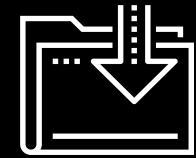


# Introduction to Blockchain

FinTech  
Lesson 18.1



# Class Objectives

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By the end of this lesson, you will be able to:



Explain how a blockchain works and its implementations.



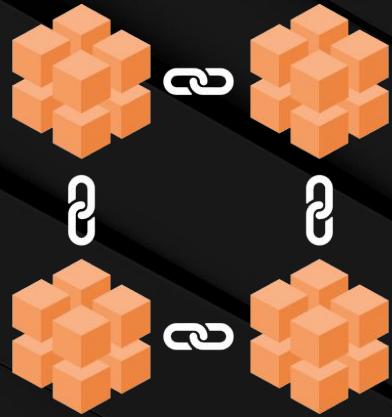
Describe the key features of all blockchains.



Describe the differences between centralized and decentralized systems.



Launch a shareable web application using the Streamlit Python library.



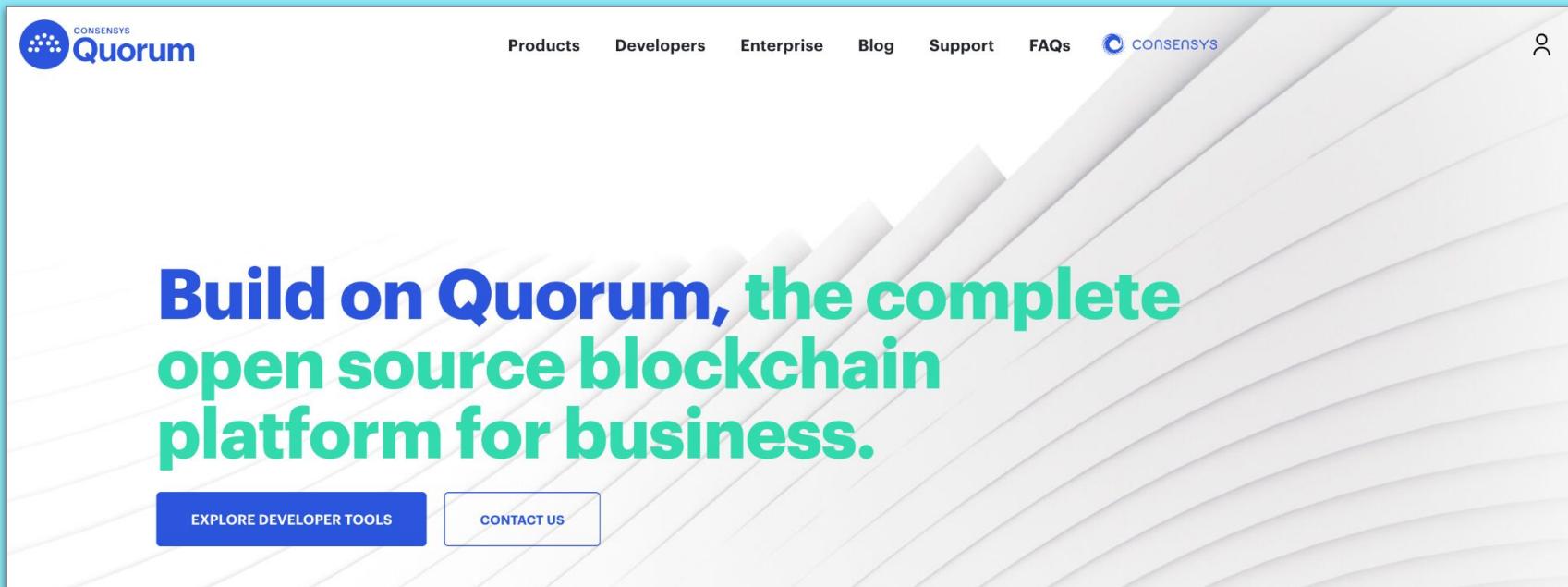
**Blockchain is exciting and critical for any career in fintech. Blockchain technology powers not just cryptocurrencies, but also decentralized applications and, in some cases, even business networks.**



Blockchain may be a buzzword in the industry, but it's also much more than that—it's a new way of thinking about money and software applications.

# Quorum

Traditional financial institutions have been skeptical about blockchain technology. However, JP Morgan Chase created Quorum, an Ethereum-based blockchain, in order to leverage the security that blockchain provides for their own systems.



The image shows the homepage of the Quorum website. At the top left is the Quorum logo, which includes a blue circular icon with white dots and the word "Quorum". To its right are navigation links: Products, Developers, Enterprise, Blog, Support, and FAQs. Further to the right are the ConsenSys logo and a user icon. The main headline, "Build on Quorum, the complete open source blockchain platform for business.", is displayed in large, bold, blue and green text. Below the headline are two buttons: "EXPLORE DEVELOPER TOOLS" and "CONTACT US". The background features a light gray diagonal striped pattern.

CONSENSYS  
**Quorum**

Products Developers Enterprise Blog Support FAQs

CONSENSYS

Build on Quorum, the complete  
open source blockchain  
platform for business.

EXPLORE DEVELOPER TOOLS

CONTACT US

# Questions?





How many of you have heard  
of blockchain?



How many of you have heard  
of cryptocurrency?



How many of you have conducted  
a transaction on a blockchain by  
using a digital wallet?

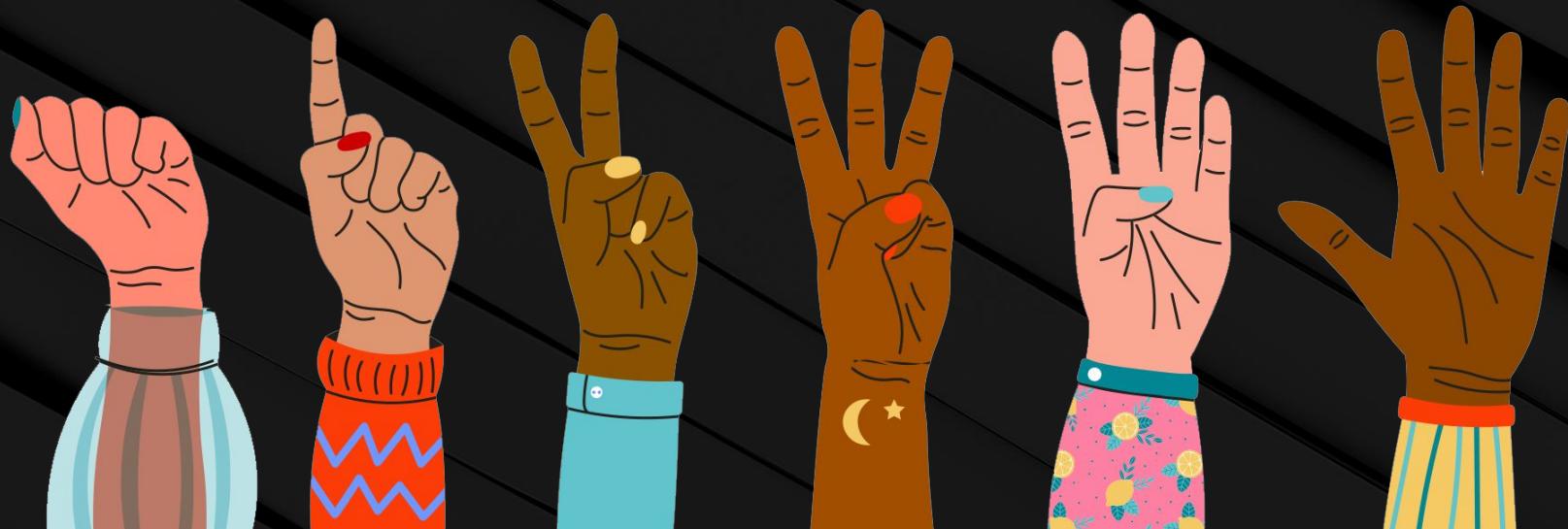


How many of you have ever  
traded cryptocurrency?

