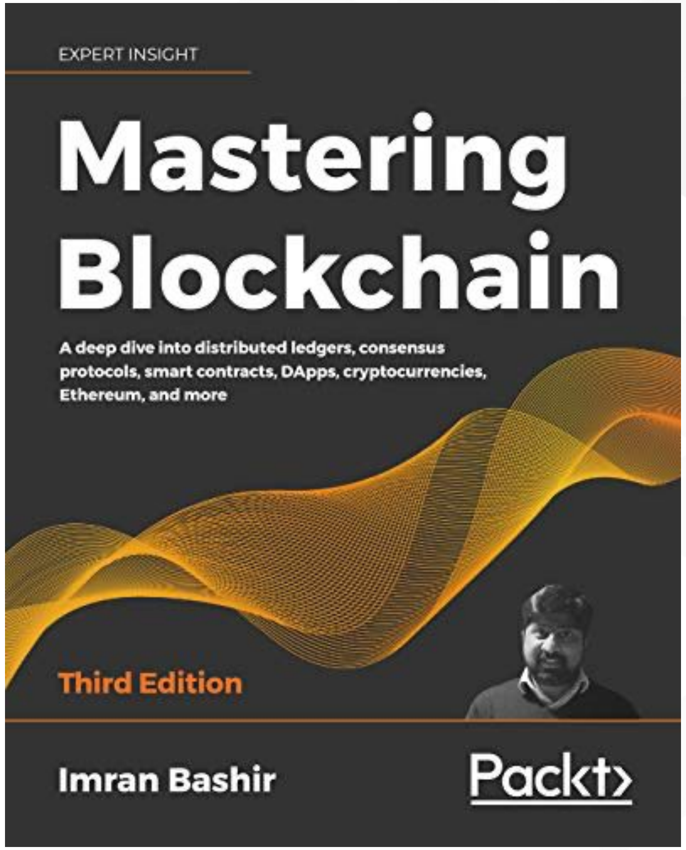
Mastering Blockchain

Third Edition

Chapter 1, Blockchain 101



EXPERT INSIGHT

Mastering Blockchain

A deep dive into distributed ledgers, consensus protocols, smart contracts, DApps, cryptocurrencies, Ethereum, and more

Third Edition

Imran Bashir

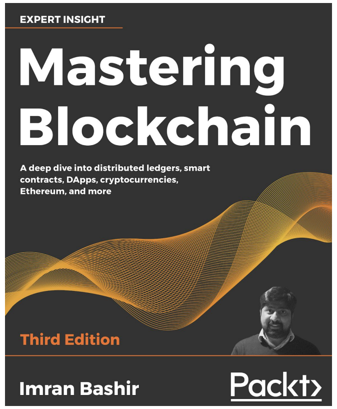
Packt

Outline

- Describing the fundamentals of distributed systems
- Defining blockchain technology
- Understanding how blockchain technology was developed
- Detailing the elements of a blockchain
- Identifying the benefits and limitations of blockchain technology

Introduction

Blockchain is a new revolutionary technology that will change our lives. In this chapter we will cover the theory of blockchain technology, and its technical foundations.


EXPERT INSIGHT

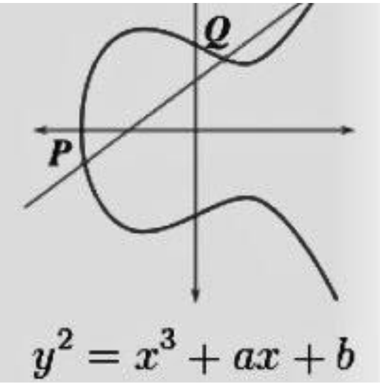
Mastering Blockchain

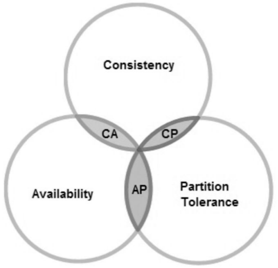
A deep dive into distributed ledgers, smart contracts, DApps, cryptocurrencies, Ethereum, and more

