IMAGE: ISTOCK

SPECIAL REPORT:

HOW BLOCKCHAIN WILL DISRUPT BUSINESS

ZDNet

TechRepublic

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BLOCKCHAIN AND BUSINESS: LOOKING BEYOND THE HYPE

CHARLES MCLELLAN/ZDNET


IMAGE: ISMAGILOV, GETTY IMAGES/ISTOCKPHOTO

The term blockchain can elicit reactions ranging from a blank stare (from the majority of the general public) to evangelical fervour (from over-enthusiastic early adopters). But most people who know a bit about the technology detect a pungent whiff of hype, leavened with the suspicion that, when the dust settles, it may have a significant role to play as a component of digital transformation.

The best-known example of blockchain technology in action is the leading cryptocurrency Bitcoin, but there are many more use cases -- think of blockchain as the 'operating system' upon which different 'applications' (such as Bitcoin) can run. So, what is a blockchain?

At heart, a blockchain is a special kind of database in which 'blocks' of sequential and immutable data pertaining to virtual or physical assets are linked via cryptographic hashes and distributed as an ever-growing 'chain' among multiple peer-to-peer 'nodes'. Additions to the blockchain can only be made after validation by a majority of nodes using a consensus mechanism, the two main ones being Proof of Work (PoW) and Proof of Stake (PoS), after which the new blocks are distributed to all nodes. At the moment, PoW is the most common consensus mechanism, the best-known example being Bitcoin mining by solving cryptographic puzzles. However, PoS is less costly in terms of computing resources and electricity, and can deliver faster throughput.

A blockchain is therefore a cryptographically secure distributed ledger in which each node has a verified, up-to-date and immutable history of all transactions that have ever taken place among participants that do not necessarily need to trust one another. Validated transactions cannot be altered or tampered with, and can only be reversed by a subsequent transaction.

There are two broad types of blockchain networks: 'permissionless', which anyone can join; and 'permissioned', in which participants are authenticated by whoever is running it. The latter can be further divided into 'private' and 'community' blockchain networks -- a single enterprise versus a group of companies involved in

a particular business process, for example. In permissionless blockchains, like those underpinning Bitcoin or Ethereum, more reliance is placed on consensus mechanisms to confirm identities and validate transactions.

Business rules that govern what happens to assets during transactions are known as smart contracts, which form a link between decentralized applications (or dApps) and the blockchain itself. Ethereum is the leading example of a smart contract-based blockchain system. The linkage of virtual or physical assets to digital tokens is called tokenisation, while the process of raising funds by offering a new cryptocurrency or token in exchange for traditional currency, or an existing cryptocurrency like Bitcoin, is called an Initial Coin Offering or ICO.

DO YOU NEED A BLOCKCHAIN?

As a distributed ledger, blockchain can be used to record any transaction, and keep track of any asset and associated payments. Compared to traditional business processes, blockchain can deliver time and cost savings, along with better security -- especially in a permissioned network. But before we go any further, let's consider the general circumstances in which blockchain technology is appropriate.

The key issues here are the number of participants in the business process and the level of mutual trust, as Cisco's Tom Davies has elegantly encapsulated in the flow diagram to the right.

Note that in many cases a traditional database is the more appropriate solution. The key question is whether a trusted third party is available or required: if not, the remaining paths lead to the potential use of a blockchain -- be it public, community or private.

Here's how analyst firm Gartner summarises the key characteristics of different kinds of blockchain:

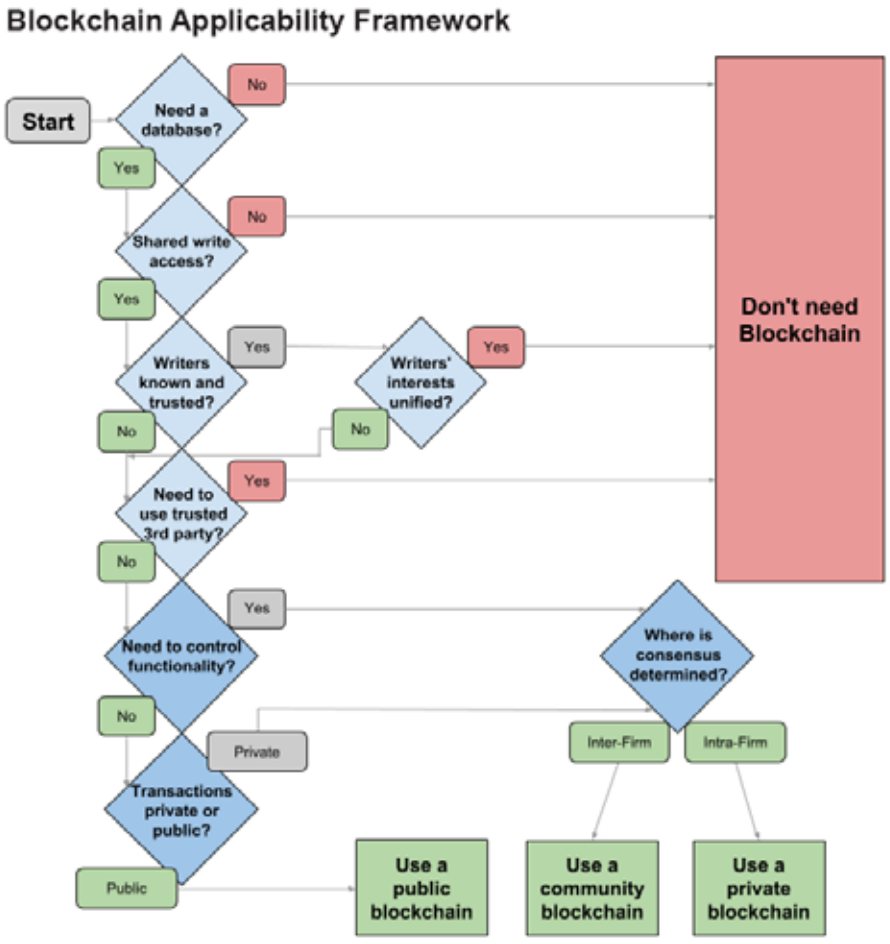
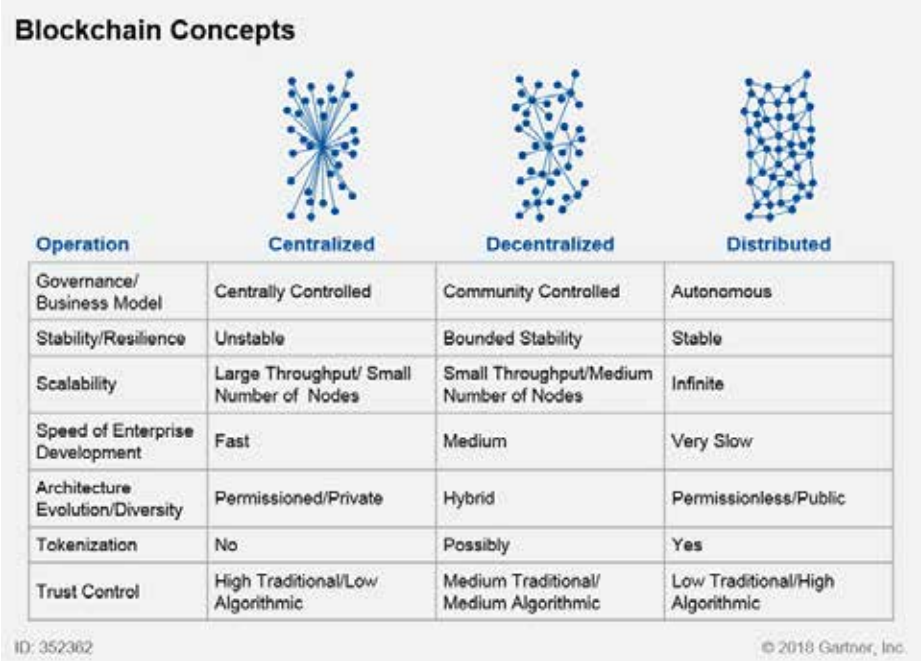


IMAGE: REDRAWN BY ZDNET FROM AN ORIGINAL BY TOM DAVIES (CISCO)



CREDIT: GARTNER

WHAT THE ANALYSTS SAY (2018)

Gartner

The latest Trend Insight Report from Gartner on Blockchain-Based Transformation sums up the current position succinctly: "While blockchain holds long-term promise in transforming business and society, there is little evidence in short-term reality." The report notes that most executives are focusing on blockchain to improve current business processes and records management, but stresses that there is also significant potential in digital assets and decentralisation. The analyst firm makes three specific predictions:

> As a distributed ledger, blockchain can be used to record any transaction, and keep track of any asset and associated payments. Compared to traditional business processes, blockchain can deliver time and cost savings, along with better security -- especially in a permissioned network.

- Through 2022, only 10% of enterprises will achieve any radical transformation with the use of blockchain technologies.
- By 2022, at least one innovative business built on blockchain technology will be worth $10 billion.
- By 2026, the business value added by blockchain will grow to slightly over $360 billion, then surge to more than $3.1 trillion by 2030.

Gartner characterises the 2018-2021 phase as 'irrational exuberance', which is followed by 'larger focused investments, many successful models' (2022-2026) and 'global large-scale economic value-add' (2027-2030):

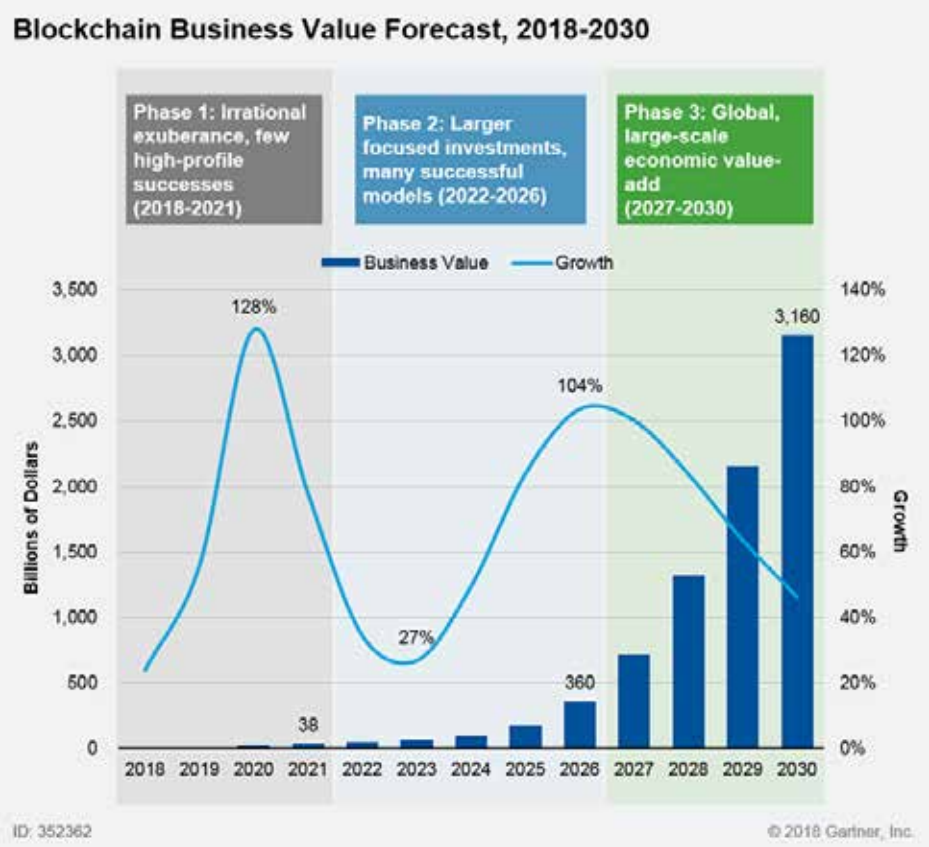


IMAGE: GARTNER

Maximising the potential of blockchain "requires adapting and transforming core models, processes and systems," says Gartner. However, the analyst firm continues, "these systems are literally the last place a business wants change to occur, because of the large risk to operations." As a result, the technology could "take a decade to become significant in business transactions".

IDC

IDC's latest Worldwide Semiannual Blockchain Spending Guide covers Gartner's 'irrational exuberance' phase (up to 2021) and forecasts a compound annual growth rate (CAGR) of 81.2 percent from 2016 with total spending of $9.7 billion in 2021. The biggest blockchain investments -- over 40 percent of worldwide spending -- will be made by the US during this period, followed by Western Europe, China and Asia/Pacific (excluding Japan and China), says IDC. (Note that spending associated with various cryptocurrencies that utilise block-chain, such as Bitcoin, is not included in IDC's spending guide.)

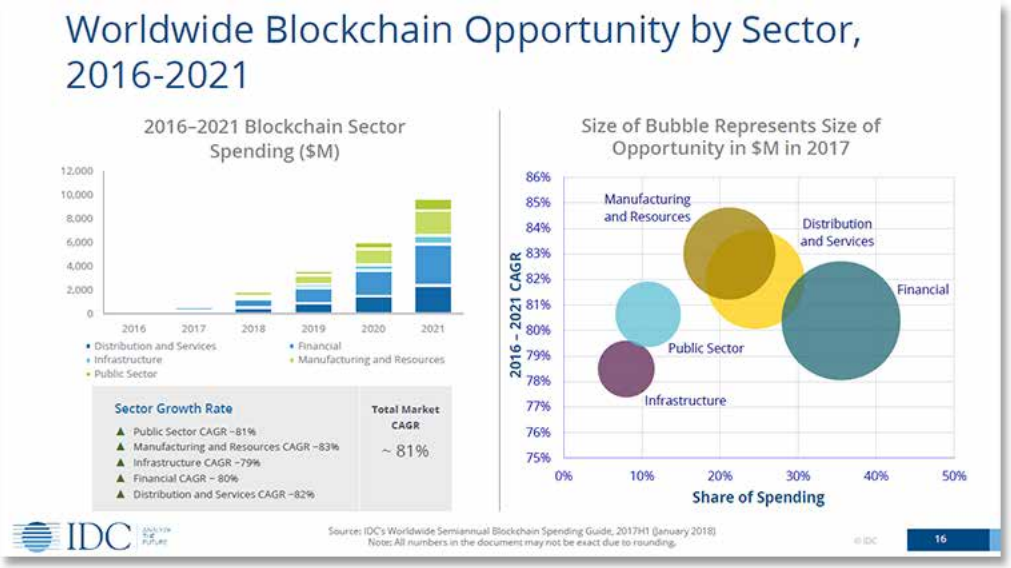


IMAGE: IDC

expects the financial sector to lead the way in blockchain spending for 2018 with $754 million, followed by distribution and services ($510m) and manufacturing and resources ($448m). As far as specific use cases are concerned, the analyst firm's leading contenders are cross-border payments & settlements ($242m in 2018), lot lineage/provenance ($202m in 2018) and trade finance & post-trade/transaction settlements ($199m in 2018). The first of these use cases is a hot political topic in the UK as it attempts to negotiate a post-Brexit customs arrangement with the EU. IDC expects this top three to remain the largest spending areas through 2021. Other prominent blockchain use cases cited by the analyst firm are regulatory compliance, asset/goods management and identity management.

"There are a multitude of potential new use cases for blockchain, as transactions and records are the lifeblood of just about every organization. However, we are seeing initial blockchain spending to transform existing highly manual and inefficient processes such as cross-border payments, provenance and post transaction settlements. These are areas of existing pain for many firms, and thus blockchain presents an attractive value proposition," said IDC's Jessica Goepfert, program director, Customer Insights & Analysis in a statement.

Forrester

In Predictions 2018: Be Ready To Face The Realities Behind The Blockchain Hype, Forrester outlines the key 2018 blockchain trends for CIOs, kicking off with a now-familiar note of caution: "Blockchain technology may not possess the miraculous capabilities that press articles and those with software, books, or other agendas to sell have ascribed to it. But the potential is undeniable: Blockchain technology, if implemented appropriately, supports new business and trust models."

Key takeaways from the report are: It's Going To Be Evolution, Not Revolution ("expect steady progress on the technology front to reflect enterprise requirements and a more mature approach to projects"); and Security Takes Center Stage ("we'll see more blockchain-based initiatives around fraud management and identity"..."developers and security pros will pay much greater attention to the security risks posed by interfaces with existing systems, serious software bugs, and potential future risks posed by quantum computing").

Echoing Gartner, Forrester notes that "many blockchain and distributed ledger projects merely seek to improve existing processes", whereas "true innovators are looking much further ahead". CIOs are cautioned to set realistic expectations, understand their use cases and related interdependencies, and to start small, building their blockchain ecosystems early. As far as security is concerned, the advice is to grow blockchain expertise in developer and security teams, and focus on integration options and regulatory compliance.

WHAT THE SURVEYS SAY (2018)

Gartner

In Gartner's 2018 CIO Survey just 1 percent of CIOs reported any blockchain adoption and only 8 percent were in short-term planning or active experimentation. Emphasising the immaturity of the blockchain ecosystem, 77 percent of CIOs surveyed said their organisation had no interest in and/or had no action planned to investigate or develop the technology.