# FIST TO FIVE:

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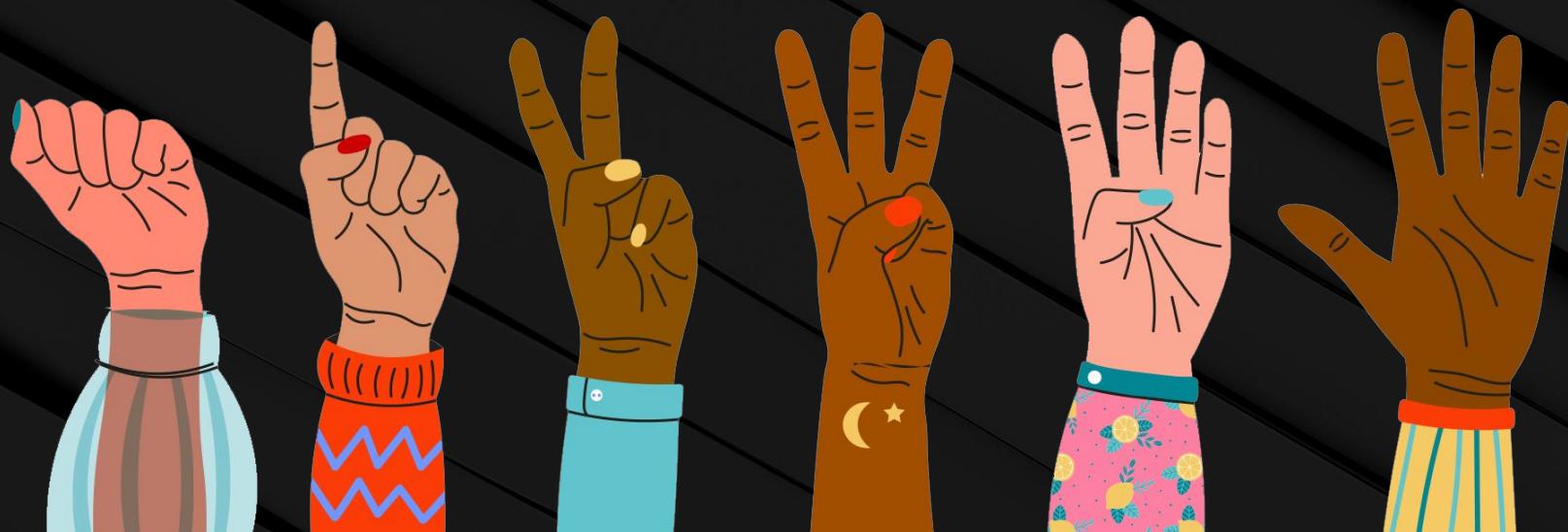
## How familiar are you with blockchain?



## FIST TO FIVE:

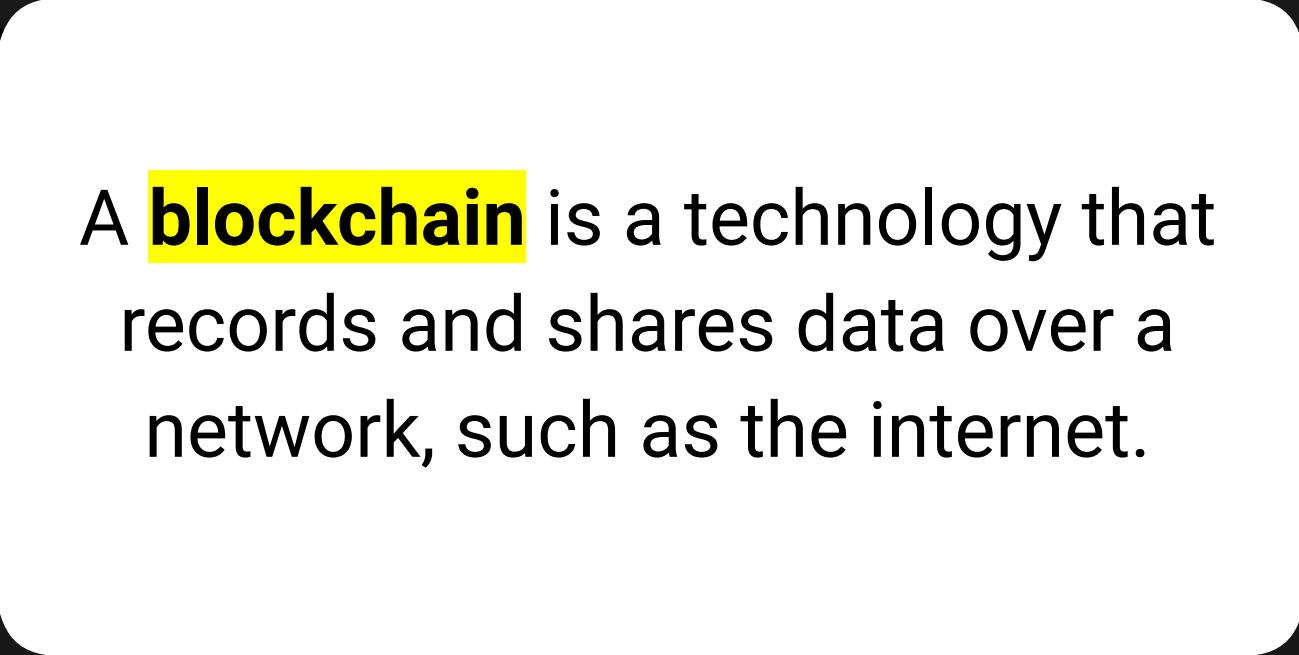
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How comfortable are you having a conversation  
about blockchain technology?





