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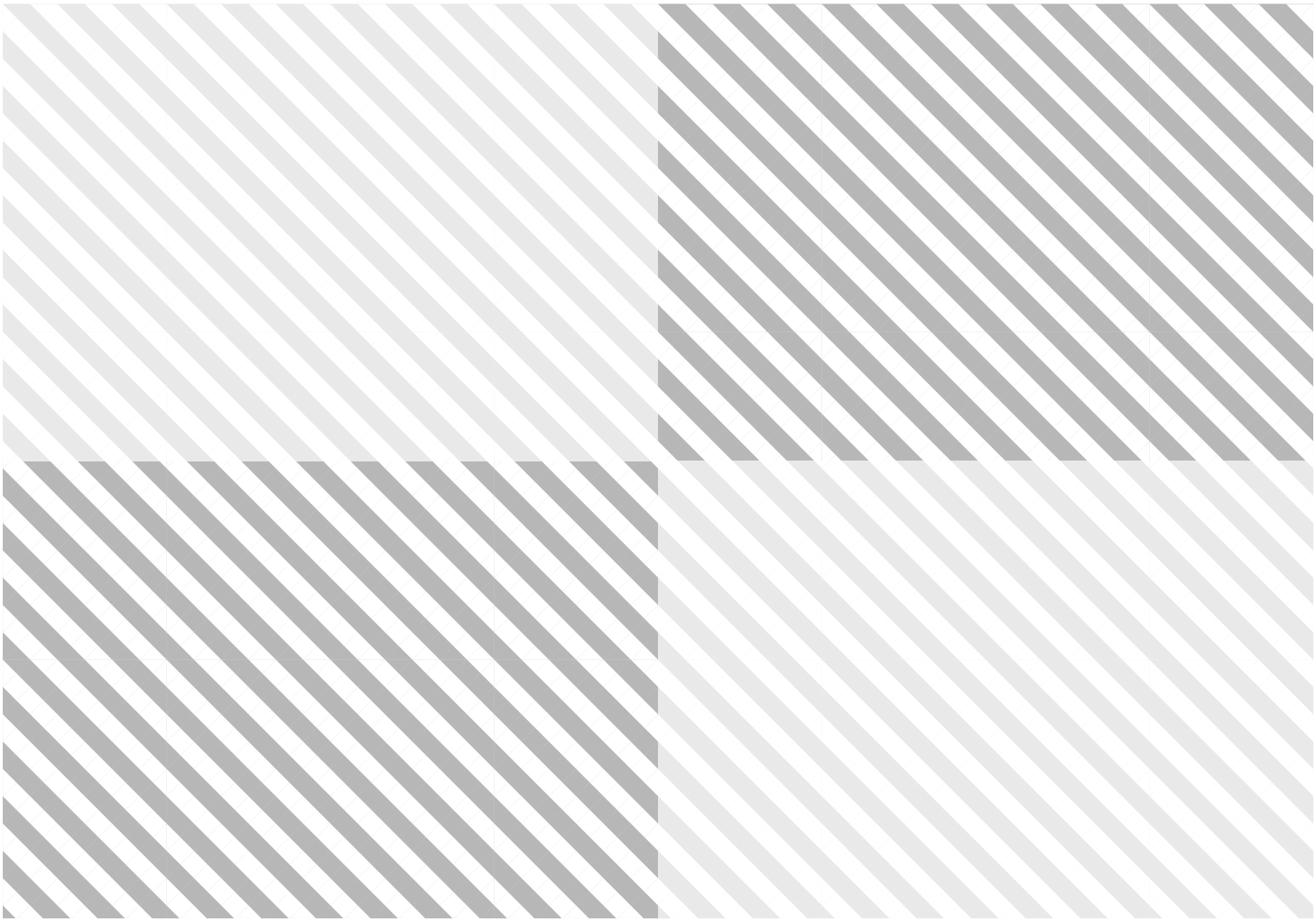
White Paper

Blockchain Beyond the Hype
A Practical Framework for Business Leaders

April 2018



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White paper authors:

