

COVER STORY

BLOCKCHAIN: THE INVISIBLE TECH THAT'S CHANGING THE WORLD

BY ROB MARVIN

Blockchain isn't a household buzzword, like the cloud or the Internet of Things. It's not an in-your-face innovation you can see and touch as easily as a smartphone or a package from Amazon. But when it comes to our digital lives—every digital transaction; exchange of value, goods and services; or private data —blockchain is the answer to a question we've been asking since the dawn of the Internet age: How can we collectively trust what happens online?

Every year we run more of our lives—more core functions of our governments, economies, and societies—on the Internet. We do our banking online. We shop online. We log into apps and services that make up our digital selves and send information back and forth. Think of blockchain as a historical fabric underneath recording everything that happens exactly as it occurs. Then the chain stitches that data into encrypted blocks that can never be modified and scatters the pieces across a worldwide network.

Blockchain always has an immutable “ledger” that you can see, verify, and control. At the same time, it has no single point of failure from which records or digital assets can be hacked or tampered with. Because of its distributed-ledger technology, blockchain has applications across every kind of digital record and transaction. And in 2017 we'll begin to see them explode.

First up are the big banks and tech giants. Big business will always drive innovation, and the rise of blockchain-based smart contracts (read on for more explanation of them) turns blockchain into a middleman to execute all manner of complex business deals, legal agreements, and automated exchanges of data. Companies such as Microsoft and IBM are using their cloud infrastructure to build custom blockchains for customers and experiment with their own use cases. On the academic side, researchers are exploring blockchain applications for projects ranging from digital identity to medical and insurance records.

At the same time, dozens of startups are using the technology for everything from global payments to music sharing, from tracking diamond sales to the legal marijuana industry. That's why blockchain's potential is so vast: When it comes to digital assets and transactions, you can put absolutely anything on a blockchain. A host of economic, legal, regulatory, and technological hurdles must be scaled before we see widespread adoption of blockchain technology,

but first movers are making incredible strides. Within the next handful of years, large swaths of your digital life may begin to run atop a blockchain foundation—and you may not even realize it.

BEYOND BITCOIN

Blockchain is the data structure that allows bitcoin, the market-proof cryptocurrency, to thrive through a combination of decentralized encryption, anonymity, immutability, and global scale. Though blockchain is the not-so-secret weapon behind bitcoin's rise, blockchain was always destined to evolve far beyond it. Blockchain has the potential to tower above bitcoin's shadow and to underpin the evolution of our digital future.



To explain how blockchain came to be, though, we have to begin briefly with the legacy of bitcoin. For Jeff Garzik, it started the way many a buzzy idea in the tech community has over the years: with a post on “news for nerds” and OG tech aggregator Slashdot.org. Garzik is the CEO and cofounder of enterprise blockchain startup Bloq, but he spent a decade as a bitcoin core developer. He was also recently elected to the Board of Directors of The Linux Foundation (as the first member with a blockchain and cryptocurrency background).



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JEFF GARZIK
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In July 2010, Garzik was working on Linux at Red Hat when what he calls “The Great Slashdotting” occurred. One viral post (<https://news.slashdot.org/story/10/07/11/1747245/bitcoin-releases-version-03>) introduced programmers, investors, and tech nerd-dom at large to the concept of bitcoin, and thus to blockchain. Garzik had always been fascinated with the goal of making seamless digital payments work on a global scale. When he realized how bitcoin’s underlying technology worked, he said itit “knocked him on his bum.”

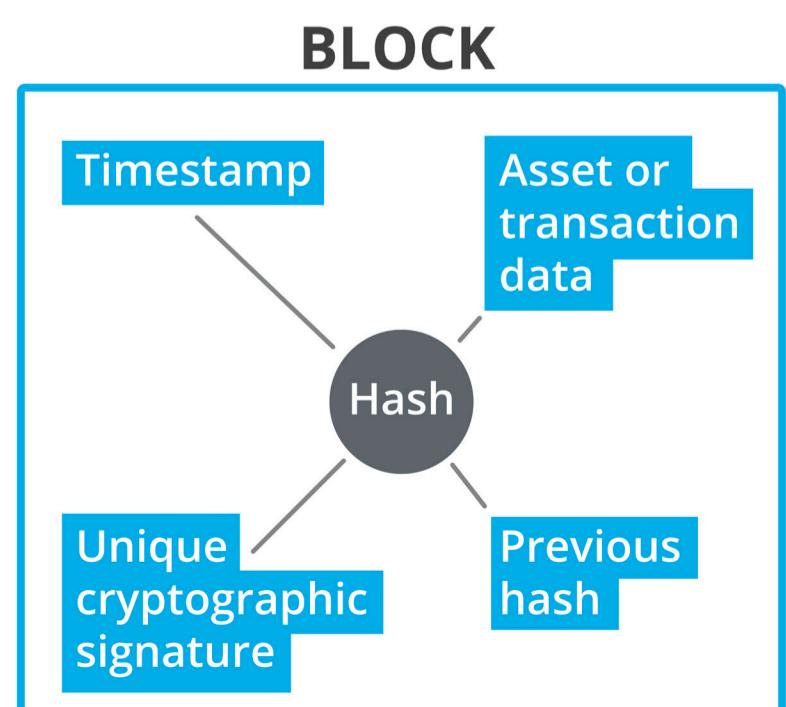
“I had already thought to myself about how someone might create a decentralized version of PayPal. When Elon [Musk] and Peter Thiel and the other founders created PayPal, they had this vision of a global ledger that could easily and cheaply add entries between users like a database entry. That vision met reality with banking laws and cross-border friction, with legal hurdles and regulations not only in the U.S. but around the world. It made that kind of decentralized global currency impossible, or so we thought.

