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2nd IBM Limited Edition



Grasp blockchain
fundamentals

—
Make blockchain real
for business

—
Get started
on blockchain

Manav Gupta



Blockchain

2nd IBM Limited Edition

by Manav Gupta

**for
dummies®**
A Wiley Brand

Blockchain For Dummies®, 2nd IBM Limited Edition

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Table of Contents

INTRODUCTION	1
About This Book	1
Foolish Assumptions	2
Icons Used in This Book.....	2
CHAPTER 1: Grasping Blockchain Fundamentals	3
Tracing Blockchain's Origin	3
The shortcomings of current transaction systems	4
The emergence of Bitcoin	5
The birth of blockchain	6
Revolutionizing the Traditional Business Network	6
Exploring a blockchain application	7
Recognizing the key business benefits.....	9
Building trust with blockchain	10
CHAPTER 2: Taking a Look at How Blockchain Works	13
Why It's Called "Blockchain"	13
What Makes a Blockchain Suitable for Business?	14
Shared ledger	15
Permissions	15
Consensus.....	16
Smart contracts.....	17
Identifying Participants and Their Roles.....	18
CHAPTER 3: Propelling Business with Blockchains	19
Recognizing Types of Market Friction	20
Information frictions.....	20
Interaction frictions	20
Innovation frictions.....	21
Moving Closer to Friction-Free Business Networks	21
Reducing information friction	22
Easing interaction friction	22
Easing innovation friction	23
Transforming Ecosystems through Increased Visibility.....	24

CHAPTER 4:	Blockchain in Action: Use Cases	25
	Financial Services	25
	Trade finance	25
	Post-trade clearing and settlement	26
	Cross-border transactions	27
	Trusted digital identity	27
	Multinational Policy Management	28
	Government	28
	Supply Chain Management	29
	Food safety	29
	Global trade	30
	Healthcare	30
	Electronic medical records	31
	Healthcare payment preauthorization	31
CHAPTER 5:	Hyperledger, Hosted by The Linux Foundation	33
	Hyperledger Vision	33
	Hyperledger Fabric	35
	How Can IBM Help Developers Innovate with Blockchain?	36
	Offering an easily accessible cloud and development platform	36
	Individualized attention and industry expertise	37
CHAPTER 6:	Ten Steps to Your First Blockchain Application	39
	Determining How Blockchain Fits in Your Industry	39
	Identifying Speed Bumps in Business Processes	40
	Determining How Blockchain Can Help	40
	Choosing an Appropriate Use Case	41
	Determining the Goal of Your Blockchain Network	41
	Identifying Dependencies	42
	Choosing a Blockchain Provider and Platform	42
	Developing and Deploying Smart Contracts	43
	Testing and Fine-Tuning Your Application and Network	43

Introduction

Welcome to *Blockchain For Dummies*, 2nd IBM Limited Edition, your guide to all things blockchain for business. It's been said that blockchain will do for transactions what the Internet did for information. What that means is that blockchain allows increased trust and efficiency in the exchange of almost anything.

Blockchain can profoundly change how the world works. If you've ever bought a house, you've probably had to sign a huge stack of papers from a variety of different stakeholders to make that transaction happen. If you've ever registered a vehicle, you likely understand how painful that process can be. I won't even get started on how challenging it can be to track your medical records.

Blockchain — most simply defined as a shared, immutable ledger — has the potential to be the technology that redefines those processes and many others. To be clear, when I talk about blockchain, I'm not talking about Bitcoin. I'm talking about the underlying digital foundation that supports applications *such as* Bitcoin. But the reaches of blockchain extend far beyond Bitcoin.

About This Book

Blockchain For Dummies, 2nd IBM Limited Edition, equips you with an understanding of what blockchain is, how it works, and how it can enhance your business and the industry in which it operates. You learn the fundamentals of blockchain and how this technology revolutionizes transactions and business networks. You also discover the important difference between “blockchain” and “blockchain for business” and what makes blockchain an ideal solution for streamlining business networks.

You find out about Hyperledger, a Linux Foundation project, designed to help advance technology and thought leadership of cross-industry blockchain technologies. You learn about Hyperledger Fabric, an open-source framework, and the instrumental role it plays in developing a blockchain for business. Finally, you find out everything you need to spin up a blockchain network today.

Foolish Assumptions

I wrote this book based on certain assumptions about you, the reader. First, I assume that whether you're coming from a technical or business side of things you're relatively new to blockchain. Regardless of your role, however, I assume you're interested in finding out more about blockchain and its tremendous potential. I also assume you want to know more about the steps you need to take to start deploying blockchain-based business networks.

Icons Used in This Book

Every *For Dummies* book has small images, called icons, sprinkled throughout the margins. I use the following icons in this book:



TIP

This icon guides you to faster, easier ways to perform a task or better ways to put blockchain to use in your business.



REMEMBER

This icon highlights concepts worth remembering and other important topics.



WARNING

If you see this icon, proceed with caution. Here you find advice on how to avoid the most common pitfalls.



ON THE
WEB

Seek out this icon if you want to find out more about blockchain and related topics on the web.

- » Exploring the roots of the shared ledger system
- » Appreciating blockchain's business potential

Chapter 1

Grasping Blockchain Fundamentals

Blockchain is a shared, immutable ledger that facilitates the process of recording transactions and tracking assets in a business network. An *asset* can be tangible (a house, a car, cash, land) or intangible (intellectual property, patents, copyrights, branding). Virtually anything of value can be tracked and traded on a blockchain network, reducing risk and cutting costs for all involved.

That's the elevator speech for blockchain. In the rest of this chapter, you review additional details to help you more fully appreciate this technology and its potential for streamlining business operations.

Tracing Blockchain's Origin

You can gain a deeper understanding of blockchain by exploring the context in which it was developed: the need for an efficient, cost-effective, reliable, and secure system for conducting and recording financial transactions. In this section, I provide that context and describe the characteristics of blockchain that make it such a suitable solution.

The shortcomings of current transaction systems

Throughout history, instruments of trust, such as minted coins, paper money, letters of credit, and banking systems, have emerged to facilitate the exchange of value and protect buyers and sellers. Important innovations (for example, telephone lines, credit card systems, the Internet, and mobile technologies) have improved the convenience, speed, and efficiency of transactions while shrinking — and sometimes virtually eliminating — the distance between buyers and sellers.



WARNING

In spite of this, many business transactions remain inefficient, expensive, and vulnerable, suffering from the following limitations:

- » Cash is useful only in local transactions and in relatively small amounts.
- » The time between transaction and settlement can be long.
- » Duplication of effort and the need for third-party validation and/or the presence of intermediaries add to inefficiencies.
- » Fraud, cyberattacks, and even simple mistakes add to the cost and complexity of doing business, exposing all participants in the network to risk if a central system — such as a bank — is compromised.
- » Credit card organizations are walled gardens with a high price of entry. Merchants must pay the high costs of onboarding, which often involves considerable paperwork and a time-consuming vetting process.
- » Half of the world's people don't have access to bank accounts, requiring them to develop parallel payment systems to conduct transactions.
- » Limited transparency and inconsistent information hinder the efficient movement of goods in the shipping industry.

