bnp-paribas-launches-initiatives-fight-global-warming, accessed 7 Feb. 2019.
206. "Together we are an ecosystem," LiquidShare, n.d. www.liquidshare.io, accessed 6 Feb. 2019.
207. "Liquidshare DLT joint venture formed by seven-strong finance consortium," *Finextra News*, *Finextra Research*, 11 July 2017. www.finextra.com/newsarticle/30818/liquidshare-dlt-joint-venture-formed-by-seven-strong-finance-consortium, accessed 6 Feb. 2019.



208. "Board Members" and "Our Team: Advisors," n.d. www.liquidshare.io, accessed 6 Feb. 2019.
209. Sanne Wass, "Blockchain Solution for Syndicated Loans Becomes First App to Go Live on R3's Corda," *Global Trade Review*, Exporta Publishing & Events Ltd., 24 April 2018. www.gtreview.com/news/fintech/blockchain-solution-for-syndicated-loans-becomes-first-app-to-go-live-on-r3s-corda, accessed 29 June 2019.
210. Solomon Teague, "Blockchain-Based Platform for Letters of Credit Goes Live," *Euromoney*, Euromoney Institutional Investor PLC, 1 Nov. 2018. www.euromoney.com/article/b1bmtfpxq5qk9/blockchain-based-platform-for-letters-of-credit-goes-live, accessed 29 June 2019.
211. BNP Paribas Securities Services, "Optimal asset custody," Press Release, BNP Paribas, 26 Nov. 2018. group.bnpparibas/en/news/bnp-paribas-securities-services-optimal-asset-custody, accessed 7 Feb. 2019.
212. Jim Smith, "Q&A With Nathalie Doré of BNP Paribas Cardif," Blue Dun, Blue Dun LLC, 3 June 2019. blue-dun.com/nathalie-dore-bnp-paribas-cardif, accessed 29 June 2019.
213. "BNP Paribas Securities Services launches ClimateSeed, its first accredited Social Business," Press Release, 9 Nov. 2018. group.bnpparibas/en/press-release/bnp-paribas-securities-services-launches-climateseed-accredited-social-business, accessed 7 Feb. 2019.
214. Mary Lacity, Kate Moloney, and Jeanne W. Ross, "Blockchain at BNP Paribas: The Power of Co-Creation," Center for Information Systems Research Working Paper 428, Massachusetts Institute of Technology Sloan School of Management, March 2018, p. 10.
215. Mary Lacity, Kate Moloney, and Jeanne W. Ross, "Blockchain at BNP Paribas: The Power of Co-Creation," Center for Information Systems Research Working Paper 428, Massachusetts Institute of Technology Sloan School of Management, March 2018, pp. 9-11.
216. John R. Pierce, *What Futurists Believe*, eds. Joseph F. Coates and Jennifer Jarratt (Mount Airy and Bethesda, MD: Lomond Publications and World Future Society, 1989): Ch. 19, "John R. Pierce," p. 241.
217. Joichi Ito, "Blockchain: The View Ahead," roundtable, *Business of Blockchain*, MIT Media Lab and Technology Review, Cambridge, MA, 18 April 2017. [Events.technologyreview.com/video/watch/ito-johnson-ali-view-ahead-closing-roundtable](http://events.technologyreview.com/video/watch/ito-johnson-ali-view-ahead-closing-roundtable), accessed 6 Feb. 2019.
218. Stephan Tual, interviewed by Alan Majer, 11 Sept. 2017, as published in Alan Majer, "Slock.it: Enabling IoT and the Universal Sharing Network," foreword by Don Tapscott, Blockchain Research Institute, 21 Dec. 2017.
219. MARIO, Artillar, et al, "Bitcoin History," *What Is Blockchain Technology?* BitcoinWiki.org, version edited 17 Dec. 2018. en.bitcoinwiki.org/wiki/Bitcoin_history#Bitcoin_in_2008; "Bitcoin Historical Price and Events," 99 Bitcoins, 99Coins Ltd., 11 Jan. 2019. 99bitcoins.com/price-chart-history, both accessed 4 Jan. 2019.
220. "Historical Snapshot: 28 April 2013," *CoinMarketCap*, CoinMarketCap OpCo, 28 April 2013. coinmarketcap.com/historical/20130428, accessed 4 Jan. 2018.
221. "Bitcoin," *CoinMarketCap*, as of 10 July 2019, 12:49. coinmarketcap.com.