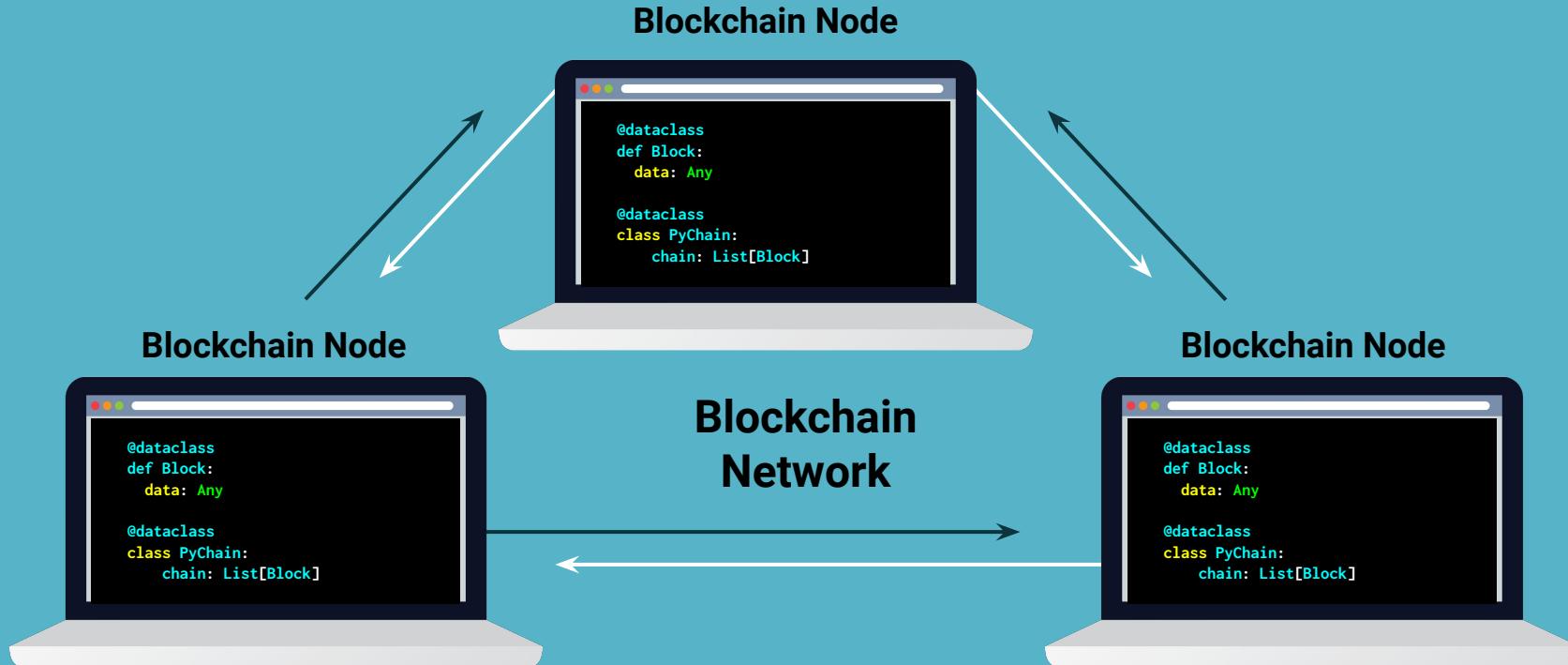
# What Is Blockchain?



A **blockchain** is a technology that records and shares data over a network, such as the internet.

# Blockchain Network

Blockchains can be thought of as a bunch of computers that allow users to securely record and access data from anywhere on the network.



# Blockchain Examples

---

Most often, people associate blockchain with cryptocurrencies. This association is accurate, but cryptocurrency is just one application of blockchain.

Blockchains can be used to record any type of transaction or data.

Examples include:



Recording an agreement to buy a house



Recording a vote



Recording a marriage contract

# Blockchain Examples

# Mythical Games

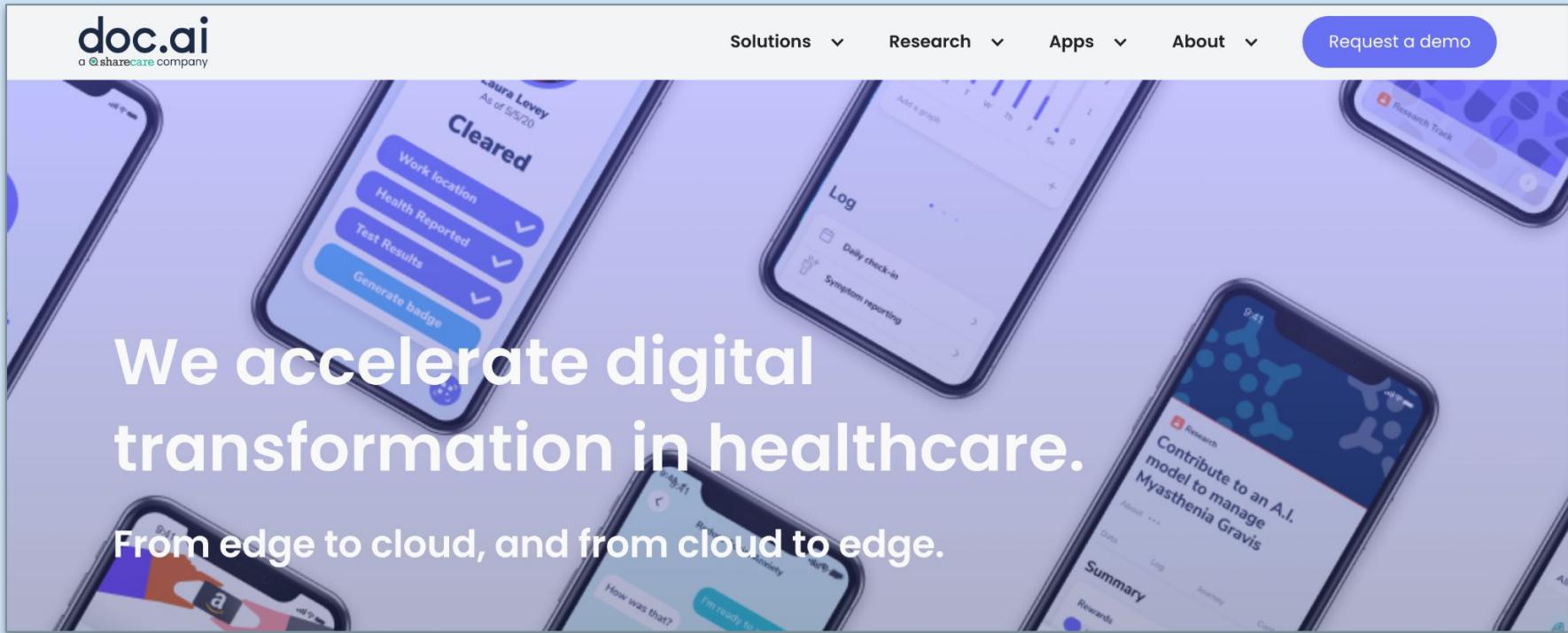
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Mythical Games, a large games studio, allows users to buy and sell digital in-game items over a blockchain, even across different games.



**WE ARE MYTHICAL -  
A NEXT GENERATION  
GAME TECHNOLOGY STUDIO**

Doc.ai links medical records across a distributed ledger to lower healthcare costs and advance scientific research.