“Bitcoin turned all of that on its head,” Garzik went on. “From an engineering perspective, the proof of work was this very elegant way to elect a leader, the block creator, in this decentralized and potentially adversarial system. Bitcoin layered on top of that engineering a set of economic and game-theory incentives that paid you in the script of the system itself, creating this virtuous cycle where it’s in your best economic interest to follow the consensus rules and create the longest, strongest chain possible. I didn’t realize until that post on that day how elegantly it could be done.”

It's important to understand why bitcoin and blockchain are not the same thing. In Garzik's TEDx Talk (<https://www.youtube.com/watch?v=vaPgfErzeuo>), he described bitcoin as "an organism." It has layers, like other software. On top of the bitcoin blockchain is billions of dollars worth of cryptocurrency, but beneath that is a ledger just like any other blockchain. The underlying ledger works without the currency and can be used to securely transfer any digital asset over the Internet. The currency, on the other hand, doesn't work without the ledger. Garzik said bitcoin was just the first demo application of what blockchain can do. In this case, it built a monetary revolution on the back of an all-seeing ledger, one that's everywhere and nowhere at once, and gave the cryptocurrency its power.

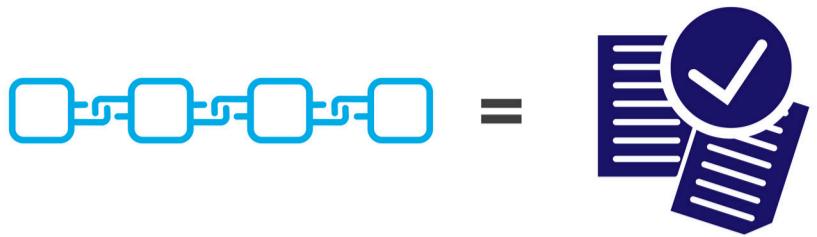
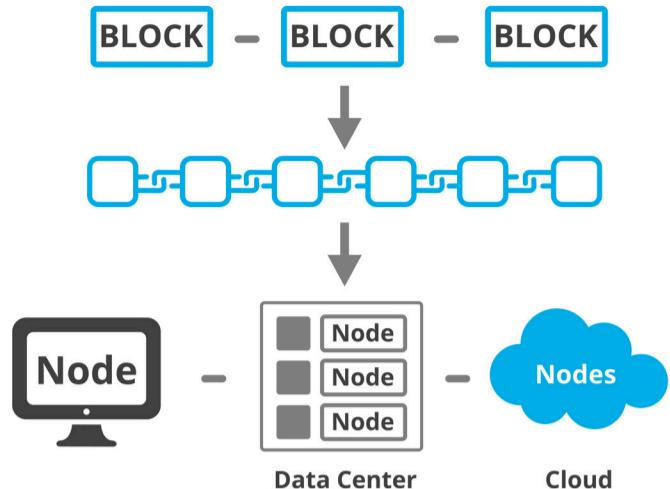
BLOCKCHAIN FOR BEGINNERS

People often get bogged down in technological complexity when trying to understand blockchain, but the basic concept is a simple and universal one. We have facts and information we don't want accessed, copied, or tampered with, but on the Internet, there's always a chance it could be hacked or modified. Blockchain gives us a constant—a bedrock we know won't change once we put something on it and where a transaction will be verified only if it follows the rules.



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**Together these blocks form a chain,
distributed across a worldwide
network of nodes.**

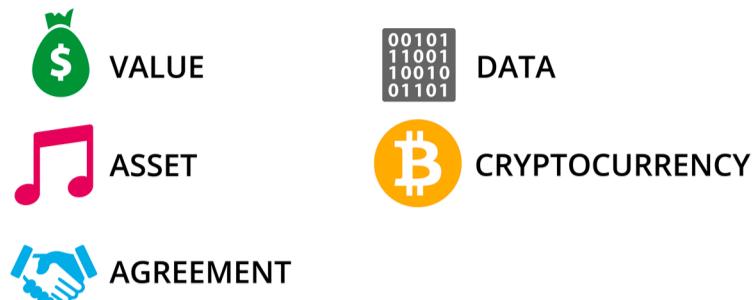


Each block in the chain has data from the previous block. The blockchain is a ledger of transactions that automatically verifies itself.

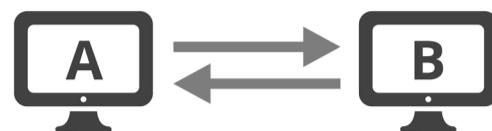
Blockchain's beginnings date back two years before that viral Slashdot post. In 2008, bitcoin founder and still-mysterious Satoshi Nakamoto (a pseudonym) published a famous white paper (<https://bitcoin.org/bitcoin.pdf>) explaining the basics of “mining” data into a block, then using a hash (a time-stamped link) to chain those blocks together across a decentralized network of “nodes” that verify each and every transaction. In the 2016 book *Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World*, authors Don and Alex Tapscott explain Nakamoto’s bitcoin model about as succinctly as one can:

Bitcoin or other digital currency isn't saved in a file somewhere; it's represented by transactions recorded in a blockchain—kind of like a global spreadsheet or ledger, which leverages the resources of a large peer-to-peer (P2P) network to verify and approve each bitcoin transaction. Each blockchain, like the [bitcoin blockchain] is distributed: it runs on computers provided by volunteers around the world. There is no central database to hack. The blockchain is public: anyone can view it at any time because it resides on the network... and the blockchain is encrypted... it uses public and private keys (rather like a two-key system to access a safety deposit box) to maintain virtual security.

