Blockchain

A technical primer

Dawn of a new era

Blockchain, in many ways, appears to signify the dawn of a new era as it relates to the way we store and exchange value. In fact, it can be considered one of the biggest technology breakthroughs in recent history, similar to the advent of the Internet in the early 1990s. At that time, the Internet provided a new and more sophisticated way to search and share information, a way that was much more efficient and transparent.

Today, blockchain presents a similar value proposition and provides a way to transact in a secure, immutable, transparent, and auditable way. However, the understanding of the technology varies widely in terms of its potential and applicability. Through this primer, we aim to demystify blockchain and share our assessment of the current and future landscape, key drivers and impediments, potential applications, and considerations for companies.

Defining blockchain

A blockchain is a digital and distributed ledger of transactions, recorded and replicated in real time across a network of computers or nodes (figure 1). Every transaction must be cryptographically validated via a consensus mechanism executed by the nodes before being permanently added as a new "block" at the end of the "chain." There is no need for a central authority to approve the transaction, which is why blockchain is sometimes referred to as a peer-to-peer trustless mechanism.

Blockchain utilization

Broadly, there are three levels of blockchain utilization[1] (figure 2):

Storage of digital records: Blockchain can be used to store digital identities of individuals, organizations, assets, titles, voting rights, and essentially everything that can be represented digitally.

Exchange of digital assets: Blockchain can execute peer-to-peer transactions without trusted third-party intermediaries, reducing clearing and settlement times and related costs.

Recordation and execution of smart contracts: Simply put, smart contracts are digital codes that enable the automated execution of specified actions based on contractual conditions as validated by all the parties. Think of smart lease contracts, which enable automated rental payments, or smart loan contracts, which transfer the asset ownership in case of a default.[2] In that way, smart contracts can not only auto-execute recurring business transactions but also potentially help to reduce contractual defaults. Smart contracts recorded in a blockchain are immutable, so high-quality code is required to avoid errors and fraud.

Implementation of blockchain can be classified into two types: public and permissioned. Public blockchains are open and allow anyone to confirm transactions; permissioned blockchains are only accessible to pre-approved parties.

Understanding blockchain's competitive landscape and quantifying its potential

Blockchain's ecosystem, like its technology, is rapidly evolving and we are witnessing the development of new platforms, applications, consortia, and partnerships. Many companies are collaborating with blockchain start-ups and some of the large players are even developing their own solutions and filing patents.[3] In addition, most companies are opting to be a part of a consortium, which typically includes industry players, regulators, and governments.[4] These groups typically support the development of decentralized business platforms and applications.

Prominent blockchain consortia include Enterprise Ethereum Alliance, R3, and Hyperledger, which provide open source platforms to enable cross-industry applications of blockchain, rather than just being limited to the cryptocurrency world.[5] The number of projects based on these platforms has witnessed a sharp rise in the last few years. For instance, according to GitHub, a global software collaboration platform, Ethereum hosted 9,970 projects in mid-2017, compared to 1,439 projects in 2015 and starting from 3 projects in 2013.[6]

In terms of growth and market potential, most estimates project a robust growth rate for the blockchain market in the next few years. For instance, according to one estimate, the global blockchain technology market is expected to grow at a compounded annual growth rate (CAGR) of 62.1 percent between 2015 and 2025 to reach $16.3 billion.[7] The potential in terms of business impact is even more optimistic. According to Gartner, "The business value-add of blockchain will grow to slightly more than $176 billion by 2025, and then it will exceed $3.1 trillion by 2030."[8]

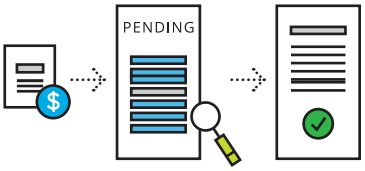
Figure 1. How does blockchain work?

Blockchain allows for the secure management of a shared ledger, where transactions are verified and stored on a network without a governing central authority. Blockchains can come in different configurations, ranging from public, open-source networks to private blockchains that require explicit permission to read or write. Computer science and advanced mathematics (in the form of cryptographic hash functions) are what make blockchains tick, not just enabling transactions but also protecting a blockchain's integrity and anonymity.

1

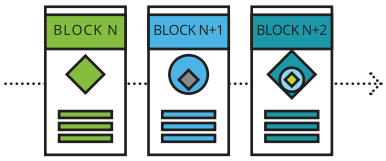
TRANSACTION Two parties exchange data; this could represent money, contracts, deeds, medical records, customer details, or any other asset that can be described in digital form.