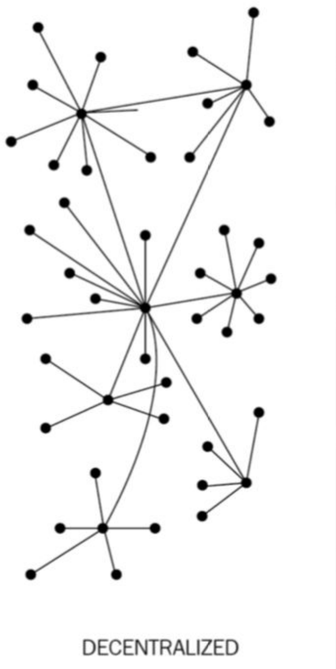
Third Edition

Imran Bashir

Packt>



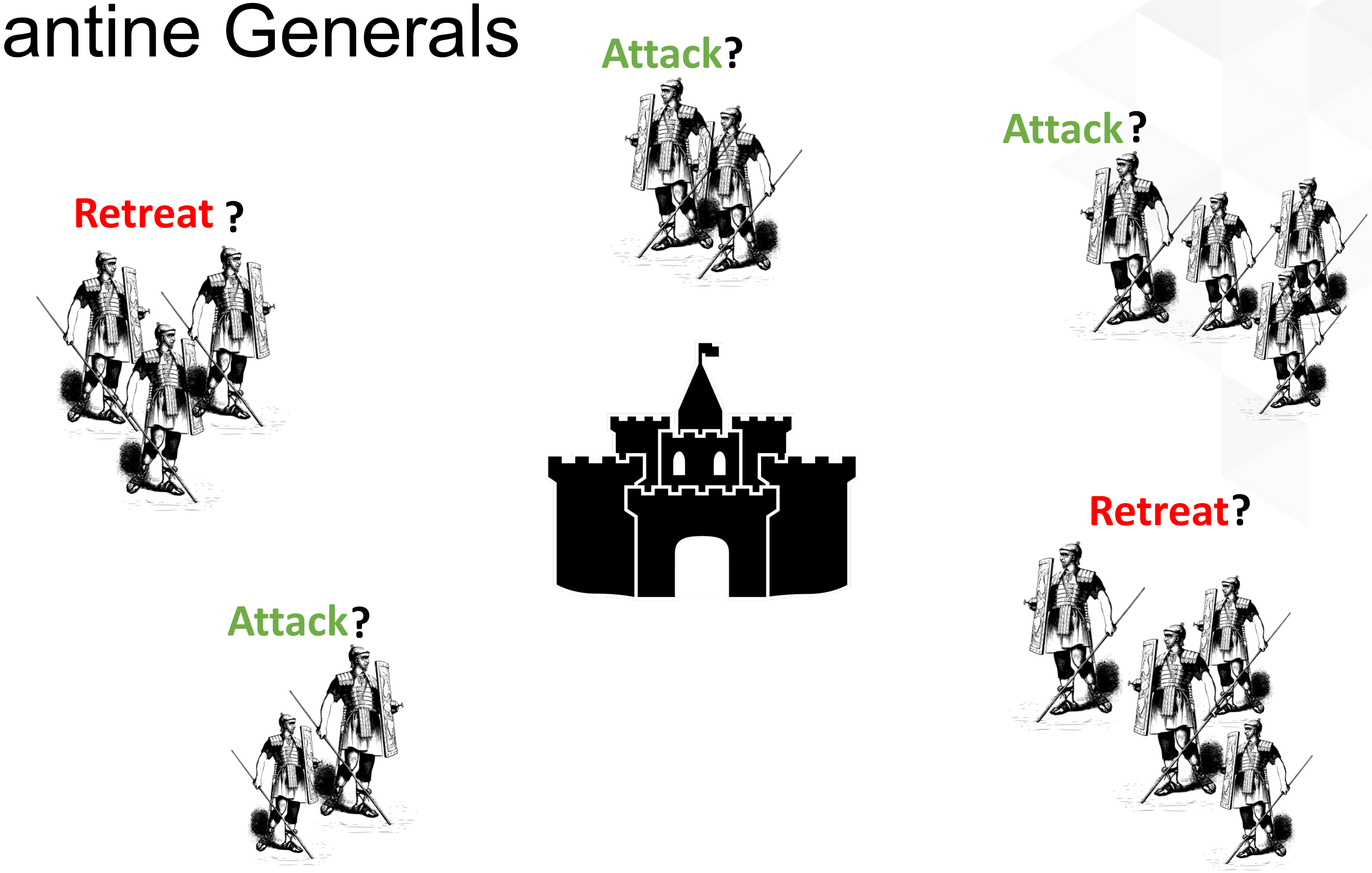




Introducing distributed computing

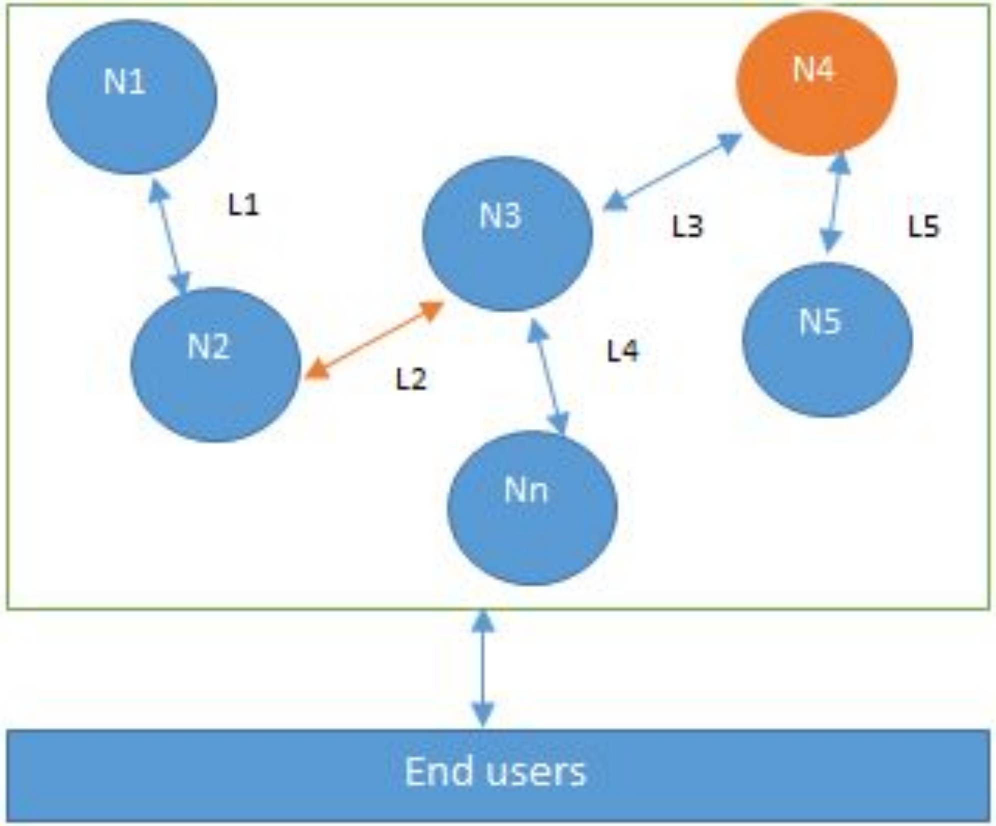
- A distributed system is a computing paradigm whereby two or more nodes work with one another, in a coordinated fashion, to achieve a common outcome.
- A distributed system is modeled in such a way that end users see it as a single logical platform.
- Examples include clusters and clouds.