Catherine Mulligan, Co-Director, Centre for Cryptocurrency Research and Engineering, Imperial College London

Jennifer Zhu Scott, Principal, Radian Partners, Hong Kong SAR

Sheila Warren, Project Head, Blockchain and Distributed Ledger Technology, World Economic Forum

JP Rangaswami, Chief Data Officer, Deutsche Bank, United Kingdom

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Preface

This common sense and practical framework is designed to assist executives in understanding whether blockchain is an appropriate and helpful tool for their business needs. It starts from the premise that blockchain is merely a technology – much like many others that are already used in society – and like other technologies it is as much about change management and careful attention to the economics and business models of industries and companies involved as it is about technology evangelism. For any organization, blockchain technology should not be a goal in itself but a tool deployed to achieve specific purposes.

This toolkit is based on real-world experience of blockchain in a variety of projects across a variety of industries that have been analysed by Imperial College London to develop an initial framework. The framework has been reviewed and further developed by members of the 2017 World Economic Forum's Global Future Council on Blockchain and has been trialled through a variety of means, including with global chief executive officers (CEOs) at the World Economic Forum Annual Meeting 2018 in Davos-Klosters. Over the coming months, the World Economic Forum's Center for the Fourth Industrial Revolution, in partnership with various institutions, will be releasing customized versions of this toolkit focused on specific sectors and use cases.

Introduction

There has been an overwhelming amount of hype surrounding blockchain over the past year. It has been proposed as a solution to such a dizzying array of problems and industries that it is increasingly difficult to keep up, let alone develop a reasoned and sensible approach to the technology. One of the most unique aspects of blockchain is its high number of evangelists – people who believe blockchain can solve everything from global financial inequality to access to financing for start-ups, the provision of ID for refugees, to solving supply chain problems and enabling people to sell their houses without needing an estate agent. It has started to seem that the most intractable of the world's problems have merely been waiting for blockchain to arrive. This is not only misleading and untrue but also becomes a barrier to decision-makers in taking a balanced perspective on the technology.

The very enthusiasm, therefore, to (over) promote the technology is also the very thing that is damaging its long-term prospects. In addition, a knee-jerk pivot to blockchain when other existing technologies could suffice not only consumes resources in pointless experimentation but also slows the development of sustainable solutions for the problems at hand, and can even lead to the absorption of unrecoverable costs. Given the relatively early stages of this technology, anchoring on blockchain without consideration of associated risks, including, among others, cost, security and the relevant industry's regulatory environment, can be detrimental.

This level of evangelism is both unwarranted and damaging to the overall development work required to reap the benefits of distributed ledger technologies (DLT), of which blockchain is the best-known example. In this paper, the terms "blockchain" and "DLT" will mostly be used interchangeably to refer to DLT. Truly innovative deployments of blockchain require a match between blockchain's specific benefits and use cases that enable realization of these benefits, followed by dedicated hard work to get it right and embed in organizations and industries. DLT is not a workaround for business processes, nor is its use a guarantee of stakeholder alignment. It is only once the hard work of engagement and deployment has been done that we will truly start to reap the benefits of the innovation provided by consensus and pseudonymous value transfer. The rest is likely to remain merely the stuff of white papers.

Demand

At the World Economic Forum Annual Meeting 2018 in Davos, an early version of this toolkit was introduced to a workshop of C-suite executives from large corporations, most of whom expressed that they were actively considering adopting blockchain technology in some manner. One publicly listed energy company discussed its plans for an initial coin offering (ICO), with a focus on broadening its reach to stakeholders and potential customers (instead of raising funds). A traditional bank was considering using blockchain-based crypto-tokens for transferring remittances. The chief executive officer (CEO) of a large power company noted that the economic incentives for using blockchain technology to enable micro grid or peer-to-peer energy trading were too great to be ignored. Even in the much-debated cryptocurrency space, 100% of the participants believed that even after the cryptocurrency bubble burst, the token economy would be here to stay.