2



VERIFICATION Depending on the network's parameters, the transaction is either verified instantly or transcribed into a secured record and placed in a queue of pending transactions. In this case, nodes—the computers or servers in the network—determine if the transactions are valid based on a set of rules the network has agreed on.

3



STRUCTURE Each block is identified by a hash, a 256-bit number, created using an algorithm agreed upon by the network. A block contains a header, a reference to the previous block's hash, and a group of transactions. The sequence of linked hashes creates a secure, interdependent chain.

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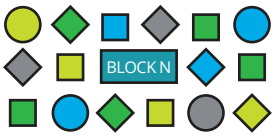

VALIDATION Blocks must first be validated to be added to the blockchain. The most accepted form of validation for open-source blockchains is proof of work—the solution to a mathematical puzzle derived from the block's header.

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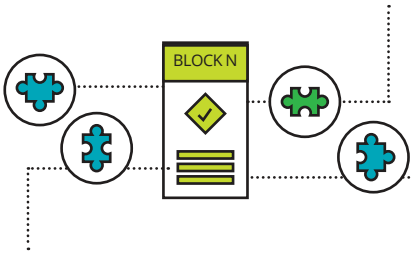

BLOCKCHAIN MINING Miners try to "solve" the block by making incremental changes to one variable until the solution satisfies a network-wide target. This is called "proof of work" because correct answers cannot be falsified; potential solutions must prove that the appropriate level of computing power was drained in solving.

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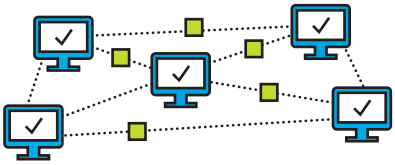

THE CHAIN When a block is validated, the miners that solved the puzzle are rewarded and the block is distributed through the network. Each node adds the block to the majority chain, the network's immutable and auditable blockchain.

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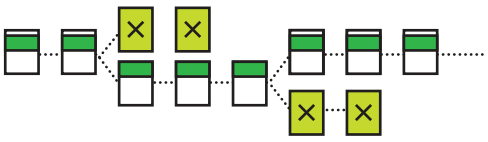
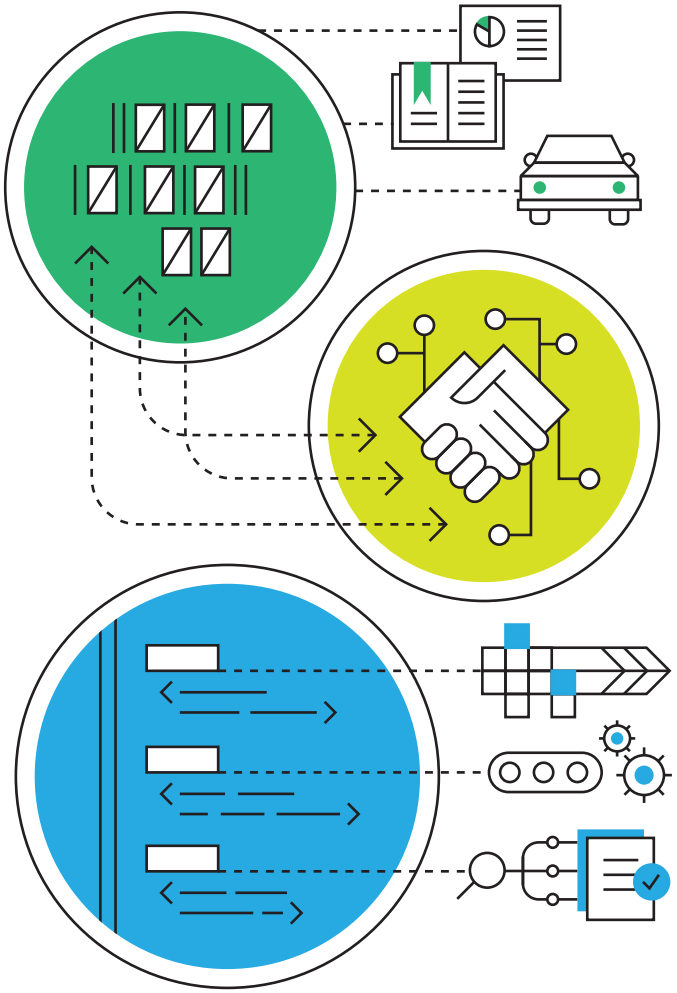


BUILT-IN DEFENSE If a malicious miner tries to submit an altered block to the chain, the hash function of that block, and all following blocks, would change. The other nodes would detect these changes and reject the block from the majority chain, preventing corruption.