The image shows a collection of smartphones arranged in a grid-like pattern, each displaying a different screen from the Doc.ai mobile application. One phone in the foreground displays a 'Cleared' status summary for 'Laura Levey' with sections for 'Work location', 'Health Reported', 'Test Results', and 'Generate badge'. Another phone shows a 'Log' screen with 'Daily check-in' and 'Symptom reporting' options. A third phone in the bottom right corner shows a 'Research' section for 'Myasthenia Gravis' with a call to action to 'Contribute to an A.I. model to manage Myasthenia Gravis'. Other phones show screens for 'Activity', 'How was that?', and 'I'm ready to...'. The overall theme is digital health and data management.

We accelerate digital transformation in healthcare.

From edge to cloud, and from cloud to edge.

# Bloq

Bloq, an infrastructure platform, allows any company to add blockchain applications to its existing business.

The image shows the Bloq website homepage on the left and a screenshot of the Bloq Console interface on the right.

**Homepage (Left):**

- Header:** bloq, Products, Solutions, Company, Contact, Blog, Log In, Sign Up.
- Section:** Protocols, Build it with bloq.
- Text:** Managed infrastructure for building on blockchain networks.
- Buttons:** SIGN UP →, Request Demo.

**Bloq Console (Right):**

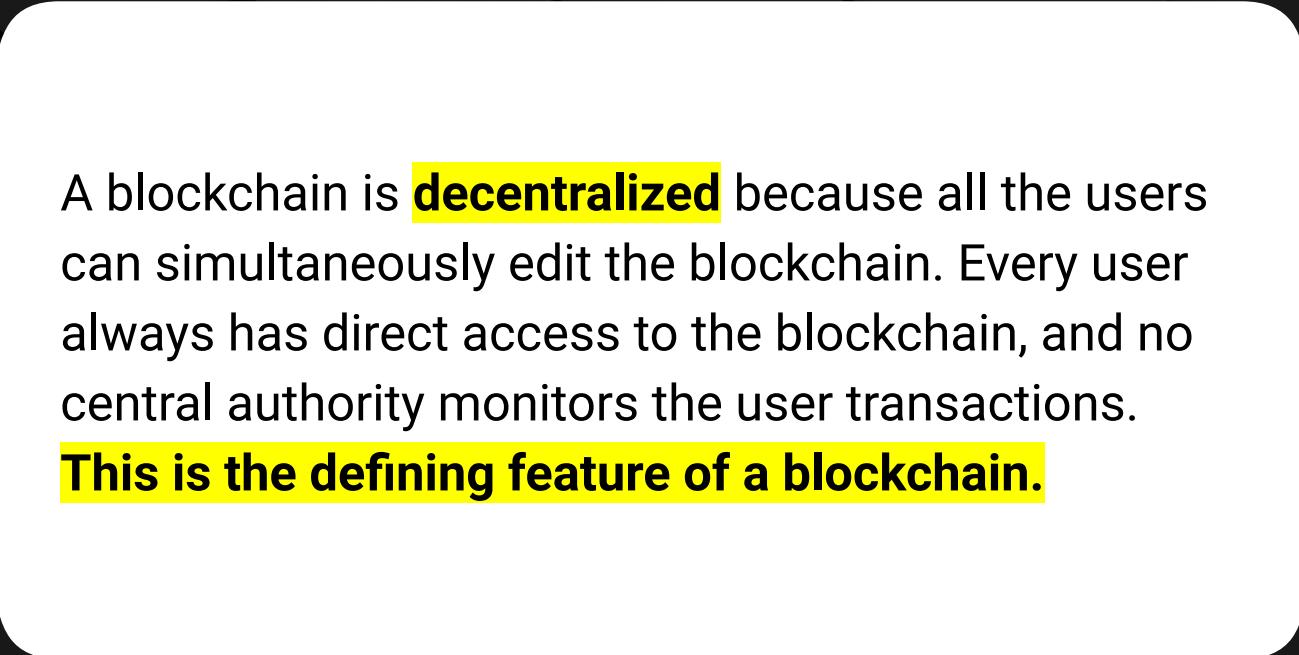
- Section 1: Setup Chain**
  - Bitcoin, Bitcoin Testnet, Bitcoin Cash, Bitcoin Cash Testnet, Ethereum, Ethereum Classic.
- Section 2: Configure Node Cluster**
  - Node Performance: Standard (selected), High.
  - Authentication: (options shown but not selected).
- Side Panel:** Bloq Connect provides real-time blockchain access and indexing.

# TraDove

TraDove is a platform that connects suppliers with customers. It relies on blockchain to enable trust and lower transaction costs.

The image shows a screenshot of the TraDove platform. At the top, there is a navigation bar with the TraDove logo, a search bar, and links for "About Us", "Blogs", "Join for Free", and "Sign In". Below the navigation bar, a large blue banner features the text "Where business Buyers and Sellers meet, connect and trade around the world." To the right of this text is a 3D diagram illustrating the platform's architecture. The diagram shows a central "TRADOVE CONNECTION BLOCKCHAIN SMART CONTRACT" represented by a stack of four cubes. A line labeled "SMART CONTRACT" connects this central contract to a "SELLER" station on the left and a "BUYER" station on the right. The "SELLER" station includes an illustration of a person at a desk with a computer monitor displaying a graph and a robotic arm. The "BUYER" station includes an illustration of a person at a desk with a computer monitor displaying a green checkmark. At the bottom left, there is a graphic of three puzzle pieces labeled "Buyers", "TraDove", and "Sellers".

# **Features of Blockchain**

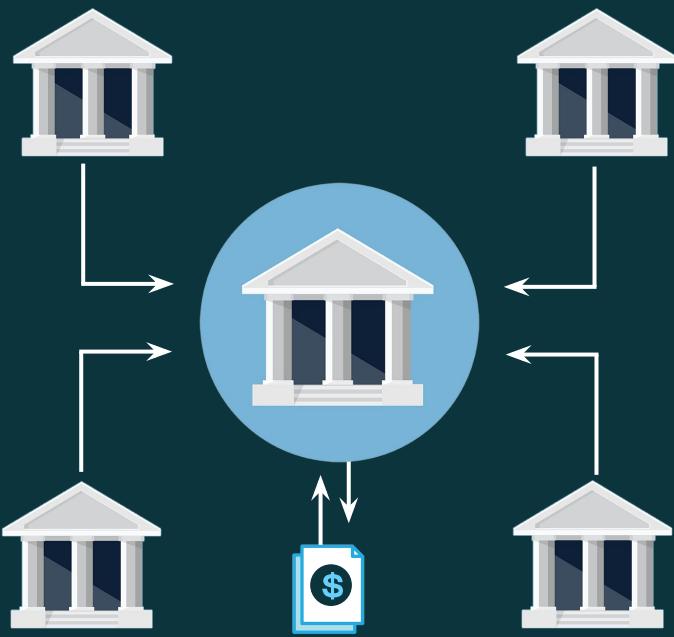


A blockchain is **decentralized** because all the users can simultaneously edit the blockchain. Every user always has direct access to the blockchain, and no central authority monitors the user transactions.