Despite the strong interest in adopting the technology, the group had significant questions and confusion about whether blockchain would actually address their business needs and had serious concerns about security, immutability and when to use a private or public blockchain. This confusion is indicative of conversations with hundreds of private-sector leaders over the past year who expressed a need for objective and practical guidance in cutting through the hype and identifying where blockchain could add true value to their companies.

In direct response to this need, the framework contained below is not intended to serve as a reference tool for "Blockchain 101", as such information is readily available from multiple reliable sources. Instead, it is intended to provide tools for analysing whether blockchain might be useful for a particular problem. Thus, no prior knowledge of blockchain is necessary.

The Business Rationale

Whether to adopt blockchain is not merely a technological decision; it is also a business decision. Good use cases must solve real problems for organizations. Great use cases solve real problems at a cost that is significantly lower than the benefits the adoption brings. As the decision-makers within an organization, it is important not to be tempted by the hype but instead to think honestly about whether using blockchain is a sound business decision – even in those cases where a well-defined problem exists. As with any technology deployment, the business need itself is the place to start. Blockchain's unique properties, however, mean that a new analytical framework is useful, in part because of the fact that blockchain has emerged at a unique point in society's technological development.

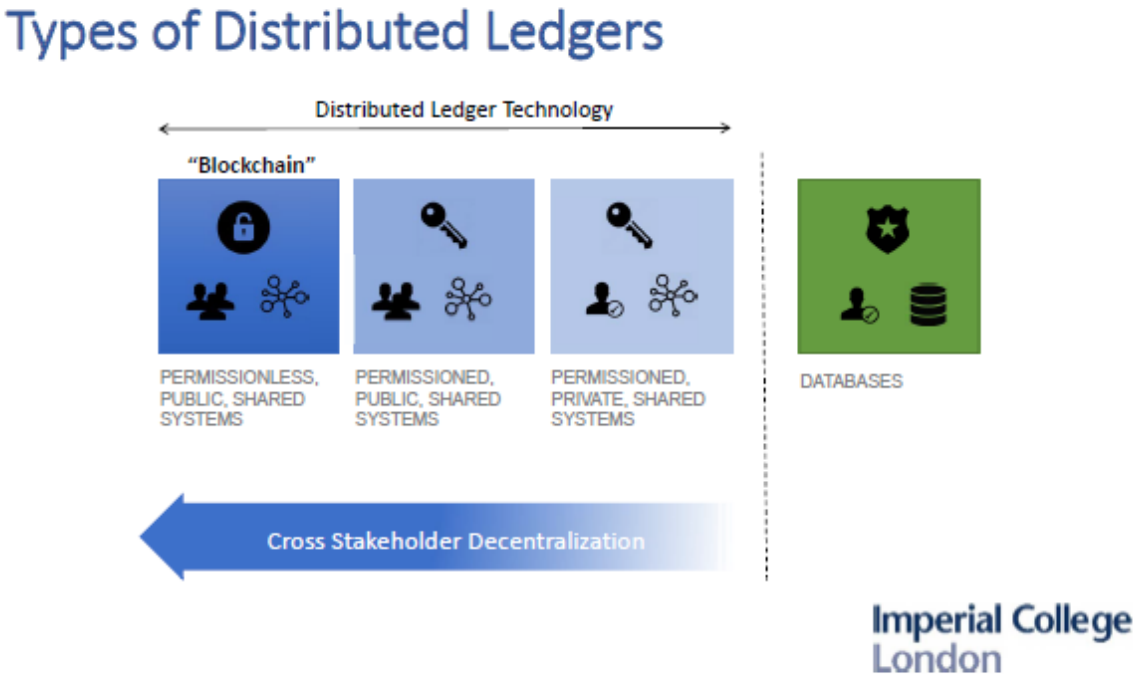
The ICT revolution has placed cheap and powerful computational capacity in the hands of many people around the globe. As a result, the physical capital for creation and production is now broadly distributed throughout society – and in control of individuals, rather than under the control of large-scale entities such as corporations, governments and research institutions. One example of this has been seen in the media industry, with the development of user-generated content (UGC) and the increasing popularity of platforms such as YouTube. Blockchain is very similar to this concept, except that it allows individuals to exchange money and other assets with one another, without requiring an intermediary to do so.

