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Blockchain

Enigma. Paradox. Opportunity

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Foreword

You may have read about Bitcoin or heard about it at a 'FinTech' conference. You may have used Bitcoins to purchase pizza, coffee or even a spaceflight. Wherever the word has cropped up, fierce debates have often followed. Early adopters passionately claim that Bitcoin will remove dependencies on banks and governments. Hardened business tycoons advise that Bitcoin is just a 'flash in the pan'.

While the debate about Bitcoin rages on, researchers have been quietly examining the technology that underpins this and other digital currencies. This is the realm of the blockchain – a protocol for exchanging value over the internet without an intermediary – and there is a growing buzz about how it might transform not just banking but many other industry sectors, too.

In a recent survey by the World Economic Forum (WEF), a majority of experts and executives in the information and communications technology sector expected at least ten per cent of global GDP to be stored on blockchain platforms by 2025. And while the WEF doesn't expect the tipping point for the technology to occur until around 2027, we anticipate that adoption will occur much faster as a multitude of applications emerge in different sectors.

But who can benefit from this technology? What are the key blockchain applications and how will they work? How do organisations create value from them? And what are the technical, cultural and commercial challenges they will face? This paper is part of a series of reports under the title of "Disrupt: *Deliver*" – Deloitte's approach to developing understanding of and new points of view on disruptive technologies. And, in the following pages, we take a close look at the blockchain and tackle these questions.

In our view, there are new and emerging opportunities for organisations in all sectors to create and deliver compelling services for their customers using the power of disruptive innovation. As they formulate their plans for the coming months, we also hope that this paper helps business and public sector leaders understand the cultural and organisational challenges that are inevitably brought by the use of blockchain technologies, and provides them with the insights they need to overcome them.

We hope that you find this paper useful and we look forward to your feedback.

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Introduction

> "Obviously a closed platform is a serious brake on innovation."
>
> Sir Tim Berners-Lee, inventor of the World Wide Web

Throughout history, many items have been used as a store of value, from cowrie shells and clay tablets to coins and today's ubiquitous paper money. Even distributed payment networks have existed for millennia: thousands of years before the advent of Bitcoin, the people of South Asia, Africa and the Persian Gulf were using hawala for peer-to-peer money transfer.[1]

As our understanding of money has matured, so have the methods and modes for exchanging it. The Bitcoin 'experiment', which was started by Satoshi Nakamoto (presumed to be a pseudonym) in 2008, has demonstrated that there can be a viable digital alternative to cash and other mediums of exchange in modern society.[2] And although Bitcoin has had a chequered history, with its association with the dark net and websites like Silk Road, it has also triggered debates about the opportunities that come from the blockchain – the technology 'backbone' and protocols that Bitcoin and other digital currencies use.[3]

According to the Bank of England, a blockchain is *"a technology that allows people who don't know each other to trust a shared record of events"*.[4] This shared record, or ledger, is distributed to all participants in a network who use their computers to validate transactions and thus remove the need for a third party to intermediate.

The concept is approaching a tipping point in its adoption, according to the World Economic Forum.[5] VentureScanner.com estimates that there are now over 800 new ventures in the global Bitcoin 'ecosystem', which have collectively raised over $1 billion in funding.[6] These companies include specialist Bitcoin exchanges, such as Coinbase and Itbit; Bitcoin 'miners', such as Petamine and 21e6, which provide specialist computer hardware for validating Bitcoin transactions; Bitcoin wallet and payments companies, such as EasyWallet.org and CryptoPay; and many other infrastructure, news and related services companies.[7]

In the FinTech space, the New York-based financial innovation start-up R3CEV has announced that it is working with over 40 banks to conduct research and experiments with the aim of creating a new industry-wide blockchain.[8] Separately, Visa Europe, Westpac, the Commonwealth Bank of Australia, RBS and many of the UK's high street banks have all announced that they are working on their own proof-of-concepts using blockchain.[9,10,11,12] Citi claims to have built three blockchains and its own cryptocurrency, 'Citicoin', to test them.[13] And the first patent for a securities settlement system using cryptocurrencies has been filed by an investment bank.[14]

For consumers, a growing number of mainstream merchants accept Bitcoin as payment for their goods or services. Overstock.com, one of the first major online retailers to accept Bitcoins, made more than $124,000 in Bitcoin sales on January 10, 2014, its first day of accepting the currency.[15] Recently, Overstock.com became the first company to receive approval from the US Securities and Exchange Commission to issue shares using the Bitcoin blockchain.[16]

Understandably, the focus on digital currencies like Bitcoin has created a common misconception that blockchains are relevant only to the banking sector. *"There has long been significant interest in the many different uses for blockchain technology,"* says one commentator, *"However, the 'non-currency' use-cases … have until recently, generally commanded less total mindshare than 'currency' use-cases."*[17]

So who else can benefit from a blockchain? How does it generate value? And, perhaps more importantly, how can the technology be applied to existing organisations and their current business models?

This paper aims to address these questions and help leaders in different sectors navigate the emerging opportunities offered by blockchain technology. Blockchain's impact is illustrated in four domains: banking, insurance, the public sector and the media industry. We also discuss some of the challenges as organisations start planning to adopt this technology.

A blockchain is "a technology that allows people who don't know each other to trust a shared record of events".[4] This shared record, or ledger, is distributed to all participants in a network who use their computers to validate transactions and thus remove the need for a third party to intermediate.

What is a blockchain?

> "The network is robust in its unstructured simplicity. Nodes work all at once with little coordination."[18]
>
> Satoshi Nakamoto

How does a blockchain work?