The Byzantine Generals problem



Attack or retreat?
Consensus required to win

Design of a distributed system

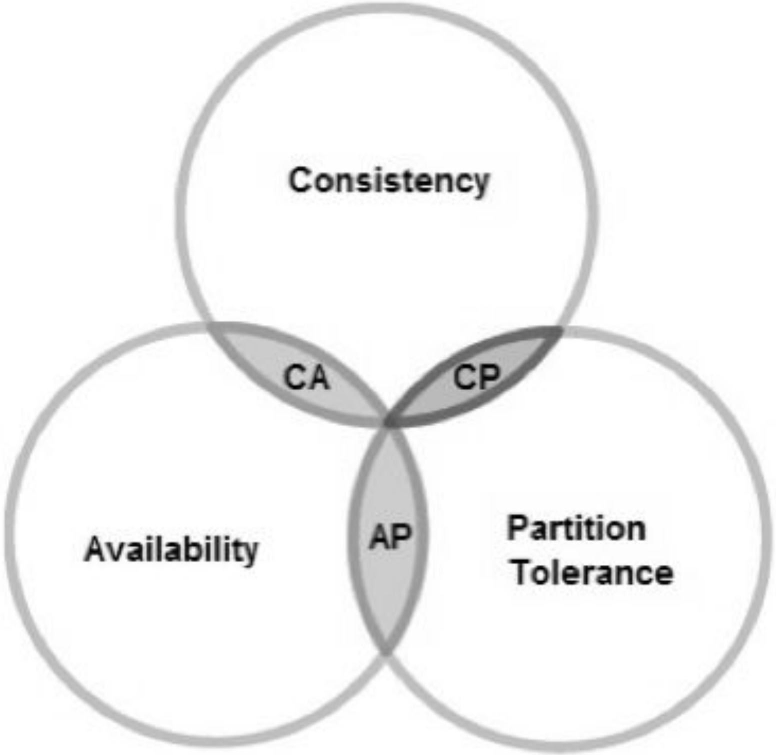


N4 is a Byzantine node, L2 is broken or a slow network link

CAP theorem

This states that a distributed system cannot have all three of the desired properties simultaneously; that is:

- Consistency
- Availability
- Partition tolerance



Types of faults in distributed systems

Fail-stop faults (crash faults)

- Where components crash or cease to operate
- Simpler to deal with

Byzantine faults

- Where components are potentially untrustworthy or malicious
- Difficult to deal with

Defining ‘Blockchain’

Layman's definition: Blockchain is an ever-growing, secure, shared recordkeeping system in which each user of the data holds a copy of the records, which can only be updated if all parties involved in a transaction agree to update.

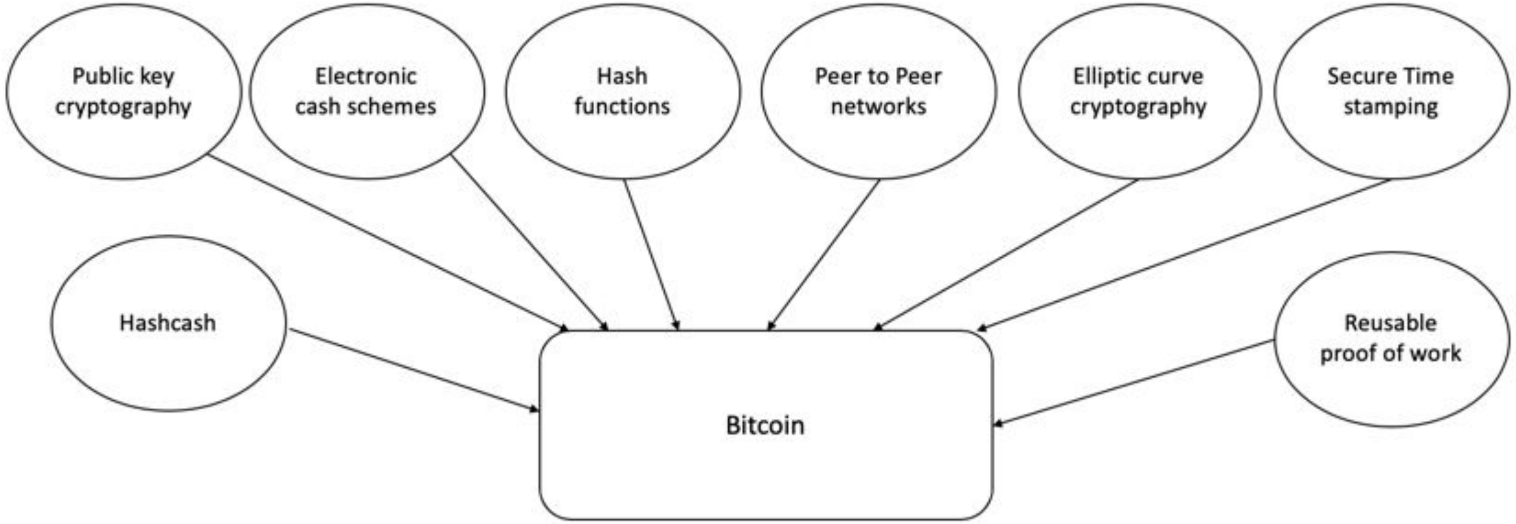
Technical definition: Blockchain is a peer-to-peer distributed ledger that is cryptographically-secure, append-only, immutable (extremely hard to change), and updateable only via consensus or agreement among peers.

