NOVEMBER 2017

Blockchain Primer
From Enabling Bitcoin to Blocking Blood Diamonds

Introduction: Is Blockchain a Fad — or a Revolution?

> Over the past decade, blockchain has become one of the toasts of the technology universe.

Blockchain has been called "the invisible technology that's changing the world."[1] Some have claimed that "blockchain will revolutionize business and redefine companies and economies."[2] Others have billed it as a life-altering system that may soon rival the internet in its reach and impact, a ubiquitous force for connectivity, prosperity, innovation, and social change whose reach will span the globe.

Simply put, over the past decade, blockchain has become one of the toasts of the technology universe. Yet few grasp the underpinnings of blockchain and its true potential. It is not quite a household term. It is not something we can feel in our hands like a smartphone or see on our screens like a web browser. It is not currently a tangible part of our daily lives, nor are its uses and applications widely understood by everyday consumers.

So, for starters, what is blockchain? Blockchain is a technology based on distributed ledgers. Many may recognize "ledgers" as an accounting term. Ledgers provide a way to catalogue and account for data. They are an element of recordkeeping that date to the pre-digital world. Blockchain technology

---

1   Rob Marvin, "Blockchain: The Invisible Technology That's Changing the World," *PCMag* (August 29, 2017), available at https://www.pcmag.com/article/351486/blockchain-the-invisible-technology-thats-changing-the-wor.

2   Marco Iansiti and Karim R. Lakhani, "The Truth About Blockchain," *Harvard Business Review* (January–February 2017), available at https://hbr.org/2017/01/the-truth-about-blockchain.

allows for distributed ledgers — essentially shared recordkeeping — that can maintain a constantly expanding list of transactions in a transparent, secure, and lasting way. What makes blockchain unique and innovative is that participants in peer-to-peer networks can view updates on record edits as they happen, making it unnecessary to have a third party to gather, edit, or distribute those changes.[3]

When users submit transactions, they add their "block" to a series of sequential blocks "chained" together by a cryptographic hash function. Cryptographic hash functions assign unique, immutable, and irreversible data values to each block. That process begins with the initial block of the chain, a pre-computed block called the "genesis block." Every user transmits information directly, without relying on trusted intermediaries like lawyers, brokers, or financial institutions that are ordinarily required to verify transactions between entities who might not know each other. This is because most blockchains operate using the "proof-of-work" paradigm. Transactions are broadcast to the peer-to-peer network and verified by peers of the network called "miners," that confirm the validity of new transactions.

Distributed ledgers are built so that anyone with access to the database can view its complete history — and no single person or party controls it. The strength of blockchain lies precisely in it being a decentralized distributed ledger. To ensure that the transactions are legitimate, updates to the blocks or records are authenticated and verified through digital signatures and encryption.[4]

Blockchain is perhaps best known as the underlying technology behind Bitcoin, enabling users to verify purchases, track exchanges of funds, and keep records that anyone can audit. However, it has applications that extend beyond currency transactions. Uses and implementations open a world of opportunity for industries and end users. Indeed, blockchain is slowly emerging as a virtual foundation for massive shifts in how business is conducted across different sectors and industries.

The case studies outlined in this primer and many more potential uses — involving contracts, agreements, land transfers, information about identities, purchases, and global supply chains — all will have a digital record and signature that are private and secure and can be stored, verified, and easily shared.

If the applications of blockchain are leveraged, it can transform old industries and create new ones. The potential is tremendous and the options limitless.

> Blockchain is perhaps best known as the underlying technology behind Bitcoin, enabling users to verify purchases, track exchanges of funds, and keep records that anyone can audit.

---

[3] U.S. House of Representatives Committee on Energy and Commerce, "The Disrupter Series: Digital Currency and Blockchain Technology" (March 14, 2016), available at http://docs.house.gov/meetings/IF/IF17/20160316/104677/HHRG-114-IF17-20160316-SD002.pdf.

[4] U.S. Postal Service Office of Inspector General, "Blockchain Technology: Possibilities for the U.S. Postal Service" Report no. RARC-WP-16-011 (May 23, 2016), available at https://www.uspsoig.gov/sites/default/files/document-library-files/2016/RARC-WP-16-001.pdf.

Real-World Applications: The Possibilities May Be Endless

Blockchain's potential uses are diverse, varied, and broad, ranging from real estate and finance to legal systems and global supply chains.

Perhaps the best part about this technology is that it simplifies and secures the processes of signing agreements, tracking goods, and collecting information. Blockchain enables access to contracts and records under certain conditions or times.[5] When an individual agrees to share an agreement at a given time or for a specific purpose only, blockchain technology ensures that this occurs seamlessly. When labeled as a transaction, this codification provides a source of security without the chance for third-party interference or fraud. What once may have required multiple hard-copy documents, an agent or broker, a handful of websites, and a complicated ledger of transactions, can all be compiled on a single chain.

Blockchain can verify the details of a contract or sale, the signing and execution of that contract, the connections between multiple businesses and parties, and the identity of individuals into one place, as seen in the examples that follow — each of them parts of a portrait of how blockchain is already changing the way we do business.

