February 2018

The Essential Eight technologies
Board byte: blockchain

Blockchain technology has the potential to disrupt many aspects of how companies do business. What should boards know?

Blockchain is a nascent technology that can simplify and secure transactions among parties. But there are many misconceptions about the new technology. And it poses certain risks. Boards should understand these risks, as well as the potential opportunities and the impacts on company strategy.

Imagine not having to use a middle man for any transaction. That's one of the key advantages of blockchain technology. There has been a lot of buzz about blockchain, but what is it, exactly?

A blockchain is a ledger of all transactions in a network. It is decentralized, meaning that it is not stored in any single location. Participants in the network themselves confirm the transactions, or "blocks." So there is no need for a trusted third-party intermediary. Blockchain can have powerful applications in payments, supply chains and voting. But it is a nascent technology. There is a long way to go to realize such ambitions.

Blockchain is built on four main concepts:

1. It is a distributed ledger, so every participant in the network has simultaneous access to a view of the information.

2. Cryptographic functions ensure the integrity and security of the information.

3. Participants confirm changes directly with one another. This replaces the need for a third party to authorize transactions.

4. It can run additional business logic (set by computer code) that allows the agreement on and automatic enforcement of the expected behavior of a transaction or asset embedded in the blockchain. These are known as smart contracts.

Blockchain's benefit: Is it tamper-proof?

A blockchain's integrity hinges on strong cryptography that validates and chains together blocks of transactions with hashes. Each new block contains a hash of the previous block, making it nearly impossible to tamper with any individual transaction record without being detected.

A hash function is an algorithm that converts an input of letters and numbers into an encrypted output of a fixed length.

Together, these concepts create a powerful opportunity to displace reliance on central trust actors or intermediaries (e.g., brokers, bankers, lawyers, retailers). Other benefits of blockchain can include greater security and transparency and more accurate tracking of transactions, along with a permanent ledger of activity. These benefits are expected to reduce costs for companies.

Many blockchains already exist, and more are being created every day. There is no single version of what a blockchain looks like. They can be open to everyone (public) or for a controlled group (private). The best-known public blockchain is the one that underlies the cryptocurrency bitcoin.

"Blockchain is the first native digital medium for value, just as the internet was the first native digital medium for information."