Transaction volumes worldwide are growing exponentially and will surely magnify the complexities, vulnerabilities, inefficiencies, and costs of current transaction systems. The growth of ecommerce, online banking, and in-app purchases, coupled with the increasing mobility of people around the world, have fueled

the growth of transaction volumes. And transaction volumes are exploding with the rise of Internet of Things (IoT) — autonomous objects, such as refrigerators that buy groceries when supplies are running low and cars that deliver themselves to your door, stopping for fuel along the way.

To address these challenges and others, the world needs faster payment networks that provide mechanisms to establish trust, require no specialized equipment, have no chargebacks or monthly fees, and offer a collective bookkeeping solution for ensuring transparency and trust.

The emergence of Bitcoin

One solution that's been developed to address the complexities, vulnerabilities, inefficiencies, and costs of current transaction systems is *Bitcoin* — the digital currency launched in 2009 by a mysterious person (or persons) known only by the pseudonym Satoshi Nakamoto.

Unlike traditional currencies issued by central banks, Bitcoins have no central monetary authority. No one controls it. Bitcoins aren't printed like dollars or euros; they're "mined" by people (and increasingly by businesses) running computers all around the world who use software to solve mathematical puzzles. Rather than relying on a central monetary authority to monitor, verify, and approve transactions and manage the money supply, Bitcoin is enabled by a peer-to-peer computer network made up of its users' machines, akin to the networks that underpin BitTorrent and Skype.



TIP

Bitcoin has several advantages over other current transaction systems, including

- » **Cost-effective:** Bitcoin eliminates the need for intermediaries.
- » **Efficient:** Transaction information is recorded once and is available to all parties through the distributed network.
- » **Safe and secure:** The underlying ledger is tamper-evident. A transaction can't be changed; it can only be reversed with another transaction, in which case both transactions are visible.

The birth of blockchain

Bitcoin is actually built on the foundation of blockchain, which serves as Bitcoin's shared ledger. Think of blockchain as an operating system, such as Microsoft Windows or MacOS, and Bitcoin as only one of the many applications that can run on that operating system. Blockchain provides the means for recording Bitcoin transactions — the shared ledger — but this shared ledger can be used to record any transaction and track the movement of any asset whether tangible, intangible, or digital. For example, blockchain enables securities to be settled in minutes instead of days. It can also be used to help companies manage the flow of goods and related payments, or enable manufacturers to share production logs with original equipment manufacturers (OEMs) and regulators to reduce product recalls.



REMEMBER

The takeaway lesson: Bitcoin and blockchain are *not* the same. Blockchain provides the means to record and store Bitcoin transactions, but blockchain has many uses beyond Bitcoin. Bitcoin is only the first use case for blockchain.

Revolutionizing the Traditional Business Network

With traditional methods for recording transactions and tracking assets, participants on a network keep their own ledgers and other records. This traditional method can be expensive, partially because it involves intermediaries that charge fees for their services. It's clearly inefficient due to delays in executing agreements and the duplication of effort required to maintain numerous ledgers. It's also vulnerable because if a central system (for example, a bank) is compromised due to fraud, cyberattack, or a simple mistake, the entire business network is affected.

Business networks also use blockchain. The blockchain architecture gives participants the ability to share a ledger that's updated through peer-to-peer replication each time a transaction occurs. *Peer-to-peer replication* means that each participant (also called a *node*) in the network acts as both a publisher and a subscriber.

Each node can receive or send transactions to other nodes, and the data is synchronized across the network as it's transferred.

The blockchain network is economical and efficient because it eliminates duplication of effort and reduces the need for intermediaries. It's also less vulnerable because it uses consensus models to validate information. Transactions are secure, authenticated, and verifiable.



REMEMBER

The participants in both transaction systems are the same. What has changed is that the transaction record is now shared and available to all parties.

A blockchain network has the following key characteristics:

- » **Consensus:** For a transaction to be valid, all participants must agree on its validity. (See Chapter 2 for more about consensus mechanisms.)
- » **Provenance:** Participants know where the asset came from and how its ownership has changed over time.
- » **Immutability:** No participant can tamper with a transaction after it has been recorded to the ledger. If a transaction is in error, a new transaction must be used to reverse the error, and both transactions are then visible.
- » **Finality:** A single, shared ledger provides one place to go to determine the ownership of an asset or the completion of a transaction.

Exploring a blockchain application

Car companies make leasing a vehicle look easy; in reality, it can be quite complicated. A significant challenge faced by today's car leasing networks is that even though the physical supply chain is usually integrated, the supporting systems are often fragmented. Each party within the network maintains its own ledger, which can take days or weeks to synchronize (see Figure 1-1).

By using a shared ledger on a blockchain network, every authorized participant can access, monitor, and analyze the state of the vehicle regardless of where it is within its life cycle (see Figure 1-2).

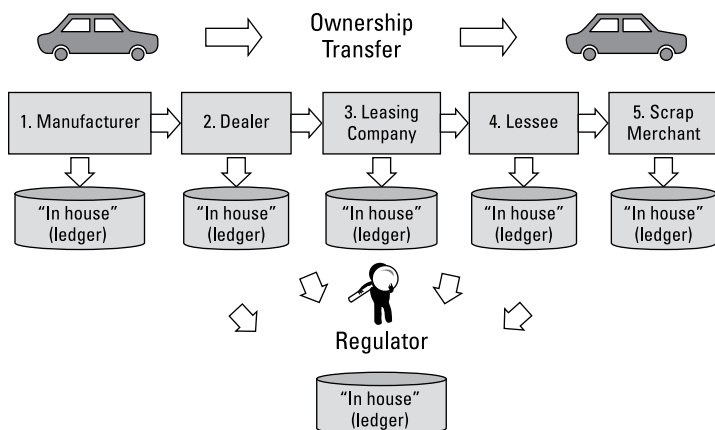


FIGURE 1-1: Tracking vehicle ownership without blockchain.

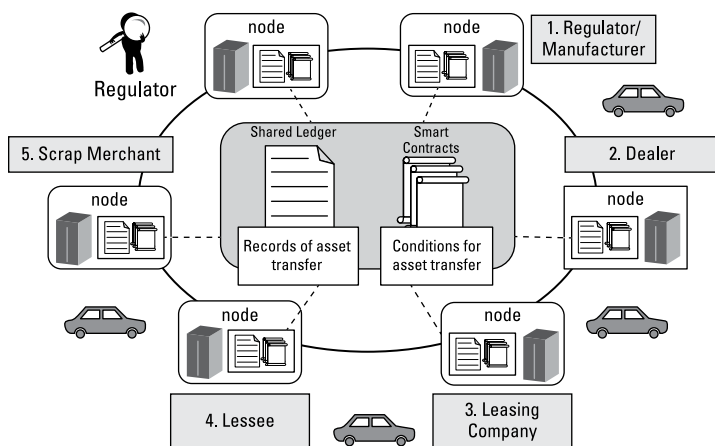


FIGURE 1-2: Tracking vehicle ownership with blockchain.