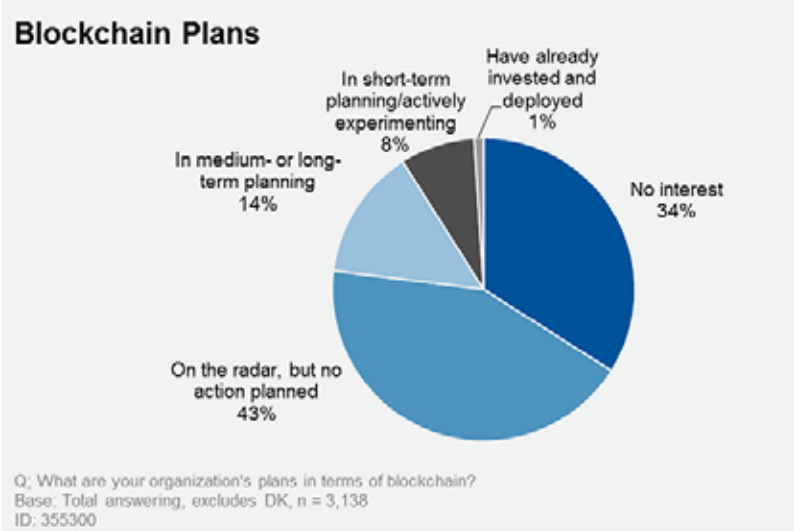


IMAGE: GARTNER

"This year's Gartner CIO Survey provides factual evidence about the massively hyped state of blockchain adoption and deployment," said David Furlonger, vice president and Gartner Fellow in a statement. "It is critical to understand what blockchain is and what it is capable of today, compared to how it will transform companies, industries and society tomorrow," he added.

According to Furlonger, rushed blockchain deployments could result in significant problems of failed innovation, wasted investment, rash decisions and even rejection of a game-changing technology.

Skills shortages and IT culture/structure issues are likely to be major barriers to blockchain adoption. In Gartner's survey, 23 percent of the 293 CIOs that were actively experimenting with or have already deployed

blockchain said that it requires the most new skills to implement of any technology area, while 18 percent reported that blockchain skills are the most difficult to find. A further 14 percent said that blockchain requires the greatest change in IT department culture, and 13 percent believed that blockchain implementation required structural changes to the IT department.

Leading the way in blockchain planning and experimentation in Gartner's survey were the telecoms, insurance and financial services sectors.

"While many industries indicate an initial interest in blockchain initiatives, it remains to be seen whether they will accept decentralized, distributed, tokenized networks, or stall as they try to introduce blockchain into legacy value streams and systems," Furlonger said.

IBM

IBM's Forward Together report, subtitled 'Three ways blockchain Explorers chart a new direction', drew on survey responses from 2,965 CxOs gathered in the first quarter of 2017. Those already experimenting with, piloting or implementing blockchains -- 33 percent of the survey population -- were termed 'Explorers', while those not considering the technology were tagged (somewhat dismissively) as 'Passives'.

Unsurprisingly, given the above definition, all of IBM's Explorers expected blockchain to support their enterprise strategies in some way, with increased transactional transparency coming top of the list:

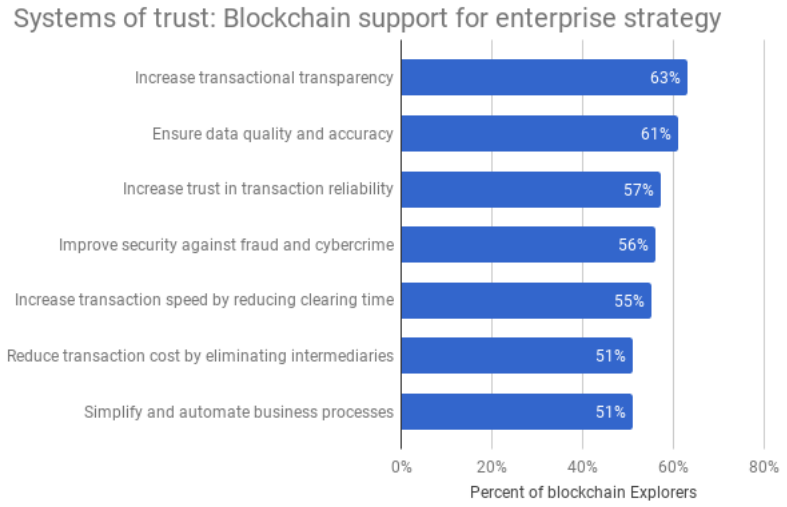


IMAGE: DATA: IBM / CHART: ZDNET

IBM cites healthcare as a pioneering sector for blockchain adoption, noting its suitability for storing and providing secure access to lifetime patient data. "If every vital sign from a doctor's visit or wearable health device, and records of all medicines taken, illnesses and operations could be securely shared on blockchain, then the quality and coordination of care would be expected to rise and costs to fall," the report claimed.

Another widely held belief expressed in IBM's survey is that blockchain could render the need for trusted intermediaries obsolete, allowing organisations to collaborate and compete in novel ways.

IBM extracts three lessons from its conversations with early-adopting blockchain Explorers, starting with the observation that organizations should identify new opportunities to monetise data and alternative payment models ("Orchestrate economic advantage"). Lesson number two extols the value of industry consortia in promoting business standards so that geographically separate organisations can connect ("Establish a circle of trust"). Finally, the report cautions against a wait-and-see approach to blockchain, noting that the first platforms may shape its future evolution for decades ("Learn fast and keep an open mind").

Underscore VC

Venture capital firm Underscore VC sought the opinions of 'hundreds' of blockchain thought leaders to compile its 2018 Future of Blockchain Survey. Respondents identified more than 30 industries that they consider ripe for 'meaningful disruption' over the next five years. The top 15 were: Financial transactions; Micropayments; Banking; Supply chain; Crowdfunding; Securities trading; Voting; Healthcare; Cloud storage; Virtual property; Real estate transactions; Legal signatory processes; Energy markets; Small business lending; and Government.

The number-one factor accelerating blockchain adoption was decentralised control, while the leading hindrance was lack of scalability -- something that 78 percent of respondents believed will take 3-5 years to solve.

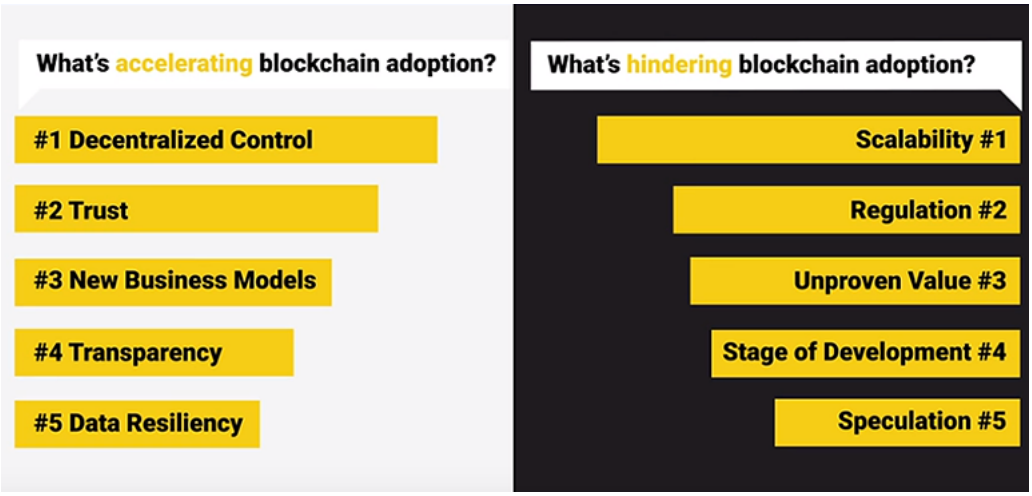


IMAGE: UNDERSCORE VC

Putting blockchain's current state of development into historical perspective, Underscore VC's respondents judged it to be comparable to June 1997 in the dot-com era -- that is, three years before the dot-com bubble burst in March 2000.

Over three-quarters (78%) of respondents believed that overall blockchain adoption will be accelerated by the use of private blockchains in enterprises. However, 69 percent also thought that the current ability of enterprises to implement blockchain technology is very low.

Commenting on this discrepancy, Underscore VC co-founder Michael Skok said: "Building on our 16 years of investing experience, surveys, and understanding the way open source and cloud computing have been adopted, the enterprise has generally been a laggard. We expect the same will be true of blockchain. We believe that the public blockchain will be the area of innovation, and the way that will come about is with startups, and upstarts like Ethereum leading with innovative distributed applications (dApps)."

Gowling WLG

Gowling WLG, a Global 100 legal practice and a founding member of the Blockchain Research Institute (part of The Tapscott Group), canvassed FinTech experts in businesses around the world and conducted in-depth interviews with a panel of experts to compile its 2018 report The Ultimate Disruptor: How Blockchain Is Transforming Financial Services.

A key point made by members of Gowling's expert panel is the distinction between cryptocurrencies and the underlying blockchain/distributed ledger technology (DLT).

For example, regarding criticism of the computing and electricity costs of coin mining, Dean Elwood, CEO at Umony, said: "We are not using blockchain as a currency. We are applying the same technology in a different way -- we have a DLT chain which represents an audit trail which is cryptographically secure and can prove that auditable elements have not been tampered with. The software has become a commodity and is now low cost to manage. For non-currency/mining use cases, computing power required isn't a problem."

Gowling's expert panel identified a wide range of sectors, headed by banking and finance, that could benefit from blockchain and DLT:

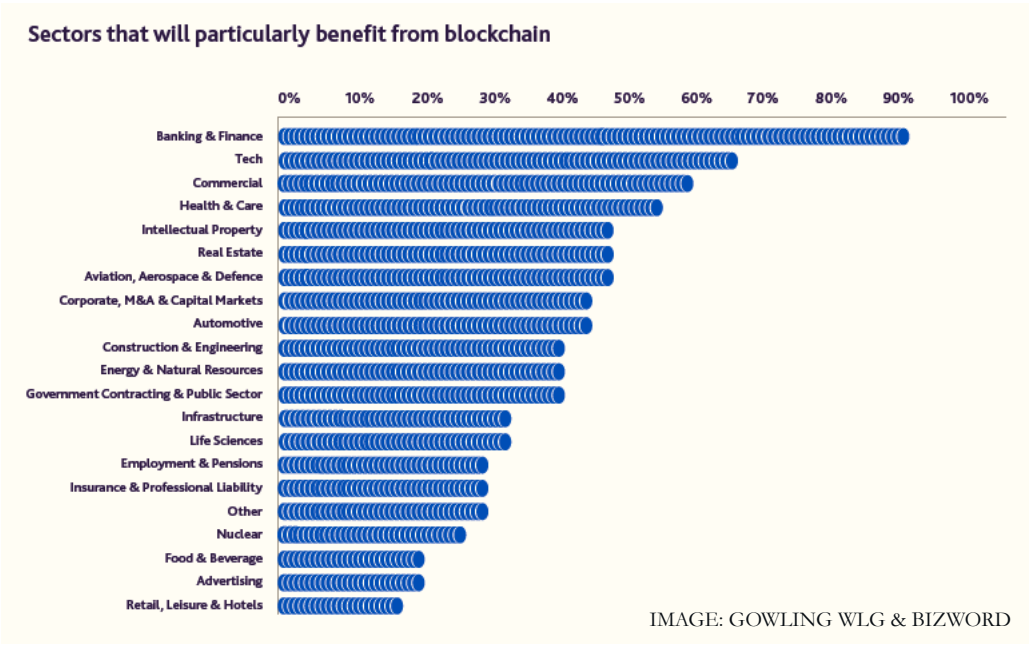


IMAGE: GOWLING WLG & BIZWORD

THE BLOCKCHAIN LANDSCAPE (2017/18)

As you'd expect with an emerging technology, the blockchain market is a rapidly evolving one. Analyst IDC has compiled a view of the blockchain landscape as it stood at the end of 2017, showing the major players, and outlining the current structure of the market.

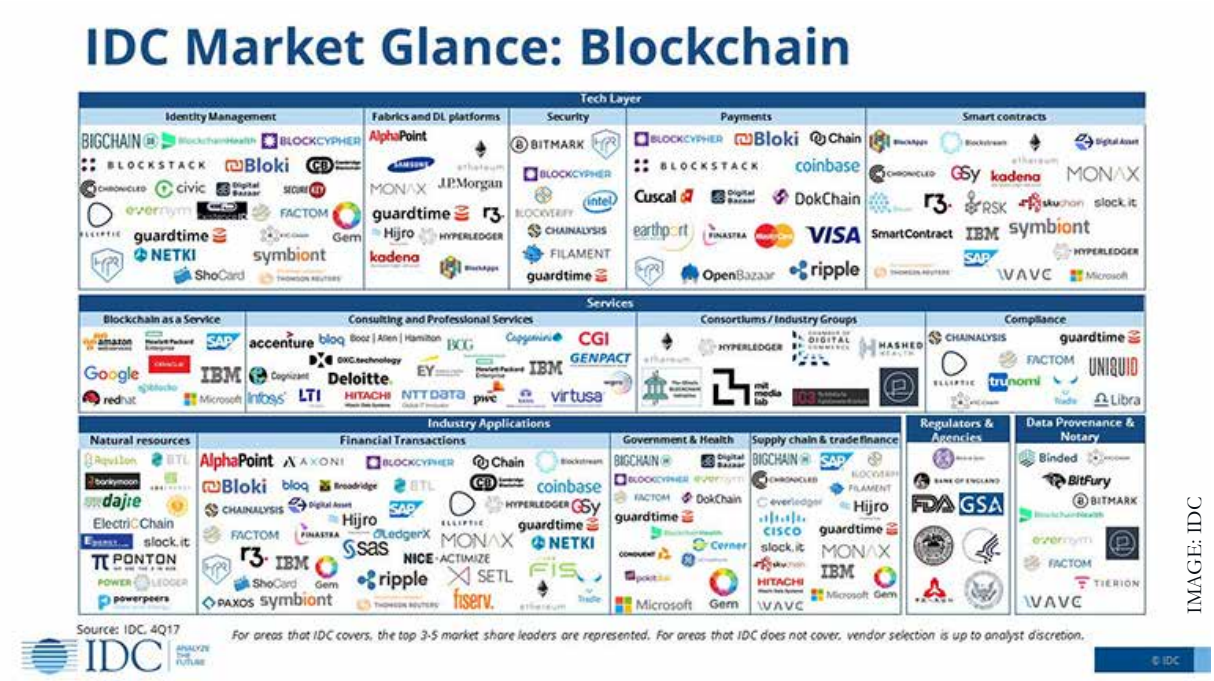
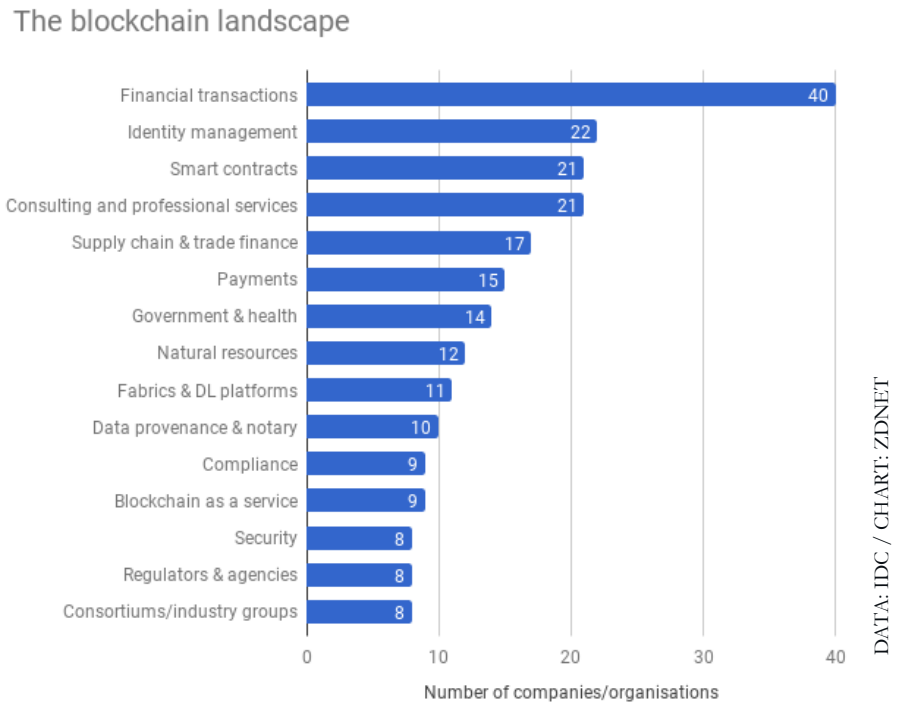


IMAGE: IDC

Companies listed: Accenture, Amazon, Aquilon Energy Services, BigchainDB, BitVault, Blockchain Global, Blockchain Health Co., BlockCypher, Blockstack, BlockStream, Bloq, Booz Allen Hamilton, Broadridge Software, BTL Group, Cambridge Blockchain, Capgemini, CGI Group, Chronicled, Cisco Systems, Civic Technologies, Cognizant Technology Solutions, Coinbase, Conduent, Cuscal, Deloitte, Digital Asset Holdings, DXC Technology, Earthport, Elliptic Technologies, Ernst & Young, Ethereum, Everledger, Evernym, Factom, GEC, Genpact, Google, GuardTime, Hashed Health, Hewlett Packard Enterprise, Hijro, Hitachi, Hyperledger, IBM, Infosys, Intel, JPMorgan Chase, MasterCard, Microsoft, Monax Industries, Netki, NTT, Oracle, PwC, Red Hat, Ripple Labs, Samsung, SAP, SAS Institute, SecureKey Technologies, ShoCard, Skuchain, Slock.it, Symbiont, Tata Group, The Boston Consulting Group, Thomson Reuters, Tradle, Trunomi, Virtusa, Visa, Wipro

There are 72 companies listed in total, covering five Tech layers (Identity management, Fabrics & DL platforms, Security, Payments, Smart contracts), four Services categories (Blockchain as a service, Consulting and professional services, Consortiums/industry groups, Compliance), four Industry applications (Natural resources, Financial transactions, Government & health, Supply chain & trade finance), plus Regulators & agencies and Data provenance & notary.