– Don and Alex Tapscott, "The Impact of the Blockchain Goes Beyond Financial Services," Harvard Business Review, May 10, 2016.
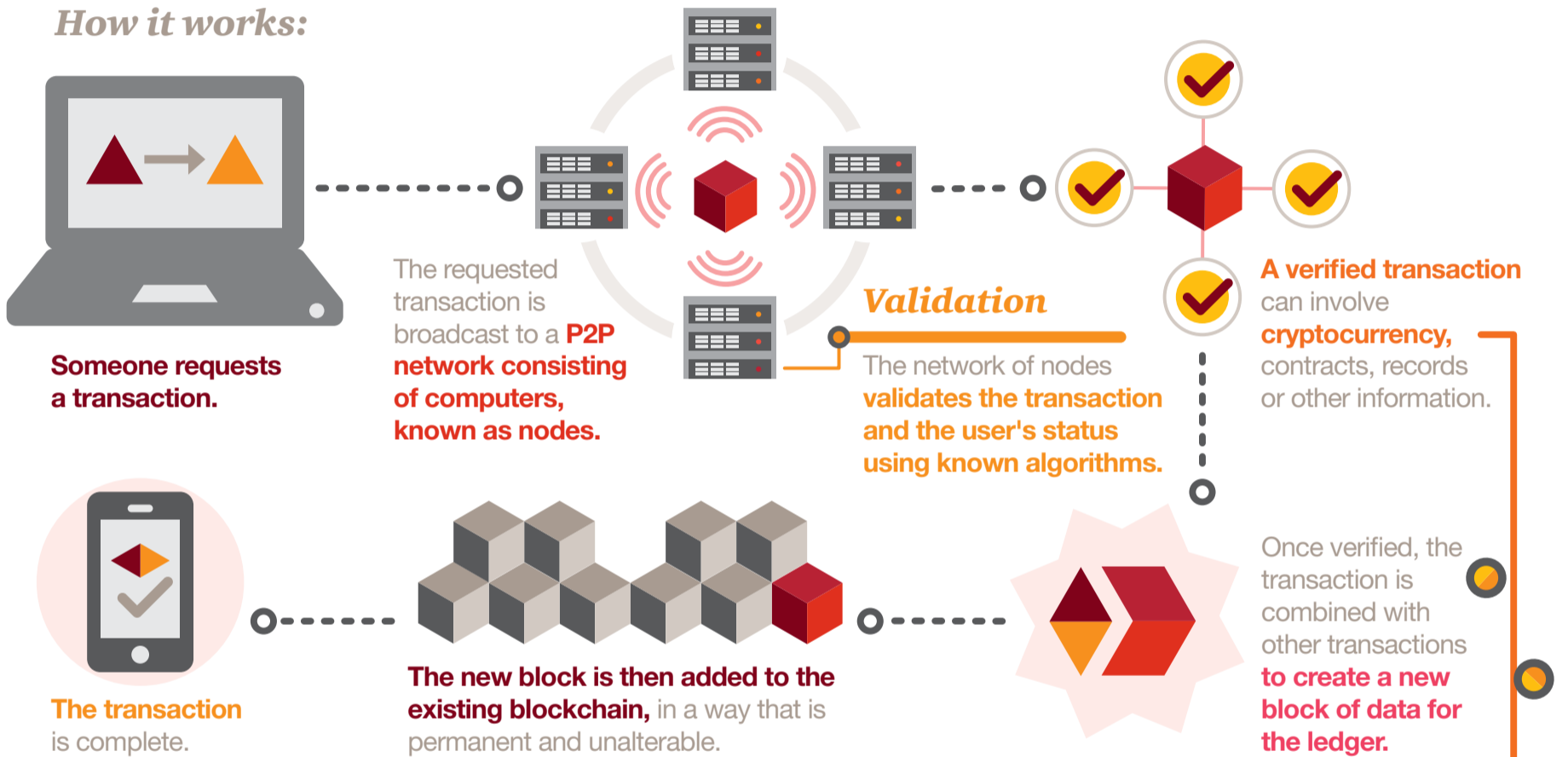
A look at
blockchain technology

What is it?

The blockchain is a decentralized ledger of all transactions across a peer-to-peer network. Using this technology, participants can confirm transactions without the need for a central certifying authority. Potential applications include fund transfers, settling trades, voting and many other uses.

How it works:

Someone requests a transaction.

The requested transaction is broadcast to a **P2P network consisting of computers, known as nodes.**

Validation

The network of nodes **validates the transaction and the user's status using known algorithms.**

A verified transaction can involve **cryptocurrency,** contracts, records or other information.

Once verified, the transaction is combined with other transactions **to create a new block of data for the ledger.**

The transaction is complete.

The new block is then added to the existing blockchain, in a way that is permanent and unalterable.

Benefits

- **Increased transparency**
- **Accurate tracking**
- **Permanent ledger**
- **Cost reduction**

Unknowns

- **Complex technology**
- **Regulatory implications**
- **Implementation challenges**
- **Competing platforms**

Cryptocurrency*

Cryptocurrency is a medium of exchange, created and stored electronically in the blockchain, using encryption techniques to control the creation of monetary units and to verify the transfer of funds. Bitcoin is the best known example.

Has no intrinsic value in that it is not redeemable for another commodity, such as gold.

Has no physical form and exists only in the network.

Its supply is not determined by a central bank and the network is completely decentralized.

Sources: PwC, Next in Tech blog.

PwC, "Money is no object: Understanding the evolving cryptocurrency market, 2015.

strategy+business, "A Strategist's Guide to Blockhcain," January 2016.

TechDay, "How Blockchain Is Disrupting Everything," 2016.

*For more on cryptocurrencies, see page 6.

Looking past the hype to the risks

A solution to sharing your personally identifiable information?