Blockchain definition

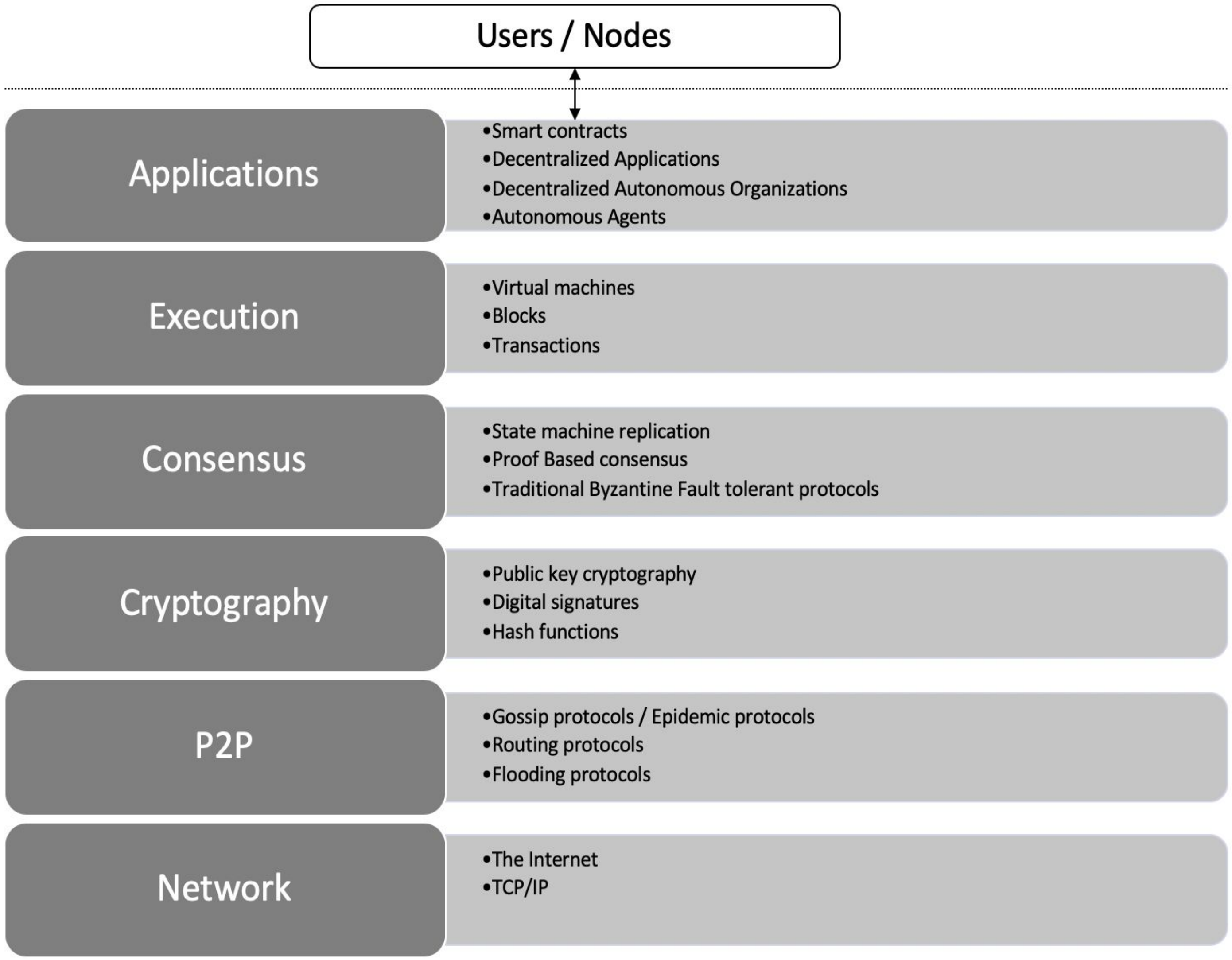
- Peer-to-peer
- Distributed ledger
- Cryptographically secure
- Append only
- Updateable via consensus (consensus-driven)