Most companies are involved in more than one market area, and it should come as no surprise that Financial transactions leads the field by some distance:



BLOCKCHAIN ISSUES (2018)

As all things blockchain-related approach and reach 'peak hype' (see below), the first signs of the inevitable backlash are appearing. Bitcoin has received a lot of negative press recently, for example, which is one reason why Gartner has it as the sole occupant of the 'Trough of disillusionment' in its current blockchain Hype Cycle:

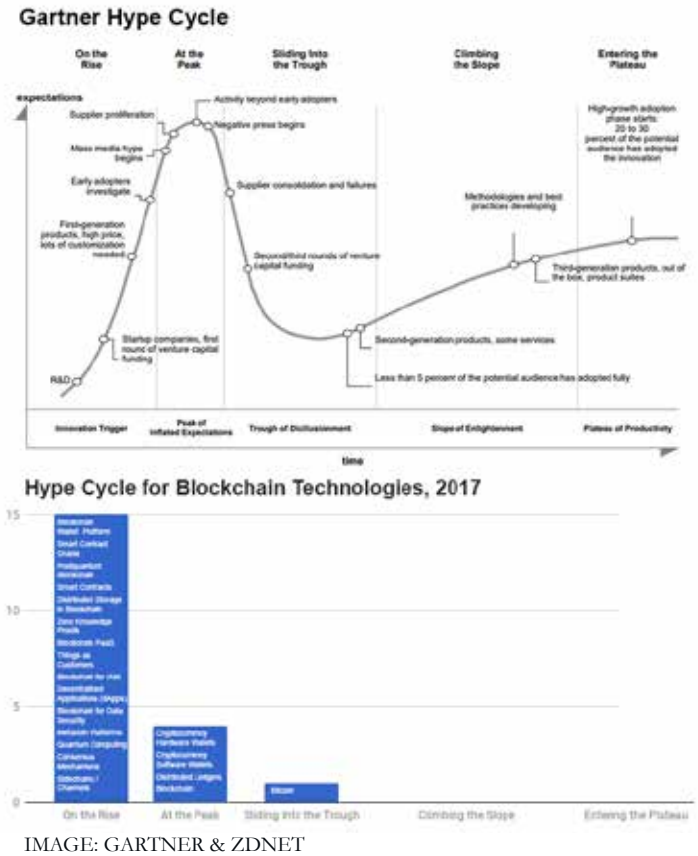


IMAGE: GARTNER & ZDNET

Security is widely regarded as a major advantage of blockchain, but there are still significant risks inherent in the technology (as currently implemented), according to the authors of a recent paper entitled A Survey on the Security of Blockchain Systems. Here's a summary of the nine risks identified by Li et al, and their applicability to blockchain '1.0' (cryptocurrencies) and/or '2.0' (smart contracts):

Taxonomy of blockchain risks		
Risk	**Cause**	**Range of Influence**
51% vulnerability	Consensus mechanism	Blockchain 1.0, 2.0
Private key security	Public-key encryption scheme	
Criminal activity	Cryptocurrency application	
Double spending	Transaction verification mechanism	
Transaction privacy leakage	Transaction design flaw	
Criminal smart contracts	Smart contract application	Blockchain 2.0
Vulnerabilities in smart contract	Program design flaw	
Under-optimized smart contract	Program writing flaw	
Under-priced operations	EVM design flaw	

The *51% vulnerability* refers to the fact that, if a single miner amasses more than 50 percent of the blockchain's hashing power (in a PoW system) or coin ownership (in a PoS system), that miner can manipulate and modify the blockchain information in various ways.

If a blockchain user's *private key* -- their self-generated and maintained identity and security credential -- is compromised, then their blockchain account can be tampered with.

Some trading platforms allow users to buy and sell products anonymously using Bitcoin, leading to *criminal activity* such as ransomware, underground markets and money laundering.

Double spending is where the same cryptocurrency is used multiple times for transactions, and is "relatively easy to implement in PoW-based blockchains, because the attacker can exploit the intermediate time between two transactions' initiation and confirmation to quickly launch an attack," say Li *et al.*

Blockchain systems take measures to protect the *transaction privacy* of users. But, say Li et al: "Unfortunately the privacy protection measures in blockchain are not very robust." They quote a study which found that actual transaction inputs could be inferred with 80 percent accuracy in the cryptocurrency Monero.

Criminal smart contracts "can facilitate the leakage of confidential information, theft of cryptographic keys, and

various real-world crimes (e.g. murder, arson, terrorism etc.)", say Li *et al*, who describe an example involving password theft.

Smart contracts may have *security vulnerabilities* caused by program defects, say Li *et al*, who list a taxonomy of no fewer than 12 types. In one quoted study, 46 percent (8,833 out of 19,366) of Ethereum smart contracts were found to be vulnerable to four kinds of security bug.

Attitudes about blockchain have become more positive since the 2018 survey, with 86% of respondents agreeing that 'Blockchain technology is broadly scalable and will eventually become mainstream' compared to 84% in 2018.

User interaction with Ethereum smart contracts is charged by 'gas', which can be exchanged with 'Ether' (Ethereum's cryptocurrency). "Unfortunately, some smart contracts' development and deployment are not adequately optimized," say Li *et al*. A tool that can auto-discover three gas-costly patterns reported *under-optimization* in 80 percent of a sample of Ethereum smart contracts.

The 'gas' value of an Ethereum operation is proportional to the computing resources it consumes. However, this can be difficult to estimate, leading to under-priced operations. "For example, some IO-heavy operations' gas values are set too low", say Li *et al*, "and hence these operations can be executed in quantity in one transaction. In this way, an attacker can initiate a DoS (Denial of Service) attack on Ethereum."

OUTLOOK (2018)

It's clear that, in the terminology of Gartner's Hype Cycle, blockchain is approaching the 'At the Peak' stage, characterised by mass media hype and supplier proliferation, with activity beyond early adopters and negative press waiting to usher in the inevitable slide towards the 'Trough of Disillusionment'.

That's not to say that the current noise around blockchain is all hot air -- just that there's a lot of piloting, early adopting, supplier consolidation and VC (or ICO) funding to come before the untenable use cases are weeded out and the long climb up the 'Slope of Enlightenment' begins.

Large parts of the enterprise may well get retooled using more efficient and secure blockchain technology, and new blockchain-based business models may emerge. But don't expect this to happen overnight.

Update: December 2019

When ZDNet published its mid-2018 special feature on blockchain, it was clear that there was a lot of interest in the distributed ledger technology, and that the blockchain ecosystem, although immature, was evolving rapidly.

Data harvested from the Github software development platform by State of the DApps provides a good illustration of how blockchain platforms that support decentralised applications, or DApps, have progressed in recent years:

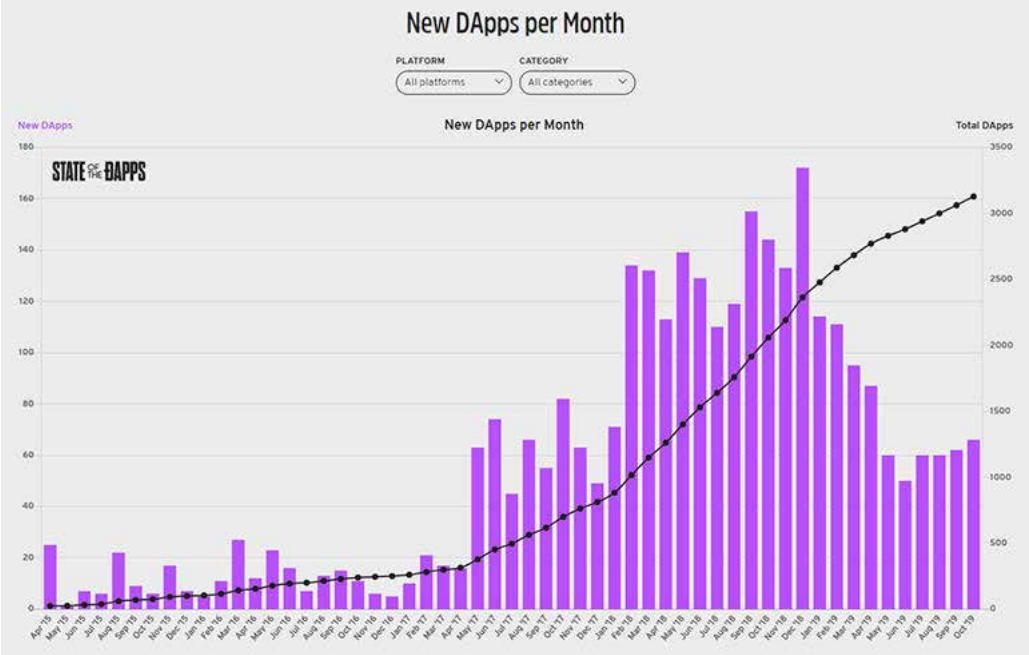


IMAGE: STATE OF THE DAPPS

DApp creation on Github -- most of it on the Ethereum platform -- took off in 2017, reaching a peak in December 2018, before plunging to December 2017 levels in June 2019. As of October 2019 there were 3,128 DApps hosted on Github, with most of the transaction activity in exchanges, gambling, games, wallets and finance.

Developer activity in the blockchain ecosystem certainly seems to have undergone a 'boom-and-bust' trajectory over the past two years. Is the 'bust' temporary or permanent? Let's see what the analyst community and recent surveys have to say.

WHAT THE ANALYSTS SAY (2019)

Gartner

Gartner's 2019 Hype Cycle for Blockchain Technologies places most components at either the 'Innovation Trigger' or 'Peak of Inflated Expectations' stages. In the former, 'proof-of-concept stories and media interest trigger significant publicity', while in the latter 'early publicity produces a number of success stories -- often accompanied by scores of failures'. Blockchain itself, along with distributed ledgers and cryptocurrency mining, is consigned to the dreaded 'Trough of Disillusionment', where 'interest wanes as experiments and implementations fail to deliver'.

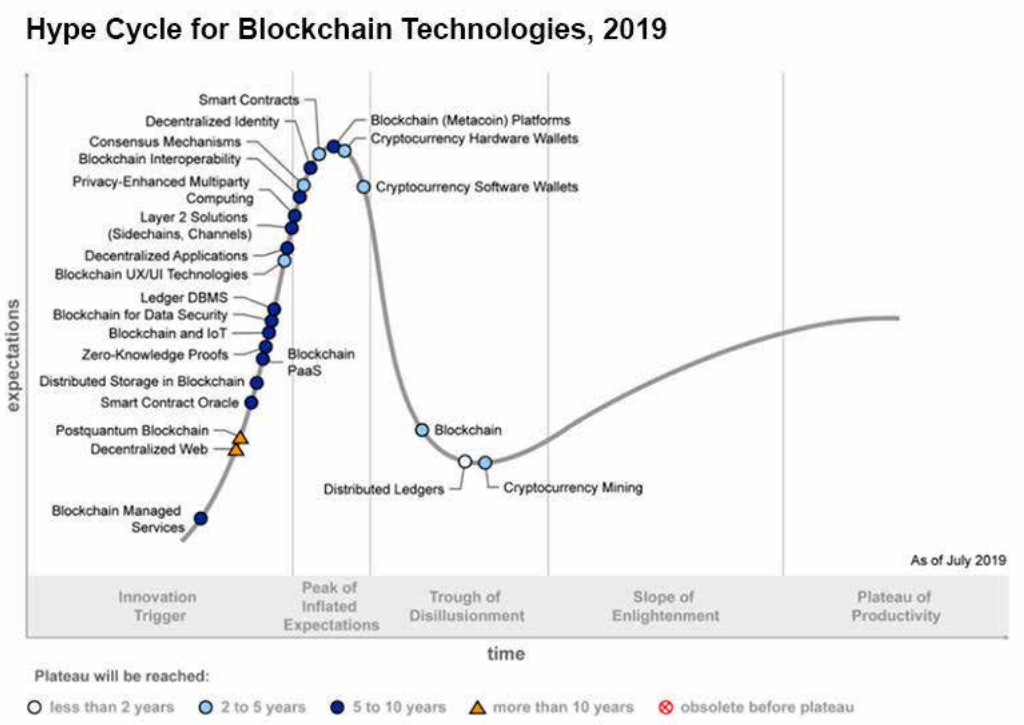


IMAGE: GARTNER

blockchain to become mainstream, says Avivah Litan, distinguished analyst and research vice president at Gartner, "users shouldn't have to worry about picking the right platform, the right smart contract language, the right system interfaces, and the right consensus algorithms. They also shouldn't have to concern themselves over how they will interoperate with partners that use different blockchain platforms for their projects."

Litan compares the blockchain back end to the internet's DNS or TCP/IP protocols, which don't matter to web users: "All web users care about is their web-based applications. All blockchain users need to care about is their decentralized applications," she says.

Recent developments in key areas -- blockchain interoperability, smart contract portability and cross chain functionality, data privacy and key management -- should bring mainstream adoption closer, Litan says.

In the meantime, though, Gartner predicts that 90% of current enterprise blockchain platform implementations will require replacement within 18 months to remain competitive, secure and avoid obsolescence. "Many CIOs overestimate the capabilities and short-term benefits of blockchain as a technology to help them achieve their business goals, thus creating unrealistic expectations when assessing offerings from blockchain platform vendors and service providers," said Gartner senior research director Adrian Lee.

Gartner expects the blockchain market to remain fragmented in the medium term: "Due to the lack of an industry consensus on product concept, feature set, core application requirements and target market, we do not

expect there to be a single dominant blockchain platform within the next five years. Instead, we expect a multi-platform world to emerge," Lee said.

Looking further ahead, Gartner forecasts that business value added by blockchain will grow to around $176 billion by 2025 and exceed $3.1 trillion by 2030.

IDC

IDC's updated Worldwide Semiannual Blockchain Spending Guide sees blockchain spending growing at a 'robust' five-year CAGR (compound annual growth rate) of 60.2% between 2018 and 2023. Blockchain spending in 2019 is forecast to be $2.7 billion (an increase of 80% over 2018), rising to $15.9 billion in 2023.

Despite 'sometimes heated' discussions and debates over blockchain, IDC research director James Wester says that "enterprise adoption of the technology has quietly reached a tipping point across multiple use cases. Companies are recognizing value from initial pilot programs and moving those projects into production."

There is still uncertainty about blockchain technology, Wester says, particularly regarding governance and regulation, but "adoption of blockchain for financial services, identity, trade, and other markets is encouraging."

The top sectors for worldwide blockchain spending in the 2018-2023 timeframe, according to IDC, will be banking (30%), followed by discrete and process manufacturing (20%). Process manufacturing will grow fastest (68.8% CAGR), with discrete manufacturing, professional services, retail and utilities all outperforming the market on spending growth.

Spending on two of the biggest blockchain use cases -- cross-border payments & settlements, and trade finance & post-trade/transaction settlements -- will be driven by the banking industry, IDC says, with the manufacturing (discrete and process) and retail sectors driving spending on lot lineage/provenance and asset/goods management.

IDC estimates that the combination of IT services and business services will account for nearly 70% of all blockchain spending in 2019, with blockchain platform software the next largest spending category. Regionally, the US will be the largest market, spending $1.1 billion in 2019, followed by Europe ($661m) and China ($304m).

"With enterprises moving past the proof-of-concept phase, it's not a matter of whether blockchain is here to stay but rather the scope of blockchain's adoption," said Stacey Soohoo, research manager, Customer Insights & Analysis, at IDC. "Sharing data between institutions, simplifying outdated processes, and bringing transparency to business processes while also encouraging collaboration and partnerships -- these are the tangible benefits that blockchain brings to the table."

Juniper Research

Juniper Research specialises in research, forecasting and consultancy around emerging digital market sectors, and has recently produced a white paper examining the 5 Most Promising Use Cases for Blockchain.