Networks using blockchain-style immutability and encryption are being designed to eliminate the need to share personally identifiable information online. The Sovrin Network, for example, uses unlinked identifiers and verified assertions (third-party attestations that function like physical credentials) that can be shared in a trusted way through a distributed ledger. The state of Illinois is considering this approach for birth certificates. Its proposed framework would allow parents and doctors present at a child's birth to officially log that birth on a permissioned blockchain. Government agencies would verify birth registration information and then cryptographically sign identity attributes (e.g., blood type, legal name), creating "verifiable claims." This information would be stored on a tamper-proof distributed ledger and accessible only with consent from a legal guardian. Businesses and governments would be able to verify citizenship by requesting access to this information. The Finnish government and the Canadian Province of British Columbia are also exploring this type of "self-sovereign" identification.
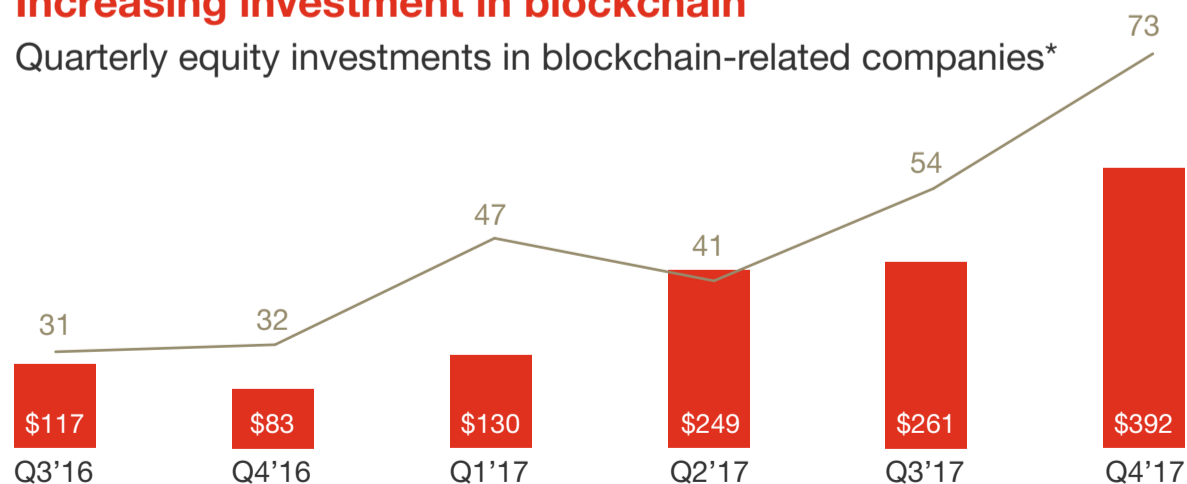
Blockchain offers opportunities, but there are risks, too. It is still an emerging technology, and it needs to be proven before it can be scaled for broader use. While blockchains themselves have unique security features, there is significant risk if the IT environment surrounding blockchain technology has serious weaknesses. A poorly-designed system can make it vulnerable to cybercrimes.

There is also concern about data privacy and personal identity risks. In the case of public blockchains, users are typically identified only by pseudonyms, and transactions are encrypted so no personal information is shared. This protects users' personal identities. But this anonymity can also enable criminal behavior and create a haven for the perpetration of financial crimes. In the case of private blockchains, the group managing the chain's code determines how participants are identified.

These risks should be considered against the security and potential for fraud in the systems blockchain is intended to replace.

Increasing investment in blockchain
Quarterly equity investments in blockchain-related companies*

	Q3'16	Q4'16	Q1'17	Q2'17	Q3'17	Q4'17
Number of equity deals	31	32	47	41	54	73
Total equity funding (in millions)	$117	$83	$130	$249	$261	$392

*Excluding initial coin offerings
Source: CB Insights, January 18, 2018.

■ Number of equity deals
■ Total equity funding (in millions)

Blockchain technology could add as much as $300 to $400 billion of annual economic value globally by 2027.[1]

How are companies planning to use blockchain?

Settlements/payments

Smart contracts

Supply chain/tracking

Source: Juniper Research, *Blockchain Enterprise Survey*, August 2017.