How did blockchain technology develop?

- 1950s – Hash functions
- 1970s – Merkle trees - hashes in a tree structure
- 1970s continued – Research in distributed systems, consensus, state machine replication
- 1980s – Hash chains for secure logins
- 1990s – e-Cash for e-payments
- 1991 – Secure timestamping of digital documents.
- 1992 – Hashcash idea to combat junk emails
- 1994 – S/KEY application for Unix login.
- 1997/2002 – Hashcash
- 2008/2009 – Bitcoin (the first blockchain)



Architectural view of Blockchain



Users / Nodes

Applications

- Smart contracts
- Decentralized Applications
- Decentralized Autonomous Organizations
- Autonomous Agents

Execution

- Virtual machines
- Blocks
- Transactions

Consensus

- State machine replication
- Proof Based consensus
- Traditional Byzantine Fault tolerant protocols

Cryptography

- Public key cryptography
- Digital signatures
- Hash functions

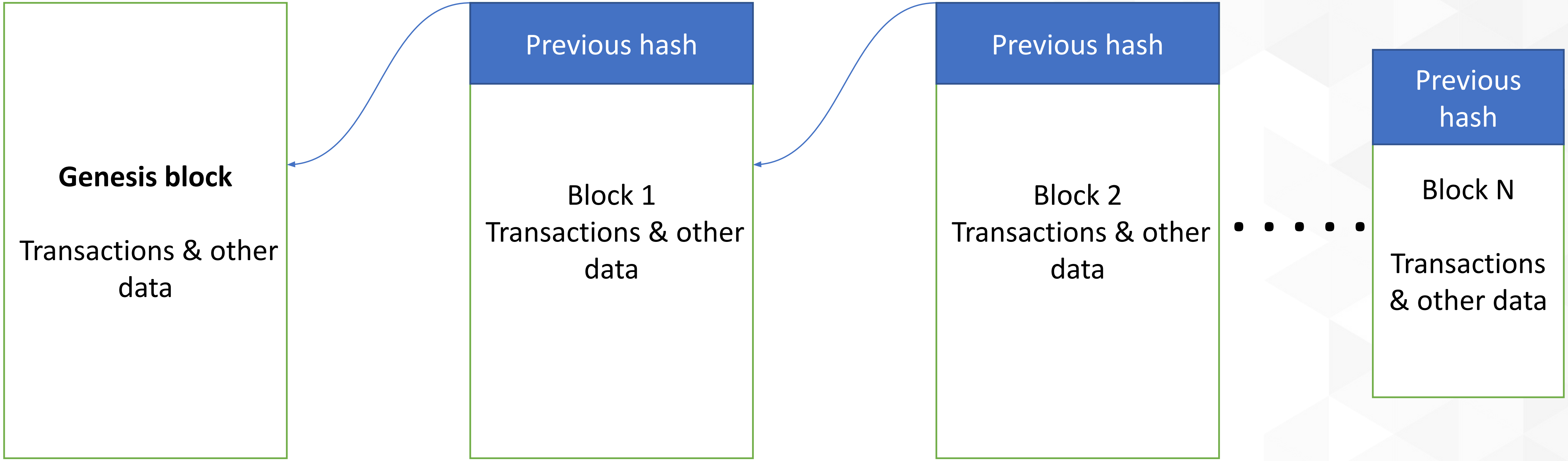
P2P

- Gossip protocols / Epidemic protocols
- Routing protocols
- Flooding protocols

Network

- The Internet
- TCP/IP

Generic structure of a blockchain

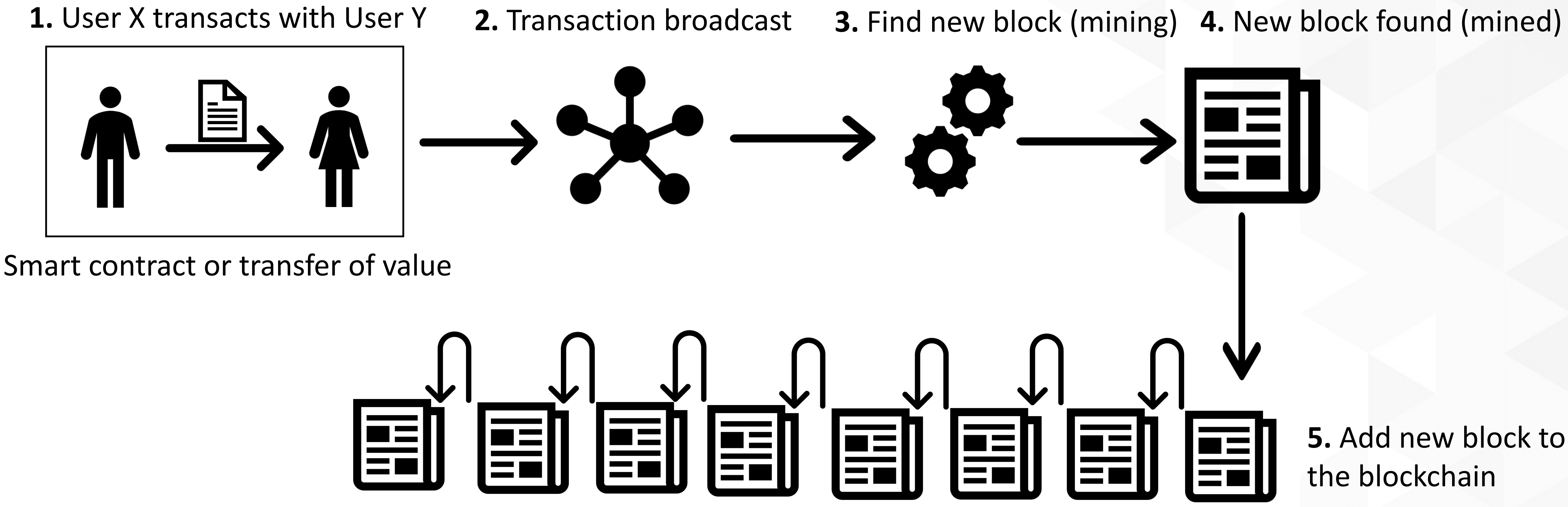


Genesis block
Transactions & other data
Previous hash
Block 1
Transactions & other data
Previous hash
Block 2
Transactions & other data
Previous hash
Block N
Transactions & other data