Juniper Research argues that blockchain offers several advantages spanning different vertical markets, including safety, decentralisation, transparency and cost-effectiveness. The quintet of use cases the company highlights cover asset tracking, financial services and digital identity, and are already in production.

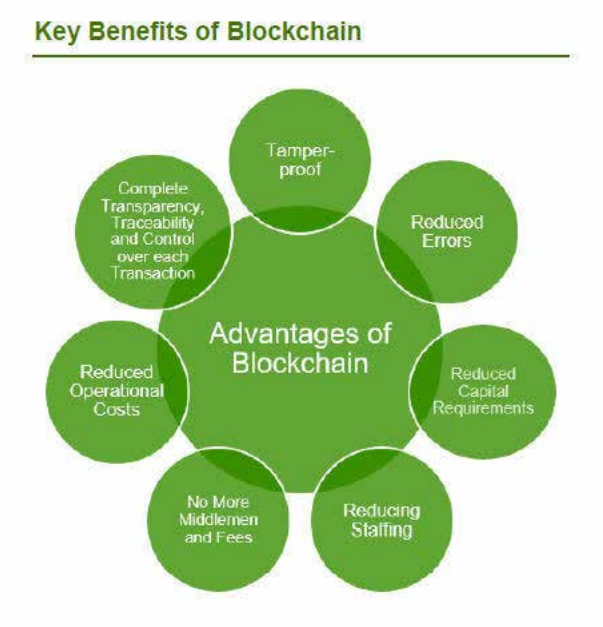


IMAGE: JUNIPER RESEARCH

Food provenance Increasing the efficiency of the food supply chain is an important issue, in terms of reducing wastage and meeting sustainability goals. Full visibility via blockchain will allow manufacturers, producers and retailers to "view their upstream and downstream activities, location and status of products, with certifications and insights for the entire value chain," says Juniper Research, which identifies the IBM Food Trust as the 'most solid' blockchain-based food provenance solution.

Medical drug tracking As well as storing and managing electronic health records on a shared ledger and using smart contracts to grant conditional access, Juniper Research identifies several other potential healthcare use cases, including: data storage in clinical trials; verifying drug provenance through the supply chain; and genome research, where blockchain can address some of the privacy concerns and computational requirements. Tracking medical drugs and equipment is the 'strongest and most cost-effective' use case for blockchain in the healthcare sector, the company says.

Cross-border settlements A blockchain-based cross-border transaction settlement solution could "increase standardisation, substantially reduce the risk of error (including double-spend) and indeed the time taken for error checking," says Juniper Research. "Blockchain affords complete traceability of financial documentation, allowing FIs (Financial Institutions) to have far greater visibility on participants and that (for example) a participant has been vouched for by other trusted parties." Key players in the blockchain-powered B2B cross-border payments space are Ripple, Visa B2B Connect and IBM Blockchain World Wire, with Ripple likely to be the 'go-to' provider in the near future, according to Juniper Research.

Insurance Blockchain could reduce the amount of fraud in the insurance market by providing an indisputable and immutable record, Juniper Research says. However, the company notes that there are significant

regulatory, legal and technological hurdles to overcome, and "due to the sensitive nature of insurance data, insurers will have to use private permissioned platforms only, which are still under development." Key uses for blockchain in the insurance space identified by Juniper Research include claims management, policy placement, P2P insurance, reinsurance and subrogation.

Digital Identity Blockchain could give users control over their digital identity via an encrypted digital hub that grants and revokes access to apps and service providers as required. This could solve some of the current problems surrounding data breaches and identity theft, says Juniper Research. Self Sovereign Identity (SSI) solutions, which typically use a blockchain to record who has validated what credential, will have significant impact in a range of verticals, the company says, including: public services and government management; retail; healthcare services; and banking.

WHAT THE SURVEYS SAY (2019)

Deloitte

Deloitte's 2019 Global Blockchain Survey was conducted in February/March 2019, polling 1,386 senior executives in 12 countries, at companies with annual revenues of at least $500 million (US) or $100 million (non-US). Executives at 31 'blockchain emerging disruptors', all with revenues below $50 million, also contributed to the survey.

Deloitte sums up the 2019 position on blockchain as: "'The question for executives is no longer, 'Will blockchain work?' but, 'How can we make blockchain work for us?'" Blockchain's relevance is certainly increasing, with 53% of respondents judging it to be a top-five strategic priority for their organisation compared to 43% in 2018:

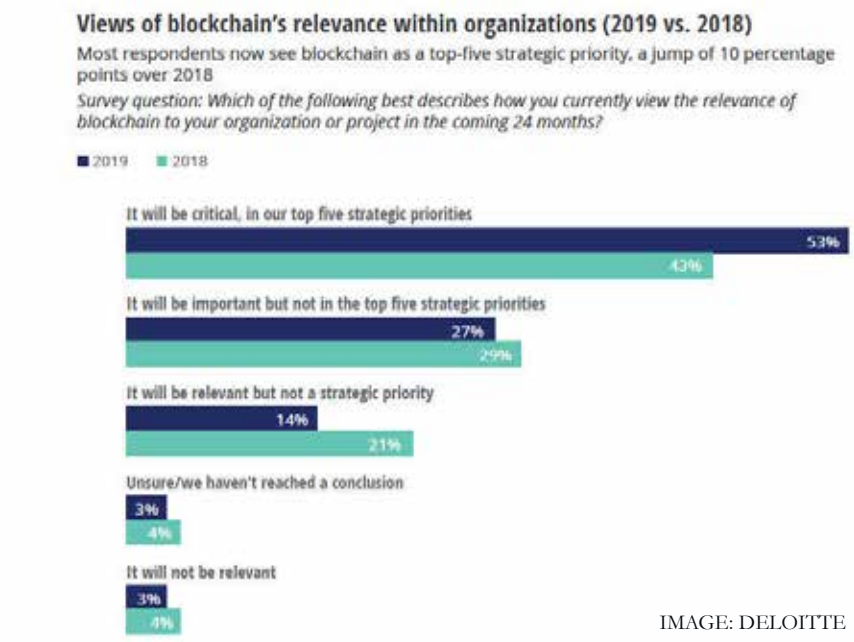


IMAGE: DELOITTE

Attitudes about blockchain have become more positive since the 2018 survey, with 86% of respondents agreeing that 'Blockchain technology is broadly scalable and will eventually become mainstream' compared to 84% in 2018. Other positive signs are belief in the C-suite about a compelling business case for blockchain (83% 2019, 74% 2018), emerging blockchain solutions to address organisations' value chain challenges (82% 2019, 77% 2018), and plans to replace current systems of record (81% 2019, 69% 2018). However, 43% of respondents still see blockchain as overhyped, up from 39% in 2018.

There's also a more even spread of barriers to investment in blockchain in the 2019 survey, headed by implementation (30%), regulatory issues (30%) and potential security threats (29%):

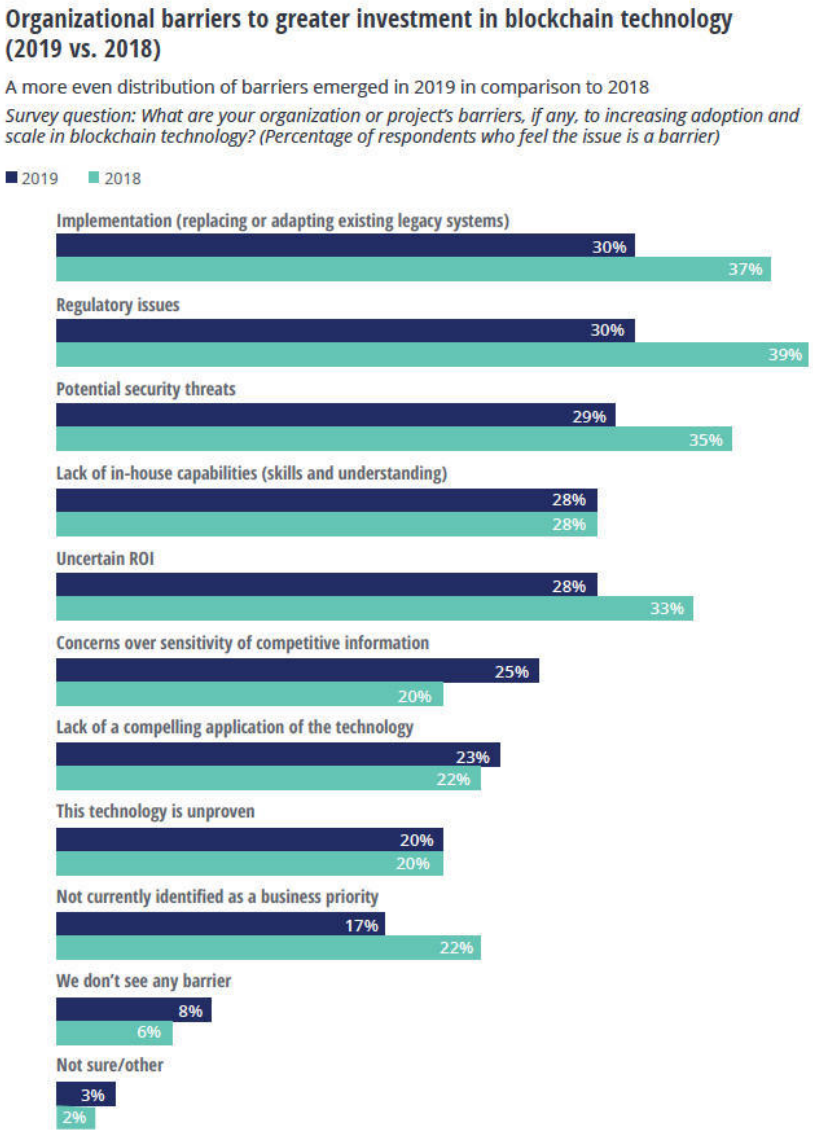


IMAGE: DELOITTE

Survey respondents are taking a broader view of blockchain these days, says Deloitte, focusing on business advantages like security and lower risk (23%), new business models and value chains (23%) and greater speed towards production or delivery (17%). Executives should be asking questions that reflect blockchain's potential role in their organisations, the report says, including:

- How are blockchain-enabled processes changing the way my sector does business?
- How can blockchain reshape my industry? What are my long-term objectives and strategies?
- Does blockchain create the potential for new market ecosystems, and what role should I play?
- How do I leverage the inherently open nature of blockchain?
- What opportunities does blockchain create for co-creating new markets?
- What are my biggest blockchain blind spots?

What of the 'emerging disruptors' that Deloitte polled in addition to its core sample of enterprise respondents? Unsurprisingly, perhaps, emerging disruptors are more focused on new business models and value chains as a blockchain advantage than enterprise respondents (43% versus 23%). When it comes to barriers to blockchain adoption, 71% of emerging disruptors identified regulatory issues, compared to 30% of enterprise respondents. And because they are inherently nimbler than large enterprises, 80% of emerging disruptors expect to see results from blockchain implementations within three years, compared to 60% of enterprise respondents.

Other topics explored own Deloitte's 2019 Global Blockchain Survey include the benefits and challenges of joining blockchain-related consortia, and a regional analysis of blockchain implementation around the world.

Overall, the Deloitte survey describes an evolving landscape, where "even those who may have looked askance at the technology in the past appear to be viewing blockchain with a new sense of possibility."

OUTLOOK (2019)

As 2019 draws to a close, blockchain is moving up the enterprise agenda, past the pilot stage and into production deployments. That's not to say mainstream adoption is anywhere near: for that to happen, issues like blockchain interoperability, smart contract portability, data privacy and key management need to be addressed, and a high percentage of current implementations will have to be replaced.

Still, when blockchain-as-a-service (BaaS) offerings are available from big players such as Microsoft, Amazon, IBM, Oracle, VMware and Fujitsu, it's clear that mainstream moves are afoot.

Promising blockchain use cases include the tracking of foodstuffs, medical drugs and equipment, cross-border settlements, insurance, and digital identity. However, more use cases and platform solutions will undoubtedly emerge, and blockchain ecosystem maturity is still years away.

RESEARCH: BLOCKCHAIN MUST OVERCOME HURDLES BEFORE BECOMING A MAINSTREAM TECHNOLOGY

MELANIE WOLKOFF WACHSMAN/TECHREPUBLIC

IMAGE: GETTY IMAGES/ISTOCKPHOTO

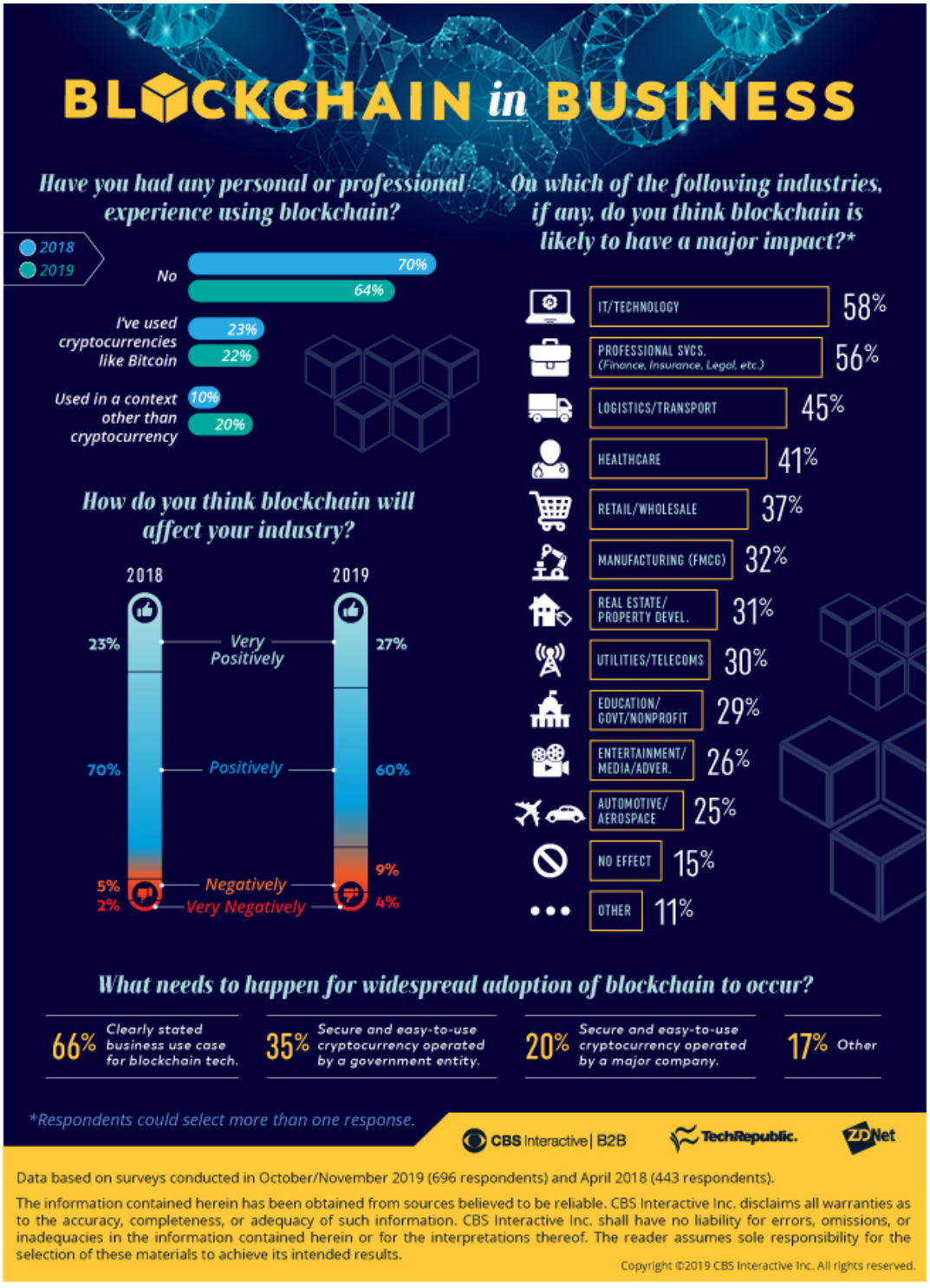
We like blockchain. At least, that's the takeaway from a recent TechRepublic Premium survey where the majority of respondents (87%) stated that blockchain will have a 'positive' effect on their industry, and 27% indicated a 'very positive' effect.

However, thinking something and actually doing it are two different actions. Despite the enthusiasm for the technology, only 10% of those respondents actively use blockchain at their company. Blockchain appears on 13% of the strategic roadmaps for respondents' organisations, compared to 7% in 2018.

Which industries will blockchain most likely impact? IT and technology was chosen by 58% of respondents, with professional services -- including finance, insurance, legal, and consulting -- a close second at 56%. Rounding out the top five cited industries were logistics & transport (45%), healthcare (41%), and retail & wholesale (37%).

What needs to happen for the widespread adoption of blockchain? Two-thirds of respondents (66%) indicated the need for a clearly-stated business use case. A cryptocurrency operated by a government entity was suggested by 35% of respondents, while a company-controlled cryptocurrency was favored by 20%.

