EMERALD**HANDBOOKS**

THE EMERALD HANDBOOK OF BLOCKCHAIN FOR BUSINESS

H. KENT **BAKER**
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EDITORS

The Emerald Handbook of Blockchain for Business

Praise for *The Emerald Handbook of Blockchain for Business:*

> Maximizing the potential of any technology to create value requires both vision and execution. Knowledge is a key to success in both. This book delivers in-depth coverage of both public and permissioned (business focus) types of Blockchains. The authors' exploration of the advantages/limitations, risks/rewards, and futures/realities is a door opener to the potential awaiting anyone serious about understanding or using blockchain technologies to impact the world.
>
> – Francis D. Poeta,
> *Serial Entrepreneur, CTO, IBM*

> The Emerald Handbook of Blockchain for Business is a must-own book for anyone interested in blockchain. It offers readers an in-depth journey starting from the origins of blockchain technology and cryptoassets, to the evolution of the technology into multiple industries including global finance, real estate, healthcare, and more. It also discusses innovative, cutting-edge developments in this ecosystem, including token economics, interoperability, and blockchain's impact on other emerging technologies.
>
> – Ron Quaranta,
> *Chairman of the Board, Wall Street Blockchain Alliance*

> The Emerald Handbook of Blockchain for Business sheds light on blockchain with 22 chapters deploying an easy-to-understand style. The book starts with fundamental concepts and extends to intricate cases. It blends the know-how and experience of academics and practitioners into the blockchain domain. This book is a candidate to be a worldwide handbook of blockchain for academics, students, practitioners, entrepreneurs, business people, consultants, researchers, policymakers, and all technology-lovers.
>
> – Professor Ibrahim E. Sancak, PhD,
> *ZWIRN-Research Center, Ostfalia University of Applied Sciences, Germany, Founding (E) Director, Market Oversight and Enforcement Division, Capital Markets Board of Turkey*

> In this book, the team of experts delivers a balanced introduction to the world of blockchain and its diverse applications. The authors first explain the theoretical fundamentals of blockchains and the different components and then cover a spectrum of industry and

business applications of this transformational technology. With the wide topic coverage, this book presents a comprehensive must-read primer for anyone interested in the study of blockchain.

– Petr Novotny, PhD,
Research Staff Member & Master Inventor, IBM Research

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The Emerald Handbook of Blockchain for Business

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INVESTOR IN PEOPLE

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Acknowledgments

> When you're editing, you want to be the perfect appreciator, not another writer.
>
> –Joseph Kanon

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Part I
Blockchain: History and Background

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Chapter 1

Blockchain: An Overview

H. Kent Baker, Ehsan Nikbakht and Sean Stein Smith

Abstract

Blockchain is an emerging technology that started in the cryptocurrency sphere with bitcoin but expanded to include numerous applications. This chapter provides an overview of the book. It begins by identifying the three main components of a blockchain. Next, it discusses the book's purpose, distinguishing features, and its intended audience. The chapter then outlines the book's structure, consisting of 22 chapters divided into four main parts. It offers a brief synopsis of each section and chapter. Finally, it ends with a summary and conclusions.

Keywords: Blockchain; cryptocurrency; distributed ledger; business applications; regulatory issues; consensus mechanisms

Introduction

> The blockchain cannot be described just as a revolution. It is a tsunami-like phenomenon, slowly advancing and gradually enveloping everything along its way by the force of its progression.
> William Mougayar, advisor, investor, and author of *The Business Blockchain*

Although an emerging technology, blockchain is here to stay. It combines three main components: (1) a distributed network, (2) digital transactions, and (3) a stored ledger. As Blythe Masters, an experienced financial services and technology executive, notes, "Blockchain technology, or distributed ledger technology, is just a way of using the modern sciences of encryption to enable entities to share a common infrastructure for database retention" (Johnson 2016). However, the buzzwords blockchain and distributed ledger can be confusing. A common misconception is that blockchain and distributed ledger are the same. A

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distributed ledger refers to a decentralized database existing across several locations or among multiple participants. A blockchain is just one type of distributed ledger. A *blockchain* is basically a shared database filled with entries that must be confirmed and encrypted. Each document entry is dependent on a logical relationship to all its predecessors. The term blockchain refers to the "blocks" that get added to the chain of transaction records. Unlike blockchain, a distributed ledger does not necessarily require having a data structure in blocks (Belin 2020). One way to view blockchain and distributed ledger is similar to thinking of Coke and soft drinks. The former is a type of the latter.

Cryptocurrency bitcoin was the first mainstream manifestation of blockchain's potential. Satoshi Nakamoto, a pseudonymous person or group, first outlined bitcoin in a 2008 white paper (Nakamoto 2008). In early 2009, Nakamoto released bitcoin to the public resulting in enthusiastic supporters starting to exchange and mine this virtual currency (Martucci 2020). Although bitcoin was the first established cryptocurrency, previous attempts tried to create online currencies with ledgers secured by encryption such as b-money and bit-gold, but they were never fully developed (Marr 2017).