In his original Bitcoin white paper, Satoshi Nakamoto defined an electronic coin – the Bitcoin – as *"a chain of digital signatures"* known as the 'blockchain'.[19] The blockchain enables each coin owner to transfer an amount of currency directly to any other party connected to the same network without the need for a financial institution to mediate the exchange.

We can illustrate how a blockchain works by using Bitcoin as an example, as shown in Figure 1. Bitcoin, like other blockchains, uses cryptography to validate transactions, which is why digital currencies are often referred to as 'cryptocurrencies'. Bitcoin users gain access to their balance through a password known as a private key. Transactions are validated by a network of users called 'miners', who donate their computer power in exchange for the chance to gain additional bitcoins using a shared database and distributed processing.

Figure 1. How the Bitcoin blockchain works

Bob owes Alice money for lunch. He installs an app on his smartphone to create a new Bitcoin wallet. A wallet app is like a mobile banking app and a wallet is like a bank account.

To pay her, he needs two pieces of information: his private key and her public key.

Bob gets Alice's public key by scanning a QR code from her phone, or by having her email him the payment address, a string of seemingly random numbers and letters.*

The app alerts Bitcoin 'miners' around the world of the impending transaction. 'Miners' provide transaction verification services.

The miners verify that Bob has enough bitcoins to make the payment.

Many transactions occur in the network at any time. All the pending transactions in a given timeframe are grouped (in a block) for verification. Each block has a unique identifying number, creation time and reference to the previous block.

*Anyone who has a public key can send money to a Bitcoin address, but only a signature generated by the private key can release money from it.

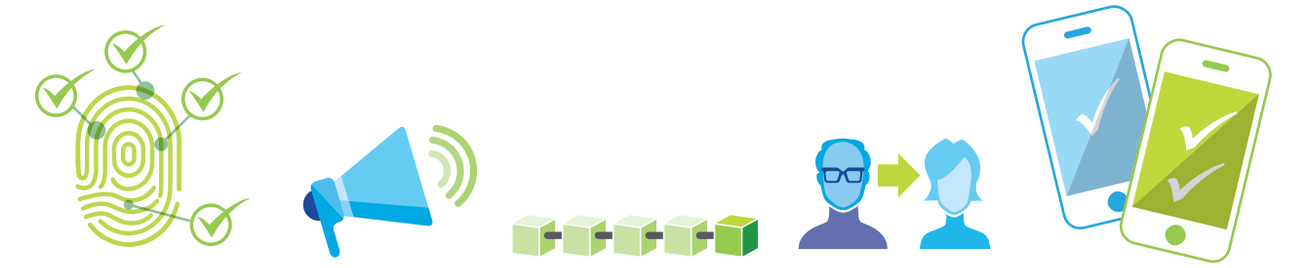
Graphic: Deloitte University Press. Source: American Banker[20]

What is in a blockchain?

Despite its apparent complexity, a blockchain is just another type of database for recording transactions – one that is copied to all of the computers in a participating network.[21] A blockchain is thus sometimes referred to as a 'distributed ledger'. Data in a blockchain is stored in fixed structures called 'blocks'. The important parts of a block are:

- **its header**, which includes metadata, such as a unique block reference number, the time the block was created and a link back to the previous block
- **its content**, usually a validated list of digital assets and instruction statements, such as transactions made, their amounts and the addresses of the parties to those transactions.[22]

Given the latest block, it is possible to access all previous blocks linked together in the chain, so a blockchain database retains the complete history of all assets and instructions executed since the very first one – making its data verifiable and independently auditable. As the number of participants grows, it becomes harder for malicious actors to overcome the verification activities of the majority. Therefore the network becomes increasingly robust and secure. Indeed, blockchain solutions are being planned to protect data from the UK's nuclear power stations, flood-defence mechanisms and other critical infrastructure.[23]



The new block is put in the network so that miners can verify if its transactions are legitimate. Verification is accomplished by completing complex cryptographic computations.

When a miner solves the cryptographic problem, the discovery is announced to the rest of the network.

The algorithm rewards the winning miner with 25 bitcoins, and the new block is added to the front of the blockchain. Each block joins the prior block so a chain is made – the blockchain.

Within ten minutes of Bob initiating the transaction, he and Alice each receive the first confirmation that the bitcoin was signed over to her.

All the transactions in the block are now fulfilled and Alice gets paid.

What are the differences between public and private blockchains?

Like many other types of database, blockchains can be public or private. The Bitcoin network is public (also called "permission-less") because anyone can read or write data from or to the ledger if they are running the appropriate Bitcoin software. Private blockchains, on the other hand, are networks where the participants are known *a priori* and have permission to update the ledger. Participants may come from the same organisation or from different organisations within an industry sector where the relationships between them are governed by informal arrangements, formal contracts or confidentiality agreements.