With blockchain, network participants can interact as follows:

1. The regulator creates and populates the registration for the new vehicle on the blockchain and transfers vehicle ownership to the manufacturer.
2. The manufacturer adds the make, model, and vehicle identification number to the vehicle template within the parameters allowed by the *smart contract* (a digital agreement or set of rules that govern a transaction — see Chapter 2 for details).

3. The dealer can see the new stock availability.

Ownership of the vehicle can be transferred from the manufacturer to the dealership after a smart contract is executed to validate the sale.

4. The leasing company can see the dealer's inventory.

Ownership of the vehicle can be transferred from the dealer to the leasing company after a smart contract is executed to validate the transfer.

5. The lessee can see the cars available for lease and complete any form required to execute the lease agreement.

6. The leasing process continues between various lessees and the leasing company until the leasing company is ready to retire the vehicle.

At this point, ownership of the asset is transferred to the scrap merchant, who, according to another smart contract, has permission to dispose of the vehicle.

Recognizing the key business benefits

For business, blockchain has the following specific benefits:

- » **Time savings:** Transaction times for complex, multi-party interactions are slashed from days to minutes. Transaction settlement is faster because it doesn't require verification by a central authority.
- » **Cost savings:** A blockchain network reduces expenses in a few ways:
 - Less oversight is needed because the network is self-policed by network participants, all of whom are known on the network.
 - Intermediaries are reduced because participants can exchange items of value directly.
 - Duplication of effort is eliminated because all participants have access to the shared ledger.
- » **Tighter security:** Blockchain's security features protect against tampering, fraud, and cybercrime. If a network is permissioned, it enables the creation of a members-only network with proof that members are who they say they are and that goods or assets traded are exactly as represented.



TIP

Not all blockchains are built for business. Some are permissioned, while others aren't. A permissioned network is critical for a blockchain for business, especially within regulated industries. It offers

- » **Enhanced privacy:** Through the use of IDs and permissions, users can specify which transaction details they want other participants to be permitted to view. Permissions can be expanded for special users such as auditors who may need access to more transaction detail.
- » **Improved auditability:** Having a shared ledger that serves as a single source of truth improves the ability to monitor and audit transactions.
- » **Increased operational efficiency:** Pure digitization of assets streamlines transfer of ownership. Transactions can be conducted at a speed more in line with the pace of doing business.

Chapter 2 goes into more detail on what makes a blockchain network ideal for business.

Building trust with blockchain

Blockchain enhances trust across a business network. It's not that you can't trust those whom you conduct business with; it's that you don't need to when operating on a blockchain network.

Blockchain is particularly valuable at increasing the level of trust among network participants because it provides cryptographic proof over a set of transactions; because transactions can't be tampered with and are signed by the relevant counterparties, any corruption is readily apparent. This self-policing can mitigate the need to depend on the current level of legal or government safeguards and sanctions to monitor and control the flow of business transactions. The community of participants does that.

Where third-party oversight is required, blockchain reduces the burden on the regulatory system by making it easier for auditors and regulators to review relevant transaction details and verify compliance.

Blockchain builds trust through the following five attributes:

- » **Distributed and sustainable:** The ledger is shared, updated with every transaction, and selectively replicated among participants in near real time. Because it's not owned or controlled by any single organization, the blockchain platform's continued existence isn't dependent on any individual entity.
- » **Secure, private, and indelible:** Permissions and cryptography prevent unauthorized access to the network and ensure that participants are who they claim to be. Confidentiality is maintained through cryptographic techniques and/or data partitioning techniques to give participants selective visibility into the ledger; both transactions and the identity of transacting parties can be masked. After conditions are agreed to, participants can't tamper with a record of the transaction; errors can be reversed only with new transactions.
- » **Transparent and auditable:** Because participants in a transaction have access to the same records, they can validate transactions and verify identities or ownership without the need for third-party intermediaries. Transactions are time-stamped, ordered, and can be verified in near real time.
- » **Consensus-based and transactional:** All relevant network participants must agree that a transaction is valid. This is achieved through the use of consensus algorithms. Each blockchain network can establish the conditions under which a transaction or asset exchange can occur.
- » **Orchestrated and flexible:** Because business rules and smart contracts (that execute based on one or more conditions) can be built into the platform, blockchain business networks can evolve as they mature to support end-to-end business processes and a wide range of activities.

- » Breaking down the “blockchain” concept
- » Understanding what makes a blockchain network suitable for business
- » Checking out the network participants and the roles they play

Chapter 2

Taking a Look at How Blockchain Works

While Chapter 1 gives you a general understanding of what blockchain is and an appreciation of what it can do, you may be wondering how it works. In this chapter, I tackle that topic by taking you behind the scenes of a blockchain network without getting overly technical.

Here, you get a glimpse of how blockchain stores transactions in a way that prevents recorded transactions from being changed. You discover the four concepts that form the foundation of a blockchain for business, and you meet the network participants to learn the various roles they play.

Why It's Called “Blockchain”

Blockchain owes its name to the way it stores transaction data — in *blocks* that are linked together to form a *chain* (see Figure 2-1). As the number of transactions grows, so does the blockchain. Blocks record and confirm the time and sequence of transactions, which are then logged into the blockchain within a discrete network governed by rules agreed on by the network participants.

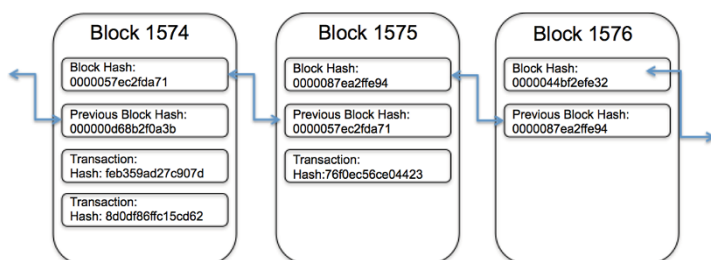


FIGURE 2-1: Blockchain stores transaction records in a series of connected blocks.

Each block contains a *hash* (a digital fingerprint or unique identifier), timestamped batches of recent valid transactions, and the hash of the previous block. The previous block hash links the blocks together and prevents any block from being altered or a block being inserted between two existing blocks. In this way, each subsequent block strengthens the verification of the previous block and hence the entire blockchain. The method renders the blockchain tamper-evident, lending to the key attribute of immutability.



To be clear, while the blockchain contains transaction data, it's *not* a replacement for databases, messaging technology, transaction processing, or business processes. Instead, the blockchain contains verified proof of transactions. However, while blockchain essentially serves as a database for recording transactions, its benefits extend far beyond those of a traditional database. Most notably, it removes the possibility of tampering by a malicious actor (for example, a database administrator).

What Makes a Blockchain Suitable for Business?