**This is the defining feature of a blockchain.**

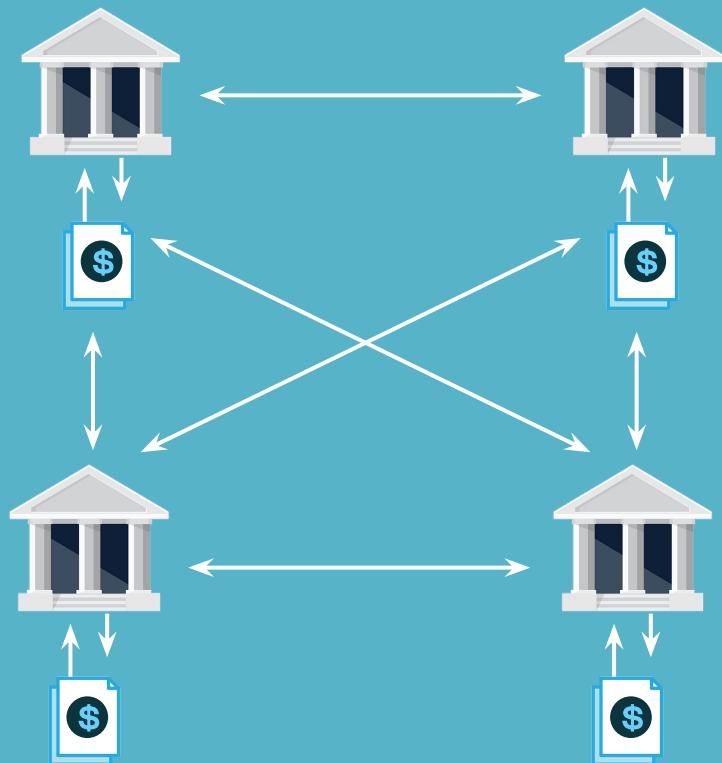
## Traditional Approach

A central and trusted third party controls the database.



## Blockchain Approach

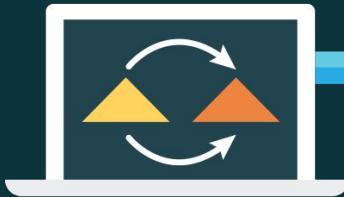
Each participant has a copy of the database, helping to ensure reliability.



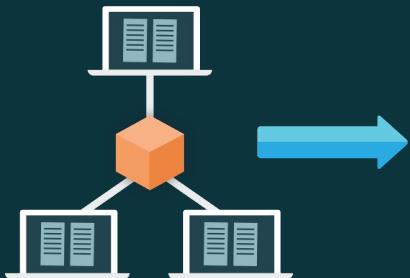
**A distributed architecture:** A blockchain is distributed for two reasons. First, many computers in various locations store identical copies of the same ledger. Second, these computers communicate with each other to arrive at particular decisions, like the validity of a new block in the chain.

# A Distributed Architecture

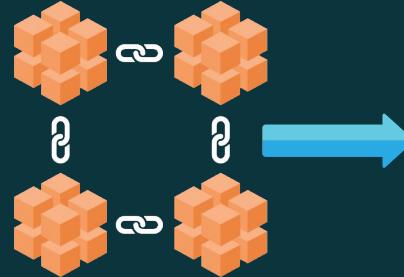
---



Blockchain participants  
create transactions.



Miners compete to  
mine new blocks.



As new block is linked  
to the blockchain. All  
computers participating  
with the blockchain update  
their copies of the ledger to  
include the new block.



Once the transaction  
has been written to  
the blockchain it  
cannot be altered.

**Trust:** Blockchain technology is designed so that users can trust that the blockchain accurately records data and prevents tampering with that data. Without this trust, no one would use a blockchain for a transaction.

**Record keeping:** In a blockchain, each block represents a transaction (or group of transactions), and the chain links these transactions over time.

**Transparency:** Anyone can review the history of the transactions in a blockchain. However, this doesn't mean that anyone can review all the data that the transactions contain—the data itself might be private or sensitive. Users can verify the existence of the transactions, as well as who added the data and when. Not all blockchains have full transparency, but it's a common feature.

# Cryptocurrencies

---

These five key features apply to any blockchain application, including cryptocurrencies.





A blockchain isn't a cryptocurrency.  
Rather, it's a common component of  
how cryptocurrencies are structured.



# Group Activity: Use Case Study

In this activity, you will work in groups to examine a use case for different cryptocurrency and blockchain projects.

The goal is to list the blockchain features that are applicable to each use case.

Suggested Time:

---

15 minutes



Time's Up! Let's Review.



What are the five key features  
of blockchains?

# Blockchains

---

The five key features of blockchains:

01

Decentralization

02

Distributed architecture

03

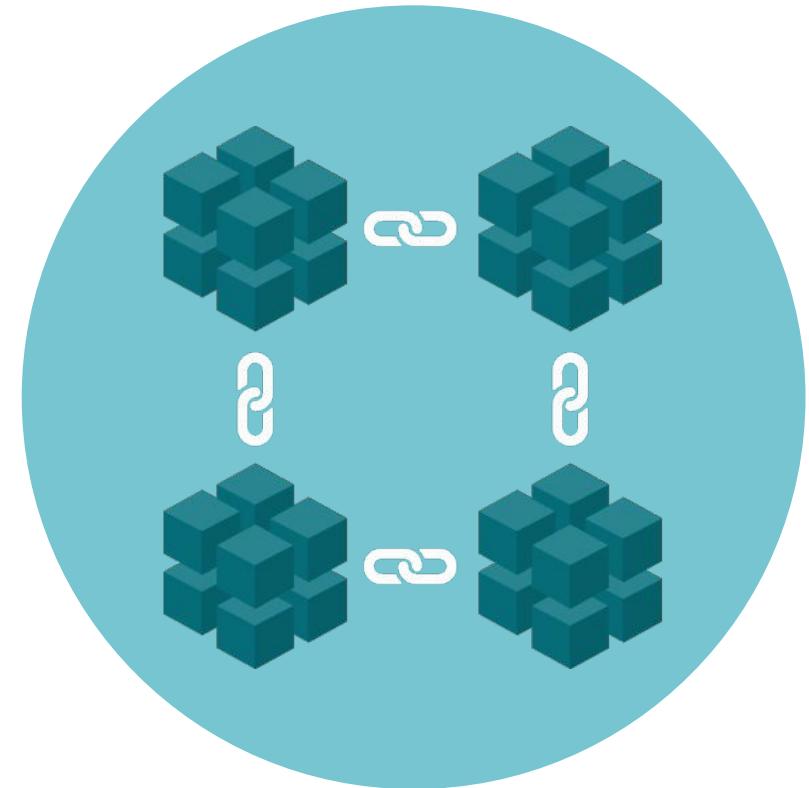
Record keeping

04

Trust

05

Transparency



# Bitcoin in Venezuela

---

The key features of blockchains applicable in the Bitcoin in Venezuela example:

<b>Decentralization</b>	There is no fear of the government devaluing the currency.
<b>Distributed architecture</b>	Users only need a computer in order to participate in the Bitcoin blockchain. It's publicly accessible to almost anyone in the world, and it doesn't require bank accounts that are located abroad.
<b>Record keeping</b>	
<b>Trust</b>	Users trust that their currency will not be devalued and that their funds are secure.
<b>Transparency</b>	

# Monero

---

The key features of blockchains applicable in the Monero example:

<b>Decentralization</b>	There is no authority overseeing the distribution or use of the Monero cryptocurrency. Therefore, its use in potentially illegal transactions is unmonitored.
<b>Distributed architecture</b>	
<b>Record keeping</b>	
<b>Trust</b>	Users trust that the transactions conducted on the blockchain will remain anonymous and private.
<b>Transparency</b>	

# Stellar

---

The key features of blockchains applicable in the Stellar in Venezuela example:

Decentralization	
Distributed architecture	Stellar's business focuses primarily on developing markets where a centralized system can be more challenging to implement. The cross-border nature of the systems design is integral to making the application accessible.
Record keeping	Stellar seeks to provide money remittance and bank loan distribution to the unbanked population—two areas where accurate and immutable records are paramount.
Trust	
Transparency	Stellar is open source.

# Ethereum

---

All five key features are demonstrated by the Ethereum blockchain and underlie its success, especially as it relates to the creation of smart contracts.

01

Decentralization

02

Distributed architecture

03

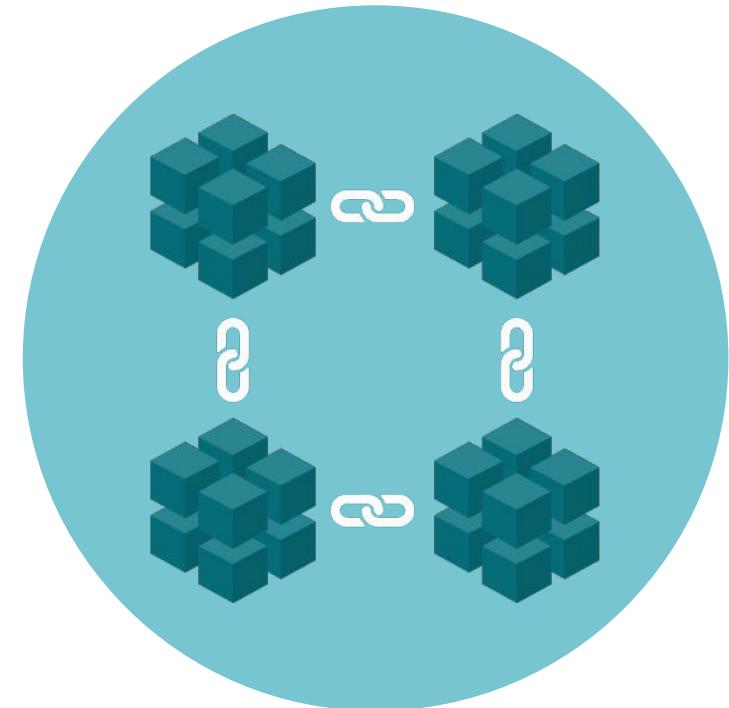
Record keeping

04

Trust

05

Transparency



**Smart contracts** are key in Ethereum's success. They allow for the creation of decentralized financial (DeFi) applications. The creation and distribution of smart contracts embody all five features of blockchain technology.

# Machine-to-Machine Transactions

---

The key features of blockchains applicable in the Machine-to-Machine Transactions example:

Decentralization	
Distributed architecture	The software can be scaled to many machines.
Record keeping	The record-keeping functionality makes it easy to track usage and payments from one machine to another.
Trust	
Transparency	

# CryptoCribs

---

The key features of blockchains applicable in the CryptoCribs example:

<b>Decentralization</b>	CryptoCribs is a service provider. Its application is built on a decentralized network, which makes it more resistant to outages.
<b>Distributed architecture</b>	Because all renters and rentees can access the software, CryptoCribs works toward eliminating intermediaries in the rental process.
<b>Record keeping</b>	
<b>Trust</b>	Trust is integral to the short-term, peer-to-peer rental business.
<b>Transparency</b>	

# Proof of Impact

---

The key features of blockchains applicable in the Proof of Impact example:

Decentralization	
Distributed architecture	Proof of Impact provides data that is readily available to all users.
Record keeping	
Trust	The immutable nature of information contained on a blockchain ensures data integrity.
Transparency	

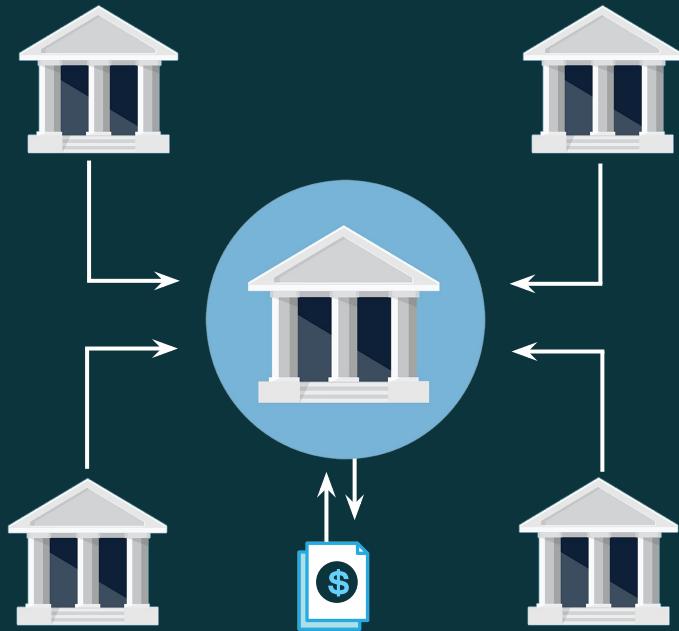
# Questions?



# Centralization and Traditional Banking

# Centralization and Traditional Banking

Historically, most systems that maintain financial records—for example, banks and governments—have been centralized. This means that one location or one authoritative source runs the financial tasks that are involved in maintaining the system.



**For example:** Banks keep internal logs of their money flows. A bank exchanges assets (like cash and stocks) with a wide variety of customers. But the bank doesn't rely on those customers to agree on the amount of money that the bank currently has. The bank keeps its own authoritative record.

# Centralization and Traditional Banking

People usually consider banks to be trustworthy institutions.



So, when \$50 is transferred from one bank account into a friend's account at a different bank, both parties can trust that the money will arrive at the correct destination. They can also trust that the bank will record a decrease of \$50 in the sender's balance and an increase of \$50 in the receiver's balance.

The bank's internal log of its money flow is an example of a centralized accounting system, which is also called a **ledger**.

# Centralization

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At a basic level, a ledger keeps track of financial transactions. Any financial ledger includes both settlement and reconciliation.