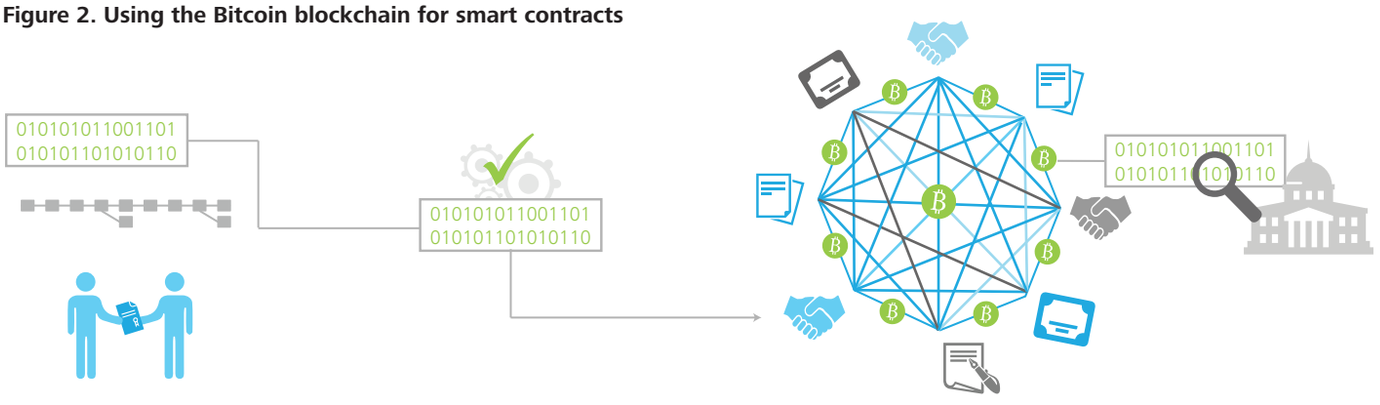
In the absence of trust, public blockchains typically require additional mechanisms to arbitrate disputes among participants and protect the integrity of the data. This involves added complexity because there is no central authority to arbitrate in a decentralised network. In the Bitcoin blockchain, for example, new transactions can only be added to the blockchain after a participant on the network solves a complex mathematical problem, known as a 'proof-of-work'. This process is called 'mining'. The effort miners have to expend on finding a solution to this mathematical problem acts as a sign that the transactions are valid, even though the miners may not know one another.

What alternatives are there to the Bitcoin blockchain?

Blockchains come in many different types. As well as the Bitcoin blockchain, a number of other independent blockchains have emerged in recent years. None has yet achieved the same scale as Bitcoin but they do offer other benefits, such as increased speed, larger data capacities, different consensus methods or more advanced functionality. Litecoin, for example, is a smaller competitor of Bitcoin but offers faster transaction times.[24] The Ripple Transaction Protocol is a simpler type of blockchain providing instant, certified and low cost international payments targeted at banks and non-bank financial services companies.[25] Transactions on Ripple's distributed ledger are validated by consensus rather than using a proof-of-work approach like Bitcoin because a level of trust is assumed between the parties to a transaction.

Ethereum, on the other hand, is an open-source, crowd-funded project, much like the Bitcoin blockchain but which allows a network of peers to administer their own 'smart contracts' – short computer programmes carried on the blockchain that execute their instructions once certain criteria have been met.[26] It is these smart contracts that have the potential to transform business processes in many industry sectors. For example, Figure 2 illustrates how Bitcoin-based smart contracts could enhance transparency in investment banking.

Figure 2. Using the Bitcoin blockchain for smart contracts



1. An option contract between parties is written as code into the blockchain. The individuals involved are anonymous, but the contract is in the public ledger.
2. A triggering event like an expiration date and strike price is hit and the contract executes itself according to the coded terms.
3. Regulators can use the block chain to understand the activity in the market while maintaining the privacy of individual actors' positions.

Graphic: Deloitte University Press, DUPress.com

In addition, technology companies like Microsoft are now providing 'Blockchain-as-a-Service' (BaaS) on their existing cloud platforms.[27] BaaS enables developers from any organisation to deploy private or semi-public blockchains using Bitcoin, Ripple, Ethereum and other protocols, and experiment with decentralised applications without incurring the capital costs associated with setting up their own networks.

What elements are common to all blockchains?

- **A blockchain is digitally distributed across a number of computers in almost real-time:** the blockchain is decentralised, and a copy of the entire record is available to all users and participants of a peer-to-peer network. This eliminates the need for central authorities, such as banks, as well as trusted intermediaries, such as brokerage firms.

- **A blockchain uses many participants in the network to reach consensus:** the participants use their computers to authenticate and verify each new block – for example, to ensure that the same transaction does not occur more than once. New blocks are only adopted by the network once a majority of its participants agree that they are valid.

- **A blockchain uses cryptography and digital signatures to prove identity:** transactions can be traced back to cryptographic identities, which are theoretically anonymous, but can be tied back to real-life identities with some reverse engineering.

- **A blockchain has mechanisms to make it hard (but not impossible) to change historical records:** even though all data can be read and new data can be written, data that exists earlier in a blockchain cannot in theory be altered except where the rules embedded within the protocol allow such changes – for instance, by requiring more than 50 per cent of the network to agree on a change.

- **A blockchain is time-stamped:** transactions on the blockchain are time-stamped, making it useful for tracking and verifying information.

- **A blockchain is programmable:** instructions embedded within blocks, such as "if" this "then" do that "else" do this, allow transactions or other actions to be carried out only if certain conditions are met, and can be accompanied by additional digital data.

Blockchains come in many different types. As well as the Bitcoin blockchain, a number of other independent blockchains have emerged in recent years. None has yet achieved the same scale as Bitcoin but they do offer other benefits, such as increased speed, larger data capacities, different consensus methods or more advanced functionality.

The Internet of Value-Exchange

"[The] Bitcoin protocol and network today is that foundational layer. It is [a] value transfer network. Beyond that, it is a core, backbone security service securing contracts, physical and digital property, equities, bonds, robot AI and an enormous wave of applications which have not yet been conceived."[28]

Jeff Garzik, Bitcoin core developer and CEO, Dunvegan Space Systems

How does a blockchain deliver value?