> Blockchain's potential uses are diverse, varied, and broad, ranging from real estate to finance to legal systems to global supply chains.

The Rise of Smart Contracts

Too often, small- and medium-sized businesses suffer and jobs are lost because transaction costs are high; different companies' databases are incompatible with one another; and payment flows for products and sales are outdated.

Blockchain can resolve these challenges through arguably its most far-reaching application thus far: the development and execution of "smart contracts."

Here's the idea behind smart contracts: Rather than simply using blockchain to track financial transactions, blockchain can be designed to automatically implement the terms of any agreement once certain benchmarks are met. These accords can self-execute, without needing an outside validator to confirm that the terms of the contracts have been fulfilled; instead, once the agreed-upon actions have occurred, all parties can immediately validate the outcome — no third party is required.[6]

---

5   Kevin Peterson, Rammohan Deeduvanu, Pradip Kanjamala, and Kelly Boles, "A Blockchain-Based Approach to Health Information Exchange Networks," HealthIT.gov, available at https://www.healthit.gov/sites/default/files/12-55-blockchain-based-approach-final.pdf.

6   For more, see Institute for Development and Research in Banking Technology, *Applications of Blockchain Technology to Banking and Financial Sector in India*, available at http://www.idrbt.ac.in/assets/publications/Best%20Practices/BCT.pdf.

Here's the benefit of smart contracts: Greater efficiency, clarity, and consistency across business dealings of all kinds. For instance, through blockchain technology, smart contracts can create invoices that pay a supplier when a shipment is received.[7] Or a firm could indicate via blockchain that a product has been delivered. Or a specific good could have a GPS signal connected to it, which would instantaneously log an update on its location, ultimately triggering a transfer of funds once the final destination is reached.

Already, smart contracts are in use in areas like venture capital funding, finance, and digital rights management.[8] But the possibilities reach much further. These self-executing compacts could change the face of business relationships — for the better — in the years ahead.

A Seamless Land Registry

In Ghana, most of the official documentation is outdated; local leaders often have their own ways of tracking titles; and no single, consistent ledger exists of all holdings.

A nonprofit organization, Bitland Global, seeks to record and track all land title transactions using blockchain technology. In the process, the organization hopes to enable more timely access to ownership information; create a land registration process that is more transparent and free from government corruption; and educate people on the significance of property rights to the growth of the broader economy.

Here's how blockchain is used for property transactions: By establishing one registry of property transactions and ownership in the country, a blockchain-based ecosystem is built where contracts can be written, signed, executed, and used by individuals, households, government officials, and organizations on the ground.

On top of the immediate benefits to landowners domestically, this system will also open new opportunities for foreigners interested in investing in Ghana's real estate by reassuring them that their transactions will happen without the risk of corruption or fraud.

This effort could see blockchain play a central role in boosting prosperity, increasing accountability, reducing litigation bottlenecks, and strengthening Ghana's legal system overall.[9]

> By establishing one registry of property transactions and ownership in the country, a blockchain-based ecosystem is built where contracts can be written, signed, executed, and used by individuals, households, government officials, and organizations on the ground.

---

7   For more, see "The Great Chain of Being Sure About Things," *The Economist* (October 31, 2015), available at http://www.economist.com/news/briefing/21677228-technology-behind-bitcoin-lets-people-who-do-not-know-or-trust-each-other-build-dependable.

8   Iansiti and Lakhani, "The Truth About Blockchain," https://hbr.org/2017/01/the-truth-about-blockchain.

9   For more, see L. Chris Bates, *Bitland Global White Paper* (January 11, 2016), available at http://www.bitland.world/wp-content/uploads/2016/03/Bitland_Whitepaper.pdf.

Enhancing Food Safety Worldwide

Everyone has seen the headlines: the recurrent tales of the latest outbreak of food contamination or the newest string of diners sickened by a dish at a popular restaurant. This phenomenon is not limited to the United States; globally, nearly 600 million people fall ill eating contaminated food each year, and hundreds of thousands die. There has to be a better way to prevent this unnecessary exposure to illness and spread of disease.

Here's how blockchain can resolve this food safety risk: It can be the cornerstone of a better, more open and fluid process for producing, inspecting, and delivering food around the world. It can enable producers and distributors to track the authenticity and safety of their goods through an unchangeable, trustworthy digital ledger that anyone can see. It can help restore consumers' faith in the international food supply chain.

IBM recently put this notion into practice. The company found that digitally tracing the provenance and movements of food from suppliers to store shelves provided purveyors with the ability to confirm the quality of their products instantly. This gave them, and their customers, greater confidence in the safety of their food.[10]

In effect, with blockchain, when a problem presented itself, it was clear where the issue originated. IBM simply had to pinpoint the step where the food was tainted or something was amiss — and no one could alter the data along the way.

Taken to a broader level, using blockchain makes it easier to identify the weak link in the food safety process without requiring the shutdown of multiple restaurants or supermarkets or the removal of products from the shelves; we could simply find the block where the damage was done and seek ways to fix it, without upending the rest of the system.

> Blockchain can be the cornerstone of a better, more open and fluid process for producing, inspecting, and delivering food around the world.