## Settlement

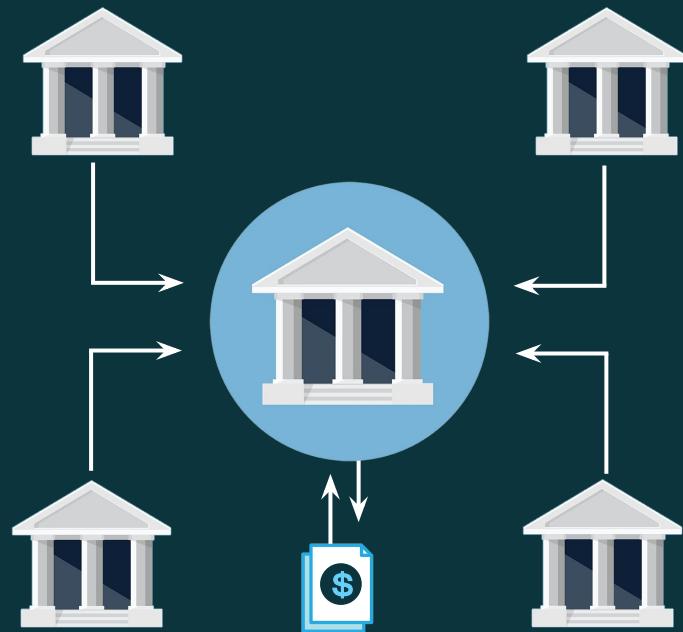
A ledger must facilitate the transfer of assets between one entity and another, which is known as a settlement.

## Reconciliation

A ledger must also verify that all its transactions have been correctly done, which is known as reconciliation.

# Centralization Advantages

It makes transactions easy and fast. Transactions just need to be logged to the appropriate server, and it's done!



Transactions are not cross-checked against other copies on the network, which saves time and energy. If the settlement and reconciliation of a single transaction in a centralized system was reviewed, it could likely be determined, in a simple manner, whether that transaction was correctly done.

# Hidden Costs of Centralization

---

Consider a centralized system that processes millions or even billions of transactions every day. There are now complex and expensive problems, such as:

01

Investment in extra servers is needed in case a server goes down or reaches capacity.

02

Any downtime can lead to a chain reaction of failed transactions and other costly problems.

03

Specialists are required—and need to be paid—to monitor these millions of transactions, and then audit any transactions that appear to be erroneous.

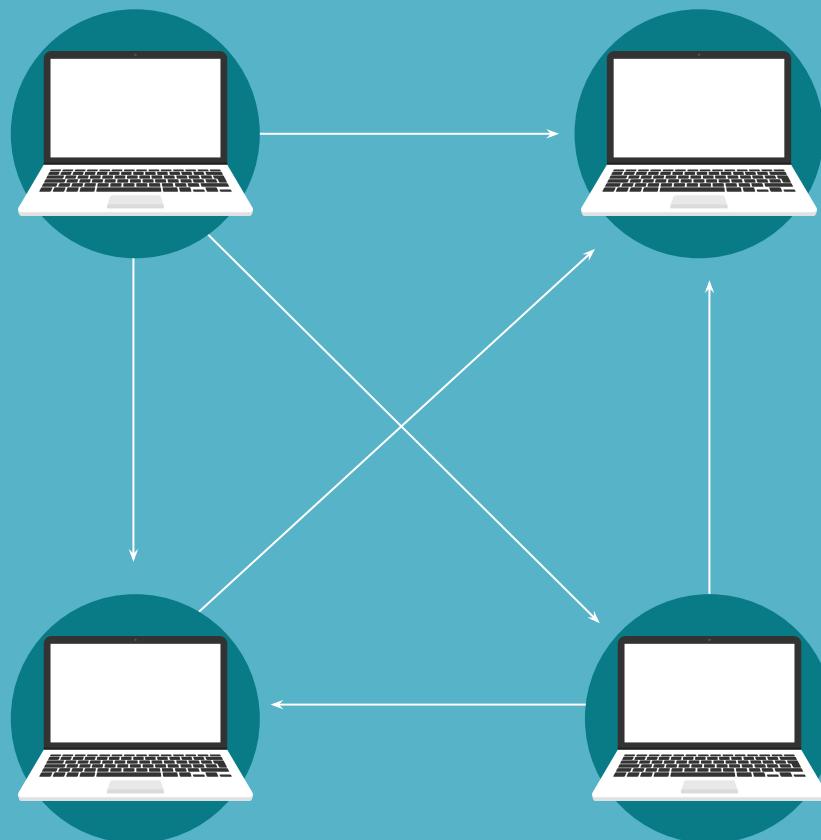
# **Decentralization and Blockchains**

Unlike a centralized financial system that has one authoritative ledger to record all transactions, the ledger of a blockchain is **distributed** across all the computers that have a copy of the blockchain.