The way in which many established transaction processing systems work is very different from the decentralised and distributed nature of a blockchain. For certain applications, the current model of value creation is likely to be bettered by faster, cheaper, more reliable and transparent processes enabled by the blockchain. This is illustrated in Figure 3. However, Jeff Garzik, one of Bitcoin's core developers, cautions against trying to do too much with a blockchain: *"Do not try to stuff every feature into the Bitcoin protocol. Let it do what it does best. Build systems on top of Bitcoin which use its strengths…. Putting all the world's coffee transactions, and all the world's stock trades, and all the world's Internet of Things device samplings, on the Bitcoin blockchain seems misguided".*[29]

There are clearly both practical and philosophical limits to the scope of applications amenable to blockchain approaches. But with a little careful thought, linking users and organisations directly together through a shared ledger and distributing processing across a network, we should be able to remove the friction that makes existing transactions slow and expensive. And because a blockchain breaks many of the rules and conventions that traditional business processes are built upon, it forces organisations to think differently about how they create value.

The problem for many organisations at the centre of traditional value-exchange processes, especially banks, or credit card and other types of payment company, is that blockchain technology is a double-edged sword.

Public blockchains, like Bitcoin, Litecoin and others, threaten disintermediation as they empower peer-to-peer networks. The value they create is taken away from central institutions and returned mainly to consumers. However, early predictions of the demise of our global banking system or national governments seem hasty and premature in the cold light of day. The reality is that while many transactions will benefit from a decentralised approach, many others will still need to be handled via an intermediary, which can, despite additional complexities and regulation, veto suspect transactions, provide guarantees and indemnities, and deliver a range of associated products and services that consumers cannot yet access on the blockchain.

Figure 3. Value of a blockchain

Characteristic	*Consumer blockchain*	*Single organisation blockchain*	*Collaborating organisations on a blockchain*
Decentralised processing network	• Increases speed of exchange and reduces time delays • Reduces price of exchange (if a fee is charged) • Improves quality, reliability and availability of services	• Increases speed of exchange between departments/ divisions, which reduces backlog and overall costs • Improves availability, reliability and maintainability of services	• Increases speed of exchange, which reduces backlog and overall costs • Improves availability, reliability and maintainability of services
Distributed ledger	• Increases transparency (in the case of public blockchains) • Increases confidence	• Increases efficiency by standardising data formats across departments/divisions and ensures process integrity • Improves auditability because records are verified in near real-time	• Increases efficiency by standardising data formats across multiple organisations, enabling interoperability, and ensures process integrity • Reduces risk of fraud, error and invalid transactions across the group because records cannot be altered • Improves auditability because records are verified in near real-time
Digital signatures	• Reduces risk of fraud or theft	• Helps identify customers and participating departments/ divisions	• Helps identify customers and participating organisations
Programmable logic	• Enables transaction criteria to be strictly enforced	• Enables new capabilities to be added to existing services and processes	• Enables new capabilities to be added to existing services and processes across the group • Enables collaboration criteria to be strictly enforced
Private vs. public	• Public blockchain enables anyone to participate in any capacity	• Private blockchain restricts processing to members or employees of the organisation but opens up use to consumers	• Private blockchain restricts participation to members of the group of organisations but opens up use to consumers

Source: Deloitte

There are considerable opportunities for organisations that adopt blockchain technology internally, using bespoke blockchains or so-called 'side-chains', which provide some interoperability with public blockchains, like Bitcoin, while adding new functionality.[30] Perhaps the most significant opportunity, though, comes from blockchains that link currently disparate parts of one enterprise together or even many different organisations from within the same sector.

Key challenges

"There have been a few different start-ups trying to create basically their own blockchains with specific use-cases. In our view we feel that kind of defeats the purpose of having a network itself because it just recreates silos."[31]

Tim Swanson, head of research at R3CEV

As the blockchain ecosystem evolves and different use-cases emerge, organisations in all industry sectors will face a complex and potentially controversial array of issues, as well as new dependencies.

Awareness and understanding

The principal challenge associated with blockchain is a lack of awareness of the technology, especially in sectors other than banking, and a widespread lack of understanding of how it works. This is hampering investment and the exploration of ideas. As George Howard, contributor to Forbes Media and Entertainment, says about the music business, *"Artists – visual, musical, or otherwise – really must educate themselves about these emerging technologies, or suffer the fate of being exploited by those who do".*[32] This is a message that applies to organisations, also.

Key questions every leader should ask:

- Who is a thought leader in my industry in blockchain technology?
- To whom do I turn to in my organisation to explain blockchains?
- How do we increase our level of understanding – at all levels?
- Is a blockchain right for my organisation? And, if so, how are we thinking about applying it and what would this mean organisationally and culturally?
- With whom do I interact within my organisation to collaborate and deliver?
- What are my competitors and peers saying about blockchain?

Organisation

The blockchain creates most value for organisations when they work together on areas of shared pain or shared opportunity – especially problems particular to each industry sector. The problem with many current approaches, though, is that they remain stove-piped: organisations are developing their own blockchains and applications to run on top of them. In any one industry sector, many different chains are therefore being developed by many different organisations to many different standards. This defeats the purpose of distributed ledgers, fails to harness network effects and can be less efficient than current approaches.

Key questions every leader should ask:

- What problems or opportunities does my organisation share with others in the sector?
- Will a blockchain approach still leave a marketplace in which we can compete?
- What are the bottlenecks that might prevent us from working together?
- How can we take a lead in bringing the community together?
- How many organisations would be needed to create a critical mass?
- What are the common standards we require?

Culture

A blockchain represents a total shift away from the traditional ways of doing things – even for industries that have already seen significant transformation from digital technologies. It places trust and authority in a decentralised network rather than in a powerful central institution. And for most, this loss of control can be deeply unsettling.

It has been estimated that a blockchain is about 80 per cent business process change and 20 per cent technology implementation.[33] This means that a more imaginative approach is needed to understand opportunities and also how things will change.

Key questions every leader should ask:

- Where can we pilot new blockchain approaches on the edges of our business?
- Who will be most affected by blockchain implementations and are they supportive?
- Which areas of our business are likely to be most disrupted?
- Have we thought about impacts on our strategy, organisational structure, business processes, governance, talent and legacy systems?