Blockchain can be used for any kind of transaction.



When a transaction occurs, the blockchain first verifies it, then executes and records the transaction.



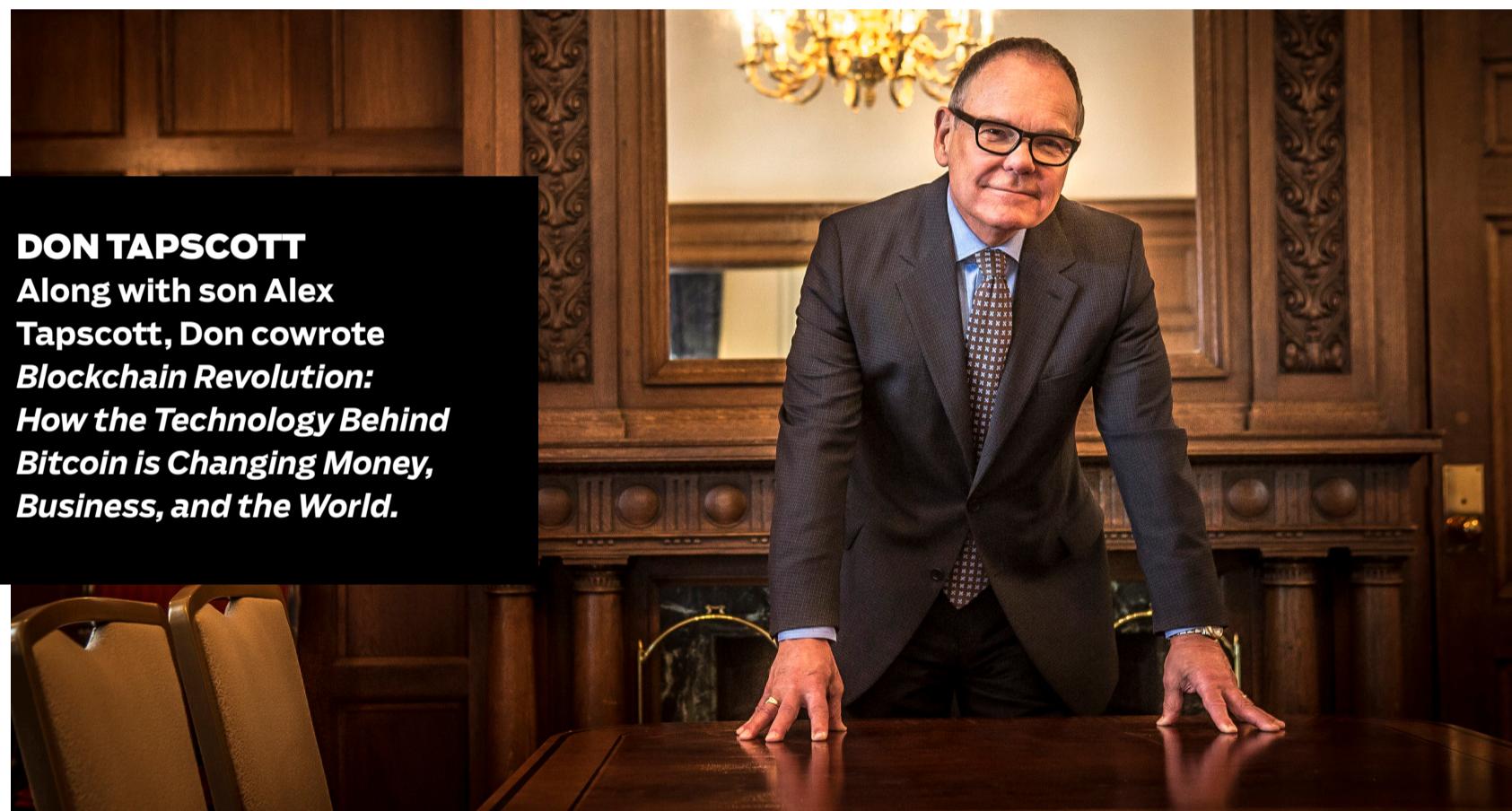
Note that nothing is completely unhackable, particularly when you don't use it as intended. Blockchain's security works not only because it's encrypted but also because it's also decentralized. Victims of the biggest blockchain breaches and cryptocurrency heists (Mt. Gox in 2014 and Bitfinex in 2016) were targeted and pilfered clean because they tried to centralize a decentralized system. Another recent blockchain security incident, the DAO hack, came down to exploited loopholes in smart contracts written atop an established blockchain, Ethereum, not within the blockchain itself. Blockchain's underlying security and encryption model is a sound one. How that security is executed is a story for another feature.

So we've explained how the network functions and how security works, but how do the blocks actually connect to one another? Why does a blockchain get stronger the longer it gets? Where does the immutability come in? The Tapscotts' explanation continues:

"Every ten minutes, like the heartbeat of the bitcoin network, all the transactions conducted are verified, cleared, and stored in a block which is linked to the preceding block, thereby creating a chain. Each block must refer to the preceding block to be valid. The structure permanently timestamps and stores exchanges of value, preventing anyone from altering the ledger... so the blockchain is a distributed ledger representing a network consensus of every transaction that has ever occurred. Like the World Wide Web of information, it's the World Wide Ledger of value... This new digital ledger can be programmed to record virtually everything of value and importance to humankind: birth and death certificates, marriage licenses, deeds and titles of ownership, educational degrees, financial accounts, medical procedures, insurance claims, votes, provenance of food, or anything else that can be expressed in code."