While the application of technology to improve business processes is nothing new, previous generations of technology were predominantly about the faster and more secure exchange of information; that is, they were aimed at delivering the same objectives faster (e.g., back office services such as payroll and accounting were digitalized). Blockchain, meanwhile, is about the exchange of value; it is intended to enable individuals to exchange currency and other assets with one another without relying on a third party to manage the transactions. It also implies the dramatic redefinition of the business processes associated within and between companies.

Types of Distributed Ledger Technology

The three main types of distributed ledger technology (DLT) are: permissionless, public systems; private, permissioned systems; and hybrid systems. Each version is useful to achieve different objectives and meet different requirements.

As illustrated below, each has its own unique properties and each has different forms of access control for reading and editing the information on the blockchain. Moving from right to left across the types of ledger, the level of decentralization increases, while transaction speed decreases.



Permissionless, public, shared systems are those that allow anyone to join the network, to write to the network and to read the transactions from those networks. These systems have no single owner – everyone on the network has an identical copy of the "ledger". In the media, the prototypical example of this is bitcoin, but there are many others. Due to the unique design goals of operating in a completely open environment without any points of centralized trust, and in which potentially malicious actors are not only allowed to submit transactions but also to participate in transaction validation, these systems add an extra component that prevents these activities. The most common method is called proof of work, but there are other models, such as proof of stake and proof of authority. Proof of work is computationally expensive, uses a significant amount of electricity, does not scale well and requires large numbers of network participants to be able to generate "trust". However, this approach does allow large numbers of participants to collaborate based on the codes only in a decentralized manner. Bitcoin and Ethereum are the two best-known examples, but there are many others.

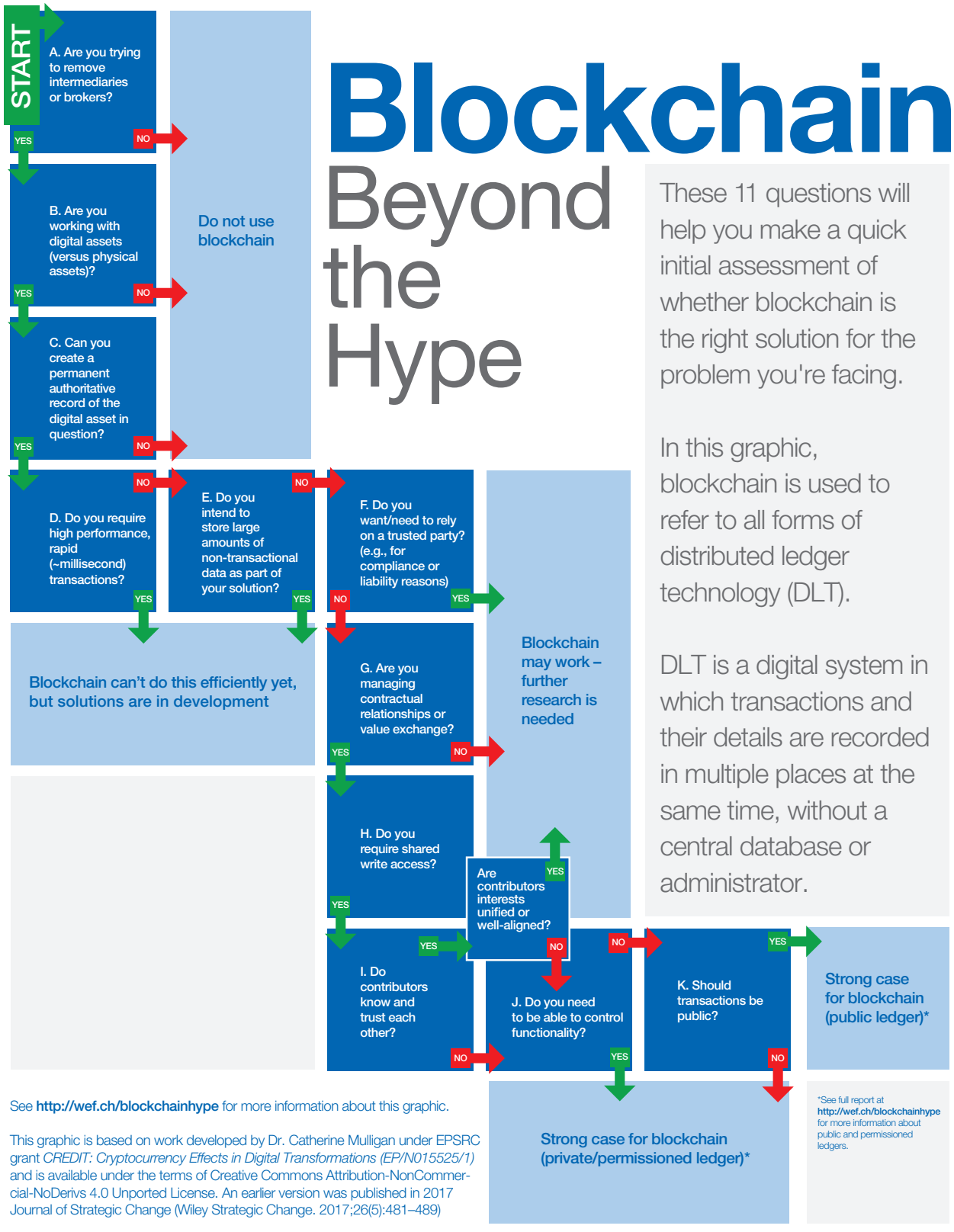
Permissioned, public, shared systems are a form of hybrid system that provide for situations where whitelisted access is required but all the transactions should be publicly viewable. Examples of this are government applications where only certain people should be able to write to the network but all transactions can be publicly verified.