222. For more on the dark side of crypto, see this piece by former CEO of Intuit and founding CEO of PayPal, Bill Harris, "Bitcoin Is the Greatest Scam in History," *Recode*, *Vox Media*, 24 April 2018. www.recode.net/2018/4/24/17275202/bitcoin-scam-cryptocurrency-mining-pump-dump-fraud-ico-value. For more on the Tezos ICO, see Gideon Lewis-Kraus, "Inside the Crypto World's Biggest Scandal," *Wired*, *Condé Nast*, 30 Oct. 2018. www.wired.com/story/tezos-blockchain-love-story-horror-story, both accessed 28 Feb. 2019.
223. Sead Fadilpašić, "What Six Nobel Laureate Economists Have to Say About Crypto," *CryptoNews*, 31 March 2018. cryptonews.com/exclusives/what-six-nobel-laureate-economists-have-to-say-about-crypto-1402.htm, accessed 6 Feb. 2019. Eugene Fama, Paul Krugman, Robert C. Merton, Robert Schiller, Joseph Stiglitz, and Richard Thaler have all expressed their concerns publicly about bitcoin and volatility of cryptocurrency prices.
224. Joichi Ito, "Why Bitcoin is and isn't like the Internet," *LinkedIn*, *LinkedIn Corp.*, *Microsoft*, 18 Jan. 2015. www.linkedin.com/pulse/why-bitcoin-isnt-like-internet-joichi-ito?articleId=5962623725013651456#comments-5962623725013651456&trk=prof-post; announcement of DCI, 15 April 2015. medium.com/mit-media-lab-digital-currency-initiative/launching-a-digital-currency-initiative-238fc678aba2, both accessed 1 Feb. 2019.
225. Mary Lacity, Kate Moloney, and Jeanne W. Ross, "Blockchain at BNP Paribas: The Power of Co-Creation," Center for Information Systems Research Working Paper 428, Massachusetts Institute of Technology Sloan School of Management, March 2018, pp. 9-11.



226. Christian Catalini and Catherine E. Tucker, "Antitrust and Costless Verification: An Optimistic and a Pessimistic View of the Implications of Blockchain Technology," MIT Sloan Research Paper No. 5523 (19 June 2018): Abstract. SSRN, ssrn.com/abstract=3199453, accessed 18 May 2019.
227. For an excellent analysis of the case, see Konstantinos Stylianou, "What Can the First Blockchain Antitrust Case Teach Us about the Crypto-Economy?" *Harvard Journal of Law and Technology*, Harvard Law School, 26 April 2019. jolt.law.harvard.edu/digest/what-can-the-first-blockchain-antitrust-case-teach-us-about-the-crypto-economy; *United America Corp. v. Bitmain et al.* (US District Court for the Southern District of Florida) Case Number 1:18-cv-25106, filed 6 Dec. 2018. www.morrisoncohen.com/siteFiles/files/2018_12_06%20-%20United%20American%20v_%20Bitmain.pdf, both accessed 29 June 2019.
228. David Ward, "Open Standards, Open Source, Open Loop," *Internet Engineering Task Force Journal, Internet Society*, 6 March 2015. www.ietfjournal.org/open-standards-open-source-open-loop, accessed 22 March 2019.
229. David Ward, "Three Years On: Open Standards, Open Source, Open Loop," *Internet Engineering Task Force Journal, Internet Society*, 7 March 2018. www.ietfjournal.org/three-years-on-open-standards-open-source-open-loop, accessed 22 March 2019.
230. Catherine Barrera, "Introduction to Cryptoeconomics," Webinar, Prysm Group, 11 June 2018, slide 7. prysmgroup.io/introduction-to-cryptoeconomics, accessed 4 Feb. 2019.
231. Catherine Barrera, "Introduction to Cryptoeconomics," Webinar, Prysm Group, 11 June 2018, slide 7. prysmgroup.io/introduction-to-cryptoeconomics, accessed 4 Feb. 2019.
232. Vitalik Buterin, "Bootstrapping a Decentralized Autonomous Corporation: Part I," *Bitcoin Magazine*, 19 Sept. 2013. bitcoinmagazine.com/articles/bootstrapping-a-decentralized-autonomous-corporation-part-i-1379644274; and Christoph Jentzsch, "Decentralized Autonomous Organization to Automate Governance," final draft, *Slock.it Website, Slock.it GmbH*, 30 April 2016. download.slock.it/public/DAO/WhitePaper.pdf, both accessed 12 Dec. 2018.