Instead of having a blockchain that relies on the exchange of cryptocurrencies with anonymous users on a public network (as is the case with Bitcoin), a blockchain for business is a private, permissioned network with known identities and without the need for cryptocurrencies.

To further understand how a blockchain for business works, and to appreciate its potential for revolutionizing business networks, you need to understand the four key concepts of blockchain for business (see Figure 2-2).

Shared Ledger	• Append-only distributed system of record shared across business network
Permissions	• Ensuring appropriate visibility, transactions are secure, authenticated, and verifiable
Smart Contract	• Business terms embedded in transaction database and executed with transactions
Consensus	• All parties agree to network verified transaction

FIGURE 2-2: The key concepts of blockchain for business.

These four concepts are explained in this section.

Shared ledger

Ledgers are nothing new; they’ve been used in double-entry bookkeeping since the 15th century. What is new is the concept of a shared, distributed ledger — an immutable record of all transactions on the network, a record that all network participants can access. With a shared ledger, transactions are recorded only once, eliminating the duplication of effort that’s typical of traditional business networks. The shared ledger has the following characteristics:

- » Records all transactions across the business network; the shared ledger is *the* system of record, the single source of truth.
- » Is shared among all participants in the network; through replication, each participant has a duplicate copy of the ledger.
- » Is permissioned, so participants see only those transactions they’re authorized to view. Participants have identities that link them to transactions, but they can choose the transaction information that other participants are authorized to view.

Permissions

Blockchains can be permissioned or permissionless. With a permissioned blockchain, each participant has a unique identity,

which enables the use of policies to constrain network participation and access to transaction details. With the ability to constrain network participation, organizations can more easily comply with data protection regulations, such as those stipulated in the Health Insurance Portability and Accountability Act (HIPAA). Permissioned blockchains are also more effective at controlling the consistency of data that gets appended to the blockchain.

With the ability to restrict access to transaction details, more transaction detail can be stored in the blockchain, and participants can specify the transaction information they're willing to allow others to view. In addition, some participants may be authorized to view only certain transactions, while others, such as auditors, may be given access to a broader range of transactions. (With a public blockchain, by contrast, the level of transaction detail may be limited to protect confidentiality and provide anonymity.)

For example, if Party A transfers an asset to Party B, both Party A and Party B can see the details of the transaction. Party C can see that A and B have transacted but can't see the details of the asset transfer. If an auditor or regulator joins the network, confidentiality services can ensure that the auditor alone sees full details of all transactions on the network. Cryptographic technology — this time through the use of *digital certificates* — makes this possible.

Just like a passport, a digital certificate provides identifying information, is forgery resistant, and can be verified because it was issued by a trusted agency. The blockchain network will include a certification authority who issues the digital certificate.

Consensus

In a business network where participants are known and trusted, transactions can be verified and committed to the ledger through *consensus* (agreement). Consensus mechanisms vary from blockchain to blockchain, but include the following:

- » **Proof of stake:** To validate transactions, validators must hold a certain percentage of the network's total value. Proof of stake might provide increased protection from a malicious attack on the network by reducing incentives for attack and making it very expensive to execute attacks.
- » **Multi-signature:** A majority of validators (for example, three out of five) must agree that a transaction is valid.

» **Practical Byzantine Fault Tolerance (PBFT):** PBFT is an algorithm designed to settle disputes among computing *nodes* (network participants) when one node in a set of nodes generates different output from the others in the set.



REMEMBER

Blockchain for business requires *pluggable consensus* — a way to implement whichever consensus mechanism is deemed best for any given industry segment.

Smart contracts

A *smart contract* is an agreement or set of rules that govern a business transaction; it's stored on the blockchain and is executed automatically as part of a transaction.

For example, a smart contract may define contractual conditions under which corporate bond transfer occurs; it could also encapsulate the terms and conditions of travel insurance, which may be executed automatically when a flight is delayed by more than six hours, for example.

PROOF OF WORK: AN UNNECESSARY EXPENSE FOR A BLOCKCHAIN FOR BUSINESS

When participants are anonymous (such as in the Bitcoin world), commitment is expensive. On the Bitcoin network, consensus is reached through proof of work. The network challenges every machine that stores a copy of the ledger to solve a complex puzzle based on its version of the ledger. Machines with identical copies of the ledger "team up" to solve the puzzle they've been given. The first team to solve the puzzle wins, and all other machines update their ledgers to match that of the winning team. The idea is that the majority wins because it has the most computing power to solve its puzzle first.

Proof of work is useful on a public blockchain, such as the one used for Bitcoin, but it consumes considerable computing power and electricity, making it an expensive way to reach consensus.

Identifying Participants and Their Roles

Various participants on a blockchain network play a role in its operation. They include

- » **Blockchain user:** A participant (typically a business user) with permissions to join the blockchain network and conduct transactions with other network participants. Blockchain technology operates in the background, so the blockchain user has no awareness of it. There are typically multiple users on any one business network.
- » **Regulator:** A blockchain user with special permissions to oversee the transactions happening within the network. Regulators may be prohibited from conducting transactions.
- » **Blockchain developer:** Programmers who create the applications and smart contracts that enable blockchain users to conduct transactions on the blockchain network. Applications serve as a conduit between users and the blockchain.
- » **Blockchain network operator:** Individuals who have special permissions and authority to define, create, manage, and monitor the blockchain network. Each business on a blockchain network has a blockchain network operator.
- » **Traditional processing platforms:** Existing computer systems that may be used by the blockchain to augment processing. This system may also need to initiate requests into the blockchain.
- » **Traditional data sources:** Existing data systems that may provide data to influence behavior of smart contracts and help to define how communications and data transfer will occur between traditional applications/data and the blockchain — via API calls, through MQ style cloud messaging, or both.
- » **Certificate authority:** An individual who issues and manages the different types of certificates required to run a permissioned blockchain. For example, certificates may need to be issued to blockchain users or to individual transactions.

- » Recognizing blockchain's potential for eliminating market friction
- » Working toward friction-free business networks
- » Harnessing the transformative power of increased visibility

Chapter 3

Propelling Business with Blockchains

Global trade has been the single greatest creator of wealth in human history — and market friction the greatest obstacle to wealth. Over the years, businesses have overcome multiple sources of friction. Institutions and instruments of trust emerged to reduce risk in business transactions. Technology innovations helped overcome distances and inefficiencies. Still, many business transactions remain inefficient, expensive, and vulnerable.

Blockchain technology has the potential to remove much of the remaining *market friction* — the speed bumps that throttle the pace of business. As friction dissipates, a new science of organization will emerge, revolutionizing the way industries and enterprises are structured. With transparency the norm, a robust foundation for trust can become the springboard for further ecosystem evolution. Participants and assets once shut out of markets can join in, unleashing an accelerated flow of capital and unprecedented opportunities to create wealth.