Cost and efficiency

The speed and effectiveness with which blockchain networks can execute peer-to-peer transactions comes at a high aggregate cost, which is greater for some types of blockchain than others. This inefficiency arises because each node performs the same tasks as every other node on its own copy of the data in an attempt to be the first to find a solution. For the Bitcoin network, for example, which uses a proof-of-work approach in lieu of trusting participants in the network, the total running costs associated with validating and sharing transactions on the public ledger are estimated to be as much as $600 million a year and rising.[34] This total does not include the capital costs associated with acquiring specialist mining hardware.

Blockchains are something of a productivity paradox, therefore. At the scale of the entire network the process is significantly productivity enhancing, but requires a certain 'critical mass' of nodes. Yet, even so, individual nodes can work extremely hard and may not contribute very much to the network overall.

Therefore, decisions about implementing blockchain applications need to be carefully thought through. The returns to individual processing nodes – either individuals in a public blockchain or organisations in a sector-wide blockchain – may diminish as the network grows in size. This means that blockchain applications must harness network effects to deliver value to consumers or to sectors at large.

Key questions every leader should ask:

- What is the business case for implementing a blockchain? How do we make it pay?
- What are the bottlenecks in the processes we are replacing with the blockchain?
- What are the main drivers of cost in our implementation of the blockchain?
- How can the cost and processing load be shared among participating organisations?

Regulation and governance

Regulations have always struggled to keep up with advances in technology. Indeed, some technologies like the Bitcoin blockchain bypass regulation completely to tackle inefficiencies in conventional intermediated payment networks. One of the other challenges of the blockchain approach, which was also one of its original motivations, is that it reduces oversight.

Centralised systems, particularly in financial services, also "act as shock absorbers in times of crisis" despite their challenges and bottlenecks.[35] Decentralised networks can be much less resilient to shocks, which can impact participants directly, unless careful thought is given to their design.

There is thus a strong argument for blockchain applications to work within existing regulatory structures not outside of them, but this means that regulators in all industries have to understand the technology and its impact on the businesses and consumers in their sector.

Key questions every leader should ask:

- How do current regulations impact our application of blockchain?
- Where are current regulations lacking?
- What will a regulator want to know about our application?
- How do we work with the regulator to bring our application to market?
- What else might we have to do alongside the existing rules to keep regulators happy?

Security and privacy

While cryptocurrencies like Bitcoin offer pseudonymity (Bitcoin transactions are tied to 'wallets' rather than to individuals), many potential applications of the blockchain require smart transactions and contracts to be indisputably linked to known identities, and thus raise important questions about privacy and the security of the data stored and accessible on the shared ledger.

Some argue that while no technology is completely secure, no one has yet managed to break the encryption and decentralised architecture of a blockchain.[36] Identities created within a blockchain would be unique and offer a higher level of assurance that the party was who they claim to be. But these claims do not take away from the need for every organisation adopting the technology to consider how privacy and security can inform the design. In particular, driving public acceptance of blockchain applications will likely mean proactively framing the discussion of privacy around concepts of value, security and trust.

Key questions every leader should ask:

- How are we applying security to our application and is privacy a priority?
- Who has access to the ledger and how is access controlled?
- How are updates to the software or application agreed and made?
- Have we thought about what our customers think about our application beforehand?
- How are we engaging with our customers?

From vision to reality

> "We always overestimate the change that will occur in the next two years and underestimate the change that will occur in the next ten. Don't let yourself be lulled into inaction."
>
> Bill Gates, technologist and philanthropist

Today, performing an online transaction – such as paying for goods or services – is almost impossible without involving a third party, such as a bank or credit card company. When these transactions work, they are taken for granted. When they fail, the complexities, fragmented nature and opacity of the systems used to handle the exchange are often exposed.

Some bold predictions suggest that the institutions at the centre of current transaction systems will cease to exist in just a few years. Others are more conservative, positing a relatively low impact in the short term for blockchain applications other than payments. The reality is likely to be somewhere between these two extremes. And different markets will also move at different speeds, particularly where the role of central institutions is less dominant.

Jonathan Swift, author of *Gulliver's Travels*, said, *"Vision is the art of seeing what is invisible to others"* and this quote sums up what is needed from businesses today. As the blockchain ecosystem steadily builds, the prospects of more significant change occurring within the next decade will increase. Organisations that fail to create a vision and adopt a 'wait-and-see' attitude towards blockchain are unlikely to develop the expertise or break down the organisational and cultural barriers needed to work effectively with this new technology. Nor are they likely to engage their peers or stakeholders in discussions about how the technology may affect their industry at large.

For start-ups and entrepreneurs, interest in the blockchain space is growing rapidly. For legacy organisations, particularly large multinationals, the situation is more challenging. These types of organisation can be stirred into action by identifying specific opportunities where the existing modes of value exchange in the sector create bottlenecks and then analysing how a distributed ledger might help address them. By solving concrete problems, organisations can more effectively identify the technical, organisational, cultural and talent changes necessary to realise new benefits – and then scale what works.

Beyond the tactical changes for organisations, it is important to consider the potential magnitude of business and process change caused by a shift onto sector-wide blockchain platforms. Engaging with like-minded organisations to develop and foster these collaborations and prepare for change is vital. Understanding the risks and level of disruption beforehand is also key to the design of effective systems.

Ultimately, the blockchain is not just about cryptocurrencies and faster peer-to-peer payments. It is also part of an ecosystem of advanced but fledgling technologies, including artificial intelligence, robotics and crowdsourcing, that look set to play a fundamental role in the future of commerce and society. Blockchain will affect the way that individuals and organisations interact, the way that businesses collaborate with one another, the transparency of processes and data, and, ultimately, the productivity and sustainability of our economy.