Permissioned, private, shared systems are those that have whitelisted access, meaning that only those people with permission can read or write to such systems. They may have one or many owners – often consortia are formed to manage the ownership.

Decision Tree

This tool is intended to enable rapid initial analysis of whether blockchain is an appropriate solution for a defined problem. It is not intended to provide a final authoritative answer but to assist senior decision-makers in evaluating whether to deploy resources in exploring a blockchain-based solution to a given problem space and, if so, at what scale. The hope is that shifting focus to the business problem, and away from a particular solution, will mitigate the effects of the hype surrounding this technology and encourage a practical approach while reducing the risk of ill-advised experimentation.

The decision tree is composed of a number of questions that assist in defining whether a blockchain is the correct approach for a particular business or not.



See **http://wef.ch/blockchainhype** for more information about this graphic.

This graphic is based on work developed by Dr. Catherine Mulligan under EPSRC grant *CREDIT: Cryptocurrency Effects in Digital Transformations (EP/N015525/1)* and is available under the terms of Creative Commons Attribution-NonCommercial-NoDerivs 4.0 Unported License. An earlier version was published in 2017 Journal of Strategic Change (Wiley Strategic Change. 2017;26(5):481–489)

A. For a blockchain to be an appropriate solution, it is important to understand the business context – does the business problem require the removal of an intermediary? For example, would it be cheaper to collaborate directly with suppliers/competitors rather than use a clearing house? An example of this is the banking industry using a solution such as CORDA to manage remittances between themselves; this allows them to deliver services faster, securely and more cheaply than with existing technologies. They do this by redefining how business processes are delivered in their industry. Another example may be removing brokers from an industry – such as a technology broker or an insurance broker.

B. For blockchain to be successfully applied, it needs to be working with "digitally native" assets, meaning assets that can be successfully represented in a digital format. While this may sound complex, it is actually relatively straightforward. If an asset has a physical representation that can change form, then it is difficult to effectively manage that asset on a blockchain. An example of this is tracking and tracing food on the blockchain – if a company wishes to track and trace wheat across the entire supply chain as it becomes bread, it is difficult to use blockchain to manage its transition from wheat, to flour, to bread.