Recognizing Types of Market Friction

Market friction is anything that impedes the exchange of assets, adding costs or delays: taxes, regulations, bureaucracy, fraud, the involvement of intermediaries, delays in executing contracts, and more. Various types of market friction impact different industries in different ways and to varying degrees; they remain a drag on global business and trade, slowing business or even stopping it cold. In this section, you find out about the common types of market friction that blockchain is capable of alleviating.

Information frictions

Information frictions result from the following limitations:

- » **Imperfect information:** Participants in a transaction don't have access to the same information, giving one party an unfair advantage. Information may also be incorrect or inconsistent, leading to bad decisions or delays while reconciling it.
- » **Inaccessible information:** The potential value of abundant data and information is greatly constrained by the technical challenges of storing, processing, sharing, and analyzing it. As a result, much information isn't collected or remains inaccessible.
- » **Information risks:** Technological risks to information — from hacking to cybercrime and privacy concerns to identity theft — are on the rise. These incur growing costs, as well as damage to brand reputations.

Interaction frictions

Interaction frictions arise when either the cost of transaction is too high or the degree of separation (physical or otherwise) between parties is too great. Business transactions that take days and are costly to manage via intermediaries are prime candidates for disruption by nimbler competitors.



REMEMBER

Interaction frictions are often magnified by the number of interactions required. Blockchain's peer-to-peer architecture can often reduce the number of interactions or parties required to execute a transaction, thus reducing the number of potential sources of interaction friction.

Innovation frictions

Innovation frictions are any conditions, internal or external, that compromise an organization's ability to respond to market changes, such as the following:

- » **Institutional inertia:** Internal bureaucracy and legacy systems, along with the natural human resistance to change, can impede a company's responsiveness.
- » **Restrictive regulations:** While regulations may be required to control industry behavior, they have the side effect of introducing costs and delays.
- » **Invisible threats:** New competitive business models made possible by new technologies are threats for which organizations can't plan. For many, this growing uncertainty will disrupt continued business success. Both small organizations and nimble, larger ones will try new approaches. Though many will fail, some will redefine entire industries.

Moving Closer to Friction-Free Business Networks

In every century, innovations have chipped away at sources of friction — the inefficiencies stifling progress. The first letters of credit established a new basis for trust in the 14th century. The telephone delivered real-time voice communication over great distances. The Internet threw into hyper-drive what was once a slow march to dissipate friction. Technologists and economists alike began to anticipate a world that was friction-free. Friction, in theory, could be “digitized away.”

The Internet did flatten some frictions, such as transaction costs. And while it has ameliorated some forms of imperfect information, it hasn't resolved the issue completely. The frictions that remain are consequential. Indeed, they've become the basis for competition as start-ups race to capitalize on their destruction.

At the same time, other frictions have grown. Conflicting cross-border regulations throttle globalization. New threats such as cyberattacks are costly to prevent and even more expensive to

recover from. Ecosystems are choked by intermediaries ready to take their cuts. The good news is that a new technology — blockchain — holds the promise of eliminating or at least significantly reducing these remaining frictions.

Reducing information friction

Uncertainty over the information needed to make business decisions often acts as a barrier to business. Blockchain has several properties that reduce information friction, including the following:

- » **Shared ledger:** Blockchains shift the paradigm from information held by a single owner to a shared lifetime history of an asset or transaction. Participants can validate transactions and verify identities and ownership without the need for third-party intermediaries. All relevant information can be shared with others based on their roles and access privileges.
- » **Permissions:** A blockchain for business network can be set up as a members-only club, where every participant has a unique identity, and participants must meet certain criteria to conduct transactions. Participants can conduct transactions confident that the person they're dealing with is who she claims to be.
- » **Cryptography:** Advanced encryption, along with permissions, ensures privacy on the network, preventing unauthorized access to transaction details, and deterring fraudulent activity.
- » **Consensus:** Ensures that all transactions are validated before being appended to the blockchain, and the blockchain itself is highly tamper-resistant.

Easing interaction friction

Blockchain is particularly well-equipped to reduce interaction friction because it removes the barriers between participants in a transaction. Blockchain properties that reduce interaction friction include the following:

- » **Shared ledger:** Asset ownership can be transferred between any two participants on the network, and the transaction recorded to the shared ledger.

- » **State-based communication:** Today, banks communicate via secure messaging architecture, such as SWIFT, to accomplish tasks, with each bank maintaining its state of the task locally. With blockchain, banks can send messages that represent the shared state of the task on the blockchain, with each message moving the task to the next state in its life cycle.
- » **Peer-to-peer (P2P) transactions:** On a blockchain for business network, participants exchange assets directly, without having to process the transaction through intermediaries or a central point of control, thus reducing the costs and delays associated with the use of intermediaries.
- » **Consensus:** In place of intermediaries, blockchain uses consensus algorithms to validate and authorize transactions. Participants can conduct business at a pace that's more in line with the pace of their business decisions.
- » **Smart contracts:** Smart contracts eliminate the hassles and delays inherent in contracts by building the contract into the transaction. Through smart contracts, the blockchain establishes the conditions under which a transaction or asset exchange can occur. No more faxing or emailing documents back and forth for review, revision, and signatures.

Easing innovation friction

Innovation friction is possibly the most difficult to overcome through technology alone, but blockchain can help in the following ways:

- » **Eliminate the cost of complexity.** As an organization's operations become increasingly complex, its growth results in diminishing returns. Blockchains have the potential to eradicate the cost of complexity and ultimately redefine the traditional boundaries of an organization.
- » **Reduce costs and delays of regulatory processes.** Automation can't entirely eliminate governance through regulation, but it can lower the costs and reduce delays inherent in regulatory processes.
- » **Expand opportunities.** Blockchain can be both good and bad for businesses by providing the technology that enables businesses to develop new competitive business models. Some businesses will fail, while others redefine entire industries.

For more insights on how blockchain is helping remove friction and building trust across businesses, visit IBM's industry page at www.ibm.com/blockchain/industries.

Transforming Ecosystems through Increased Visibility

By improving visibility, blockchain has the potential to transform entire ecosystems. Supply chains are prime examples of blockchain's potential for transformation that could span industries. Initial blockchain efforts may have quick impact by transforming even a small portion of the supply chain, such as the information used during importing. If import terminals received data from bills of lading earlier in the process, terminals could plan and execute more efficiently and without privacy concerns. Blockchain technology could make appropriate data visible in near real time (for example, the departure time and weight of containers) without sharing information about the owners or value of the cargo. Costly delays and losses due to missing paperwork would be avoided.

On a grander scale, blockchains could enable a robust and secure exchange for shared logistics, coordinating a vast array of activities from sharing spare space in a warehouse to optimizing truck fleets and shipping containers. Retailers and manufacturers could greatly improve demand forecasting and stock replenishment. Financial institutions, armed with a detailed track record of a supplier's reliability, could extend much needed credit to fuel growth. Regulators could trace the origin of goods from raw materials, making it easier to identify counterfeit items, as well as sources of tainted materials.

Chapter 4 provides examples of more specific use cases in which you can utilize blockchain technology.