Since its inception, blockchain has stretched its wings beyond the crypto sphere. Imaginative thinkers have identified new ways for this powerful technology to bring innovative solutions to different problems that result in clear benefits for individuals and institutions. Blockchain offers the potential of creating a safer world. Today, blockchain provides an abundant and diverse set of use cases across society. Every so often, new technology has the promise to change the world in ways that are currently unimagined. Blockchain is such an innovation. Not surprisingly, many companies, governments, financial institutions, and entrepreneurs are engaging with blockchain. Yet, because blockchain can be an extreme and disruptive change, its infiltration into business and society has been uneasy and sometimes met with resistance.

About This Book

This section discusses the book's purpose, distinguishing features, and its intended audience.

Purpose

The book's main purpose is to provide academics, practitioners, students, and others with a broad understanding of some current issues in the emerging blockchain technology and its applications. The coverage extends from discussing basic concepts and their application to increasingly intricate and real-world situations. This volume spans the gamut from theoretical to practical while offering a useful balance of detailed and user-friendly coverage. A discussion of relevant research permeates the books.

Another objective of this book is to provide an overview and understanding of two distinct areas. First, integral to any advanced or industry-specific analysis is

the need for practitioners and academics to understand and articulate the core components of how blockchain technology functions. Specifically, questions addressed within this book include what differentiates blockchain from existing data management options and what business problems can be solved via its implementation. Second, the book explains how different industry sectors are using blockchain technology. Upon completing this book, readers should know how blockchain functions and some business applications of increased blockchain integration. The book is not intended to provide solutions to every question blockchain poses, but rather to offer the actionable business intelligence required to make effective decisions. *The Emerald Handbook of Blockchain for Business* provides a fresh look at this intriguing and dynamic but often complex subject.

Distinguishing Features

Several features distinguish *The Emerald Handbook of Blockchain for Business* from others.

- *Focuses on business applications and challenges*: The book provides a detailed examination of some of the most important aspects of blockchain. It focuses on the opportunities and challenges facing blockchain adoption and implementation across different industries.
- *Offers insights from a diverse set of authors*: The book skillfully blends the contributions of scholars and practitioners into a single review of critical topics about blockchain. The varied backgrounds of the contributors assure different perspectives and a rich interplay of ideas.
- *Provides an internally consistent approach*: While retaining the content and perspectives of the many contributors, the book follows an internally consistent approach in format and style. Like a choir that contains many voices, this book has many chapter authors with their separate voices. A goal of both a choir and this book is to have the many voices sing together harmoniously. Accomplishing this task requires skilled editing by the coeditors to create a seamless flow when moving from chapter to chapter. Hence, the book is much more than merely a collection of chapters from an array of different authors.
- *Reflects current trends and research on blockchain*: When discussing the results of empirical studies that connect theory and practice, the objective is to distill them to their essential content so they are understandable to a wide array of readers with different backgrounds.
- *Contains end-of-chapter discussion questions*: The end of Chapters 2–22 contains between four and six discussion questions that reinforce key concepts with guideline answers presented at the end of the book. This feature should be especially important to faculty and students using the book in courses.
- *Offers a glossary of blockchain terms*: The book contains a glossary of key terms related to blockchain for easy reference.

Intended Audience

Given its broad scope, this practical and comprehensive book should be relevant to academics, practitioners, students, and others interested in blockchain. For academics, the book provides the basis for a better understanding of various aspects of blockchain and as a springboard for future research. Academics can also use the book as a stand-alone or supplementary resource for courses in blockchain or related areas. Since this book covers both the technological underpinnings of blockchain and related applications, it should be of interest to practitioners seeking to become more knowledgeable about this fast-moving subject area. Students and others wanting to improve their knowledge of blockchain should find this book essential reading.

Structure of the Book

The remainder of this book consists of 21 chapters divided into four main parts. A brief synopsis of each section and chapter follows.

Part I – Blockchain: History and Background

Besides the current chapter, this part consists of three other chapters (Chapters 2–4) that provide important background information that sets the stage for the remaining parts.

Chapter 2 – History of Distributed Ledgers and Blockchain (Joey Ryan and Sean Stein Smith)

This chapter examines one of the most innovative and disruptive technologies in the modern era – blockchain and its various applications. Although blockchain is commonly associated with bitcoin, a cryptocurrency developed to serve as a replacement for existing fiat currencies, the landscape continues to experience rapid change. New cryptocurrency options, specifically an array of stablecoins that private sector actors or even government agencies may issue, continue to accelerate adoption by individuals and institutions. Stablecoins are cryptocurrencies pegged or otherwise connected to an external asset such as fiat currencies or commodities. Their initial purpose was to reduce price volatility commonly associated with bitcoin and other traditional cryptocurrencies. The chapter also discusses blockchain's opportunities and challenges, including interoperability, cybersecurity, and other technical considerations. It introduces blockchain, crypto assets, and different industry applications.