Blockchain in action: the financial services industry

Companies in the financial services industry have been among the first to adopt blockchain technology. They have focused on two areas: cryptocurrencies and infrastructure. Cryptocurrency applications include payments, digital wallets and trading. Infrastructure solutions look to blockchain technology to replace decades-old infrastructure around networks for trading and exchange transactions. These changes could reduce the risk, fraud and costs inherent in traditional transaction validation and ledger management. Blockchains can eliminate redundancy, version control problems and delays that are standard in today's banking system because every core transaction is processed just once in a single shared electronic ledger.

How could it be used?

Stock exchanges: Blockchain could be used to facilitate the issuance, transfer and settlement of securities.

Post-trading activity: Nearly 40 financial institutions around the world formed the Post Trade Distributed Ledger Working Group to investigate how blockchain technology can be used to enhance the clearing, settlement and reporting of trades.

How do smart contracts work?

Contract definition

Users define the terms and trigger events of their contract(s) and specify parameters between counterparties

⌄⌄

Triggering events

Events trigger contract execution according to pre-defined terms. Devices are interconnected through the blockchain for users to verify the information

⌄⌄

Execution of contract

Upon consensus, the contract terms are executed and blockchain integrations with third-party application programming interfacess are utilized for inter-connected services

⌄⌄

Value transfer & final settlement

Accounts are settled and the information is broadcasted throughout the network

The mortgage industry: From start to finish, buying a home today means dealing with a host of intermediaries, paperwork, fees and time. Real estate registry records, for example, are often antiquated, paper-based and located across various governmental agencies. Moving these documents to a public ledger would streamline the process, reducing the time, paperwork and costs involved in the process.

Cross-border trade: Blockchain has the potential to disrupt trade finance, the millennia-old system relying on mostly paper-based transactions that support the global exchange of goods. Currently, the parties involved (importers, exporters, shippers, bankers, etc.) all maintain their own financial documents and databases for every transaction – which need to be reconciled against each other. Blockchain's smart contracts would automate payments among all parties, and digital documents would eliminate current manual, paper-based systems.

Blockchain: beyond financial services

Blockchain activity is expanding beyond financial services. Companies in shipping, manufacturing, consumer goods, automotive and healthcare, among others, are exploring uses for the technology. They are developing applications in supply chain management, logistics and product origin tracking (i.e., the authenticity, security and traceability of goods).

How could it be used?

Shipping and supply chain management – Moving freight across the globe is a big business. One error or discrepancy in the data can wreak havoc, causing major delays and increased costs. In August 2017, the Blockchain in Transport Alliance (BiTA) was founded as a forum for the development, standards setting and adoption of blockchain in the trucking, transportation and logistics industries. Blockchain potentially offers a way to improve efficiency and transparency in global trade, as well as to lower costs. Other companies are exploring how to use blockchain to improve food safety and origin tracking throughout the supply chain. It can be used to track goods from farms to grocery stores to consumers.

Proxy voting and elections – Investor relations manager Broadridge and others are exploring using blockchain in proxy voting. They say it can improve the transparency of proxy voting and supporting analytics. Some speculate that blockchain could also be used for election voting, to improve the security of the process and encourage greater participation. Constituents would use their mobile devices or computers to vote. Each person could vote only once, with each vote recorded on the immutable blockchain ledger, ensuring no manipulation, tampering or fraud.

How blockchain is transforming audits

Blockchain could also impact the audit profession. If all transactions for a company occur in an autonomously-monitored environment, auditors will be able to reduce their effort validating the intermediate processes. Blockchain technology may allow auditors to focus more attention on the output of the system instead of subjecting it to the sample-based testing. The focus may shift to assuring that the blockchain itself and the technology around it are secure.

High hopes for blockchain in healthcare – Many companies in the healthcare industry are thinking about how blockchain might help solve one of the industry's biggest problems: securing and standardizing data. Data today isn't often shared among doctors or providers. Patients themselves have to request copies of their medical histories. Blockchain's ledger technology would ensure the integrity of personal health information, medical records and prescriptions, clinical trials and medical research. And all healthcare participants (e.g., doctors, surgeons, pharmacists, insurers, patients) would have access to that secure ledger of data. In Europe, Estonia is using blockchain to secure its citizens' medical histories.