C. Can a permanent record be created for the digital asset in question? This is perhaps the most critical question, since a blockchain needs to be the source of trust. If there are multiple sources of trust regarding the state of an object, then the object cannot be effectively stored on the blockchain. In those instances where a permanent record can be created, it is important that all parties that have responsibility for the state of the digital asset in question agree how that state will be handled/managed in the new business process prior to any development occurring. Separately, is a permanent record desirable? If an unalterable record is superfluous or counterproductive, for example, in a situation where the need to delete information is critical, then blockchain/DLT is not an appropriate solution. It would not make sense, for example, to store an ordinary grocery list on a blockchain.

D. At this point, it is appropriate to also assess the speed required for the business process in question. If it requires millisecond performance on transactions, blockchains are unable to handle this effectively yet and it is advisable to work with either existing technologies or wait until blockchains can handle such transaction speeds. As of April 2018, various forms of DLT carry between a two- and 10-minute processing time.

E. It is not currently advisable to store non-transactional data on a blockchain. If this is required for a specific use case, it is not advisable to use a blockchain. If, however, the trust in question is related to transaction records (rather than the underlying data itself), then a blockchain may be applicable. In all cases, any private information or any data that may be in conflict with local and global data-protection regulations, such as GDPR, should not be stored on the blockchain.

F. If an industry has specific requirements on the use of intermediaries or trusted partners, then it may be complicated to deploy blockchain, even if other benefits of its use are readily apparent. In use cases where regulation plays a big role, it may be necessary to include regulators in the project and deliver means by which the regulators can ensure compliance with laws, such as anti-trust and competition law. This engagement will be a critical piece that needs to be addressed in many industries. An example is an industry that has strict requirements from multiple regulators, such as antitrust and environmental, each of which requires visibility into a different aspect of the transaction data, and where the issuer does not seek to display the entirety of the transaction data to any one regulator for legal or other reasons. It could be quite difficult to deploy a blockchain for this situation without regulatory engagement.

G. For blockchain to assist in reducing costs and delivering real business value, it is important that a blockchain looks at managing transactions around digital assets – if a business problem is not really about managing contractual relationships and value exchange, then there is little need for a blockchain – a different technology could probably solve that problem more effectively.

H. Does the use case require shared write access? In other words, do some/all of the members of the network in question need to be able to write transactions to the blockchain? If the use case does not require such shared write access, another technology will probably provide a better solution.

I. If the actors/entities already know one another and trust one another, there is probably no need for blockchain. If they do not know or trust one another and/or have misaligned interests, there may be a good reason to use blockchain.

J. If the ability to change the functionality on a blockchain (e.g., node distribution, permissioning, engagement rules, etc.) without having a detailed discussion across the large open-source forums for blockchain is desirable, then you should select a **private**, **permissioned** blockchain.

K. If transactions need to be kept **private**, then a **private**, **permissioned** blockchain is appropriate. If not, then a **public**, **permissionless** blockchain may be used.

Use Cases

Characteristics of high-potential use cases

Shared repository	**A shared repository** of information is used by multiple parties
Multiple writers	**More than one entity** generates transactions that require modifications to the shared repository
Minimal trust	A level of **mistrust exists between entities** that generate transactions
Intermediaries	**One (or multiple) intermediary** or a central gatekeeper is present to enforce trust
Transaction dependencies	Interaction **or dependency between transactions** is created by different entities

Use Case: Using Blockchain to Access Distributed GPUs

This use case examines the role that blockchain may play in enabling access to valuable distributed idle computing capacities. A leading holographic and advanced imaging company has software that produces special effects for movies and is used by more than 7 million game developers and industrial designers. One of the main challenges it constantly faces is providing large-scale graphics processing units (GPUs) to render customer projects. Until now, the major centralized cloud providers have not been able to provide sufficient capacity. The chronic GPU shortage and lack of economies of scale make GPU cloud rendering unaffordable for the majority of users. This example is a good use case that thoughtfully designed a token ecosystem that could discover hidden values in idle GPUs and solve the company's long-term capacity issues as they grow. Starting with the business problem, the company was able to assess that blockchain was, in fact, an appropriate solution.