- » Considering various implementations of blockchain in business
- » Appreciating blockchain's transformative power across industries
- » Envisioning how blockchain may streamline business in your industry

Chapter 4

Blockchain in Action: Use Cases

One of the best ways to understand blockchain, appreciate its potential, and determine whether it may be able to improve the way your organization conducts business is to look at potential use cases. In this chapter, I present a number of use cases across a wide variety of industries.



REMEMBER

The use cases in this chapter only scratch the surface of the potential for blockchain technology. As the technology matures, this list will grow. You can find the latest use case examples at www.ibm.com/blockchain/for-business.

Financial Services

The financial services industry has several exemplary use cases for blockchain.

Trade finance

Trade finance provides delivery and payment assurance to buyers and sellers. Within this realm, there are two examples.

Example 1

Small and medium-sized enterprises (SMEs) are the engine of emerging markets, creating 80 percent of new jobs and 40 percent of national income. But around 50 percent of those SMEs don't have access to formal credit due to banks lacking visibility into their creditworthiness. One IBM Blockchain solution is bringing together nine regional European banks — many of which have been long-time fierce competitors — to simplify domestic and cross-border trade while increasing overall trade transparency and reducing risk.



TIP

The benefits of this solution include

- » New revenue streams for the SME community on the platform
- » Initiating new trading relationships to offer greater value to the community
- » Fostering overall trade and economic growth

Example 2

Businesses need a way to streamline the process of obtaining approvals from multiple legal entities (customs, port authorities, trucking or rail transportation firms, and so on) for the movement of goods across borders. The blockchain can be used by the legal entities to sign all approvals, keeping all parties informed regarding the approval status, when goods are received and when payment is transferred from the importer's to the exporter's bank.



TIP

The benefits of this solution include

- » Complex processes simplified into a single process, all accessing a shadow ledger
- » Increased access to capital because it's not caught up in long settlement times, errors, or disputes
- » Increased trust and accountability among enterprises, regulators, and consumers

Post-trade clearing and settlement

Exchanging one currency into another is the backbone of ensuring fluidity in international trade. But current financial exchange (FX) transaction processes can be wildly inefficient due to the use

of different legacy systems, often resulting in lengthy transaction settlement times. An IBM Blockchain solution reduces settlement costs and increases market liquidity by netting non-CLS currencies. Participants are able to submit FX transactions for five products for netting in 140 currencies, connecting them directly to the platform via a highly secure, permissioned ledger or the SWIFT system banks already use.



TIP

FX markets and their participants benefit from this solution through

- » Reduced settlement costs and increased market liquidity
- » Permissioned, distributed ledger providing an added layer of security

Cross-border transactions

Banks need a way to manage nostro/vostro accounts. *Nostro* (ours) refers to an account a domestic bank holds in a foreign bank in the foreign country's currency. *Vostro* (yours) is how the foreign bank refers to that account. Such accounts are used to facilitate and simplify trade and foreign exchange transactions through reconciliation. Nostro/vostro accounts can become stored account transactions on a blockchain to dramatically improve transparency and efficiency through automated reconciliation of accounts.



TIP

The benefits include

- » The ability to manage transactions across all of a bank's nostro/vostro accounts through a single interface
- » Greater visibility of transaction status, current balance, and tracking over time
- » Consistent, timely, and accurate picture across all nostro/vostro accounts

Trusted digital identity

Headlines in recent years have been grim for digital privacy. Outdated and broken identity systems have exposed all of us to fraud and theft of digital identities. An IBM Blockchain client has developed next generation privacy-enhancing services to help Canadian consumers conveniently and privately assert identity

information through trusted providers like banks, telcos, and governments. As a result, these consumers can connect to critical online services with a digital credential they already have and trust, while ensuring that their information is only ever shared with their explicit consent.



TIP

The benefits include

- » User access to services customers want faster
- » Reduced fraud and elimination of centralized honeypots of data
- » Triple-blinded transactions to preserve privacy

Multinational Policy Management

Managing complex multinational insurance across jurisdictions is a complex process defined by unique regulatory environments, inefficient information sharing, and different currency flows. In response, IBM Blockchain helped convert a multinational, controlled master policy and local policies into a blockchain “smart contract” that provides a shared view of policy data and documentation in real time across the insured, insurer, brokers, and network partners.



TIP

The benefits for participants include

- » A new level of trust and transparency in the multinational network
- » Enabling the insurer and its partners to deliver multinational insurance more efficiently
- » Improved contract certainty, regulatory compliance, and country-specific alignment

Government

A considerable amount of government involves recording transactions and tracking ownership of assets, all of which can be made more efficient and transparent through the use of blockchain.

Establishing trusted identity remains a problem due to forgery and expensive background checks required in verification. Millions of people worldwide may have forged their identity documentation and may not be exactly who they say they are. Millions upon millions of refugees and their children go undocumented. People in the poorer parts of the world may not have sufficient proof to establish identity as required by certain service providers; for example, banks typically require proof of residence or utility bills to establish identity, neither of which may exist in the developing country.

Organizations can apply blockchain by issuing digitally authenticated birth certificates that are unforgeable, time-stamped, and accessible to anyone in the world. The benefits to this include

- » Reduced costs and time in identity verification
- » Reduction in human trafficking
- » Transparency in grant allocations

Supply Chain Management

IBM Blockchain is delivering significant value to complex supply chains around the world, eliminating traditional friction points and providing entirely new degrees of transparency and trust. Well beyond the theoretical, IBM Blockchain clients are collaborating in networks and on solutions that have the potential to elevate the quality of the food supply, speed the movement of goods internationally, and much more.

Food safety

According to a study from the Food Marketing Institute and Grocery Manufacturers Association, the average food recall costs a company \$10 million — not including losses of sales, illnesses, deaths, and damage to their brand. IBM Food Trust brings together growers, processors, wholesalers, distributors, manufacturers, retailers, and others to enhance visibility and accountability in each step of the food supply. Powered by IBM Blockchain, IBM Food Trust directly connects participants through a permissioned, permanent, and shared record of food origin details, processing data, shipping details, and more.



TIP

IBM Food Trust benefits include

- » Secure sharing of permissioned data through a holistic food supply chain solution
- » Faster responses to recalls and other food safety issues to reduce foodborne illnesses
- » Publishing and querying standards-compliant data for powerful food trace and recall capabilities
- » Sharing and viewing single-sourced inspection and quality certifications and registrations throughout the supply chain

Global trade

More than \$4 trillion in goods are shipped each year, with 80 percent of those shipments carried by the ocean shipping industry. Yet the cost of trade documentation is estimated to reach one-fifth of the actual physical transportation costs because different supply chain participants — manufacturers, shippers, insurers, banks, customs and border agents, and more — rely on vastly different systems to process transactions, often slowing or completely stopping the movement of goods. A proposed IBM joint venture with a world leader in logistics will use IBM Blockchain's distributed ledger technology to help speed goods on their journey from manufacturer to market, providing one universal view of the truth to unleash new transparency and remove friction.