Source: Eric Piscini, Joe Guastella, Alex Rozman, and Tom Nassim, *Blockchain: Democratized trust*, Deloitte University Press, February 24, 2016.

Figure 2. Three levels of blockchain



1 Storing digital records

Blockchain allows unprecedented control of information through secure, auditable, and immutable records of not only transactions, but also digital representations of physical assets.

2 Exchanging digital assets

Users can issue new assets and transfer ownership in real time without banks, stock exchanges, or payment processors.

3 Executing smart contracts

Self-governing contracts simplify and automate lengthy and inefficient business processes.

Ground rules: Terms and conditions are recorded in the contract's code.

Implementation: The shared network automatically executes the contract and monitors compliance.

Verification: Outcomes are validated instantaneously without a third party.

Source: Eric Piscini, Gys Hyman, and Wendy Henry, "Blockchain: Trust economy," *Tech Trends 2017*, Deloitte University Press, February 7, 2017.

Key drivers, challenges, and potential solutions of blockchain

The growth of blockchain technology is driven by many factors, including:

- **Lower costs of bandwidth, data storage, and computing:** Like other technologies, blockchain also benefits from declining costs and rising capabilities in computing, storage, and bandwidth.[9] This enables multiple nodes in a blockchain network to connect and act in a seamless manner.
- **More efficient way to maintain trust:** With increased globalization and digitization of businesses, maintaining trust can become expensive, time consuming, and inefficient.[10] Blockchain's immutability would increase the reliability of data and counterparties with reduced chances of fraud, thereby increasing trust. For example, two business parties transacting would not need to maintain their own record of the transaction

and would use the blockchain as a single source of truth instead.

- **Prevalence of decentralized business models:** Decentralized business models are becoming more common in a world of the "sharing" economy. However, these models still have large aggregators that control the information and systems, implying unequal redistribution of value among all contributors.[11] Blockchain can democratize the value exchange in sharing-economy businesses by removing the need for centralized aggregators.

While the above factors, among others, seem to be driving blockchain's adoption, there are certainly some challenges that should be tackled to ensure wider and smooth adoption of the technology.

- **Low awareness and understanding:** This might be the principal challenge related to blockchain technology. According to Deloitte's 2016 executive survey on blockchain technology,[12] 39 percent of senior executives at large US organizations have little or no knowledge of blockchain.[13] To remedy this, executives can connect with industry thought leaders, get access to existing use cases, or connect with industry associations.
- **Lack of standards and best practices:** There is a lack of uniform standards on blockchain technology even as new blockchain-based solutions are being developed. According to the Deloitte survey, 56 percent of executives consider technical standards as critical for wider adoption.[14] Industry players would need to collaborate better to build uniform standards and protocols rather than develop their own internal versions.
- **Regulatory and legal uncertainty:** As often, regulations have not kept pace with the advances in technology. Any regulation that recognizes blockchain applications, including smart contracts or digital identities, can provide a big boost to its adoption. According to the Deloitte survey, 48 percent of executives believe that federal regulations around blockchain applications could boost adoption.[15] Industry players can work in tandem with the regulators to devise enabling regulations in a phased manner. Similarly, smart contracts' validity is not yet recognized in court, although many states and countries are reportedly working toward it.

Blockchain goes way beyond FSI

The general perception of blockchain is that the technology is primarily applicable to the financial services industry. Of course, much of this perhaps comes from more popular use cases in the cryptocurrencies and payments space as FSIs have been the early adopters. In reality, blockchain has applications across several other industries (table 1),

In addition to the above challenges, there are some key implementation considerations and questions that companies will likely need to address, such as technology, operations, talent, and compliance. For detailed insights on these and other technical challenges, please refer to Deloitte's recent report, *Taking blockchain live*.