Endnotes

1. Hawala relies on an extensive network of connected individuals ("Hawaladas") to agree and validate transactions between parties. It offers many of the same benefits we would recognise in today's digital networks, including cost-effectiveness, efficiency, reliability and lack of bureaucracy. Further information on Hawala can be found in "An Introduction to the Concept and Origins of Hawala", Edwina A. Thompson, Journal of the History of International Law, Volume 10, 2008.
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Blockchain applications in banking

> "I don't know what's going to succeed. What I'm certain of is that we are going to see blockchain solutions, peer-to-peer solutions emerging in our industry and we want to be close to that development."[1]
>
> Simon McNamara, Chief Administrative Officer, RBS

A recent article from Let's Talk Payments lists 26 separate banks currently exploring the use of blockchain technology for payments processing.[2] R3CEV, the New York start-up, says that it is working with 42 banks to explore a common set of standards and best practices with a view to creating commercial applications using a blockchain.[3]

This doesn't sound like an industry on the ropes. In fact, the race to develop applications highlights a sector-wide desire for change in traditional financial systems. In this fast-moving environment, no one wants to be left behind.

The thinking around blockchain concepts to facilitate the exchange of money is well-established. Indeed, this is the original use-case for digital currencies like Bitcoin. However, there are further opportunities for banks to use the blockchain technology to improve other services and compliance activities less likely to be subject to disintermediation.

Example: Know Your Customer

What are the current bottlenecks or issues?

Global efforts to prevent money laundering and the financing of terrorism are incredibly expensive for financial firms to maintain. In 2014, it was estimated that global spending on Anti-Money Laundering (AML) compliance alone amounted to $10 billion.[4] The banks are coming under pressure from investors and analysts to reduce costs, but many expect the budgets for their compliance teams to increase in the coming years rather than decrease.[5, 6]

In addition to the financial burden, Know Your Customer (KYC) requests can also delay transactions, taking 30 to 50 days to complete to a satisfactory level.[7] Current KYC processes also entail substantial duplication of effort between firms.

While annual compliance costs are high, there are also large penalties for failing to follow KYC guidelines properly. Since 2009, regulatory fines, particularly in the US, have followed an upward trend, with record-breaking fines levied during 2015.[8]

How the blockchain could help

The sharing of customer information is already starting to take place. For example, SWIFT recently established its KYC Registry, with 1,125 member banks sharing KYC documentation, but this amounts to only 16 per cent of the 7,000 banks in their network.[9]

The use of a distributed ledger system, such as a blockchain, however, could unlock advantages by automating processes and thus reducing compliance errors. A blockchain-based registry would not only remove the duplication of effort in carrying out KYC checks, but the ledger would also enable encrypted updates to client details to be distributed to all banks in near real-time. In addition, the ledger would provide a historical record of all documents shared and compliance activities undertaken for each client. This record could be used to provide evidence that a bank has acted in accordance with the requirements placed upon it should regulators ask for clarification. It would also be of particular use in identifying entities attempting to create fraudulent histories. Subject to the provisions of data protection regulation, the data within it could even be analysed by the banks to spot irregularities or foul play – directly targeting criminal activity.

Although many people perceive applications on the blockchain to offer anonymity, the technology can actually be used to cement real-world identities to cryptographic identities in the database. Companies like I/O Digital, Sho Card, Uniquid, Onename, Ascribe Gmbh and Trustatom all offer businesses, including banks, the ability to scan customer documents and identity information and then generate private and public keys to seal them before the data is encrypted and sent to the blockchain.[10] The FinTech startups Chainalysis and IdentifyMind Global help banks comply with KYC and AML regulations as they consider whether to provide banking services to Bitcoin-related businesses.[11]

Given the expectation that banks will increase their use of blockchain applications in areas such as transaction settlement and payment systems, the use of a common distributed ledger for KYC checks might also offer the opportunity to link many banks to enforce compliance. In the Netherlands, for example, Dutch banks are partnering with Innopay in an attempt to enrol a number of other banks in a common digital identity service.[12] This interoperability, combined with the application of smart contracts could be used to automate some aspects of the compliance process. For instance, transactions could only be permitted to occur with parties for whom adequate KYC evidence exists on the blockchain.

Implications

The burden of KYC compliance could be significantly reduced through the use of a shared database of client background documentation. In some respects, use of a blockchain for settlements and payments creates an even stronger case for tighter controls around KYC.

Under the strain of regulation, creaking legacy IT systems and a tight market for technical talent, asking banks to make wholesale changes to their business models is difficult. Pilot programmes and proof-of-concept activities could allow banks to explore faster, cheaper, better ways of facilitating payments and improving KYC compliance. They could also help regulators stay on top of changes in process and technology.

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Blockchain applications in insurance

> "When I saw what the fundamental principles of the blockchain provided, it was just patently obvious to me that it would make sense around reducing fraud related instances of valuables."[1]
>
> Leanne Kemp, Chief Executive Officer, Everledger

Insurers, like banks, are intermediaries and, at first glance, there is great potential for insurers to use blockchain technology to streamline payments of premiums and claims.

In addition, blockchain technologies could support the significant digital transformation underway in the industry because much of this transformation relies on data. For example, actuaries and underwriters are using the ever-expanding universe of data to build models that more accurately estimate risk and price it accordingly. Arguably the most exciting example of this trend is in telematics: insurers are using data from sensors to price motor risk more accurately, reducing the premiums of young safe drivers, and this technology is spreading to other types of cover, such as home insurance.