233. Nathaniel Popper, "A Hacking of More Than \$50 Million Dashes Hopes in the World of Virtual Currency," *The New York Times, The New York Times Company*, 17 June 2016. www.nytimes.com/2016/06/18/business/dealbook/hacker-may-have-removed-more-than-50-million-from-experimental-cybercurrency-project.html, accessed 22 Nov. 2017.
234. Don Tapscott and Alex Tapscott, "Realizing the Potential of Blockchain: A Multi-stakeholder Approach to the Stewardship of Blockchain and Cryptocurrencies," World Economic Forum, June 2017. www3.weforum.org/docs/WEF_Realizing_Potential_Blockchain.pdf, accessed 6 Feb. 2019.
235. Vlad Gheorghiu, Sergey Gorbunov, Michele Mosca, and Bill Munson, "Quantum-Proofing the Blockchain," foreword by Don Tapscott, Blockchain Research Institute, 23 Nov. 2017.
236. Dylan Yaga, Peter Mell, Nik Roby, and Karen Scarfone, "Blockchain Technology Overview," NISTIR 8202, 3 Oct. 2018. nvlpubs.nist.gov/nistpubs/ir/2018/NIST.IR.8202.pdf, accessed 18 Jan. 2019.
237. Dylan Yaga, Peter Mell, Nik Roby, and Karen Scarfone, "Blockchain Technology Overview."
238. Primavera De Filippi and Greg McMullen, "Governance of Blockchain Systems: Governance of and by Distributed Infrastructure," foreword by Don Tapscott, Blockchain Research Institute and Coalition of Automated Legal Applications, 27 June 2018.
239. Soumak Chatterjee, Louisa Bai, et al., "Blockchain in Global Trade: Revitalizing International Commerce in the Digital Era," foreword by Don Tapscott, Blockchain Research Institute, 22 April 2019.
240. Soumak Chatterjee, Louisa Bai, et al., "Blockchain in Global Trade."
241. Thomas Hardjono, Alexander Lipton, and Alex "Sandy" Pentland, "Towards a Design Philosophy for Interoperable Blockchain Systems," *ArXiv.org, Cornell University*, 16 May 2018. arxiv.org/pdf/1805.05934.pdf, accessed 28 Feb. 2019.
242. Vitalik Buterin, "Chain Interoperability," R3 Reports, R3 HoldCo LLC, 9 Sept. 2016. static1.squarespace.com/static/55f73743e4b051cfcc0b02cf/t/5886800ecd0f68de303349b1/1485209617040/Chain+Interoperability.pdf, accessed 25 March 2019.
243. Stefan Thomas and Evan Schwartz, "A Protocol for Interledger Payments," Interledger Project, Ripple, 9 Feb. 2016. interledger.org/interledger.pdf, accessed 25 March 2019.
244. Adam Back, Matt Corallo, Luke Dashjr, Mark Friedenbach, Gregory Maxwell, Andrew Miller, Andrew Poelstra, Jorge Timón, and Pieter Wuille, "Enabling Blockchain Innovations with Pegged Sidechains" (commit 5620e43), 22 Oct. 2014. blockstream.com/sidechains.pdf, accessed 28 Feb. 2019.
245. "What Are Atomic Swaps? The Most Comprehensive Guide Ever!" *Blockgeeks, Oct. 2018*. blockgeeks.com/guides/atomic-swaps, accessed 28 Feb. 2019.



246. Marek Laskowski, "Blockchain Interoperability: Challenges and Opportunities," foreword by Don Tapscott, Blockchain Research Institute, forthcoming in 2019.
247. Thomas Hardjono, Alexander Lipton, and Alex Pentland, "Towards a Design Philosophy for Interoperable Blockchain Systems," *ArXiv.org, Cornell University, 15 May 2018, pp. 12-13*. arxiv.org/pdf/1805.05934.pdf, accessed 6 Feb. 2019.
248. Thomas Hardjono, Alexander Lipton, and Alex Pentland, "Towards a Design Philosophy for Interoperable Blockchain Systems," pp. 13-14.
249. Thomas Hardjono, Alexander Lipton, and Alex Pentland, "Towards a Design Philosophy for Interoperable Blockchain Systems," p. 14.