Generic elements of a blockchain

- Addresses
- Accounts
- Transactions
- Blocks
- Peer-to-peer network
- Scripting or programming language
- Virtual machine
- State machine
- Nodes
- Smart contracts

How a blockchain works



1. User X transacts with User Y

Smart contract or transfer of value

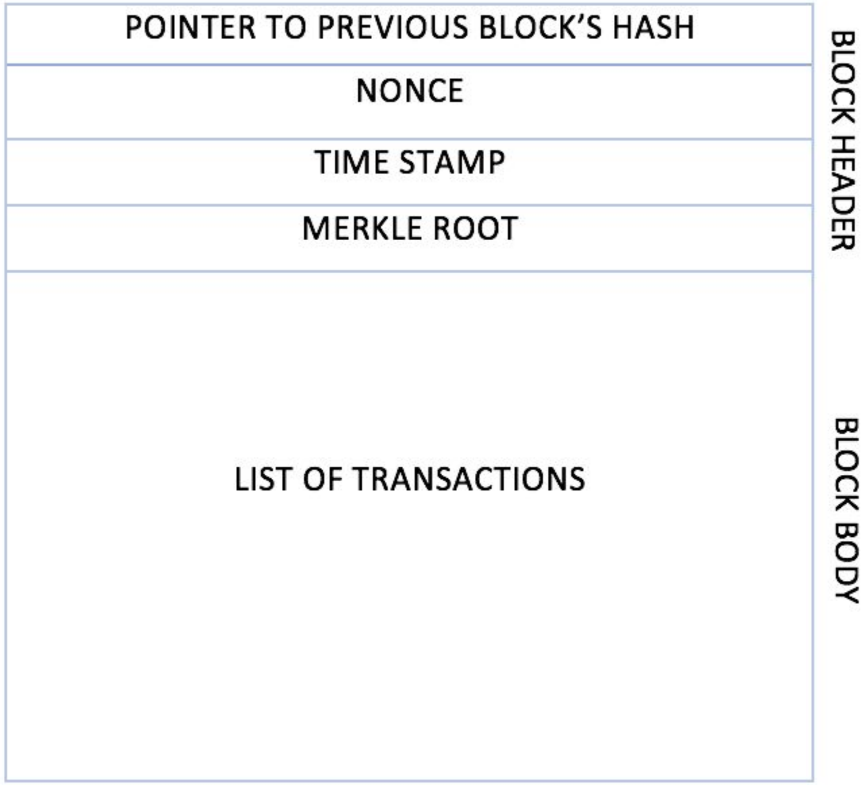
2. Transaction broadcast

3. Find new block (mining)

4. New block found (mined)

5. Add new block to the blockchain

Generic block structure



POINTER TO PREVIOUS BLOCK'S HASH

NONCE

TIME STAMP

MERKLE ROOT

LIST OF TRANSACTIONS

BLOCK HEADER

BLOCK BODY

Benefits of blockchain

- Decentralization
- Transparency
- Trust
- Immutability
- High availability
- Highly secure
- Simplification of current paradigms
- Faster transactions
- Cost saving

Limitations of blockchain

- Scalability
- Adaptability
- Regulation
- Relatively immature technology
- Privacy

Features of a blockchain

- Distributed consensus
- Transaction verification
- Platform for smart contracts
- Transferring value between peers
- Generation of cryptocurrency
- Provider of security
- Immutability
- Uniqueness

Exercise

- Think about a scenario where blockchain can solve a challenge at your place of work or education, or in your community.
- Read the Bitcoin paper at https://bitcoin.org/bitcoin.pdf

Summary

In this presentation, we:

- Covered the design of a distributed system and faults in distributed systems.
- Defined blockchain as a distributed ledger—a replicated digital ledger which is immutable and updateable only via consensus.
- Introduced precursors to blockchain technology such as hash functions, consensus mechanisms, Hashcash, and e-cash schemes.
- Explored various elements of a blockchain, such as addresses, peer-to-peer networks, blocks, and transactions.
- Considered the benefits and limitations of blockchain technology.