However, unlike in banking, the general view among the industry is one of 'wait and see'. *"Insurers do not necessarily need a current Bitcoin strategy to remain competitive," says one observer, "but should nonetheless continue to monitor the space and consider it as an area for potential innovation".*[2]

Early activity has tended to focus on optimising current ways of working within organisations rather than on investigating the potential of a blockchain to address industry-wide problems and opportunities.

Everledger, for example, uses the blockchain to create a distributed ledger that records details of precious stones like diamonds.[3] This ledger allows insurers (as well as potential purchasers) to check the history of any individual stone, including previous claims that have been made, helping insurers prevent, detect and counter fraud.

Example: Claims handling

What are the current bottlenecks or issues?
For customers, insurance contracts are typically complex and difficult to understand because of the legal language used. In addition, when accidents or crimes happen, customers can often be faced with a complex and drawn-out claims process.

From the insurer's perspective, the industry is facing ever-tighter regulation and a growing threat from fraud – whether from small-claims fraud by individuals or more serious and organised fraud spanning multiple insurers in the industry. The Insurance Fraud Bureau (IFB) is a not-for-profit body set up to tackle organised crime affecting the UK general insurance industry. In a typical motor insurance scam, for example, drivers deliberately stage or cause an accident or even pretend to have had an accident, and claims are then made by the various criminals involved. These so-called 'crash for cash' scams cost the industry around £400 million a year.[4] Where claims are made against multiple policies held by different insurers, it becomes difficult to detect the fraud unless cross-industry data is shared.

How the blockchain could help
Smart contracts powered by a blockchain could provide customers and insurers with the means to manage claims in a transparent, responsive and irrefutable manner. Contracts and claims could be recorded onto a blockchain and validated by the network, ensuring only valid claims are paid. For example, the blockchain would reject multiple claims for one accident because the network would know that a claim had already been made. Smart contracts would also enforce the claims – for instance, triggering payments automatically when certain conditions are met (and validated).

Edgelogic provides a bridge between the Internet of Things – devices connected to the internet – and a blockchain, conceivably allowing accidents or problems detected by sensors in the home to trigger a set of instructions that automatically transfer cash for repairs from an insurer.[5]

Adopting a common blockchain across the sector could create a step-change in value in the insurance industry: claims-handling could become more efficient and streamlined, resulting in an improved customer experience. Such an approach could also help to reduce further, if not entirely prevent, fraud if identity management was also enforced on the blockchain – meaning that criminals could no longer crash for cash, or exploit the current challenges of sharing data unless their methods for obscuring identities became significantly more sophisticated.

Implications

A common claims-handling platform would still make it possible for individual insurers to compete for customers, offering a range of products and prices by virtue of the smart contracts they set up. Moreover, a blockchain could allow the industry as a whole to streamline its processing and offer a better user experience for customers who have to make a claim. Simultaneously, storing claims and customer information on a blockchain would cut down fraudulent activity – it would certainly make it much harder for criminals to mask their identities or attempt to claim more than once. Indeed, in many respects, with projects like the IFB now long-established, the general insurance industry faces a smaller cultural and organisational hill to climb than does banking and other sectors.

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Blockchain applications in the public sector

"The most efficient way to produce anything is to bring together under one management as many as possible of the activities needed to turn out the product."

Peter Drucker

The public sector is a complex machine – centralised in respect of its responsibility for governance and public service delivery, yet fragmented and often disconnected in terms of its organisational structure and ability to share data.

The effects of long-running austerity cut deep – reductions in departmental budgets offer a stark choice to central and local government bodies alike: sweeping cuts, shrinking headcount and reduced services on the one hand or wholesale transformation of service delivery on the other.

Blockchains could be used to address inefficiencies in current systems and increase the effectiveness of public service delivery. For example, a blockchain could serve as the official registry for government-licensed assets or intellectual property owned by citizens and businesses, such as houses, vehicles and patents. A blockchain could facilitate voting in elections, ensuring that each eligible person uses only one vote. A blockchain could also help in back-office functions, to coordinate and streamline tendering and purchasing across departments, agencies, and other arms-length bodies. In all cases, a blockchain could reduce fraud and error while delivering big benefits in terms of efficiency and productivity.

While interest in the technology appears to be growing, public sector applications using the blockchain are, as yet, rare. The government in Honduras, for example, kicked-off a project last year with Factom to reduce fraud in its public land registry by moving data onto a distributed ledger, but this project has apparently stalled.[1] And BitHealth, a US start-up, is investigating use of the Bitcoin blockchain to store and transmit healthcare records securely to make it easier for patients to receive treatment wherever they are in the world.[2] These are early days, though, and almost every part of the public sector could benefit in some way from blockchain technology.

Example: Asset registry

What are the current bottlenecks or issues?
All land or property must be registered with the appropriate public sector body if it is bought, gifted, inherited, mortgaged or received in exchange for other property.[3] In November 2015, the number of residential property transactions in the UK exceeded 100,000, and the number of non-residential transactions was nearly 9,000.[4] Across the financial year 2014-15, the total number of residential property transactions completed with a value of £40,000 or above was over 1.2 million.[5]

The size of the housing market makes it costly to keep track of the many property transactions that accumulate over time. And for buyers and sellers, information about the ownership of properties can only be accessed or updated via the central register held by the public sector.