Even the government is getting in on blockchain – The US Department of Homeland Security, for example, is looking to blockchain to process international travelers, secure data collected by cameras and other devices at US ports of entry and to facilitate trade across borders. Other potential uses by the government include collecting taxes, issuing passports, recording land transfers and generally ensuring the integrity of records and services.

Adoption benefits and barriers

As a collaborative technology, blockchain offers the ability to dramatically improve the business processes that occur between – and within – companies. The immutability of data stored in blockchains provides a level of trust and transparency few technologies can attempt to match. It also allows for accurate tracking and greater transparency. Blockchains are expected to reduce risk and fraud. Many companies anticipate a significant cost reduction for transactions and recordkeeping. Using one single distributed ledger can eliminate the time and effort that go into reconciling multiple versions.

But just like with any new technology, there are also barriers to adoption. In order for blockchain to be successful, there needs to be broad adoption where enough parties are either using the same underlying blockchain platform or interoperable platforms. That means further development and adoption of standards and specifications. Some companies may have to overhaul their existing systems, while others may have to integrate blockchain technology with legacy infrastructure. Both require time and money. Scaling blockchain to process a significantly higher volume of transactions is another challenge. And there is uncertainty around how the technology will be regulated.

There is also the question of how to implement controls to ensure that the people doing the transactions are trustworthy. Without that, the system itself and the recorded actions cannot be trusted, and there could be unintended consequences. Because the ledger is tamper-proof, some people may believe that they are in a fully-protected environment. But the more autonomous a blockchain environment becomes, the more risks it poses.

Questions boards can ask management about blockchain

Boards will want to understand the opportunities and risks that come with blockchain. Here's what boards can ask management about how blockchain will fit into the company's strategy:

- Have we thought about how we could use blockchain technology and considered the pros and cons? What are our competitors doing? What are the security and privacy risks, as well as mitigating factors, of using blockchain?

- What would our blockchain business model look like? Would we use a public or private blockchain? What vendor would we use? How much would it cost? How much cost volatility would there be moving to blockchain?

- Do we have the systems and technology to support blockchain technology? What controls do we have in place? What are our backup business continuity plans if blockchain goes down? How does blockchain fit into our data protection strategy?

- Have we discussed how to audit blockchain technology to ensure trust in the system?

- What are the regulatory, compliance, accounting and other business issues blockchain could pose?

- Do we have people with the technical expertise and digital skills needed for us to invest in blockchain?

- Are there realistic alternatives to blockchain that should be considered?

Boards that develop a basic understanding of blockchain and the other Essential Eight technologies can better oversee management's decisions related to which are relevant to the company's business and most likely to create strategic opportunities.

For more resources on what boards should know about the Essential Eight and digital transformation, go to our website, *Digital hub: insights for corporate board members*.

Find additional resources on blockchain and emerging technologies on PwC's *Next in Tech* hub. And for information on cryptocurrencies, read *Ten questions every board should ask about cryptocurrencies*.

Contacts

For a deeper discussion about how this topic might impact your business, please contact:

Vicki Huff Eckert
Global and US New Venture
and Innovation Leader
(408) 817 4136
victoria.huff@pwc.com

Paula Loop
Leader, Governance Insights Center
(646) 471 1881
paula.loop@pwc.com

Barbara Berlin
Director, Governance Insights Center
(973) 236 5349
barbara.berlin@pwc.com

Project team

Elizabeth Strott
Senior Research Fellow
US Integrated Content Team

Chrisie Wendin
Editorial Director, Technology
US Integrated Content Team

Alan Morrison
Senior Research Fellow
US Integrated Content Team

Karen Bissell
Marketing Manager
Governance Insights Center

Felipe Oppen
Design
Creative Team

Ryan Lasko
Design
Creative Team

1. UBS, "Beneath the bubble," October 13, 2017.

pwc.com