250. "Columbia University and IBM Establish New Center to Accelerate Innovation in Blockchain and Data Transparency," Press Release, Fu Foundation School of Engineering and Applied Science, Columbia University, 17 July 2018. engineering.columbia.edu/press-releases/columbia-ibm-center-blockchain-data-transparency, accessed 6 Feb. 2019.
251. China Internet Nationwide Financial Services, "China Internet Nationwide Financial Services Signed an Agreement with Research Institute of Information Technology (RIIT) of Tsinghua University to Establish an Industry Trusted Blockchain Application Technology Joint Research Center," *Cision PR Newswire, PR Newswire Association LLC, 1 Aug. 2018*. tinyurl.com/y8eyc7e9, accessed 6 Feb. 2019.
252. Center for Biomedical Blockchain Research, 14 June 2018. biomedicalblockchain.org, accessed 6 Feb. 2019.
253. Sean Chen, "Center for Blockchain Research Launches," *The Stanford Daily, 22 June 2018*. www.stanforddaily.com/2018/06/22/center-for-blockchain-research-launches, accessed 6 Feb. 2019.
254. University College Oxford Blockchain Research Centre, 28 Aug. 2018. blockchain.univ.ox.ac.uk, accessed 6 Feb. 2019.
255. Coinbase Report, "The Rise of Crypto in Higher Education," *The Coinbase Blog, Coinbase Inc., 28 Aug. 2018*. blog.coinbase.com/the-rise-of-crypto-in-higher-education-81b648c2466f, accessed 18 Dec. 2018. Robert Morse, Alexis Krivian, and Elizabeth Martin, "The Best Universities in the World 2018," *US News & World Report LP, 29 Oct. 2018*. www.usnews.com/education/best-global-universities/rankings, accessed 18 Dec. 2018.
256. Coinbase Report, "The Rise of Crypto in Higher Education," *The Coinbase Blog, Coinbase Inc., 28 Aug. 2018*. blog.coinbase.com/the-rise-of-crypto-in-higher-education-81b648c2466f, accessed 18 Dec. 2018.
257. Coinbase Report, "The Rise of Crypto in Higher Education." Yermack said that class size grew from 35 students in 2014 to 230 students in 2018.
258. Coursera team, "2018's Most Popular Courses," *Coursera Collection, Coursera Inc., n.d*. www.coursera.org/collections/popular-courses-2018, accessed 6 Feb. 2019.
259. Mary Lacity, Kate Moloney, and Jeanne W. Ross, "Blockchain at BNP Paribas: The Power of Co-Creation," Center for Information Systems Research Working Paper 428, Massachusetts Institute of Technology Sloan School of Management, March 2018, p. 11.
260. Enterprise Ethereum Alliance, "Members," n.d. entethalliance.org/members; and Hyperledger, "Members," n.d. www.hyperledger.org/members, both accessed 22 March 2019.
261. Blockchain in Transport Alliance, "BiTA member," n.d. www.bitastudio.com/members, accessed 25 March 2019.
262. Dale Chrystie, interviewed via telephone by Kirsten Sandberg, 12 March 2019.
263. Marek Laskowski, interviewed via telephone by Kirsten Sandberg, 26 Feb. 2019.
264. Elizabeth M. Pierce, "Designing a Data Governance Framework to Enable and Influence IQ Strategy," Presentation, Proceedings of the MIT 2007 Information Quality Industry Symposium, Cambridge, MA, 19 July 2007. mitiq.mit.edu/IQIS/Documents/CDOIQS_200777/Papers/01_08_1C.pdf, accessed 25 March 2019.
265. Elizabeth M. Pierce, "Designing a Data Governance Framework."
266. Marek Laskowski, interviewed via telephone by Kirsten Sandberg, 26 Feb. 2019.
267. Peta Tomlinson, "Blockchain Technology Is Set to Be the Driving Force behind the Belt and Road Initiative," *ACCA Global, Association of Chartered Certified Accountants, 1 Nov. 2018*. www.accaglobal.com/my/en/member/member/accounting-business/2018/11/insights/blockchain-technology.html, accessed 19 Jan. 2019. This article first appeared in the Chinese edition of *Accounting and Business, Nov. 2018*.
268. Donika Kraeva, "Blockchain's Growth Has Caused a Payment Skills Gap," *PaymentsSource, SourceMedia, 17 Sept. 2018*. www.paymentsource.com/opinion/blockchain-has-a-talent-gap, accessed 25 Sept. 2018.