The concept of immutability is maybe the most crucial to understand when trying to wrap your head around blockchain and why it's important. An object that once created can never be changed has infinite value in our editable, ephemeral digital world.

Harking back to the “strength in numbers” principle, the more nodes a blockchain is distributed over, the more stronger and more trusted it becomes. It’s verification on top of verification to infinity. Bloq’s Garzik talked about how the network effect of blockchain is key to its immutability, and why it’s the reason the public bitcoin blockchain is still the most popular and trusted blockchain out there:



DON TAPSCOTT
Along with son Alex
Tapscott, Don cowrote
*Blockchain Revolution:
How the Technology Behind
Bitcoin is Changing Money,
Business, and the World.*

“The immutability factor is very much dependent on the network effect. You see that with bitcoin very specifically. The cost of creating a new digital asset is essentially zero. Therefore you have to demonstrate an overwhelming amount of value in overcoming that network effect if you want to convince someone to switch away from the bitcoin blockchain, which not only has a good track record but high security value from a technical perspective. Security and immutability are a direct function of the economics—how much investment there is in the ecosystem, and how many people are using it.”

Once you understand what a blockchain is and how it works, the next question an everyday tech user would have is how it'll affect them. If you're not a business that's building a blockchain-based product or service, why should you care? As Don Tapscott explained it in Blockchain Revolution and in a 2016 TED Talk of his own, it's because blockchain brings us from the Internet of information into the "Internet of value." From his TED talk:

"For the past few decades, we've had the Internet of information,. When I send you an email or a PowerPoint file, I'm actually not sending you the original; I'm sending you a copy. That's great, and it has democratized information. But when it comes to assets; things like money, financial assets like stocks and bonds, loyalty points, intellectual property, music, art, a vote... sending you a copy is a really bad idea. If I send you \$100, it's really important that I don't have the money afterward... Today, we rely entirely on big intermediaries; middlemen like banks, government, big social media companies, credit companies, and so on to establish trust in our economy. These intermediaries perform all the business and transaction logic of every kind of commerce, from identification and authentication of people through to clearing, settling, and record-keeping... they capture our data, which means we can't monetize or use it to better manage our lives, and our privacy is being undermined... so what if there were not only an Internet of information, but an Internet of value. Some kind of vast, global, distributed ledger running on millions of computers and available to everybody, and where every kind of asset from money to music could be stored, moved, transacted, exchanged, and managed, all without powerful intermediaries."

That, in a nutshell, is blockchain.

WHAT ARE SMART CONTRACTS?

If you think of blockchain as an operating system for data, then smart contracts are its killer app. Smart contracts add complex logic and rules atop a blockchain that can automate traditional contract management and digitize the world around us the same way apps like Uber are automating away the need to wave your hand in the air to hail a cab.

You can't talk about the future of blockchain without explaining the role smart contracts will play. If the world is going to run on blockchain, much of it will rely on smart contracts to execute the data exchanges and program in rules to

govern how each code-triggered agreement works. Smart contracts are also a flexible mechanism that can serve as the blockchain middleman for all manner of agreements and data exchanges. At the inaugural Smart Contracts Symposium in New York this past December, panelists were asked to describe smart contracts as though they were explaining them to a teenager.

“Think about getting carded at a bar,” said Jerry Cuomo, vice president of blockchain technologies at IBM. “From an identity perspective, I can imagine a blockchain managing verification of a citizen’s identity. A smart contract could ensure something like my daughter going out for her 21st birthday and the bouncer only being able to see her age, not her address. Blockchain could set up a centralized identity verification system that could make the world safer for dads like myself.”

Symposium experts pointed to identity management as an application to watch in 2017, but the list goes on. The Chamber of Digital Commerce, the leading trade association that represents the blockchain industry, organized the symposium and also runs the Smart Contracts Alliance. The Chamber and Alliance (with Deloitte) recently released a white paper entitled “Smart Contracts: 12 Uses Cases for Business & Beyond” detailing a dozen broad areas and industries where smart contracts could change the game.

In a broad legal sense, smart contracts provide what Bloq’s Garzik calls “adjudication-as-a-service:” a real-time version of the court system that, for finance scenarios, can cut time on deal closings, banking and securities transactions, and even global trade finance from weeks or months to days, hours, or minutes. On the digital identity front, the white paper calls smart contracts a “user-centered Internet for individuals”



JERRY CUOMO
Vice president
of blockchain
technologies at IBM.

giving users control over the data, digital assets, and online reputation associated with them. Blockchain also affords the ability to decide what personal data is and isn't shared with businesses—the same concept behind the driver's license analogy.

Beyond identity, the white paper also talks about how smart contracts can be applied to getting a mortgage and instantaneously processing auto-insurance claims. In the medical research field, they can serve as a mechanism to ensure better patient privacy in clinical trials while promoting more open data-sharing in the cancer research community. Another of the paper's use cases is land titling. Countries around the world, including Ghana, Georgia, and Honduras, that are typically rife with property fraud and land disputes are already implementing smart contracts to facilitate property transfers and land ownership.