Creating a Digital ID Recognized Worldwide

Around the world right now, upwards of one billion people lack official documentation of who they are, where they were born, or where they live.

Without a form of identification, it becomes difficult — and, oftentimes impossible — to apply for a job or gain access to basic services like education or quality health care. This crisis has become especially acute as global refugee flows have reached record levels in recent years. Migrants and families fleeing their homes find themselves in foreign countries and new communities without any proof of their identity or background, unable to pin down employment or rebuild their lives.

---

[10] Bridget van Kralingen, "Blockchain's Role in Improving Global Food Safety," IBM ThinkBlog (October 19, 2016), available at https://www.ibm.com/blogs/think/2016/10/blockchain-food-safety/.

Here's how blockchain can be the solution to this challenge, too: Accenture and Microsoft are joining forces to build a digital ID network on the backs of blockchain technology. The effort seeks to help individuals, particularly refugees, prove their personal history as they attempt to gain access to education, financial institutions, hospitals, and necessities of every kind.[11]

This dynamic platform will use blockchain to link existing records and systems across borders and allow people to retrieve their personal information no matter where they are — demonstrating how this public database once unique to currency exchanges can be applied to track data in a wide range of fields and contexts.

Developing a Groundbreaking Learning Platform

The University of Texas System recently partnered with Salesforce to build a next generation learning platform. The initiative is called Total Educational Experience (TEx) 2.0.[12] Among its many capabilities, TEx 2.0 will give students real-time feedback on their work and provide faculty with dedicated insight on individual student progress. The new and improved digital educational environment will equip students and faculty with the resources needed for a high-quality learning experience.

Here's how blockchain will revolutionize higher education: TEx 2.0, built on the Salesforce platform, incorporates the ChainScript and is one of the first uses of blockchain on the Salesforce platform. With ChainScript, students will be able to keep a permanent, immutable track record of all their earned credits, certificates, skills, and other elements of their academic journey. Most importantly, it will shift the academic transcript as we know it into a decentralized and authenticated permanent record on the blockchain. The ability to track accomplishments across different institutions and educational experiences can have a tremendous effect in removing obstacles and ensuring learners reach their academic goals.

> With ChainScript, students will be able to keep a permanent, immutable track record of all their earned credits, certificates, skills, and other elements of their academic journey.

---

[11] Press Release, "Accenture, Microsoft Create Blockchain Solution to Support ID2020," Accenture (June 19, 2017), available at https://newsroom.accenture.com/news/accenture-microsoft-create-blockchain-solution-to-support-id2020.htm.

[12] Press Release, "UT System Partners with Tech Industry Leader to Develop Next-Generation Learning Platform," The University of Texas System (September 27, 2016), available at https://www.utsystem.edu/news/2016/09/27/ut-system-partners-tech-industry-leader-develop-next-generation-learning-platform.

Tracking Diamonds

Tracking and authenticating goods, especially luxurious ones, can sometimes be a hassle plagued with fraud and corruption. Everledger is a company that uses blockchain to track diamonds from their origins all the way to the store.[13] For diamond shoppers, this means being able to identify whether their diamond of choice has been mined ethically and if it is has met all the legalities necessary to reach its final destination.

Here's how blockchain helps track diamonds: Knowing a diamond's origin can help consumers avoid the so called "blood diamonds" while raising awareness and enhancing the security measures surrounding mining and transportation of the gems.

The policy implications of blockchain technology will require close study and exhaustive research so leaders can help maximize the economic and societal benefits of this emerging infrastructure and address challenges from the outset.

Policy Challenges and Implications

The policy implications of blockchain technology will require close study and research so leaders can help maximize the economic and societal benefits of this emerging infrastructure and address challenges from the outset.

Several areas of law could be affected and will demand resolution or direction. For instance, are smart contracts covered by existing legal frameworks, such as standard contract law? Are current consumer protections sufficient? On top of that, who will bear responsibility for oversight and operation of the smart contracts?

And what about regulations related to supply chains, particularly when products cross borders? If we eliminate the intermediaries, who will supervise the process, the movement of goods, the payments for services rendered, or address any glitches along the way?

The list could go on. There are critical questions to be addressed. And we encourage governments around the world to start considering these issues. We need the public sector to create an environment that enables companies and entrepreneurs to innovate, experiment, prosper, and thrive.

We need leaders in global capitals to be partners in tapping into the growing economic possibilities at hand. In fact, we believe governments should serve as an example in this regard, seeking out opportunities to leverage blockchain technology in order to better serve their citizens.

---

[13]   Learn more at Everledger, available at https://www.everledger.io/.

Conclusion

It is no longer a question that blockchain has the potential to change the way we conduct business, interact, execute agreements, exchange goods and money, and much more.

The extent of its reach and effect is yet to be determined. The capabilities of blockchain need to continue to be explored, recognized, and implemented. It is important that the private and public sectors work together to drive innovation and discovery of the technology.

Think Deeply

Give Back

Look Forward

Software.org: the BSA Foundation is an independent and nonpartisan international research organization aimed at educating policymakers and the broader public about the hugely positive impact that software has on our lives, our economy, and our society.