269. Economic Graph Team, "LinkedIn 2018 Emerging Jobs Report," introduction by Guy Berger, *LinkedIn Economic Graph*, LinkedIn Corp., Microsoft, 13 Dec. 2018. economicgraph.linkedin.com/en-us/research/linkedin-2018-emerging-jobs-report, accessed 18 Jan. 2019.
270. Adam M. Brandenburger and Barry J. Nalebuff, "Universal Lessons Every Manager Can Learn from Andy Grove's Paranoia," *Books in Review, Harvard Business Review* (Nov.-Dec. 1996): 168-175. faculty.som.yale.edu/barrynalebuff/InsideIntel_HBR1996.pdf, accessed 10 Feb. 2019. Brandenburger and Nalebuff reviewed Andrew S. Grove, *Only the Paranoid Survive: How to Exploit the Crisis Points That Challenge Every Company and Career* (New York: Currency/Doubleday, 1996).
271. Steve Bates, "Know Blockchain? You're Hired," *SHRM*, Society for Human Resource Management, 29 Aug. 2018. www.shrm.org/resourcesandtools/hr-topics/talent-acquisition/pages/blockchain-jobs-hired.aspx, accessed 25 Sept. 2018.
272. Amy Castor, "Blockchain Start-up Po.et Nabs Former Washington Post VP as Its New CEO," *Nasdaq, NASDAQ*, 13 Feb. 2018. www.nasdaq.com/article/blockchain-startup-poet-nabs-former-washington-post-vp-as-its-new-ceo-cm920930, accessed 18 Dec. 2018.
273. WashPostPR, "The Washington Post Names Jarrod Dicker Vice President of Commercial Technology and Development," *Press Release, The Washington Post, WP Company*, 24 Jan. 2019. www.washingtonpost.com/pr/2019/01/24/washington-post-names-jarrod-dicker-vice-president-commercial-technology-development/?noredirect=on&utm_term=.79dca47df77d, accessed 22 Feb. 2019.
274. Mary Lacity, Kate Moloney, and Jeanne W. Ross, "Blockchain at BNP Paribas: The Power of Co-Creation," Center for Information Systems Research Working Paper 428, Massachusetts Institute of Technology Sloan School of Management, March 2018.
275. Thaisa Fernandes, "How Google Design Sprint Works," *Product Management 101 Blog, A Medium Corporation*, 25 May 2019. medium.com/productmanagement101/design-sprints-at-google-85ff62fed5f8, accessed 29 June 2019.
276. Jim Smith, "Q&A with Nathalie Doré of BNP Paribas Cardif," *Blue Dun, Blue Dun LLC*, 3 June 2019. blue-dun.com/nathalie-dore-bnp-paribas-cardif, accessed 29 June 2019.
277. Jim Smith, "Q&A with Nathalie Doré of BNP Paribas Cardif."
278. Jim Smith, "Q&A with Nathalie Doré of BNP Paribas Cardif."
279. Marek Laskowski, "Blockchain Interoperability: Challenges and Opportunities," foreword by Don Tapscott, Blockchain Research Institute, forthcoming in 2019.
280. Ford CEO Mark Fields credited the phrase to management guru Peter Drucker, though it never appeared in Drucker's writings. For more on culture's impact, see Boris Groysberg, Jeremiah Lee, Jesse Price, and J. Yo-Jud Cheng, "The Culture Factor," *Harvard Business Review, Harvard Business School Publishing*, 1 Aug. 2018. hbr.org/2018/01/the-culture-factor, accessed 29 June 2019.
281. Tom Serres and Bettina Warburg, "Introducing Asset Chains: The Cognitive, Friction-free, and Blockchain-enabled Future of Supply Chains," foreword by Don Tapscott, Blockchain Research Institute, 28 Nov. 2017.
282. Matt Higginson, Marie-Claude Nadeau, and Kausik Rajgopal, "Blockchain's Occam Problem," *McKinsey & Company Financial Services, McKinsey & Company*, Jan. 2019. www.mckinsey.com/industries/financial-services/our-insights/blockchains-occam-problem, accessed 19 Jan. 2019.
283. "Amazon Quantum Ledger Database (QLDB) FAQs," Announcements, Amazon Web Services, Amazon.com, 28 Nov. 2018. aws.amazon.com/qldb/faqs, accessed 6 Jan. 2019.







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