Real-world smart contracts are also gaining traction in a few other interesting ways. Everledger is a blockchain-based fraud-detection system for valuable physical assets, particularly jewelry and diamonds. It uses a hybrid blockchain that combines the bitcoin blockchain with its own private blockchain to build smart contracts that certify physical diamonds. It combats the sale of conflict diamonds by keeping a transaction history for each gem.

"Everledger takes a diamond or a piece of art and hashes it to the blockchain," said MIT's Forde. "For something like a diamond ring, Everledger takes an image of it—like a unique diamond fingerprint—which can then be scanned against the blockchain to verify it's the same one."

Once you open the door of tracking and manage physical assets, smart contracts can tackle the whole supply chain. IBM and Walmart are even partnering in China to track the movement of pork (seriously) to keep people from eating tainted meat.

You can also use smart contracts for digital content such as music. Mycelia, a "collective of creatives, professionals and lovers of music" founded by musician Imogen Heap, is a blockchain-based protective ecosystem pushing smart contracts as a way for musicians to share free-trade music and to ensure the profits go back to the artists.

Mycelia is an example of blockchain and smart contracts' potential for digital rights management (DRM). Smart contracts in digital music files or other copyrighted material might enable artists to better sell directly to consumers without the need for labels, lawyers, or accountants, with royalties paid out automatically.

A sleeping giant in this conversation is the effect smart contracts could have on the Internet of Things. Think about all the data that your smart devices collect. Fitness trackers collect your body's vital statistics. Thermostats collect temperature data. Alexa has records of every search and request you've ever asked of her. If the IoT ran on a blockchain, and smart contracts governed that real-time data, it could create a whole new class of lending and other usage-based agreements, according to Erin Fonte, Head of the Financial Services Regulatory and Compliance Practice Group at corporate law firm Dykema.

"If you had smart and connected cars that could report back actual usage stats, you could tie pricing into real-time usage and have it automatically adjust over the length of your vehicle lease and financing," said Fonte.

Think about how connected devices enable mobile payments without traditional credit card swiping at the point of sale. Instead of swiping your card at a terminal, you touch a thumb to your iPhone to use Apple Pay. The automated payment system is authenticating individuals and providing verifiable legal proof of transaction authorization, just as a smart contract using those same two permissions—authorization and permission—in an IoT device can make a transaction legally enforceable against a buyer or seller, which is particularly applicable in machine-to-machine (M2M) communication.

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ERIN FONTE
**Head of Financial
Services Regulatory
and Compliance
Practice Group at
corporate law firm
Dykema.**

“Amazon Dash buttons are a prime example,” explained Erin Fonte. “It’s one little branded button you stick in your house, and then you don’t have to log onto Amazon to reorder. Just press the button, and it repeats its last order. For connected homes and cars, blockchain’s ability to monitor, to collect, and to make sense of data for transactions will drive the ability for humans to authorize machines to carry out activities like this as agents.

“The next step is that you don’t need a button,” she went on. “Manufacturers will create customer and end-user [smart contract] agreements on the back end. “Your washing machine will have that feature built into the product itself.”

HOW WE BUILD A BLOCKCHAIN-BASED WORLD

Blockchain is still in its infancy. Before we see widespread adoption on the scale the technology is capable of, a lot needs to happen. We must have buy-in from government (which in the U.S. means working state-by-state on policies and legislation). The industry has to clear a labyrinth of legal and regulatory hurdles before blockchain can power better banking, identity, records, or anything else requiring official documentation that now runs on legacy government systems or even (still) on paper.

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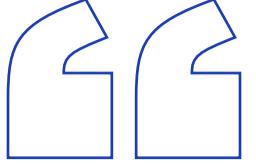
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We also need open standards to tie the blockchain industry together. The most prominent coalition working to make that happen is the Hyperledger project. Hyperledger is an open-source initiative to create an open, standardized, and enterprise-grade distributed ledger framework and code base to be used across industries. Overseen by The Linux Foundation, its members include tech companies (Cisco, IBM, Intel, Red Hat, Samsung, VMware, and more), big banks (JPMorgan, Wells Fargo, and so on), blockchain startups such as Bloq, and a host of others.

“The Linux Foundation is the key layer of governance for shepherding and maturing open-source products,” said Garzik. “There are many blockchain peddlers out in the market right now, and one of the biggest pain points we see is incompatibility; a large bank that has merged 10 businesses over the past decade and has a lot of halfway-compatible internal legacy systems. That’s where the foundation and Hyperledger really come to the fore. As young as the blockchain industry is, the kind of technical standards-making we need for interoperability has so far been absent.”

Another important Hyperledger member is R3, the wealthy elephant in the room when it comes to blockchain standardization. R3 is a consortium dedicated to research and development of advanced distributed ledger technologies for global financial markets. It also represents most of the biggest banks and financial institutions on the planet: Barclays, Credit Suisse, J.P. Morgan, the Royal Bank of Scotland, UBS, Bank of America, Citi, Deutsche Bank, HSBC, Morgan Stanley, Wells Fargo, and a number of others.

We’re already beginning to see the kind of blockchain-based international trading R3 is after. This past


**R3 is a
consortium
dedicated to
research and
development
of advanced
distributed
ledger
technologies.**



October, the first cross-border transaction between banks using multiple blockchain applications took place between the Commonwealth Bank of Australia and Wells Fargo, resulting in a shipment of cotton to China from the U.S. R3 is also becoming an example of how difficult standardizing blockchain can be. Goldman Sachs and Santander both left R3 in late 2016 in the midst of big-bank jockeying over control of a new funding round for the consortium.