TIP

Global digital trade benefits include

- » Fast, secure access to end-to-end supply chain information
- » Verifiable authenticity and immutability of digital documents
- » Trusted cross-organization workflows
- » Better risk assessments and fewer unnecessary interventions
- » Far lower administrative expenses and elimination of costs to move physical paper across international borders

Healthcare

The healthcare industry needs a more efficient and secure system for managing medical records, preauthorizing payments, settling insurance claims, and performing and recording other

complex transactions. Blockchain promises to provide much-needed relief.

Electronic medical records

Electronic medical records are currently maintained in data centers (in a cloudlike environment), and access is limited to hospital and care provider networks. Centralization of such information makes it vulnerable to security breaches and can be expensive.

Blockchain holds the complete medical history for each patient, with multiple granularities of control by the patient, doctors, regulators, hospitals, insurers, and so on, providing a secure mechanism to record and maintain comprehensive medical histories for every patient.



TIP

With this in mind, the following benefits are realized:

- » Tamper-resistant means of storing medical histories
- » Reduced time in insurance claims resolution and increased efficiency in providing insurance quotes
- » Complete patient medical history for precise drug recommendations by physicians

Healthcare payment preauthorization

The term “clinical attachments” is a concept surrounding the need for additional clinical information when a payer is adjudicating a healthcare claim. Claims are often submitted without all required supporting detail. As a result, payers need to request additional detail, which adds costs and delays to the settlement process. Further, matching up claims with supporting information is challenging for all parties involved.



TIP

Blockchain can simplify this complicated and time-consuming process, which would automate the collection and sharing of information. Additional benefits include

- » Claims can be reviewed and paid more efficiently and quickly.
- » The system can suggest alternative services that have better coverage.

- » Looking at the Hyperledger vision
- » Differentiating Hyperledger and Hyperledger Fabric
- » Understanding how IBM can help developers innovate on blockchain

Chapter 5

Hyperledger, Hosted by The Linux Foundation

Hyperledger, hosted by The Linux Foundation, is an open-source community to help advance technology and thought leadership. It's deemed an "umbrella" for developer communities building open-source blockchain and related technologies. Hyperledger was announced and formally announced in a collaborative effort to advance blockchain technology for cross-industry use in business. Now with more than 250 members (and counting) across the world, it's the fastest growing project in Linux Foundation history. Read more about the theory behind Hyperledger at www.ibm.com/blockchain/hyperledger.

Hyperledger Vision

The vision of Hyperledger is to provide robust and efficient standards for blockchain ledger technology to facilitate mainstream commercial adoption. Future applications will involve a world with many interconnected distributed databases and blockchains; each will be specialized to suit the purpose of its users

and will have the potential to communicate with other ledgers as necessary.

Another goal for Hyperledger is to provide a modular blockchain technology that contains a rich, easy-to-use application programming interface (API) and numerous core modules that enable easy development and interoperability. The API must be flexible enough to allow blockchains built outside core Hyperledger to easily interact with their components and other blockchains.

Further, Hyperledger believes that identity and patterns of behavior of any party on a network must be difficult for unauthorized parties to ascertain by inspecting the ledger. Blockchain users must be able to make certain business logic and transaction parameters confidential, rendering them inaccessible to anyone other than the stakeholders.

HYPERLEDGER AND HYPERLEDGER FABRIC: WHAT'S THE DIFFERENCE?

Hyperledger is an open-source collaborative effort to create blockchain technology suitable for the enterprise. *Hyperledger Fabric* is a blockchain framework implementation and one of the Hyperledger projects hosted by The Linux Foundation. It offers modular architecture and pluggable, interchangeable services using container technology. Other attributes include

- Supports a wide variety of industry use cases with different requirements
- Complies with statutes and regulations that exist today
- Supports verified identities and private and confidential transactions
- Supports permissioned, shared ledgers
- Supports performance, scaling, auditability, identity, security, and privacy
- Reduces costly computations involved in proof-of-work

Hyperledger Fabric

Hyperledger Fabric provides a framework for developing blockchain solutions with a modular architecture, pluggable implementations and container technology. While leveraging open-source best practices, Hyperledger Fabric also enables confidentiality, scalability, and security for business environments.

Unlike other blockchain implementations, such as Bitcoin or Ethereum, Hyperledger Fabric fulfills all four key elements of a blockchain for business:

- » **Permissioned network:** Collectively defined membership and access rights within your business network
- » **Confidential transactions:** Gives businesses the flexibility and security to make transactions visible to select parties that have the correct encryption keys
- » **Doesn't rely on cryptocurrencies:** Doesn't require mining and expensive computations to assure transactions
- » **Programmable:** Leverages embedded logic in smart contracts to automate business processes across your network

IBM is a founding member of Hyperledger and

- » Supports a broad, cross-industry and open-source approach to advance the potential for blockchain and make it mainstream
- » Believes Hyperledger will free developers across all industries to focus on building robust applications and platforms to support many different types of business transactions over the Internet
- » Has invested considerable research and development efforts exploring blockchain applications for industry, offering code and intellectual property



REMEMBER

To fulfill its true potential, blockchain requires an open-standards, open-governance approach. This encourages wide adoption and allows innovation to flourish.



TIP

Tune into the Hyperledger Rocket Chat Channel at chat.hyperledger.org, joining the growing community of thousands of developers already building with Hyperledger technologies.

How Can IBM Help Developers Innovate with Blockchain?

IBM is unlocking the potential of blockchain by making it more accessible and more open. As one of the world's leading research organizations, IBM's goal is to explore new ways to advance the science of blockchain by removing complexity to make it more accessible and open.

Offering an easily accessible cloud and development platform

Implementing blockchain solutions on IBM Cloud is the quickest way to get started. IBM has a number of cloud-based solutions to help you easily develop applications while testing the security, availability, and performance of a permissioned blockchain network.



REMEMBER

IBM blockchain networks are built to benefit from decentralized control, but some cloud environments are open to vulnerabilities. By working with teams of security experts, cryptographers, hardware experts, and researchers, IBM has created essential cloud services for tamper-resistant, trusted blockchain networks.

IBM Blockchain Platform

IBM Blockchain Platform offers a high-security plan that provides an isolated environment for business networks. The plan extends the starter features within an isolated environment that runs in a secure infrastructure. This plan offers high levels of security that close any back doors to unauthorized access and tampering. Key features of the plan include

- » A blockchain operating environment that protects host administrators and provides proof to ensure the blockchain executes in the agreed-on manner

- » High evaluation assurance level enables protection across environments where blockchain peers run in isolation from other peers and parties, preventing leaks into another party's environment
- » Crypto-optimization supporting an environment that moves hashing and the creation of digital signatures to optimized accelerators that don't drain CPU performance
- » FIPS 140-2 (the highest Federal Information Processing Standard supporting the use of blockchain in regulated industries such as government, financial services, and healthcare)



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For more about IBM Blockchain Platform options, visit www.ibm.com/blockchain/platform.