Chapter 3 – Review of Blockchain and Emerging Applications (Timothy Grief and Ehsan Nikbakht)

The purpose of this chapter is to review the main emerging applications in blockchain technology. The major areas are examined through different stages – some established and some new. The chapter discusses credit scoring, water usage

and climate change, supply chain management, health industry, smart cities, accounting and credit models, sustainable developments, business process improvements, fraud detection, predicting default in e-commerce, and breaking the poverty chain. Although blockchain has both risks and limitations, its potential opportunities and rewards are substantial. Although an application of blockchain started with a public platform for creating and trading cryptocurrencies, blockchain is now going through numerous forms of public (permissionless), private (permissioned), and hybrid systems to improve transparency, efficiency, data sharing, and reduce transaction costs.

Chapter 4 – Technical Aspects of Blockchain (Hak J. Kim)
Blockchain has gained much attention in business and society as a new way to provide trust and security in the public internet. It promises reliable data transmission by using cryptography and distributed ledger technologies. Despite substantial interest, businesses and other organizations have not widely adopted blockchain because of its complex technical nature. However, blockchain is growing quickly as it extends its usage from finance to many other sectors. Several challenges face blockchain adopters including scalability in size and speed, interoperability among networks, and legal and regulatory issues. This chapter provides a technical foundation of blockchain including concepts, key properties, architecture and components, technical algorithms, operational procedures, and technical challenges.

Part II – Types of Blockchain

This part contains five chapters (Chapters 5–9) that examine public, private, and hybrid blockchains as well as consensus mechanisms, token economies, and modifications needed to spur consumer adoption of blockchain.

Chapter 5 – Public Blockchains and Applications (Hugo Benedetti)
Public blockchains are permissionless blockchains, allowing universal access to read, write, and validate information stored in the network. This permissionless nature also implies a lack of a central coordinating authority. Instead, coordination of the blockchain's users and management is embedded in the software protocol and complemented by incentive mechanisms, together commonly referred to as cryptoeconomics. A relevant feature of public blockchains is censorship resistance, which is the inability of an adversarial user to deny access to read, write, and validate functions. It enables the decentralization, disintermediation of business processes, institutions, and networks. Censorship resistance also poses challenges, such as the inability to block ethically questionable information, transactions, and markets. Examples of public blockchain applications include monetary and financial networks (Bitcoin and Zcash), distributed virtual machines (Ethereum and EOS), and distributed data storage (Sia).

Chapter 6 – Private and Hybrid Blockchains and Applications (Gina Pieters and Sean Stein Smith)
This chapter discusses and analyzes private and hybrid blockchains and the various implications of such blockchains for enterprise adoption. It also examines stablecoins, central bank digital currencies, and central bank cryptocurrencies regarding blockchain implementation and crypto-asset development. The chapter frames technical explanations and their associated practical implications in the context of blockchain technology developments, with a focus on various kinds of hybrid blockchains such as private and private permissioned models. Finally, the chapter discusses key considerations and questions that enterprises should address before implementing and developing a private or hybrid blockchain.

Chapter 7 – Consensus Mechanisms and Related Issues (Deniz Appelbaum)
Consensus mechanisms are essential to blockchains. Any business considering blockchain technology should acquire base knowledge of these algorithms. Consensus algorithms provide blockchains with the business-friendly features of immutability, tracking, and prevention of double-spending. This chapter provides a basis for understanding how the predominant consensus mechanism proof-of-work operates via hashing and its underlying issues such as whether they are scalable for a specific application. It also covers proof-of-stake and other consensus mechanism proposals.

Chapter 8 – Token Economies (Alim Khamisa)
Decentralized peer-to-peer (P2P) blockchain networks are ushering in a new wave of open source business model innovation. Central to this innovation is the cryptographic token – a blockchain-native asset that facilitates new value creation and exchange models. Tokens enable, for the first time, web-native business models that are a driving force behind the web's evolution into a more decentralized and fairer public utility – Web 3.0. At its core, Web 3.0 disintermediates economic transactions, enables individuals to have greater control and privacy of their data, and creates a more balanced system based on the principles of shared economics that levels the playing field between individuals and businesses. It is giving rise to decentralized applications (dApps) powered by token economies and accompanying on-chain governance mechanisms. The purpose of this chapter is to provide an overview of the various types of token models and delve into token economy design. Token engineering and cryptoeconomics are emerging fields within this domain that draw on a diverse set of disciplines – economics, cryptography, distributed systems, and engineering – to design sustainable and valuable token economies.

Chapter 9 – Proposed Modifications to Spur Consumer Adoption of Blockchain (Katherine McKechnie, Alexandra M. Dunn, and Sayan Sarkar)
Data theft and fraud is a growing concern in the modern era. Protection of data conflicts with the ease of accessing data. Blockchain, which reduces the need for a