Few know the challenge of pushing for blockchain adoption better than Perianne Boring, president of the Chamber of Digital Commerce. The Chamber is currently engaged in lobbying and advocacy efforts in 14 states and counting. In North Carolina, the chamber's efforts helped pass the North Carolina Money Transmitter Act in July 2016, which updates the state's existing laws to include a defined "virtual currency."

Boring said the law is a big win for blockchain and digital currency but still only a drop in the bucket of patchwork state-by-state regulations and the even more muddled web of federal agencies. In the past year, Chamber representatives have testified at cryptocurrency regulation hearings in New Hampshire, lobbied regulatory proposals in New York and Washington states, and made official comments on virtual currency acts and regulatory frameworks from the Uniform Law Commission and the Conference of State Bank Supervisors (CSBS).

"How is digital currency supposed to be regulated? This is a huge national debate around how states can effectively regulate virtual currency and money transmission, and every state has its own opinion and a completely different way of doing things," explained Boring. "New York says businesses need a separate digital currency license to operate in the state. North Carolina said that's way too complicated and regulatory overkill and decided instead to take their existing money transmission laws and incorporate digital currency into the existing regulatory framework. We side with North Carolina in that debate."



PERIANNE BORING
President of the
Chamber of Digital
Commerce.

Boring stressed the importance of keeping blockchain technology and policy on the same page. The Chamber is also a Hyperledger member, and Boring said the Chamber will work to actively bring Hyperledger into policy discussions, to ensure lawmakers understand the pros and cons of regulations.

Yet as difficult as overcoming entrenched legacy systems and regulations can be, we already have a blueprint of how it can be done. Over the past two years, the state of Delaware has shown how governments can legislate, sanction, adopt, and implement blockchain technology to power core services.

As with much of the legislation, regulation, and business drivers behind blockchain, it starts with fintech (financial technology). More than a million companies and 66 percent of Fortune 500 companies are incorporated and legally headquartered in Delaware, in large part because of the state's largest export: uncertified shares (meaning the ability to own shares in a company without holding the actual stock certificate). In partnership with blockchain fintech company Symbiont, the Delaware Blockchain Initiative announced in 2016 will completely automate stock issuance and recordkeeping on a blockchain ledger.

‘Before the Delaware Blockchain Initiative, there was no technological solution to support digital representation of share ownership,’ explained Symbiont CEO Mark Smith. ‘From what can only be described as a forward-thinking agenda from the state, they embraced that they could reimagine how to deliver their marquee service on a distributed ledger, using Symbiont’s technology to create a new type of share and change the way a corporation works from now into the foreseeable future.’

A little finance background: The genesis moment of a private equity is when you incorporate a company. As



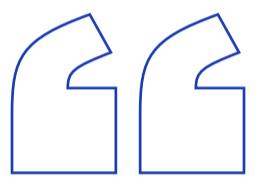
MARK SMITH
CEO of Symbiont, a
blockchain fintech
company.

Smith explained, now companies will have the ability to carry that equity all the way from incorporation up to and including an initial public offering (85 percent of IPOs happen in Delaware), all via the blockchain, with complete financial transparency for state lawyers and regulatory agencies. The entire process will run automatically on smart contracts.

Even greater implications lie in what the Delaware Blockchain Initiative is doing beyond digital shares. At the Consensus blockchain technology summit this past year, Delaware Governor Jack Markell gave a keynote speech announcing the initiative and laying out a blockchain roadmap for the next five years, including a new joint effort with Symbiont to digitize and store the entire Delaware Public Archives on a blockchain ledger in 2017.

Symbiont's Smith, who is also a co-chair of the Chamber of Digital Commerce's Smart Contracts Alliance, explained how Delaware is building cryptographic document control that will ultimately overhaul how city, county, and state municipalities share information that in many cases still exists on paper in filing cabinets. Smith's first conversation with Delaware officials was in October 2015, and between then and now, the state has gone from knowing nothing about blockchain to embracing it in its biggest export and mobilizing to push new legislation and initiatives around it.

"The state is completely reimagining how it stores and distributes public records to its citizens. Land and property titling, licensing, birth and death certificates, automobile VIN numbers, heavy machinery and luxury good registrations, all these things are being incorporated into Symbiont's technology stack behind



The state
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the Delaware blockchain,” Smith explained. “Distributed ledger technology is not a silver bullet—it’s not going to solve every problem—but it does solve some very big ones.

“When [Delaware] Governor Markell came out publicly announcing the initiative, he said he wanted to challenge us to use this powerful technology,” Smith continued. “Delaware should serve as a blueprint for many other states, each of which could operate a node right next to Delaware and build critical mass and momentum from a government perspective that could lead to other nations joining in.”

WELCOME TO OUR BLOCKCHAIN FUTURE

The change blockchain represents to our digital world is tectonic. Blockchain is broad and coming to the fore on such a massive scale that explaining it often falls back on the abstract, rather than grounding it in the kind of foundational change the technology will have on the culture of how we interact online.

The Web 1.0 was a read-only Internet of static web pages. Web 2.0, where we are now, added dynamic user-generated content and the rise of social media.



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Web 3.0 has many definitions, but one of the most popular is that of connective intelligence: where the next generation of applications, data, concepts, and people are connected by an unmediated fabric where you don't need a trust broker like a bank or tech company in the middle to ensure privacy and security. In blockchain, we finally have the technology to power Web 3.0.