This solution applies blockchain to allow distributed GPUs to be shared across the globe, reducing costs, reducing waste from underutilized GPUs and creating an efficient use of distributed computational power.

A. Within this use case, the intermediaries are actually the boundaries of the firm that currently hold the GPU computational capacity for rendering images. These intermediaries create inefficiencies in the usage of GPUs for rendering. Applying blockchain creates an incentive that allows companies to access idle GPUs on computers to replace inefficient centralized cloud GPU services. A rough estimate shows that if the company could use its token to access 1% of the world's addressable GPUs, this would be equivalent to $21 billion worth of infrastructure. There is a significant economic incentive to leverage such a distributed network and remove the intermediary/broker capacity currently used.

B. The assets in question are inherently digitally native – namely the processing capacity of the GPUs across the globe that will be shared and coordinated using the blockchain.

C. Within this use case, there are no established entities that are currently managing this asset of GPU computational capacity. Therefore, the companies in question are able to create a permanent record of the transaction in question and the distributed network of computers is able to maintain state.

D. The use case does not require millisecond transaction performance.

E. The solution does not require the storage of large amounts of data, only a record of which GPUs have agreed to contribute to a job and who has agreed to pay what amount for that access.

F. Consumer-grade GPUs installed on smartphones and computers are standardized; therefore, there is no need to rely on a trusted party to certify who can participate in the distributed GPU network. Moreover, the mechanism of exchange is an open marketplace and does not require regulation, or any kind of third party to create trust or compliance.

G. The solution is about managing contractual relationships and is, therefore, a good match for blockchain.

H. Shared write access is required so that all parties are able to have a transparent record of what has occurred and when. This provides irrefutable proof that a transaction has occurred and payment needs to happen.

I. The writers are not known to one another in this use case.

J. The distributed network needs to be able to control functionality; e.g., for upgrades of the network.

K. The transactions need to be public. As a result of this analysis, the application should select a **public**, **permissionless ledger**

Use Case: Medical Insurance

This use case, which examines the role that blockchain may play within medical insurance to prevent multiple claims from different healthcare providers, illustrates an example that fails to make it through the decision tree. The proposed solution allows for the track-and-trace of a user's medical insurance claims on the blockchain – ostensibly to allow for greater transparency in medical insurance claims and thereby faster resolution of claims for end-users, reduced fraud for providers, and an overall reduction in the cost of delivering these services. It is envisaged that a private, permissioned ledger would be used to fully protect end-user privacy.

A. In this example, the goal is to remove intermediaries between the end-users and service providers in the form of handling agencies that usually manage the end-user relationship for insurers.

B. The assets in this case are digitally native – that is, they are created from the beginning in a digital format and relate to the transactions in medical services performed or delivered that need to be paid for.

C. Within this example, if the insurers decide to provide the blockchain, they will have full control over the asset and are the ones responsible for managing and maintaining the state of that asset digitally, as well as the historical record.

D. Within this example, it is not necessary for millisecond transaction speeds for managing this asset, but instead the time frame of minutes, so a blockchain may offer a good result.

E. Since the solution is only supposed to support information related to the transactions associated with providing healthcare, it is not foreseen that any private data will be directly stored on the blockchain, but only transactions.

F. The solution encounters challenges when considered from the perspective of needing trusted sources and compliance. The medical industry is heavily regulated and requires insurance providers to provide detailed oversight of their activities, in particular with respect to the management of end-user data. Thus, DLT is not the best choice for the concept outlined and other technologies must be sought. However, a successful DLT solution is possible if the regulator is involved in the design process from the very beginning – integrating "regulation by design".

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World Economic Forum
91–93 route de la Capite
CH-1223 Cologny/Geneva
Switzerland

Tel.: +41 (0) 22 869 1212
Fax: +41 (0) 22 786 2744

contact@weforum.org
www.weforum.org