The infographic below contains selected details from the research. To read more findings, plus analysis, download the report: Blockchain in business: Where are we now, and predictions for the next decade (TechRepublic Premium).



EXECUTIVE'S GUIDE: HOW TO IMPLEMENT BLOCK-CHAIN TECHNOLOGY IN YOUR BUSINESS

LAURA SHIN/TECHREPUBLIC CONTRIBUTOR

Blockchain is one of the most important technologies to emerge in recent years, with many experts believing it will change our world in the next two decades as much as the internet has over the last five.

Although it is early in its development, firms pursuing blockchain technology include IBM, Microsoft, KT, JPMorgan Chase, Nasdaq, Foxconn, Visa, Mastercard, and shipping giant Maersk.

Research agency Gartner predicts that by 2025, the business value added by blockchain will grow to over $176 billion, surging to over $3.1 trillion by 2030.

Outlier Ventures says that over the first half of 2019, blockchain-based startups raised $822 million from 279 separate venture capital deals, with 159 investments made through seed rounds. Major investors in the blockchain space include Sequoia Capital, Andreessen Horowitz, Digital Currency Group, Pantera Capital, and Boost VC.

The applications for blockchain technology seem endless. While the first obvious ones are financial -- international payments, remittances, complex financial products, and cryptocurrency -- it can also solve problems and create new opportunities in healthcare, defense, supply chain management, luxury goods, government and voting, and other industries.

In more advanced stages, the technology could give rise to what Gartner calls 'the programmable economy', powered by entirely new business models that eliminate all kinds of middlemen, machine networks in which devices engage in economic activity, and 'smart assets' in which some form of property such as shares in a company can be traded according to programmable or artificial intelligence-based rules rather than the control of a centralized entity. It may also be possible for blockchain to shake-up current financial systems, such as the US' Know Your Customer (KYC) bank vetting scheme.

EXECUTIVE SUMMARY (TL;DR)

What is blockchain: A blockchain is a single version of the truth made possible by an immutable and secure time-stamped ledger, copies of which are held by multiple parties.

It shifts trust in business from an institution or entity to software and could someday spell the demise of many traditional companies.

Why it matters: It shifts trust in business from an institution or entity to software and could someday spell the demise of many traditional companies. It also promises to make tradeable many assets that are illiquid today, enable our devices and gadgets to become consumers, and bring trust to many areas of business, eliminating fraud and counterfeiting in the process.

How it works: Cryptography secures the data and new transactions are linked to previous ones, making it near-impossible to change older records without having to change subsequent ones. And because multiple 'nodes' (computers) run the network, one would need to gain control of more than half of them in order to make changes.

Why it's disruptive: At the very least, it promises to make firms' back-end operations more efficient and cheaper, but down the line, it could replace middleman companies altogether.

Business opportunities: New services and products will pop up in areas such as creating and trading assets, tracking provenance, managing supply chains, managing identities, and in providing ancillary services to the software itself.

Main vendors: More than a dozen platform vendors have sprung up, and several dozen consulting and implementation providers assist in adopting blockchain projects.

Career options: The main blockchain specialists include developers and business and technical architects. But roles are also needed in risk management, security, cryptography, business process management, product strategy, and analytics.

WHAT IS A BLOCKCHAIN?

A blockchain is a golden record of the truth that creates trust among multiple parties. Specifically, it's a secure, tamper-proof ledger with time-stamped transactions, distributed amongst a number of entities.

This means a blockchain -- a piece of technology -- can replace an intermediary in situations where a trusted third-party is required.

So, for instance, while we now need a bank (or several) in order to make a payment to a foreign country, a piece of software -- the program running Bitcoin -- can now send money to someone across the world for us. And the latter can be much cheaper and faster, although transaction fees vary.

Overall, blockchain technology promises greater security and lower costs than traditional databases. Blockchains can also be public or private, either permitting anyone to join a network or allowing only authorized entities to participate.

Blockchain has become the catch-all phrase for a larger group of technologies called 'distributed ledger technology' or DLT. Technically speaking, it is possible to have a distributed ledger that is not constructed as a blockchain (as described below), however, when people refer to blockchain technology, they are often speaking about DLT.

And if you want to get really technical, "DLT falls short because it assumes information gets distributed when in many cases it doesn't," says Javier Paz, senior analyst at financial services research firm Aite Group. But 'blockchain', 'distributed ledger', or 'DLT' should suffice for all but the most technical discussions.

WHY IT MATTERS

"The key differentiator between a database and blockchain is that a database is managed and controlled by someone," says Eric Piscini, principal of financial services technology at Deloitte. "A blockchain doesn't need to be managed by someone, so you don't have to trust someone to run the platform. It's run by everyone at the same time. That's a shift in business models."

Eventually, blockchains could give rise to a number of peer-to-peer networks not run by any centralized parties that enable the creation and transfer of money or other assets. For instance, the technology could be used to create an Airbnb-like network without the company Airbnb. When combined with the Internet of Things (IoT), it could create an Uber-like program without Uber. Such peer-to-peer networks are often referred to as distributed autonomous organizations (DAOs), and someday, they could transform our whole conception of companies.

HOW IT WORKS

Not every blockchain works the same way. For example, they can differ in their consensus mechanisms, which are the rules by which the technology will update the ledger. But broadly, a blockchain is a ledger on which new transactions are recorded in blocks, with each block identified by a cryptographic hash of that data.

The same hash will always result from that data, but it is impossible to recreate the data from the hash. Similarly, if even the smallest detail of that transaction data is changed, it will create a wildly different hash, and

since the hash of each block is included as a data point in the next block, subsequent blocks would also end up with different hashes. This is what makes the ledger tamper-proof -- or, at least, extremely difficult to manipulate without being detected.

Finally, security also comes from the fact that multiple computers called nodes store the blockchain, and so to change the ledger, one would need to gain control of at least 50 percent of the computing power in order to change the record -- a difficult feat especially for a public blockchain such as the main Bitcoin network; 51% percent attacks have been recorded on some crytocurrency blockchains, but they are neither quiet nor covert.

WHY IT'S DISRUPTIVE

A common saying is that blockchain technology will do what the Internet did to media -- disrupt -- but to sectors such as financial services, law, and other industries offering trust as a service.

A common saying is that blockchain technology will do what the Internet did to media -- disrupt -- but to sectors such as financial services, law, and other industries offering trust as a service.

"The industry has lived and breathed off the back of intermediation," says Gartner analyst David Furlonger. Noting that banks typically control financial activity and governments usually control the economic assets we use, he adds, "If you think about the way authentication and identification is done, the way you onboard customers, the way you share records, all of this is done through siloed, decades-old channels and processes."

"And here you have a technology that basically says you no longer need a middleman, you have one golden copy of a record that no one can change ... anyone can join any time because it's open source ... it's kind of free, anyone can create any asset and distribute it to anyone else on the planet," Furlonger continues. "You're basically saying, we're going to change the way the economic models that have grown up for the last several centuries operate. As a result, we're going to change the way society operates as well."

Furlonger believes the outcome will be what Gartner calls 'the programmable economy', which it defines as a global market powered by algorithmic businesses and DAOs running on blockchain-based networks whose assets engage in economic activity by rules coded in software or artificial intelligence.

The two most commonly used public networks so far are Bitcoin and Ethereum, although Ripple is also gaining traction due to a recent remittance deal to facilitate payments between Japan and Vietnam, as well as low transaction fees and high speeds when compared to Bitcoin.

To start, the technology will make the back-end operations of many companies more efficient because firms

that currently work with each other, and even different departments within one organization, often maintain their own ledgers, duplicating work. "At least we will see it impacting the back and middle office, eradicating the problems and cost associated with sustaining multiple versions of the truth," Paz says.

As services at certain companies become more efficient and cheaper, market share among incumbents is likely to change. And because the technology is open source "You can build that platform for a fraction of what it would cost you with traditional technologies," says Piscini. That gives both startups as well as the software itself an opening. For instance, people could use the Bitcoin cryptocurrency network, which is not run by any one company, to make payments cheaply, quickly, and efficiently.

"If you just enable transactions for others, you're in big trouble," Piscini says, "because the blockchain can replace you as an entity without the need for a legal entity to run it."

BUSINESS OPPORTUNITIES

According to Deloitte's 2019 Global Blockchain Survey, 53 percent of respondents said that blockchain technology has become a critical priority for their organizations this year -- a 10 percent increase over 2018 -- and 83 percent of those surveyed believe there are compelling use cases for the technology in the enterprise.

Although some executives might fear software replacing their role or their company's, even email hasn't killed snail mail. The technology does promise to change existing market share, but Piscini says companies can avoid becoming obsolete by seizing upon new opportunities.

"If companies provide incremental services, if they provide you the ability to dispute transactions, to do some analytics on top of that platform -- incremental value that you don't have today. That's how they're going to survive," the executive says.

In fact, blockchain technology will enable companies to offer services that previously were impossible without it.

Blockchain technology makes possible new offerings in industries as diverse as financial services, healthcare, supply chain, oil and gas, retail, music, advertising, publishing, media, energy, government, and many others.

In finance alone, it can be used for making international payments, trading stocks, bonds, and commodities, and providing an audit trail for regulators. It can create new forms of assets and make it possible to trade existing illiquid ones, such as mobile minutes, energy credits and frequent flyer miles.

"Blockchains stock information in an immutable way which significantly increases the reliability and the traceability of information," says Nathalie Janson, Associate Professor of Economics and Economist at the NEOMA Business School. "Therefore certification activities as auditing activities may look redundant in the

future. Moreover, the validation process of the blocks can be done in a decentralized manner without the need of a trusted third-party. These new technologies clearly challenge the centralized design of the banking and the financial system. We are just at the beginning of a 'big bang'."

Blockchain can be used to track provenance, stamping out fraud and counterfeiting in areas such as luxury goods, fine art, pharmaceuticals, food, and government documents. By improving traceability and transparency, the supply chain may also benefit.

It can also enable people to manage their identity and the privacy of their data instead of having to rely on centralized entities such as Google, Facebook, or Twitter.

Smart contracts, too, are of note. A smart contract is the concept of self-executing contracts -- made possible through blockchain -- that eliminates the need for trusted third-parties as overseers, potentially streamlining legal and real-estate contracts, as well as reducing transaction fees. The smart contract market is expected to reach $300 million by 2023.

"Blockchain enables trust due to a shared view of secure data, hence, improving coordination between partners," says Marco Limena, CEO of Tomia. "This, in turn, enables the elimination of third parties, resulting in significant cost savings, providing incentives of greater profit margins for telecoms companies that upgrade their digital functions to the blockchain. The 'problem-solving' nature of blockchain is what makes it lucrative."

Know Your Customer (KYC) is another example of how the blockchain could benefit the financial industry. Fraud and identity theft are a constant headache for both financial institutions and consumers, but by creating ID digital ledgers, it may be possible to bypass the lengthy KYC protocols currently in place, of which there is no common standard.

Blockchain also makes it possible for musicians, writers, and other artists to embed royalty payments into their MP3s, ebooks, and other creations to pay themselves every time their work is bought or resold. It can be used by publishers to run publications funded not by ads but by micropayments issued by readers' browsers.

It can show an individual voter that their vote was counted correctly and the entire electorate that no votes were fraudulent or counted more than once. And those are just some examples.

Blockchain is also being considered as a way to assist businesses in maintaining data security and compliance, such as in the case of the EU's General Data Protection Regulation (GDPR).

VENDORS

A host of platform vendors to enterprise have already cropped up. Although the space has more than a dozen players, the most active groups (two are not companies), in alphabetical order, are:

1. Chain, which, together with Nasdaq, created the first private blockchain in production (although on a small scale) -- Nasdaq Linq, which is used in managing shares in private companies. It also has partnerships with Visa, Citi, and Capital One.
2. Ethereum, a P2P network that's public like bitcoin but focused on smart contracts, not payments, and that has an enterprise initiative, the Enterprise Ethereum Alliance (EEA).
3. Hyperledger, the open-source effort run by the Linux Foundation and closely affiliated with IBM which counts companies as diverse as Airbus, American Express, Daimler, and Intel as members.
4. R3, a consortium of financial institutions whose distributed ledger offering, Corda, is not structured as a blockchain, meaning that transaction data is not published to the ledger of every participant in the network. Instead, transactions are published only on the ledgers of the relevant parties.

Others include Axoni, Digital Asset Holdings, Monax, Ripple, SETL, Symbiont, and tZERO.

Businesses helping firms implement blockchain solutions include Accenture, Capgemini, Chainsmiths, Deloitte, Ernst and Young, IBM Global Services, Infosys, KMPG, PwC, Polaris, Tata Consultancy Services, Wipro, and others. IBM and Microsoft are leaders in cloud blockchain services.

BLOCKCHAIN PROJECTS IN DEVELOPMENT:

- **Enterprise Ethereum Alliance:** Microsoft, Intel, Accenture, Credit Suisse, UBS, JP Morgan Chase, Bank of New York Mellon, and other technology vendors and financial institutions have joined the alliance, which aims to develop the blockchain and smart contracts for use in enterprise applications.
- **Mastercard's blockchain:** Mastercard has opened up its blockchain APIs to developers for the purpose of encouraging B2B cross-border payment technologies for the financial industry.
- **E-voting:** Estonia, in partnership with Nasdaq, has piloted blockchain as a means for shareholders to vote online in company meetings. The country's e-residency scheme is connected to the test, in which shareholder identities are verified through the blockchain.
- **Political voting:** Proposals have been brought forward for ways to harness the blockchain in government voting schemes and elections.
- **Smartphones with blockchain tech:** Sirin Labs is developing handsets with in-built cryptocurrency wallets and token conversion services.
- **Visa B2B Connect:** This year, in partnership with IBM, Visa announced B2B Connect, a blockchain-based cross-border payments network based on the open source Hyperledger Fabric framework.
- **Microsoft ION:** Microsoft's Identity Overlay Network (ION) is an early-stage distributed identity system, based on blockchain, has been designed to shake-up the way we identify ourselves and sign in to online

services. The Redmond giant hopes to increase the scale of ION from tens of thousands of operations per second to millions.

- **IBM:** IBM is investing heavily into the development of blockchain technologies and has not only launched a blockchain-as-a-service enterprise offering, but has also created a 'trust your supplier' blockchain system, a financial services platform designed to allow financial institutions to share services across the blockchain, and has a pilot in the works with Walmart to test blockchain-based tracking of pharmaceuticals.
- **Managed enterprise services:** Amazon offers the enterprise a managed blockchain service based on Hyperledger Fabric, with plans to introduce the service on the Ethereum network. Oracle also offers a similar solution to corporate customers.

CHALLENGES TO IMPLEMENTATION

Despite the possibility of blockchain technologies influencing future business models, this does not mean there are no barriers to adoption.

Deloitte surveys suggest that implementation and regulatory issues are the most problematic areas when it comes to harnessing blockchain technology. In addition, enterprise players are concerned with potential security threats, a lack of in-house expertise, the unproven nature of blockchain, and an uncertain ROI are problematic.

CAREER OPTIONS

Numerous executives have noted a talent shortage, and because financial services firms are hiring in the space, blockchain developers command high salaries, with an average of between $81,000 and $144,00, according to Glassdoor. Vacancies for blockchain and crypto specialists across the United States continue to increase.

The roles needed in the space include blockchain developers, technology and business architects, and specialties should include risk management, security, cryptography, business process management, product strategy, and analytics. Technology architects construct the blockchain so that it's appropriate for business needs, secure, and does what it intends to do.

As the technology develops further and smart contracts become a reality, staff will also be needed to combine IoT and artificial intelligence with blockchain. Less blockchain-focused roles are also necessary to ensure the solution can be integrated with, say, accounting or human resources.

"People underestimate the complexity of replacing a transaction platform with a blockchain solution," Piscini says. "It may be working in the lab, but when you work from the lab into production, you have a lot of challenges."

Despite its infancy, businesses remain open-minded about how the blockchain may become a driving force in future business transformation. Speaking to ZDNet, Richard Gendal Brown, Chief Technology Officer at blockchain firm R3 said that one of the main lures for implementation is assurance, in which "what you see is what I see" when companies wish to do business.