"The first four decades of the Internet brought us email, the World Wide Web, dot-coms, social media, the mobile web, Big Data, cloud computing, and the early days of the Internet of Things," the Tapscotts write in *Blockchain Revolution*. Through that lens, MIT's Brian Forde said, we can understand where blockchain fits into our lives.

"People have forgotten how powerful it is not to have to worry about what email app you use. When I email you, it doesn't matter if you're using Gmail or Outlook or Yahoo—you just give me your email address and go. Now think about sending money today. If I want to send you \$20, we're going to play a game of 20 questions. Do you have PayPal? How about Venmo?" said Forde.

"Imagine if we still chose our cell phone carriers and ISPs based on whether our friends and family were using Sprint or AT&T," Forde went on. "That's still the world we live in today for most digital services. You joined Facebook because your friends did. You're not going to sign up with a new payments startup if your friends are all on PayPal. It's going to be incredibly powerful for consumers to have more choice when everything running on blockchain just works."

Blockchain is taking root within a wide swath of industries. To discover which ones, all you need to do is follow the money. A Deloitte survey released in December 2016 polled blockchain-knowledgeable senior executives at organizations with \$500 million or more in annual revenue. Of the 308 respondents, 28 percent reported that their companies have already invested \$5 million or more in blockchain technology, with 10 percent investing \$10 million or more.

Although the fintech industry was early to show interest in blockchain and accounts for a significant amount of investment and activity, the survey revealed other industries aggressively pursuing blockchain.

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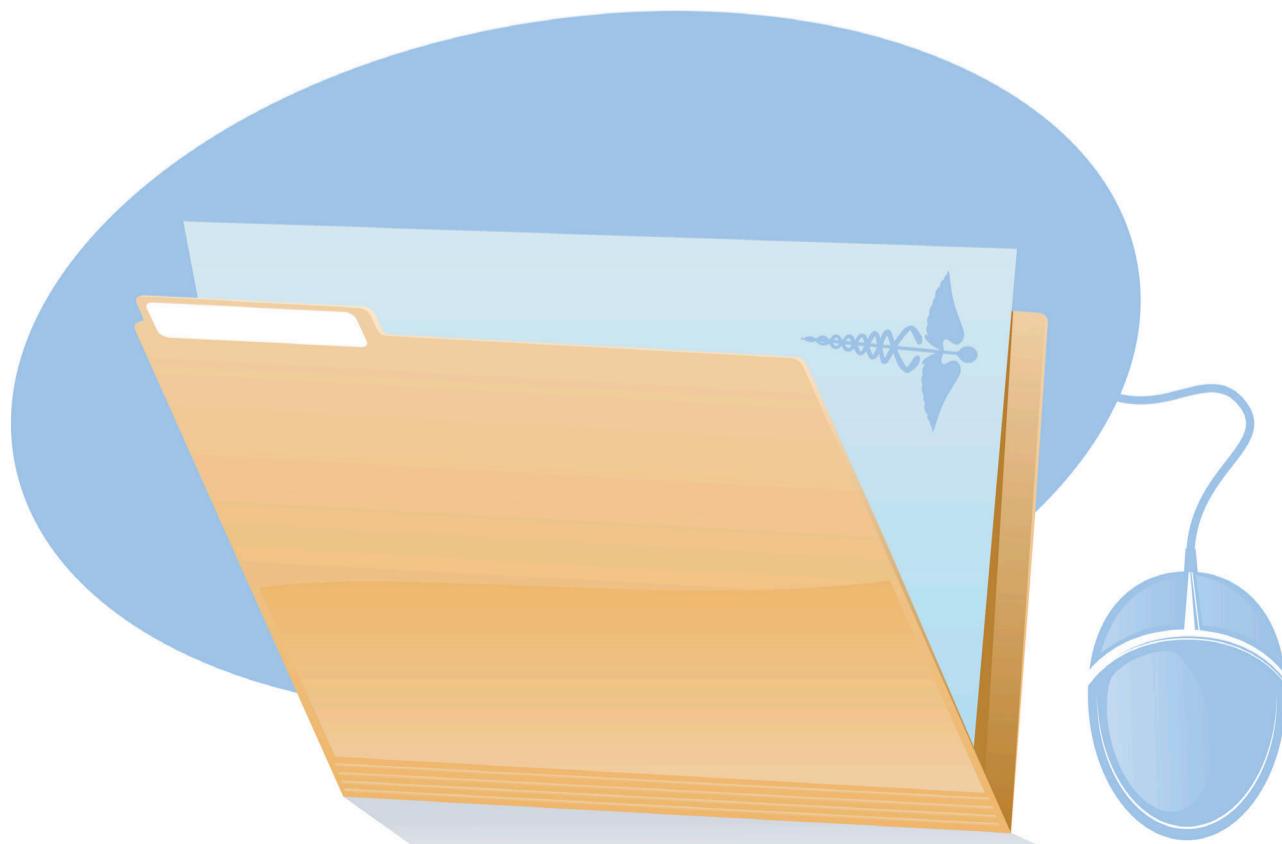
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Within the consumer products and manufacturing industry, 42 percent of respondents said they're planning to invest \$5 million or more in 2017, compared to 27 percent in the media and telecoms industry, and 23 percent in financial services. Put together, 30 percent of consumer manufacturing and media/telco industry respondents said their companies have already deployed blockchain into production.