High property prices also make houses attractive to fraudsters who may use forged documents to transfer someone else's property into their own name or to raise a mortgage on someone else's property. Once they have raised money by mortgaging the property without the owner's knowledge they disappear without making repayments, leaving the owner to deal with the consequences.[6]

Current measures to prevent property fraud have stopped fraudulent applications on properties worth more than £74 million.[7] The challenge, though, is that property fraud is not easily detected so the responsibility falls on all parties, including home owners, the government, solicitors and mortgage lenders. And with interest rates likely to rise in the future, the level of fraud may increase – leaving more people to pick up the bill.[8]

How the blockchain could help

Property transactions could be handled on a blockchain in a similar way to how payments between parties are handled using digital currencies like Bitcoin. However, instead of assuming that each 'coin' is the same, it would be possible to associate a unique house or piece of land with a particular coin, or fraction of a coin, and exchange it just like in any other transaction using digital currency. The entire transaction history of the property could then be followed through the blockchain. This concept is known as 'coloured coins' because the coins are 'coloured' to represent a specific asset, such as a house.[9]

In the blockchain, assets are held by the owners of private keys, the cryptographic 'identity' created when a user first registers for the blockchain. The title deeds and identity documents proving ownership do not themselves need to be stored on the blockchain. Instead, they can be 'hashed' – a mathematical transformation that converts long documents of text and other characters to a much shorter, fixed-length string of text and numbers. The hash is unique to the original document and can be stored with the coloured coin on the blockchain in much less space.

Using smart contracts, asset exchange could also follow specific instructions encoded as part of the transaction to be executed automatically once agreed criteria have been met.

Implications

A blockchain-based approach to registering property titles could increase the efficiency of transaction processing and reduce, if not entirely prevent, property fraud.

A property registry could be delivered via a centrally administered public blockchain, which, although replicating large elements of the current registration process, would simultaneously provide enhanced security against fraud, increased resilience and improved transparency – since the historical transaction records could be read by the public. A blockchain could also help in resolving disputes over property ownership since each transaction would be verified and stored in the distributed ledger.

For the registration authorities, a blockchain thus provides a way of combining many processes and systems into one, increasing efficiency through distributed processing and thus reducing cost.

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Blockchain applications in the media industry

"We are at an amazing point in history for artists. A revolution is going to happen, and next year it's going to take over. It's the ability of artists to have the control and the say of what they do with their music at large. The answer to this is in the blockchain."[1]

Imogen Heap, British singer and songwriter

Digital technologies have transformed content production and distribution in the global entertainment and media industry over the last two decades. The market is forecast to continue to grow over the next five years, and is currently estimated to be worth just over $2 trillion.[2]

Acute challenges remain, though, especially relating to the way in which digital content can be copied and freely distributed on the internet, and how artists are compensated when their materials are used or bought through legitimate channels.

In the news media, for example, several newspapers keep their digital content behind paywalls, charging fees to access articles and stories online, but they have had varying degrees of success. One of the latest experiments involves micropayments – payments by consumers of very small sums of money to read individual articles or even portions of articles – sufficient to make a difference to rights holders but not enough to put off consumers. Although this approach does not use a blockchain, it is a sign of the interest that now permeates the industry in finding commercial models that work for content creators, consumers and corporations alike.

Blockchain technology could help to resolve a number of these challenges by connecting authors, musicians and videographers directly with consumers, as well as by making the organisations at the heart of the industry operate more efficiently. The opportunity goes beyond simply enforcing payment for content, it could help digital rights to be identified and managed more effectively across the industry, and appropriate compensation paid to the right artists and content owners.

For example, in an industry that has already undergone significant digital disruption, many musicians are hopeful that blockchain technology can help them reinvent the music business.

Example: Royalty payments in the music industry

What are the current bottlenecks or issues?

Despite the industry at large being in rude health, the inner workings of the music business are struggling to keep up with digital technologies. The industry has traditionally been highly intermediated: artists' contracts written years ago do not necessarily reflect the way that music is now consumed, and royalty payments depend upon airplay statistics gathered by music labels and copyright databases maintained by licensing bodies.[4] Streaming services are also shaking up the traditional business model since many earn their revenues through advertising rather than from selling music. The system works increasingly well for consumers, but such is its complexity and lack of transparency that earning money as an artist is fraught with difficulty.

How the blockchain could help

A blockchain could be used to store a cryptographic 'hash' of the original digital music file, associating it with the addresses – and, potentially, the identities – of the people involved in its creation. The blockchain could also store the instructions, in the form of a smart contract, for how the artists would be compensated for the song or music.

The British artist, Imogen Heap, who released her song, *Tiny Human*, using the blockchain, explains that the technology enables rules to be included that set out how and where the music could be used – putting artists in control of their content.[6]

A number of start-ups are beginning to explore this space. Ascribe, for instance, is a company using blockchain technology and machine learning – a form of artificial intelligence – to ensure artists and content producers are being paid fees for the use of their intellectual property.[7] Ujo is a service that uses Ethereum's blockchain platform to allow musicians and other artists to record and publish rules on how they want their music to be used, which aims to solve global royalty payment and licensing problems across the industry.[8] And Bittunes is using blockchain technology to help independent artists flourish.[9]

Implications

Widespread adoption of blockchain platforms could trigger a new wave of transformation in the music business yet remain compatible with contemporary models of digital music distribution, such as downloads and streaming.

From the consumers' perspective, very little would change, potentially, except that a blockchain would ensure that copyright theft and illegal file-sharing become all but impossible. The main shift, though, occurs in the way that artists are able to manage their intellectual property, ensuring that the way their content is used and paid for is controlled.

For music labels and licensing bodies, there is an opportunity to be on the leading edge of change by working with artists and distributors to establish new standards and ways of working that reach right across the industry. A common blockchain platform, employing identity management and smart contracts, locks in rules for how revenue flows from consumer to artist every time a piece of content is played or streamed, reducing the costs associated with collecting and managing statistics, maintaining copyright databases and distributing royalty payments. It could also enable new business models, such as micropayments, being considered elsewhere in the media industry.

Endnotes

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