Brown commented:

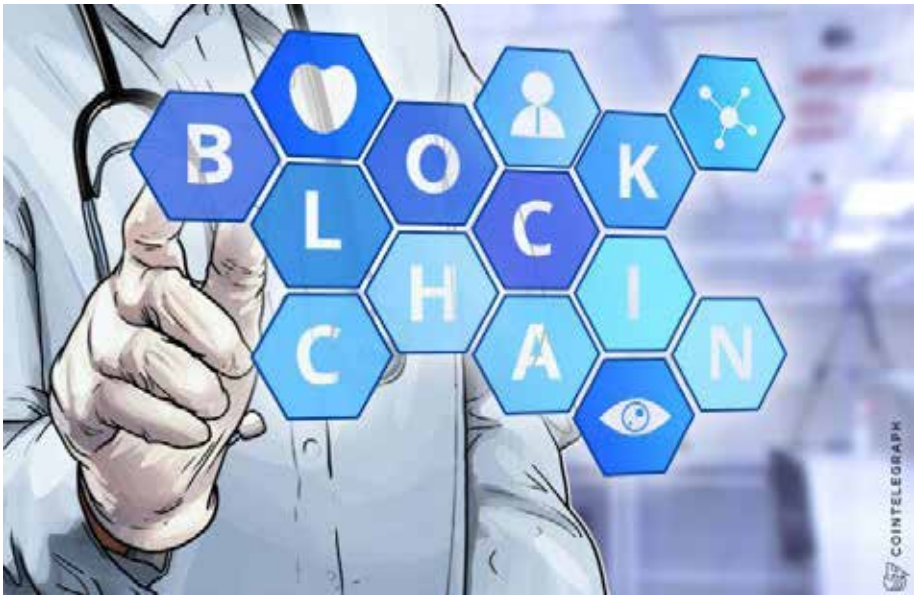
"Building on principles introduced by public blockchains, but applying them to real-world business problems, enterprise blockchain is about identifying and eliminating all the places where disagreements, ambiguity, and doubt can enter a process, so allowing it to be executed seamlessly -- across the boundaries of firms and individuals.

While this may seem trivial, it can radically transform processes that financial institutions rely on, from payments to trade finance, syndicated lending, identity management and much more.

The potential for enterprise blockchain, therefore, is that the revolution shaped by the IT industry in the optimization of the operations of individual firms can now be achieved for entire markets and the business models upon which they are built."

10 WAYS THE ENTERPRISE IS USING BLOCKCHAIN

JONATHAN GREIG/TECHREPUBLIC CONTRIBUTOR



Enterprises were initially reticent to dive headfirst into blockchain adoption when it emerged in 2008 as an integral part of Bitcoin.

But in the last five years there has been an explosion of interest in the distributed ledger technology as an unparalleled organizing force and an answer to problems that have plagued humans for thousands of years.

"Blockchain can have the greatest effect on traditionally opaque systems where information sharing across traditionally siloed groups can benefit from information verification, validation, and record confirmation, and especially places where 'trust' needs to be rebuilt or increased with such transparency," said Sandra Ro, CEO of the Global Blockchain Business Council.

"Over time, we could see a world where blockchain underlying technology can help create networks which not only verify, validate, and secure information as a single source of truth, but also, add layers of embedded payments, smart contracts automating processes, and create an overall friendlier, more efficient user experience," she added.

Dozens of groups like IBM and the Linux Foundation have been hard at work demonstrating the universal applications of blockchain technology in fields like agriculture, real estate, government, media, environment, energy, healthcare, and financial services.

Here are ten innovative ways enterprises are incorporating blockchain to revolutionize their industry.

FINANCE

The finance industry is where blockchain started, and no industry has adopted it more voraciously. Ro said blockchain has a range of popular uses within the financial services industry, including for cross-border transactions, clearings and settlements as well as in trade finance.

Huge names like JP Morgan, Fidelity, London Stock Exchange Group, and BTG Pactual in Brazil are working on various use cases like improving settlement processes, and institutional custody solutions for digital asset storage to digitization of assets for investment and trading.

Some companies are focusing on efficiencies and cost saving use cases to others, honing in on new revenue opportunities and development of ancillary business lines.

> Blockchain could be wildly successful at addressing problems of stolen identities, voting, and central banking.

Vice President of IBM Blockchain Jerry Cuomo said they have been on the ground floor of innovative financial blockchain solutions across the world.

He spoke about one example from Canada where all of the country's seven biggest banks joined together to verify the identity and authenticity of their commercial users.

"If you want to open up a bank account, chances are in canada that you've already done banking with one of the other banks. They have probably already vetted who you are because there are laws everywhere that force you to know your customer," Cuomo said, adding that the banks took it a step beyond just sharing records.

"What if we used the blockchain to block the data from each other, and only let the user have the data. And then almost license the rights to exchange the data under the control of the user and not the bank. So while onboarding, I say 'Hey, I'm onboarding for TD Bank credit card. I'm going to allow TD Bank to access my data, and I'm going to allow TD Bank to ask one or more of the other banks in the network if they're allowed to do it.' Your identity almost exclusively now sits in an encrypted wallet on your phone versus in all of the banks' databases," he explained.

Cuomo added that internationally, banks are taking the initiative to incorporate blockchain in a number of different ways. Through the Blockchain Community Initiative, 21 banks in Thailand lend each other money with a letter of guarantee through IBM Blockchain. Banks in Australia and South Africa are working on similar projects.

Kazu Gomi, CEO of blockchain research group NTT Research, said contract management was a particular point of interest for certain companies, especially those that deal with sensitive documents, corruption, or fraud.

FOOD/AGRICULTURE

One of the areas where blockchain is universally seen as an answer to a litany of problems is supply chain management. Ro said the distributed ledger technology, and its embedded immutability and transparency are a dramatic improvement over traditional logistics systems.

"Brand names like IBM Food Trust, Wal-Mart, Salesforce, and blockchain startups like Everledger are working on supply chain related 'provenance,' meaning the ability to track and trace commodities. Food, packaged goods, parts, anything that moves from point A to B to C in a supply chain," Ro said. "Some say the world is a series of supply chains."

Cuomo went into more detail about IBM's Food Trust Network, which brought together some of the biggest rivals in the food industry to better manage the entire system.

Wal-Mart, Wegmans, Nestlé, and four other major food providers banded together with IBM to create the network about three years ago. Now dozens of companies have joined in, hoping to take advantage of the system so that they can catch things like outbreaks much faster.

Before the trust was created, Cuomo said it would take Wal-Mart at least seven days to catch something like E-coli or another problem. Using the example of a bad batch of mangoes, Cuomo explained how blockchain effectively eliminates all of the investigation wait time.

"So imagine, something bad happens, and now you start feverishly trying to figure out where it came from, perhaps you get terrible reports back of people getting sick in certain cities or god forbid someone dies. You throw away all the mangoes just to be safe and now, not only do you have food making people sick or killing them, but you also have tremendous amounts of food waste," he said.

With blockchain and the Food Trust Network, it now takes Wal-Mart 2.2 seconds to trace any of their food products back to the exact farm. In another example, one major fast food retailer uses blockchain to track the temperature of meat as it moves along the supply chain from farm to restaurant.

MEDIA/ADVERTISING

Kimberly Quinones, executive director of the NYC Blockchain Center, said media companies in New York City were eager to use blockchain for things like copyrights and authentication.

"Those are ready applications and blockchain is great for processes where you have a lot of data, and you want to make it verifiable, trustworthy and readily searchable," she said. "It's not a one-size-fits-all solution but it works in really specific areas. A lot of entities are looking at applying this to new challenges rather than going back and changing something that's already well established."

Ro echoed those comments and said the Global Blockchain Business Council received interest from the media and entertainment industry particularly related to copyright management, micro-payments, and the distribution of royalty payments.

Blockchain is even being used to help better manage large advertising budgets. Cuomo said IBM works with advertisers who now have to produce ads for a very diverse network of mediums, and they need a way to see what is effective.

With IBM's help, advertisers can now tell their clients precisely how their money is being spent, where its performing, and where it isn't all in real time.

Blockchain has found an unlikely home in the ticketing industry, which for hundreds of years has been plagued by scalpers who buy tickets on the cheap and hike up prices closer to the event date.

TICKETS

Entertainment and sporting venues are turning to blockchain to get a bigger piece of the pie. They're also hoping to stop the spread of fake tickets.

"The original use case of blockchain with ticket tracking was to help prevent scalpers from selling fake tickets. The idea is that all ticket transactions from initial selling to reselling get tracked in the blockchain, allowing event managers to see if a ticket has been resold and at what price," said SailPoint senior software architect Kelly Grizzle.

"An interesting side effect came from this – event organizers can use blockchain to understand who is sitting in each seat so that they can offer special services and promotions to the fans," she added.

Blockchain has found an unlikely home in the ticketing industry, which for hundreds of years has been plagued by scalpers who buy tickets on the cheap and hike up prices closer to the event date.

IBM's Cuomo said TrueTickets, a company born out of a blockchain system, would enable venues to get a larger share of the rising ticket value.

"If a basketball team gets hot and makes a run for the playoffs, their ticket might be worth as much as $100. But the scalpers know that as the game gets closer, and the ticket is in demand because now they're a playoff contender, that ticket can sell for $1,000. The scalper will pocket $900 and give the $100 to the team," Cuomo said. "Shouldn't the team or the music venue get more of the take if the demand for the ticket goes up."

TrueTickets does exactly this, working to keep track of a ticket value to make sure venues get their full cut.

HEALTHCARE

Healthcare is a major industry seeing the effects of blockchain integration. NYC Blockchain Center's Quinones said regulations around healthcare data and information have been somewhat of a roadblock, but that hasn't

stopped companies from using blockchain to better manage patient diagnostic history and the supply chain of pharmaceutical medicine.

Cuomo said companies were testing blockchain on things like drug authenticity and the accuracy of drug trials.

In the future, he said both blockchain and artificial intelligence (AI) could work together to help doctors provide a quicker diagnosis using a person's symptoms and life-long medical history.

EDUCATION

While education institutions have not been the biggest adopters of blockchain, there are some schools eager to use the technology for certification and authentication.

Cuomo said universities have come to IBM hoping to use blockchain as a way to address fraudulent degrees, or people who falsely claim to have degrees. Right now, most employers go by a person's LinkedIn page, but really there are very few ways, other than personally calling a school, to verify that a person received the degree they said they did.

The same could go for language skills and professional certificates in a number of different industries. All of these degrees need to be verified, and could be done using blockchain technology.

REAL ESTATE

One example that Ro, Cuomo and Quinones mentioned was real estate and the opportunities for blockchain to revolutionize land registries.

"Land registries are typically operated by a government on a network with a single point of failure and/or paper records. Imagine a world where not only are land titles securely verified and confirmed for public record but also, could help reduce times to buying and selling property as well as allowing for more efficient movement and recording of ownership during the history of a property or piece of land," Ro said.

Quinones added that in New York City, an entire field, which she called "proptech," is emerging around technologies designed to help better manage real estate deals and property exchanges, which are rife with the kind of secure contracts and paperwork that blockchain can protect.

Cuomo spoke of his own experience with his home, having to repeatedly pay for title searches to prove that his home was his own. There is huge room, he said, for blockchain to handle land registries and titles.

PRECIOUS STONES

Last year, IBM announced the creation of TrustChain, a collaboration with global jewelry industry leaders seeking to use cloud-based blockchain technology to provide "one immutable and continuously updated record of transactions that is shared to all network participants."

They also teamed up with diamond conglomerate De Beers for their blockchain-backed platform Tracr, which helped track 100 high-value diamonds throughout their journey from mines to stores.

With Tracr, diamonds will be given a "Global Diamond ID" that records carat, color, clarity, and other attributes, the report said. The ID number is used to track the diamond through the supply chain and verify both its source and end destination.

GOVERNMENT

Of all the fields that could benefit most from more blockchain, governments were repeatedly cited by analysts in the industry.

Blockchain could be wildly successful at addressing problems of stolen identities, voting, and central banking.

"Sovereign, local, and state governments can really benefit from showing its citizens easier to understand, verified, transparent information as well as potentially digitizing some forms of payments," Ro said.

Cuomo said he has spoken in front of the US Congress multiple times but has mostly gotten questions about blockchain's relation to cryptocurrency, not how it could help the government run more efficiently. Thankfully, other nations are realizing how useful blockchain could be for a variety of troublesome issues.

Cuomo was in Brazil two weeks ago to inaugurate a deal with the government there to help manage birth certificates and death certificates. One of the chronic problems the government had was with the identities of people who died. People rarely reported deaths, allowing them to keep using identities for fraudulent services.

Two weeks ago, IBM recorded it's first birth on the Brazilian blockchain platform in Rio

"I do see some movement around the world from governments, but I do think the upside of governments fully embracing blockchain will change every day life in a positive way," Cuomo said. "We can do so much around eradicating identity theft and things like taxes. What if the IRS was just perpetually in line with your ecosystem so there's no need to audit because they have enough visibility?"

NONPROFITS

There has also been a huge push to use blockchain for good causes. Antti Saarnio is the founder of financial blockchain company Zippie, which he created three years ago with the mission to create earning opportunities for the underbanked and financial access for underbanked people.

"I was interested in business opportunities in bridging the wealthier world with the less wealthy world, the south and north. I saw real decentralization as an opportunity for peer-to-peer economic activity."

Zippie now handles dozens of financial transactions in Kenya and Zambia. Part of what has made the platform popular is that it allows everyone to make a small percentage of money off of everyone they bring on to the platform. People can buy prepaid minutes for their phone and send money through messaging apps with just a link.

A few charities are using the platform to reward local communities for conservation work. Some Zambian companies are using the platform to reward their customers for shopping with them by providing digital coupons and tokens that can serve as a point system.

They plan to expand into microlending as well, bringing small loans to communities, which have been kept out of official banking systems.

COULD BLOCKCHAIN BE THE MISSING LINK IN ELECTRONIC VOTING?

DANNY PALMER/ZDNET

Elections are one of the key pillars of a democratic society, but the voting process is increasingly challenged by the burgeoning power of the internet.

There are security issues around electronic voting booths, which researchers have warned are vulnerable to hacking and cyber attacks. Such weaknesses could be used to undermine trust in an election were they to be exploited.

To bolster the security, accuracy and efficiency of elections, some suggest the implementation of blockchain technology.

IMAGE: GETTY IMAGES/ISTOCKPHOTO

Blockchain is a decentralised, distributed, electronic ledger used to record transactions in such a way that transactions made using it can't be subsequently altered without the agreement of all parties. Thousands of network nodes are needed to reach consensus on the order of ledger entries.

Most famously, blockchain is used for bitcoin transactions, but it's finding use cases in everything from storing medical records to authenticating physical transactions. Such is the level of interest in blockchain technology that governments are even examining its potential use cases.

Blockchain-enabled elections have already taken place: In March, Sierra Leone voted in its presidential elections and votes in the West Districts were registered on a blockchain ledger by Swiss-based firm Agora.

By storing the data in this way, election data was "third-party verifiable and protected against any possibility of tampering," the company said, with the results publicly available to view.

But while this represents a step towards blockchain-based elections, it wasn't a full implementation: blockchain was used to secure, rather than cast votes.

"In Sierra Leone, voters voted in the traditional way, then they used the blockchain system to record those votes in an online fashion. It wasn't a true experimentation using blockchain as the instrument itself," Rick

Holgate, Research Director at Gartner told ZDNet.

Nonetheless, he said, there are advantages of using blockchain in this way -- although it isn't yet ready for anything outside small, controlled elections.

"The motivation for using blockchain in a voting environment is to make it easier for citizens, more reliable, more trusted, more distributed. There are some fundamental things about that idea which are engaging and inspiring," Holgate said.

And while those advocating blockchain for voting say it adds to the integrity of elections, Hammon pointed out that it doesn't change anything if the voter is being intimidated

However, various issues need to be overcome in order to conduct a fully blockchain-based election.

VERIFICATION AND ANONYMITY

One of the key requirements for voting is that be anonymous, with outsiders unable to access information about how someone voted. But in order for citizens to cast a vote, they need to be eligible and there has to be some way of verifying that. Balancing these two requirements is a challenge.

"Once it's on the blockchain, you want person A to be able to see that's their vote, but you don't want anyone else to see what happened, because it doesn't help with making sure the election is fair," Catherine Hammon, digital revolution knowledge lawyer at Osborne Clarke, told ZDNet.

And while those advocating blockchain for voting say it adds to the integrity of elections, Hammon pointed out that it doesn't change anything if the voter is being intimidated.

"The cleverest blockchain structure in the world won't do anything about someone with a metaphorical gun to their head and being told how to vote," she said.

Neither is blockchain going to solve anything if the cybersecurity of voting terminals remains weak. Researchers have repeatedly found that voting terminals from various manufacturers are vulnerable to attack. If the unit itself isn't protected from interference, using blockchain technology becomes pointless -- even if the intentions are good.

"Blockchain is useful, because it's a distributed system, international observers and interested third parties can have a fully separate copy of that data, which they can work onto to attest that the data within the network is valid and hasn't been manipulated," Joe Pindar, Director of protect strategy at Gemalto told ZDNet.

"But that's only half the problem, because the other half of the problem is right at the end point: the machines themselves where you're actually voting, and the simple act of a person applying to and having the legal authority and the right to vote," he said, adding "Those are a whole class of challenges that blockchain has no play to solve."

Nonetheless, there are countries which are pushing along with an attempt to introduce blockchain voting -- one of them is Brazil, which wants to store election data using the Ethereum blockchain. It's a massive task, one which will need to collect and verify data about 145 million registered voters.

If citizens are expected to verify themselves, that once again creates potential issues for the democratic process as identities can be stolen or otherwise compromised.

"There's the aspect of can you authenticate voters when votes are being cast. Brazil has that challenge, expecting citizens to authenticate themselves online," said Gartner's Holgate. "But if the citizen's information is subject to theft or compromise, where someone else could impersonate them online, you have a problem in trusting if the voter is who they say they are. There are a lot of unknowns".