Yet the industry the Deloitte report identifies with the most aggressive deployment plans is healthcare and life sciences: 35 percent of respondents in that industry say their companies plan to deploy blockchain in production within the next calendar year. When you look at some of the blockchain healthcare initiatives already out there, that stat starts to make a lot of sense.

One exciting project Forde pointed to is MedRec, an MIT initiative creating a blockchain to serve as a digital family history of medical records. Think about sitting down in a doctor's office and being asked your family medical history for a certain illness. You might, off the top of your head, have no idea of the answer. But with MedRec blockchain, families and medical providers can create a shared medical history that can be passed from generation to generation.



“With medical records, we’re all asked that question: Is there any family history of this? The answer is usually ‘I don’t know,’” said Forde. “What’s interesting here, as a result of the Affordable Care Act (ACA), we now have this mandate for electronic health records, and the government subsidizes doctors to get those records. But that data is still siloed. There needs to be a technology or protocol allowing all that data to be shared, regardless of provider. MedRec helps facilitate that. It’s not just about the interoperability of your data; it’s also about the protection of your data from fraud.”

Forde said the project is also evolving as a way for hospitals and medical practices to interface with consumer tech. Think about all the real-time health data collected by wearables and fitness trackers and even apps like Apple Health. MedRec is exploring the possibility of using blockchain to give doctors and hospitals access to that data, if you consent.

“You’ve got Fitbit, Apple Watch, all this consumer tech collecting data on your blood pressure, heart rate, etc,” said Forde. “Then you go to the hospital or your doctor and they have their own system. You see the allergist and they’ve got their own system, and none of it is connected. If there’s no interoperability between any of these systems, how are you going to get the best possible care?”

The federal government recognizes blockchain’s potential for health care, and the Department of Health and Human Services (HHS) is already doing something about it. The HHS Blockchain Challenge gathered more than 70 submissions of academic papers on blockchain usage in health IT and health-related research, announcing 15 winners this past September spanning organizations including Deloitte, IBM, MIT (MedRec was one of the winners), and The Mayo Clinic. The winners, who presented to the HHS for possible development and implementation, proposed blockchain solutions for everything from health insurance claims and payments to data interoperability and Medicaid applications. The Chamber of Digital Commerce, which participated in the challenge, sees blockchain’s potential to transform healthcare and beyond.

“The HHS received so many amazing ideas,” said the Chamber’s Perianne Boring. “In the healthcare industry, we are seeing a huge influx of interest and a lot of major problems blockchain is addressing, from patient privacy and electronic health records to tracking pharmaceuticals and doctor shopping.

Blockchain is also extremely powerful when it comes to victims of identity theft. Using the security of blockchain provides a degree of certainty that can be used to confirm your digital identity as we do more and more of our daily activities online.”



The security of blockchain provides a degree of certainty that can be used to confirm your digital identity.



That notion of identity is key. Through the digital “wallet” a blockchain creates around not only virtual money but the pieces of data that make up your identity, blockchain will act as a gatekeeper of sorts to how we interact with the digital world. Blockchain-based identity is being explored and experimented with in a host of ways, from the IoT governance model to more secure voting, and in the case of Blocksafe, as a way to reduce gun violence by securing firearms with “smart locks.”

“These digital wallets will become control centers,” explained Bloq’s Jeff Garzik.” In a multi-chain, multi-network world, you wind up with a digital experience that secures itself with several factors of authentication. Then once [the blockchain verifies] that I’m Jeff Garzik, it’ll say things like, ‘Do you want to send your autonomous car from home over to your wife’s office? Do you want to unlock the door for a guest coming over? Are you allowed to drink at this bar? Are you licensed to carry a gun?’”

One of the futures envisioned in *Blockchain Revolution* is a “second era of democracy,” one in which blockchain technology can create the conditions for fair, secure, and convenient digital voting that galvanizes the citizenry by removing so many of the systemic voting roadblocks plaguing our current system. Putting democracy on a blockchain is complicated, but startups including Follow My Vote and Settlemint are already laying out frameworks centered around blockchain-based tokens serving as votes, dropped in digital wallets for each candidate.

At a time in America when the integrity of our voting process is under intense scrutiny, blockchain—and every manifestation of the technology laid out in this story—could provide a new way forward. The book points to a 2015 paper published by the University of Athens introducing DEMOS, an end-to-end e-voting system, and an organization and “political app” in Australia called Flux that’s already using blockchain voting to try to transform the political process. When I spoke to Don Tapscott for this story, he discussed how the opportunity to “reinvent democracy” speaks to the universal power of blockchain:

“Young people didn’t vote in [the 2016 presidential] election because they’re not engaged. We urgently need to fix this. In the book, we argue for a new era of democracy based on accountability, smart contracts, and a culture of public deliberation and active citizenship enabled by the blockchain,” said Tapscott. “We should move many things onto blockchains. I think governments could move toward creating a blockchain-based identity. Think about your health records, your academic records, your citizenship and ability to vote, all unified and facilitated via blockchain. As a voter, you need 100 percent assurance that your vote was counted for the person whom you voted, that it can’t be reallocated, and that it was private. In e-voting, only blockchains can guarantee that level of assurance.

“But it goes far beyond e-voting,” Tapscott continued. “Leaders could come to power with a smart contract where they’re accountable to citizens and have to abide by the terms of the contract. There are opportunities everywhere. Look at the different hats we all wear every day. You’re a parent, a consumer, a listener of music, an employee, a voter, a citizen. Blockchain affects you in every way.”

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