For further insights on blockchain, please refer to the other *publications on Deloitte Insights*, including *Blockchain: Democratized trust* and *Blockchain to blockchains: Broad adoption and integration enter the realm of the possible.*

"Most financial services companies have been involved in blockchain via their labs, investments, and pilots for a while now. Other industries are now starting to realize the potential for disruption, as well as the new opportunities that blockchain creates."[16]

— Eric Piscini, principal, Deloitte Consulting LLP and global financial services blockchain leader

Table 1. Blockchain and its applications across industries

Industry	Blockchain-based applications
Financial services	• International payments in a faster, cheaper, and more secure way with lower counterparty risk[17] • Registry for better Know Your Customer (KYC) checks and compliance[18] • Trade finance blockchain platform to improve and accelerate the financing of international trade
Health care	• Ability to share clinical trial launches and enrollments in real time to better match patients and prevent double enrollments • Smart contracts to connect different parties—such as providers, insurers, vendors, and auditors—and automate transactions[19]
Public sector	• Registry to manage the digital identity of people and the ownership and transaction information on different assets such as real property and vehicles to increase efficiency and reduce fraud[20] • Enhanced security and transparency of voting in public election[21]
Energy and resources	• Smart contracts for more efficient and faster execution of energy trades and payments[22] • Managing and recording oil and gas transactions and connecting suppliers, shippers, contractors, and authorities via blockchain to improve supply chain processes[23]
Technology, media, and telecom	• Storing cryptographic hash of original music, linked to digital identities of owners, and using smart contracts to facilitate compensation for music[24] • Supporting data storage and interaction among a large number of IoT devices in a cryptographic format to help mitigate security concerns[25]
Consumer and industrial products	• Better management of loyalty points programs in retail and travel and hospitality[26] • Streamlining the vehicle buying and leasing process with less documentation and automated payments[27] • Enhanced supply chain management, especially traceability across products from its inception at manufacturer to usage by end customer[28]

which seem to be gradually realizing the technology's potential.

Why should companies care?

Blockchain as a technology seems too valuable to be ignored. While process efficiencies and better security are key benefits that are being targeted, perhaps the real value proposition and potential lies in the new revenue and solutions that could be enabled by the technology. Indeed, according to the Deloitte survey, 24 percent of executives believe that blockchain can facilitate new business models and more than two-fifths of the respondents who know blockchain expect it to disrupt their industries.[29]

However, as highlighted earlier, many senior executives are not well informed. This makes a strong case for everyone to understand the fundamentals of blockchain and how it applies to their respective industries.

In addition, because blockchain can be particularly advantageous when business partners exchange value, business consortia are important to increase adoption. As examples, B3i and HKMA are industry-led consortia getting business partners to collaborate on new reinsurance and trade finance platforms.

Joining consortia can be a good way to know the latest trends and be part of the technology's evolution. In addition, companies should coordinate with their key stakeholders, including customers, suppliers, and business partners, as the benefits of blockchain could be enhanced if they are on board as well.

Having said that, blockchain is certainly not the magic potion for all cost- and efficiency-related issues and businesses should carefully assess the technology's applicability and feasibility to different processes. In fact, cryptography-based trust models could bring new and unforeseen risks, so companies would need to consider appropriate changes in their risk management strategy and governance models.[30]

Final thoughts

It could take a few years before we see wide commercialization of blockchain platforms and applications. While many challenges may remain, from lack of regulatory and legal frameworks to rapid technology changes, from talent gaps to consortium building, it is important to not underestimate the impact of blockchain. Every transaction platform and fabric that we know today will likely be either improved or replaced by a blockchain-based solution. Engage now to build your future on blockchain or wait for others to create the future you will likely have to join.

ENDNOTES

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CONTACTS

Eric Piscini
Global Financial Services Blockchain leader
Principal
Deloitte Consulting LLP
+1 404 631 2484
episcini@deloitte.com

Mark Cotteleer
Research director
Center for Integrated Research
Deloitte Services LP
+1 414 977 2359
mcotteleer@deloitte.com

Jonathan Holdowsky
Senior manager
Center for Integrated Research
Deloitte Services LP
+1 617 437 3198
jholdowsky@deloitte.com

Blockchain technology is emerging as a business focus for organizations in several industries, including consumer products, manufacturing, financial services, health care, life sciences, and public sector. Termed the "Internet of Value," blockchain asserts trust, immutability, transparency, and security along with time and cost efficiencies. Deloitte helps companies achieve many goals with respect to blockchain implementation—innovation and ideation, strategy development, prototyping, and product development. Our ecosystem for education, ideation, strategy, prototyping, and development supports our clients in harnessing the opportunities and capabilities that blockchain technology has to offer. Contact our team to understand how to make blockchain a reality for your clients.

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Contributors

Editorial: Rithu Thomas, Preetha Devan

Creative: Anoop K R, Kevin Weier, Mahima Dinesh Nair

Promotion: Devon Mychal

Artwork: Mengxin Li

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