SCALABILITY

Another of those unknowns is scaling a blockchain system up to cater for what could be hundreds of millions of votes being processed.

When Bitcoin reached a value of almost $20,000 in December, transactions became a lot slower due to the number of people attempting to buy and sell the cryptocurrency. If this happens with voting, it's going to cause problems -- because election results are needed within hours.

"It'd be incredibly difficult to scale. There's a statistic on bitcoin transactions that can only handle seven a second. If you do that in an election, it might be possible in a voting context if you've got thousands rather than millions," said Osborne Clarke's Hammon.

"But if you're talking about millions of votes -- take the Brexit referendum with 35 million votes cast: if you could only verify those at seven a second, it'd take fifty five days to get everything worked out. There's a question mark," she added.

One area where blockchain can improve elections is in transparency, not only because the ledgers can easily be viewed, but also because the startups providing the technology have an opportunity to publish open-source code showing how the system works -- and that it can be trusted.

"There are these small groups of people innovating with radically different things, but when it comes to what they've produced, it has a proof-point you can review and satisfy yourself, that yes, this is secure. That is one of the really strong benefits of startups in this space doing open-source work," said Gemalto's Pindar.

NO SILVER BULLET

Like other new and emerging technologies, blockchain isn't going to provide a silver bullet for electronic voting, or counting paper ballots. But if issues around anonymity and verification are ironed out, it can certainly provide some benefits, such as completely locking down data and ensuring it can't be tampered with.

"Once the data about the voting is on the blockchain, it's locked down, it can't be changed, you can add up the count and see it's correct. That's really valuable," said Hammon. "It isn't a cure-all remedy for electric voting, but there are many ways in which it does help with some of the problems."

As shown by Sierra Leone and some other trials, this technology is being tested at a local level, but can we expect it at a national level any-time soon?

"Blockchain today is like 1993 in internet years, when it was a very much a green space without a lot of experience, and everyone was trying to play in that space. All that energy was great, but ten years on, a lot of the entrants were gone, eclipsed by late entrants who dominated the market," said Holgate.

"That's where blockchain is today. It's a lot of small, niche entrants and we haven't seen the dominant late entrants show up. Until they show up and dominate the market, it'll be a fragmented immature market. And it's still three to five years away before they arrive".

Given the slow speed with, which government and the public sector tend to move when it comes to innovation, the feeling is that blockchain-based national elections are still a number of years away.

Such systems will need extensive trials and testing before they can be rolled out on a national scale, because a national election isn't something that can jeopardised by a technology failure.

"There's interest in it, but nobody wants to do it first. You can't get an election wrong and then later say it was a technical disaster, we have to do it again -- that's not an option." said Hammon.

HOW BLOCKCHAIN COULD CHANGE HOW WE BUY MUSIC, READ NEWS, AND CONSUME CONTENT

NATALIE GAGLIORDI/ZDNET

IMAGE: MURATANI, GETTY IMAGES

The modernization of the music industry -- and the rise of streaming services like iTunes, Spotify and Pandora -- have transformed the way people buy and listen to music and consume digital content. But as the industry has transitioned into a streaming-based model, issues with rights management, copyright enforcement and royalty payments have led to new challenges that could force the music business to rethink how payments are made to artists and creators.

There are a bevy of technologies to consider in the payment space, but one gaining traction in the music industry is blockchain, best known as the technology behind Bitcoin. Boiled down, blockchain is a secure, encrypted database architecture that logs and links all transactions on a tamper-proof ledger distributed among multiple parties. As a result, a blockchain creates an immutable golden record of time-stamped transactions related to any product that can be bought and sold.

In the context of buying music, news and other digital content, the promise of blockchain is to provide decentralized control, trust, and transparency when transacting virtual property. For the creators of digital content and virtual property, this means enforceable copyrights, transparency around royalty payments, and payments made securely without an intermediary.

In the music and news media industries in particular, the blockchain could be key to rights management, procuring micropayments of advertising and eventually paving the way for a pay-per-stream/read model. As the market shifts to blockchain over time, consumers could see lower prices for content, while the content creators see increased returns.

Simply put, blockchains could cut out the middlemen and enable musicians and other digital content creators to get paid directly by their audience.

"As an artist, you are reliant on what others say and have to trust that your royalties are calculated accurately," said Ben Goulb, CEO of Storj Labs. "Blockchains are great at creating transparent, zero-trust environments where people can easily send payments programmatically and verify the information immediately."

There are also certain legal considerations associated with blockchain's transparency, including the potential to violate data privacy laws, applicable privacy policies or data security regulations. Mass adoption is also hindered by the barrier of human understanding, as many people still struggle to grasp the mechanisms and utility of blockchain.

IMPROVING A FLAWED SYSTEM

A major pain point in the media space today is the lack of transparency around royalty payments and rights management.

In music, royalty payments are often difficult to calculate when there are multiple collaborators on a single track. Record companies, publishers, and streaming service providers also operate in siloed databases, making it difficult to keep track of music rights and who is owed what money.

With a blockchain-based payment system, data from disparate systems could interact and facilitate precise payments to a number of individuals, bolstering transparency around the entire royalty system.

"With a blockchain, any artist could easily track funds over any period of time to see flows to various parties," said Goulb. "This trust-but-verify approach minimizes work for intermediaries -- or eliminates the need for them -- simplifies payments at a global level by allowing the artist to accept payment in a single currency with minimal transaction fees, and ensures artists actually make what they're due."

Blockchain is also seen as a means of addressing rampant infringement within copyright structures.

"With smart contracts on the blockchain, copyright becomes more enforceable," said Tim Leonard, CTO of transportation software company TMW Systems. "People from around the world can see the copyright information on the ledger, and the copyright laws become a lot more defendable within a court of law."

The online news business faces its own set of challenges when it comes to monetizing content. As print publications fizzle out and online news operations take over, media companies are erecting paywalls to generate revenue and fund quality journalism. The catch is that most casual news readers would rather miss out on a story than sign up for a monthly subscription.

With blockchain-verified micropayments, however, readers could pay for only the stories they choose to read.

What's more, blockchain inherently provides evidence of ownership of content, in both digital media and music.

What's more, blockchain inherently provides evidence of ownership of content, in both digital media and music. For example, with a blockchain-based cryptocurrency, accessing an article would automatically send a micropayment to a smart contract that's been originally coded to pay out all of the parties involved in the creation and publication of that article, with the appropriate payment splits, in a transparent and immutable manner.

"Also, because of blockchain's trustless consensus mechanism, content producers will be able to distribute their content directly to users, removing the long chain of middlemen, hence reducing content cost, while enhancing the speed of content delivery," said Christian Ferri, president and CEO of BlockStar, a firm that incubates decentralized technologies.

One of the early pioneers experimenting with blockchain as a new model for music is British singer-songwriter Imogen Heap, who in 2015 turned to the Ethereum blockchain-based Ujo platform to launch the song 'Tiny Human' for $0.60 per download. Heap has also founded her own blockchain-based offering, Mycelia, that aims to give artists more control over how their music is sold and circulated.

CHALLENGES TO ADOPTION

There are challenges, of course, to achieving a blockchain-based panacea for digital content purchases. Questions linger over whether there's a single blockchain capable of scaling to an entire industry, and the effectiveness of reconciliation if multiple blockchains were required.

"Micro payments and high volume transactions still have some technical hurdles such as scaling," said Bruce Fenton, managing director of Atlantic Financial, and board member of the Bitcoin Foundation. "Many blockchain apps run into technical challenges in the last mile. Overall, it's exciting and has potential but is still a ways away from being fully realized."

There are also certain legal considerations associated with blockchain's transparency, including the potential to violate data privacy laws, applicable privacy policies or data security regulations. Mass adoption is also hindered by the barrier of human understanding, as many people still struggle to grasp the mechanisms and utility of blockchain.

"People look at blockchain as almost taboo," said Leonard. "But when people get past that and start to understand the power of blockchain and completing transactions, it can take a lot of things to the next level."

BLOCKCHAIN WON'T SAVE THE WORLD, BUT MIGHT MAKE IT A BETTER PLACE

STEVE RANGER/ZDNET

One of the most striking features of blockchain is the utopian streak that runs through it -- the idea that blockchain can replace existing authorities like banks and governments with a distributed network of trust, held in place by clever mathematics.

IMAGE: ILEXX, GETTY IMAGES/ISTOCKPHOTO

Bitcoin represents blockchain in its purest form: a distributed digital network that anyone is free to join, controlled by no-one and using cryptography to secure transactions that remain visible to everyone. It's a new currency owned by no state.

Enthusiasts point to the success of bitcoin and other blockchain-based cryptocurrencies as the first example of a trend, arguing that blockchain could have a similar impact elsewhere in society. It could replace existing gatekeepers -- banks, governments or any other authority -- with a peer-to-peer network of trust where actions are transparent and visible to all, ushering in a crypto-anarchist utopia.

For example, instead of the government being in charge of confirming our identity (through passports or ID card databases), a distributed, cryptographically-secured ledger could allow us to control our own data.

But how realistic is this vision?

REVOLUTION ON HOLD

"Blockchains shift some control over daily interactions with technology away from central elites, redistributing it among users. In doing so, they make systems more transparent and, perhaps, more democratic," said a report from the European Parliament last year titled *How blockchain technology could change our lives*.

However, the report goes on: "That said, this will not probably not result in a revolution. Indeed, the governments and industry giants investing heavily in blockchain research and development are not trying to make themselves obsolete, but to enhance their services."

For now, it seems, rather than being used to destroy existing authorities, elements of blockchain technology are being used to fix problems with them -- especially around the security and reliability of data. While there are some strong reasons why blockchain-style technologies can fix some vexing problems, they're unlikely to smash the system any time soon.

> For example, instead of the government being in charge of confirming our identity (through passports or ID card databases), a distributed, cryptographically-secured ledger could allow us to control our own data.

"Blockchain is the first time we've had a reliable mechanism that is based on mathematics rather than the frailties of human nature that is capable of maintaining the integrity of the critical systems that make up our lives. No amount of cryptography and clever software will serve as a substitute for the integrity of public officials or financial institutions, but this is a technology that makes it substantially more difficult or expensive to engage in bad behaviour," argues Tomicah Tillemann, director of the Blockchain Trust Accelerator at the New America think tank.

Tillemann sees blockchain as one way of rebuilding or replacing the trust that has been lost in many of the institutions we traditionally rely on. It can help to reduce corruption, increase efficiency and engage citizens who currently feel ignored or marginalised by the system, he says.

Blockchain-based systems allow you a much higher level of confidence in the underlying integrity of the information, and can also provide a degree of security that no existing database system has been proven to replicate, says Tillemann.

He points to a blockchain-based land registry project in the Republic of Georgia, which combines a private blockchain with data that's then anchored to the bitcoin blockchain. This makes it much harder for a corrupt official to be able to change who owns a piece of land -- something that's much easier to do and cover up on a paper-based system.

"I don't believe blockchain is going to eliminate the need for government or the role of government, but I do believe it can help institutions that are struggling mightily to keep up with the velocity of change," he says.

NEW BUSINESS MODELS

But Tillemann does see a more transformative role for blockchain, and also thinks it can create trust and make it easier for individuals to share information, which could lead to new business models.

He suggests that individuals could have their own blockchain-based data wallet, in which they will store

everything from their medical records to their votes to their financial transactions. They will then be able to share access and revoke access to that information at will.

"They will have ownership of the data that defines their identity, rather than the centralised actors that control that information in our current systems," says Tillemann.

In this context, blockchain has the potential not just to upset the traditional gatekeepers like banks, but also the new digital gatekeepers -- the Facebooks, Googles and Ubers who have flourished by creating their own networks of trust.

In this context, blockchain has the potential not just to upset the traditional gatekeepers like banks, but also the new digital gatekeepers -- the Facebooks, Googles and Ubers who have flourished by creating their own networks of trust.

If I didn't need Facebook or any other network to share with my friends, or if I didn't need Uber to be able to trust and pay for transport, it might be possible to create new genuinely peer-to-peer ways of doing business.

"This is a technology with profound implications. Now, we don't know yet whether that potential is going to be realised. None of this is inevitable and it could go any number of ways, but the potential is there and worthy of our attention and respect," says Tillemann.

FILLING A TRUST VACUUM

Eleonora Harwich, head of digital and technological innovation at UK think tank Reform sees blockchain as having a much greater impact in countries where there's low trust in institutions, or where corruption is an endemic issue in public sector. That's because blockchain creates a system where you don't actually need to trust other people or agencies involved in a transaction, thanks to the tamper-proof version of the truth contained in the ledger.

That's handy for freezing out crooked officials, but less useful if you already have efficient and trustworthy authorities. So blockchain usage in government -- at least in the UK -- is more about efficiency gains than completely overhauling the way we think of public services.

"In its theoretical core, blockchain does have the intention to bring down power structures for sure. But I don't think that's the kind of applications we are talking about in the public sector," says Harwich.

Potential usages in the UK might include using blockchain to break down silos in government that hold

information about individuals. For example, blockchain technology could help with creating a single, secure patient record that individuals can control, says Harwich.

"When you talk about patient-centric care or citizen-centric services, it calls for a restructure of the data infrastructure in which we operate. The whole blockchain world is forcing us to ask questions a bit differently," she says.

However that doesn't mean the government is ready to switch over immediately. Blockchain might make sense when setting up something completely new, but government has been gathering data for hundreds of years and connecting that legacy data to the futuristic world of blockchain won't be easy.

The permanent nature of blockchain-based transactions can also be a headache in some scenarios: for example, how does someone exercise their right to be forgotten if their data is held forever in a blockchain?

BLOCKCHAIN ISSUES

For Martha Bennett, principal analyst at Forrester, the issue of transparency and how to deal with it is just one of the issues with blockchain technology.

"Radical transparency is a curse. Transparency handled appropriately is a good thing clearly, but transparency badly handled can actually be a threat to personal safety and is untenable in a commercial environment. I don't want everybody to know what I'm doing, but if all my actions on the blockchain are accessible to everybody, they know where I am, they know what I've done, so they can try and blackmail me."

Still, blockchain does have its place, says Bennett. "When you have processes involving multiple parties, where everybody should be looking at the same data but they are not, and you have endless friction and endless arguments as to whose version is right and who did what when -- that's actually when the concept can come into its own, providing they can agree on how to run the network."

As for the more utopian aspects of blockchain, Bennett is unconvinced. Just because you don't like having your data controlled by other people, that doesn't mean an infrastructure with no conditions for privacy is a great alternative, she says.

Bennett also warns that placing too much trust in the technology alone is unlikely to be successful.

"It's an illusion to pretend that just because you have a blockchain-based network, suddenly everybody will behave in an appropriate manner. Rules and regulations are what make a civil society function; you cannot provide consumer protection in an unregulated environment."

BLOCKCHAIN CONFUSION

Part of the confusion around blockchain is that when people talk about it they don't necessarily mean blockchain technology, they mean 'let's do things differently', says Vili Lehdonvirta, associate professor and senior research fellow at the Oxford Internet Institute.

"They mean 'let's come up with digital identities for objects and people that allow us to make processes more efficient, but let's do it in a way that doesn't result in those identities and all that data being owned by a Silicon Valley monopolist'," he says.

Blockchain has become a catch-all term for this kind of a vision, even if it doesn't use the distributed permissionless model of bitcoin. And certainly not every project needs to use blockchain either.

The desire to create a system that isn't controlled by a digital gatekeeper like a Google or a Facebook might be increasingly understandable, but that doesn't mean technology alone can fix the problem.

"In practice there isn't any simple technological silver bullet; you can't just install blockchain and you're all set, and we have this digital Nirvana which is all egalitarian and there are no gatekeepers. No, that's not how it works," says Lehdonvirta.

For example, while blockchain does offer the potential for more transparency, not everyone in every sector wants all transactions visible to everyone. And even where more visibility of transactions might be good for some (like in the art market, where it would enable -- at least in the UK -- artists to know when their work had been resold, enabling them to receive a cut), not everyone wants that.

"There are parties that benefit from opacity and inefficiency who are the gatekeepers often in these markets, and they are not so keen on these changes", says Lehdonvirta. "It's not like there's going to be this avalanche and everybody is going to adopt technology because it's best for everyone."

Blockchain is not a morally neutral technology; it has been created by software developers with their own agendas and interests, which means it's far from immune to politics. "There's people involved -- it didn't just fall from the sky," Lehdonvirta points out.

"It's more distributed than some other software systems, but it still has politics, it still has gatekeepers, it has power relationships, it has interests. There isn't a technological solution to the problem of politics; you still have to somehow decide who's in charge and who makes the rules."

The idea that there's no authority at all in a blockchain is perhaps missing the point. "You're still going to have people in charge; the question is who do you want to have in charge? Do you want to have a government, or do you want to have some system of software developers and commercial interests in charge?" says Lehdonvirta.