Hyperledger Fabric images on DockerHub

You can also pull Hyperledger Fabric images directly from Docker Hub to create and manage your own local blockchain network. Set up and run a blockchain network with IBM-certified Docker Compose script and images. For more detailed instructions on how to get started, visit <http://ibm.biz/QuickStartGuide>.



TIP

After you've deployed a network, you're ready to build your first blockchain application! To earn your developer badge, take this course: <http://ibm.biz/BlockchainChaincodeCourse>.

Individualized attention and industry expertise



TIP

Excited to build on blockchain? You may need help getting other members of your organization onboard. This section can help.

IBM is developing a number of blockchain solutions for clients in varied industries. You can explore blockchain use cases relevant to your business and determine your best first pilot of the technology with IBM Blockchain Services.

IBM's industry experts and strategists — as well as technical architects and developers who've built a wide range of blockchain solutions — will help you begin your blockchain journey successfully through the following three stages:

- » **Conversation and demonstration:** A 90-minute interactive session between IBM's blockchain experts and you. IBM

explains its blockchain point of view in business terms, avoiding technical jargon; discusses what blockchain can do for business; and presents a brief, live, interactive demonstration of a use case (see Chapter 4 for example use cases).

- » **Technology hands-on:** This one-day, highly interactive, face-to-face workshop dives deeper into blockchain technology. Through a combination of presentations and guided, hands-on lab exercises, IBM takes you as deep as you want to delve into blockchain technology.
- » **First project:** Your first project starts with a two-day IBM Design Thinking workshop where you and IBM explore your use case from an end-user viewpoint. IBM then plans an iterative agile development of a deliverable, finite-scale solution for the business challenge realized through a number of short, agile development sprints. These sprints are normally conducted by a small team to combine IBM expertise on blockchain and agile with the customer's knowledge of the use case and business scenario.

As businesses start to work through blockchain strategy, planning, and implementation, IBM Blockchain Services also provides teams of trained consultants around the globe to answer your questions and begin mapping out first projects.

IN THIS CHAPTER

- » Deciding where blockchain can deliver the biggest returns
- » Choosing a representative use case and setting goals
- » Identifying a platform to build your first application
- » Engaging with your peers in a robust community

Chapter 6

Ten Steps to Your First Blockchain Application

After discovering the potential transformative power of blockchain for business, you're probably eager to find out what steps you need to take toward implementing it in your business and industry. Well, you've come to the right place. Here, I present ten steps (okay, there are only nine; you caught me) to your first blockchain application.

Determining How Blockchain Fits in Your Industry

As you find out more about blockchain, you may discover how it's already impacting your industry, or certain applications of blockchain may seem obvious to you as solutions for addressing current challenges. If you're uncertain of whether blockchain has a place in your industry, answer the following questions:

- » Does my business network need to manage contractual relationships?

- » Do we need to track transactions that involve more than two parties?
- » Is the current system overly complex or costly, possibly due to the need for intermediaries or a central point of control?
- » Can the network benefit from increased trust, transparency, and accountability in recordkeeping?
- » Is the current system prone to errors due to manual processes or duplication of effort?
- » Is the current transaction system vulnerable to fraud, cyberattack, and human error?

If you answered “yes” to any of these questions, blockchain can likely benefit your industry.

Identifying Speed Bumps in Business Processes

Examine your current business processes for inefficiencies, particularly steps in the process that are prone to delays, frustration, errors, and duplication of effort. The questions in the preceding section are likely to point you in the right direction.



TIP

A more general question to ask is this: “What challenges do I currently face in my transaction networks?”

Determining How Blockchain Can Help

After identifying challenges in your transaction network, consider various attributes of blockchain that can address the inefficiencies, costs, and other issues. For example, if a lack of trust is causing friction, blockchain’s shared ledger can provide increased visibility into transaction and asset histories to improve trust. If business agreements or rules cause delays, smart contracts may be the solution. The goal here is to determine how blockchain can help overcome specific challenges.

Choosing an Appropriate Use Case

When choosing a use case, make sure it's a good fit for what you're trying to accomplish — something that adds real value as opposed to something that could be achieved just as well using a mature technology. Your use case needs to pass the following four acid tests:

- » **Consensus:** Does agreement that each transaction is valid across the business network provide some benefit?
- » **Provenance:** Is maintenance of a complete audit trail important?
- » **Immutability:** Is it important that the train of transactions is tamper-evident?
- » **Finality:** Is there a need for an agreed "system of record" across the business network?



TIP

Try to choose a use case that's organizationally less complex, so you're not overwhelmed with complexity during your maiden voyage with blockchain.

Determining the Goal of Your Blockchain Network

After choosing an appropriate use case, outline a clear and measurable goal for your first project. What do you hope to solve or improve using blockchain technology? What can you use to measure the success of your first project in meeting that goal?

Do you want to reduce resolution times of disputes? Speed up claims processing? Free up capital flow? Reduce fraud in your network? These are just a few possible objectives a blockchain network could help achieve.

Identifying Dependencies

When you have an appropriate use case in mind, consider what else you need — in addition to internal resources you already have — to start on your first blockchain project. Do you need a services partner to help deploy the first project? Do you need a platform or fabric that enables you to meet certain regulatory or compliance objectives?



TIP

Because transaction processing is becoming a team sport, a blockchain network is most successful when multiple parties are involved and becomes even more valuable and efficient as the blockchain grows. Enterprises need to learn a new model of ecosystem-based processes so it's important to start now.

Choosing a Blockchain Provider and Platform

Choose a provider and platform that best fit your industry and business needs. As you compare the suitability of different providers and platforms, seek answers to the following questions:

- »» Do you require a permissioned network?
- »» Do you need to know the identities in your business network — for example, to adhere to regulations such as anti-money laundering (AML) or know your customer (KYC)?
- »» Do you have frequent exchanges with others that could be automated and preprogrammed, freeing up valuable time and resources?
- »» Would you benefit from transaction resolution in minutes rather than days or weeks?

For help in identifying a platform that suits your needs, refer to www.ibm.com/blockchain/solutions.

Developing and Deploying Smart Contracts

The next step in your first blockchain project is to develop and deploy a blockchain application and network.



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For guidance on how to set up a blockchain network and start coding, see “IBM Blockchain 101: Quick-start guide for developers” at <http://ibm.biz/QuickStartGuide>.

Testing and Fine-Tuning Your Application and Network

The final stage in creating and deploying your first blockchain application is actually an ongoing process. Monitor your application and network and capture learnings to make improvements and expand into a wider deployment.



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You can get going with IBM Blockchain Platform Starter Edition by going to www.ibm.com/blockchain/getting-started.html.

Redefine your business networks with this updated guide to blockchain

Blockchain For Dummies, 2nd IBM Limited Edition, helps you understand what blockchain is, how it works, and how it can enhance your business networks. Understand how this innovative technology can apply to your industry and how you can get started building on blockchain today.

Inside...

- Understand what blockchain is (and is not)
- See blockchain's business potential
- Apply blockchain to various industries
- Learn about the Hyperledger project and Fabric
- Build your first application



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