BLOCKCHAIN IN HEALTHCARE GETS A REALITY CHECK FROM THE FDA, DOCTORS, AND PHARMA

VERONICA COMBS/TECHREPUBLIC

IMAGE: ISTOCKPHOTO

The hype around blockchain in healthcare has faded and pilot projects testing real-world use cases have taken its place. Insurance companies are using the technology to improve patient care. The FDA is working with manufacturers and distributors to track the pharmaceutical supply chain. Entrepreneurs are working with doctors and hospitals to reduce the burden of bureaucracy.

Mutaz Shegewi, research director, IDC Health Insights, said that the initial hype around blockchain in healthcare has been replaced by a more pragmatic understanding of the technology and potential use cases for the industry.

"There are some applications already, and a lot of forward-thinking provider organizations are piloting or investing in the technology," he said.

Shegewi described five categories of projects for blockchain in healthcare:

1. Health information access and exchange
2. Payer and provider integration
3. Patient engagement
4. Consulting and professional services
5. Consortia and industry collaborations

Shegewi said that blockchain has the potential to improve the democratization of healthcare data.

"A lot of healthcare, and the utilization of data has been designed around regulation and around the providers and very little has been designed around the patient," he said. "It is the patient that ideally should be the owner

of that data, considering it was their manifestations of health that generated that data in the first place."

Blockchain platforms could accomplish this in healthcare settings because the data is decentralized and relies on the members of the chain to contribute to it.

"It's a different dynamic of data sharing that healthcare lacks and would benefit from," Shegewi said

A DATA MARKET FOR DOCTOR CREDENTIALING RESEARCH

Two companies -- Hashed Health and Solve.Care -- are using blockchain to create new data markets and ease the administrative burden on doctors. Hashed Health is focused on the hiring process while Solve.Care is helping doctors spend more time delivering care instead of dealing with bureaucracy.

> Bass sees blockchain as a way to create a new business structure for the healthcare industry that makes it easier to reduce costs and improve patient care.

When a doctor gets a new job, the hospital has to verify the new hire's work and education credentials. The manual process takes between four to eight months and must be repeated every two years. Until a doctor's credentials have been verified, he or she can't see patients or get paid for providing services. If this process is delayed, hospitals can lose up to $30,000 per month on a single provider.

Hashed Health founder and CEO John Bass built a blockchain solution for this "hair-on-fire issue in healthcare" where there's been no innovation in 25 years.

"There's a huge ROI, so it's a great place to start in terms of blockchain," he said.

Professional Credentials Exchange (ProCredEx) uses a distributed ledger platform to create a data market for credentialing information.

"So the new business model looks like a data market or a data exchange that allows people who've done the primary source verification work to take theinformation that they've curated and offer it to other health systems, and people who need to do the same work," he said.

Instead of the hospital down the street repeating the same credentialing process, the institution can acquire verified digital artifacts from another entity, which has already completed the curation process.

"The information that's being exchanged is the primary source verification of the credential, and that's what is important here, because that's where the trust issue is," he said.

ProCredEx fits within the traditional credentialing system, a crucial element for an industry that is slow to adopt new technology.

"We think that's the best way to bring something like this to market, to not ask people to change their credentialing systems or replace something that they're already using," Bass said.

This new data marketplace is built on work that is currently a cost center. Bass described it as "a beautiful example of a two-sided marketplace that creates value for both buyers and sellers of this information."

Bass said Hashed Health uses a variety of blockchain protocols, including Ethereum, Fabric, Corda, and QLDB from Amazon, a server-less infrastructure with cryptographic guarantees.

As the technology platform took shape, Hashed Health built a network of business partners who would use the technology, including 14 large organizations that include insurance companies, health systems, and big data partners.

Now that ProCredEx is an independent company, Hashed Health is working on Bramble, another data marketplace idea. With this product, the data asset is a digital representation of a healthcare service. The asset includes the provider name, a service description, terms and conditions of the service, and a price. The healthcare service could be CT scans, MRIs, colonoscopies, lab tests, or knee replacements. The creator of the asset makes it available to purchasers. Self-insured employers could buy these services directly from the provider, essentially cutting out the insurance company.

"Using this model, you're creating kind of like (Health and Human Services Secretary) Alex Azar's dream here, which is a peer-to-peer marketplace that's very much focused on transparency, competition, and value," Bass said. "These are exactly the types of cost-reduction opportunities that you can recognize if you were to adopt this kind of peer-to-peer, stripped down market structure that's focused on rationality, competition, choice and value."

Bass sees blockchain as a way to create a new business structure for the healthcare industry that makes it easier to reduce costs and improve patient care.

"We have to start questioning the wisdom of continuing to innovate on top of these traditional siloed infrastructure and data infrastructure," he said.

Bass said that blockchain has the potential to make value chains in healthcare much more transparent.

"Along comes a technology that allows you to start to question and drive visibility and accountability into, 'Who's adding value and who's not in these value chains?'" he said. "A lot of our customers recognize that they need to innovate in that world and be a part of these solutions."

USING BLOCKCHAIN FOR ADMINISTRATIVE TASKS

Solve.Care is also working with blockchain and doctors, but this use case is focused on using technology to make using, providing, and managing healthcare easier. The platform can take over some of the administrative work that doctors have to do during a visit. It also can be used by patients to look up benefits, check costs, and make appointments.

Solve.Care's platform has five components:

- Care.Wallet - The umbrella app for doctors and patients
- Care.Cards - Applications inside the wallet for patients and doctors
- Care.Coin - A programmable token used to pay healthcare providers
- Care.Protocol - The system that connects and synchronizes wallets, cards and coins between users
- Care.Vault - The data management system

Solve.Care CEO Pradeep Goel said that clients use the platform to manage healthcare administration networks, including benefit networks (insurance companies), clinical networks (healthcare providers), and financial networks (payment arrangements among insurers and providers).

"Solve.Care's platform is useful to accountable care organizations, medical practices, insurance companies, hospitals, pharmaceutical companies, employers, and government agencies -- any organization managing or providing healthcare," Goel said.

The Care.Coins serve as digital currency for healthcare on a blockchain system.Goel said that if a care network administrator chooses to use Care.Coins within their CAN, the administrator sets the worth of the Care.Coin and links it to specific services. For a patient, that could be a ride to the doctor's office or an annual preventive care visit. For a doctor, the coin could be used to pay an incentive for meeting a certain criteria of care.

The Arizona Care Network (ACN) started using the Solve.Care platform in mid-2018. ACN is a group of doctors and other healthcare providers whose goal is to improve healthcare and reduce costs by actively coordinating care for patients. The network includes 5,500 doctors in 1,800 care locations. The ACN is using Solve.Care to set specific metrics for patient care and then to reward doctors for hitting those goals.

Using the Solve.Care app, doctors can view their own performance data as well as data from their peers and then can compare it to the network overall. This is part of the Provider Rewards Program – a set of metrics to measure a doctor's progress in keeping patients healthy. These "value-based arrangements" are the opposite of "fee for service." With value-based care, financial incentives are linked to keeping patients healthy, instead of performing procedures.

In late 2019, ACN launched a new addition to the Care.Wallet: the Diabetes Care Administration Network. The healthcare system is working with Boehringer Ingelheim Pharmaceuticals, Inc., to help patients manage the chronic condition.

Dr. David Hanekom, CEO Arizona Care Network, said that Solve.Care is driving a transformation in healthcare delivery, finance, payment, and information sharing.

"Blockchain is going to help us take those administrative processes that intrude on the relationship between the patient and the physician and free them to do what they are trained on, which is to deliver healthcare to humans and not do administrative tasks," Hanekom said.

"Without provider satisfaction, we can't drive better patient care, lower costs, and more satisfied patients."

BLOCKCHAIN CONSORTIA IN HEALTHCARE

Whether the goal is to reduce paperwork or coordinate payments, all blockchain projects in healthcare require collaboration among multiple stakeholders. Just as Hashed Health has built a group of partners to support a data market for doctor credentialing, several other partnerships have formed to explore blockchain use cases in healthcare.

Blue Cross Blue Shield's NASCO division has created a consortium with BCBS health insurance plans and pharmacy benefit manager Express Scripts.

Blockchain in Healthcare Global is a consortium working to identify best practices and challenge legal barriers to the application of blockchain. Dr. Tiffany Gray, MPH, is a member of the working group that was formed about a year ago.

"We are identifying the key standards that need to be put in place as this technology develops, as well as the policy implications and the ethical implications," she said.

Gray said she is also watching a pilot project from the FDA: the Drug Supply Chain Security Act. This project will develop an electronic, interoperable system to identify and trace certain prescription drugs as they are distributed in the United States. The project includes healthcare system, pharmaceutical companies, and retailers.

"That will be very crucial to expanding the discussion of blockchain technology and what that could potentially look like in the future," she said.

CIO JURY: 92% SAY BLOCKCHAIN WILL POSITIVELY IMPACT THEIR INDUSTRY IN THE NEXT FIVE YEARS

TEENA MADDOX/TECHREPUBLIC

IMAGE: GETTY IMAGES/ISTOCKPHOTO

Blockchain is a technology that will improve how the enterprise does business, at least for 92% of the tech leaders who responded to this month's TechRepublic CIO Jury poll.

As TechRepublic's James Sanders wrote in this month's special feature report, "Blockchain is a technology enabling the decentralized management of records in a permanent and verifiable way. By design, it is tamper proof—each block contains a cryptographic hash of the previous block—making retroactive editing of blocks impossible without altering every subsequent block in the chain. Because of the distributed control of the network, this is a practical impossibility."

Because of this, blockchain can be applied to virtually any industry. It can manage transaction records for traditional currencies, and it can be applied to other uses such as land registration, contracts, and federated social networking. The New York Times is even using it in a pilot project through IBM to label photographs in order to identify their origin and prevent "fake news" from being spread.

We polled TechRepublic's CIO Jury of 12 tech leaders to learn more about what the enterprise thinks the future holds for blockchain. We asked, "Do you think blockchain will positively impact your industry within the next five years?" Eleven of our respondents said "yes," and one said "no."

Emil Sayegh, CEO of Ntirety, a multi-cloud and hybrid cloud service company, said, "AI [artificial intelligence] and blockchain technologies are poised to meet and converge, enabled by the hybrid cloud. AI has proven its worth in real-world scenarios, and it's the perfect complement to blockchain, which is known for its limitation on scaling and somewhat less-than-real-time nature. Blockchain features immutable ledger benefits

and a decentralized nature, so it only makes sense that AI has the potential (and destiny) to fill gaps, enhancing security within blockchain-based applications, scalability, and speed."

In the financial services industry, John Gracyalny, vice president of digital member services for Coast Central Credit Union, said, "I expect blockchain to have a significant impact on the financial services industry. While we have yet to see a killer app derived from blockchain at this time, there are a lot of very smart and capable tech leaders in the industry actively searching for ways to apply the enhanced security that blockchain provides. Security is second only to accuracy in maintaining our customers' trust."

However, the sole "no" vote came from Steven Page, vice president of IT for marketing and digital banking for Safe America. He said, "I don't believe in the credit union industry will use DLT (distributed ledger technology) within the next five years. The cost and implementation being a major factor. Eventually a version of blockchain will happen. Blockchain is in its infancy at the moment. To use this type of technology to enable ID, especially outside of the credit union, will take many players. Once scale happens, then we can leverage DLT. It will happen, just don't think we will see it within the next five years."

Craig Lurey, CTO and co-founder of Keeper Security, said, "Blockchain technology has the potential to positively impact both password security and cybersecurity as a whole, but it has significant issues that must be addressed before it can be implemented widely. One of these is recoverability of the 256-bit private keys that act as blockchain users' master passwords.

"When billionaire Matthew Mellon died suddenly, he took $500 million of his Ripple cryptocurrency investments to the grave with him because no one knows where he stored the private keys to his crypto wallets. Imagine the repercussions if, instead of personal funds, this were a company's money, transactions, or records; the death of a CEO could mean the business shuts down. A system must be put in place to recover private keys in the event a user dies or is disabled, or even if the user simply loses their private key."

The construction industry shows potential for blockchain as well.

Dan Gallivan, director of IT for Payette, said one positive scenario he envisions is, "In a traditional AEC contract, we as the architect are the prime contractor with subconsultants working under our contract with the owner. Blockchain would allow for an open ledger, legally bound in the contract, of payments received from the owner to the architect. This would allow the consultants to see what's been billed, received, and paid, and what remains outstanding.

"Same with construction, general contractors would have an open blockchain ledger of their invoices, payments that the subcontractors would see as to what's been received by the owner and what remains under the contract. "This reduces fraud,duplicate payments, and is open for review. Extending this to municipal,

state, and federal contracts would allow full disclosure to the public and hopefully result in a positive project execution, less wasteful spending, and reduce fraud."

Here are this month's CIO Jury participants:

- Emil Sayegh, CEO, Ntirety
- Jeff Focke, director of IT, Border States Electric
- John Gracyalny, vice president of digital member services, Coast Central Credit Union
- Steven Page, vice president of IT for marketing and digital banking for Safe America
- Craig Lurey, CTO and co-founder, Keeper Security
- Clement Machado, computer network engineer, Medical Computer Networks, Inc.
- Michael Hanken, vice president of IT, Multiquip, Inc.
- Dan Gallivan, director of IT, Payette
- Cory Wilburn, CIO, Texas General Land Office
- Roger Berg, vice president of North America Research and Development, DENSO
- Kris Seeburn, independent technology consultant
- Aditya Athavale, director of BI and analytics, GlobalTranz

Want to be part of TechRepublic's CIO Jury and have your say on the top issues for IT decision makers? If you are a CIO, CTO, IT director, or equivalent at a large or small company, working in the private sector or in government, and you want to join TechRepublic's CIO Jury pool, email teena dot maddox at cbsinteractive dot com, and send your name, title, company, location, and email address.

LUXURY ON A BLOCKCHAIN: HOW LAMBORGHINI IS AUTHENTICATING HERITAGE VEHICLES

ASHA BARBASCHOW/ZDNE

Lamborghini Islero

Automobili Lamborghini has been providing luxury vehicles to the elite for over 55 years. While a typical sports car can cost in the ballpark of $200,000, a heritage vehicle can easily go for over $500,000. As a result, the process of selling a heritage Lamborghini is treated like the sale of a high-end piece of art.

When a Lamborghini is resold, the vehicle often goes through 800 to 1,000 certification checks that take place at the Lamborghini headquarters in Sant'Agata Bolognese, Italy.

Conducting these thorough inspections require Lamborghini technicians to work with a massive network of resources such as photographers, auction houses, dealerships, repair shops, newspapers, magazines, and other media sources to curate the full history and most importantly verify all of the parts and service of each unique vehicle.

This gruelling process, Lamborghini head of after sales Paolo Gabrielli said, led Lamborghini to leverage Salesforce Blockchain to create a trust network between these distributed partners, therefore enabling Lamborghini to authenticate each heritage vehicle faster and more securely than before.

The project is known as Lamborghini Sicura and is aimed at protecting the car as a work of art.

Gabrielli would argue the organisation has been at the forefront of innovation in the automotive market since its founding, saying Salesforce Blockchain allows Lamborghini to take its innovation a step further.

Speaking at Dreamforce 2019 in San Francisco, Gabrielli walked his audience through the process of selling a secondhand Lamborghini.

"We are able to offer to our heritage customers a full service … we pick up the car, we secure the car, we completely inspect and restore the car, we certify the car, and we ship the car to the final customer," Gabrielli explained.

"Blockchain is creating trust. It is completely integrated inside the platform."

He said the main aim is to guarantee the authenticity of the car, having an immutable record of which parts of the car are original, and which parts are authentic replacement parts -- as well as which parts, if any, are after market.

"We want to preserve the car," Gabrielli said. "The history of the car is now preserved in the blockchain."

With Salesforce Blockchain, Gabrielli said Lamborghini is digitising its authentication process by creating a trust network among technicians, repair shops, dealerships, and others that are involved in the process.

The first Lamborghini certified by the blockchain platform is the Aventador S by Skyler Grey, which was purchased by an art collector.

Arguing that blockchain will extend the value of Lamborghini's luxury heritage cars even further, Gabrielli said each vehicle will come with an immutable record of service, which also holds information on the likes of restoration and prior ownership.

Additionally, because all authentication checks are managed by Lamborghini and its trusted partner network, Gabrielli said each car is armed against potential counterfeiting. The plan is to scale Sicura globally, to the likes of dealerships, auction houses, and logistics companies.

The first Lamborghini certified by the blockchain platform is the Aventador S by Skyler Grey, which was purchased by an art collector.

Salesforce announced its enterprise blockchain platform in May.

Salesforce Blockchain is built on open source blockchain technology from Hyperledger Sawtooth and aims to allow customers to manage blockchain workflows, contracts, and apps without code.

Salesforce Blockchain is distributed, meaning there is not on sole owner of the data stored within. There's a shared copy that everyone has access to and every player in that network has agreed to the data and they can see a copy of that data. Any change made is seen and it's visible to everyone that is part of the network.

According to Salesforce, Arizona State University, IQVIA, and S&P Global Ratings are also using Salesforce Blockchain.

Arizona State is using the platform to record academic records.

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