## Centralized Database

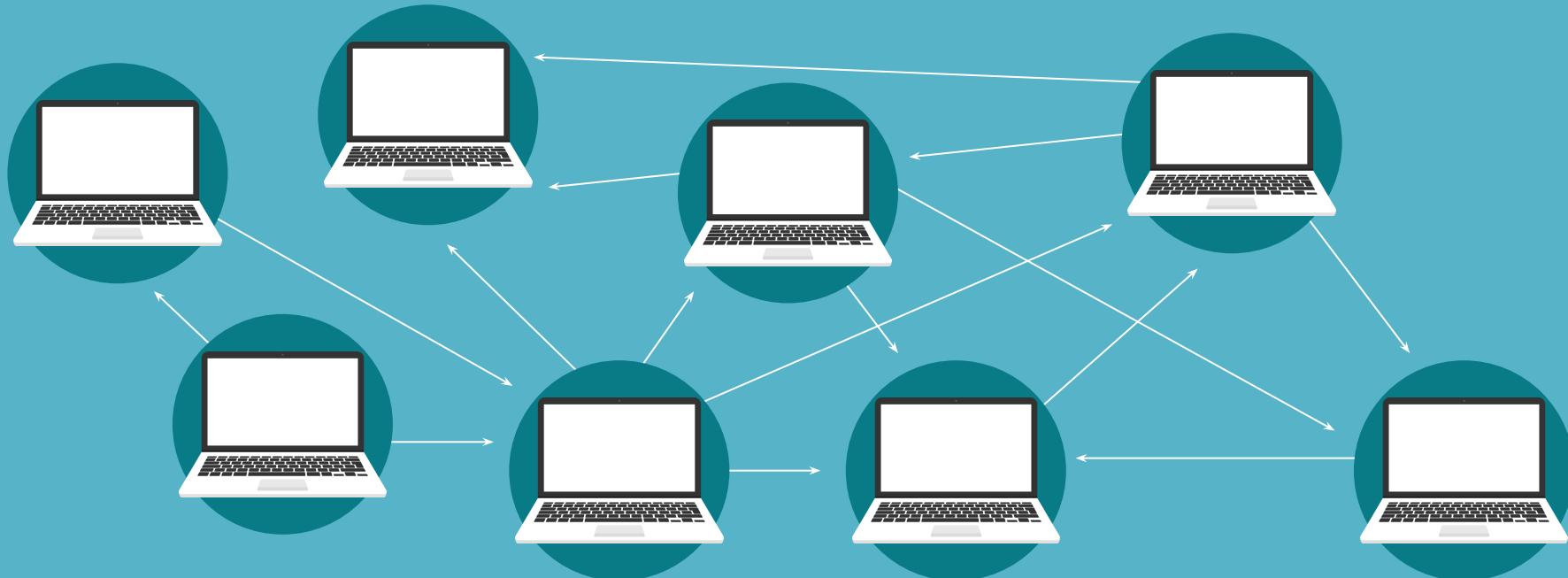


## Decentralized Database



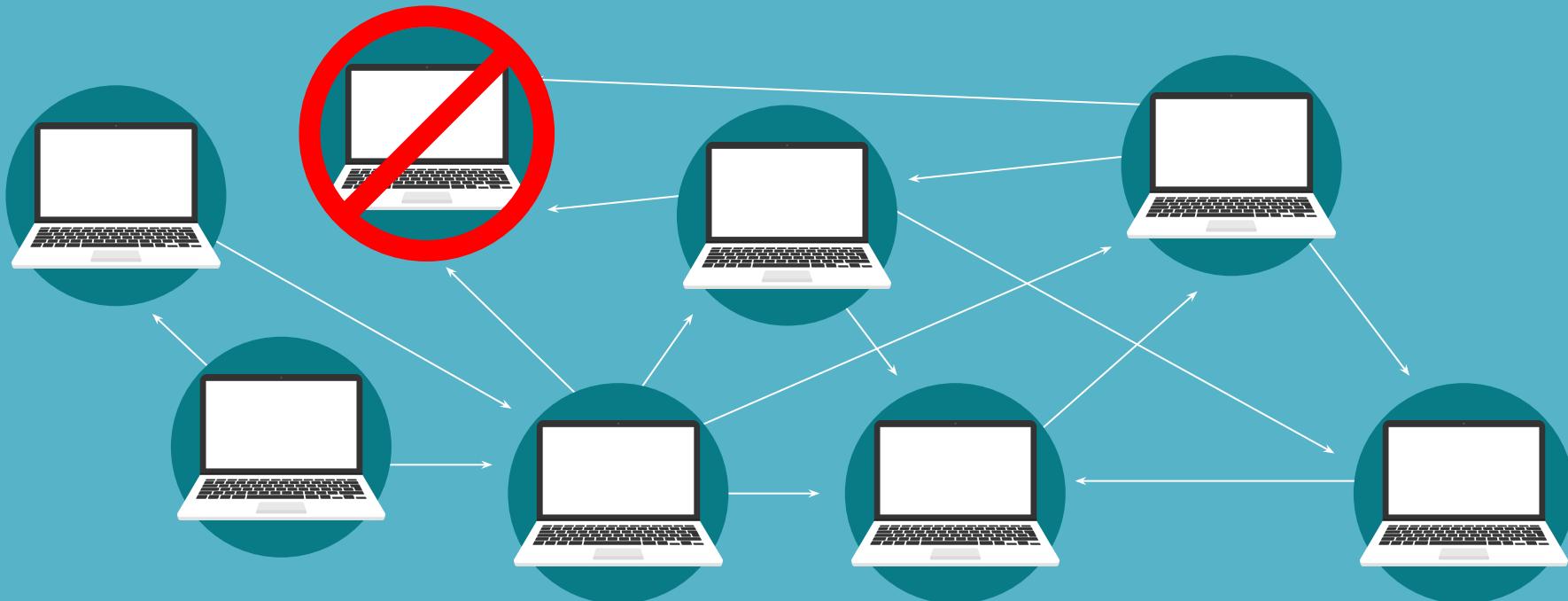
# Decentralized Database

When correctly designed, this kind of distributed ledger—spread across thousands or millions of computers, or nodes—is more immune to server outages, malicious hackers, and other factors that can cause transactions to go wrong.



# Decentralized Database

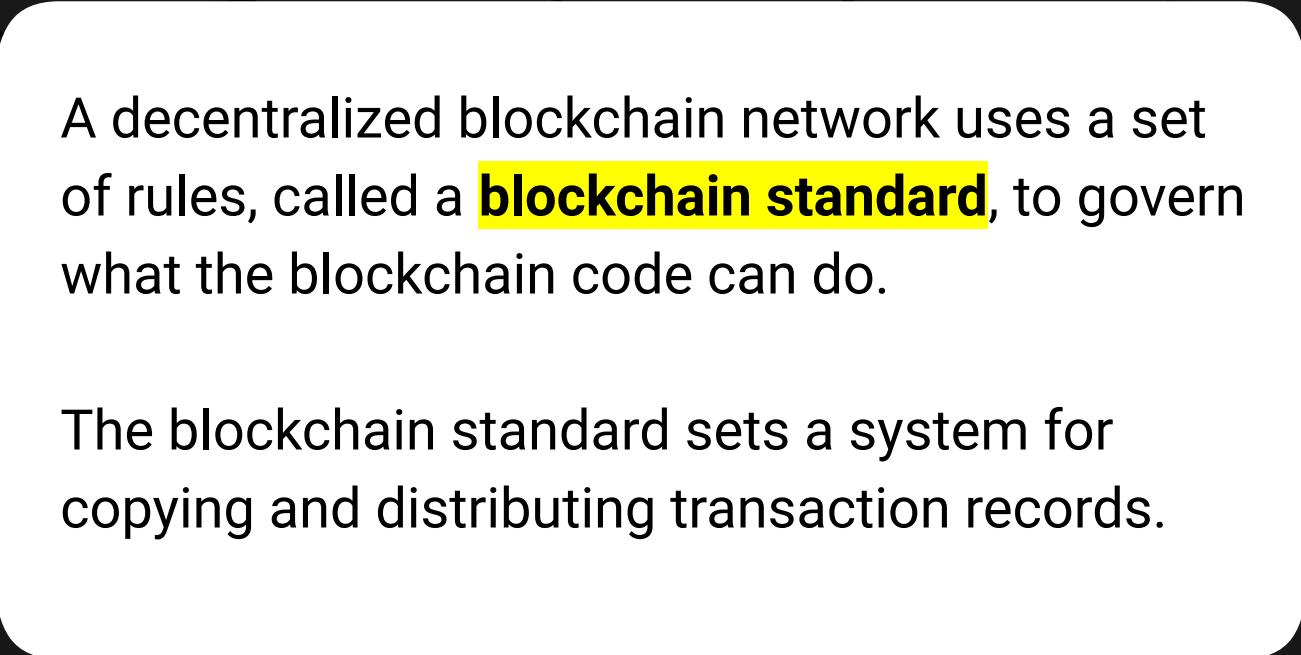
If one computer goes offline, millions remain to both maintain the transaction history and continue processing new transactions.



# Decentralized Database

Even if a malicious hacker compromises the blockchain on thousands of computers, the system is designed so that the remaining blockchains—replicated on potentially thousands or millions more computers—will automatically identify the compromised blockchains as invalid.





A decentralized blockchain network uses a set of rules, called a **blockchain standard**, to govern what the blockchain code can do.

The blockchain standard sets a system for copying and distributing transaction records.

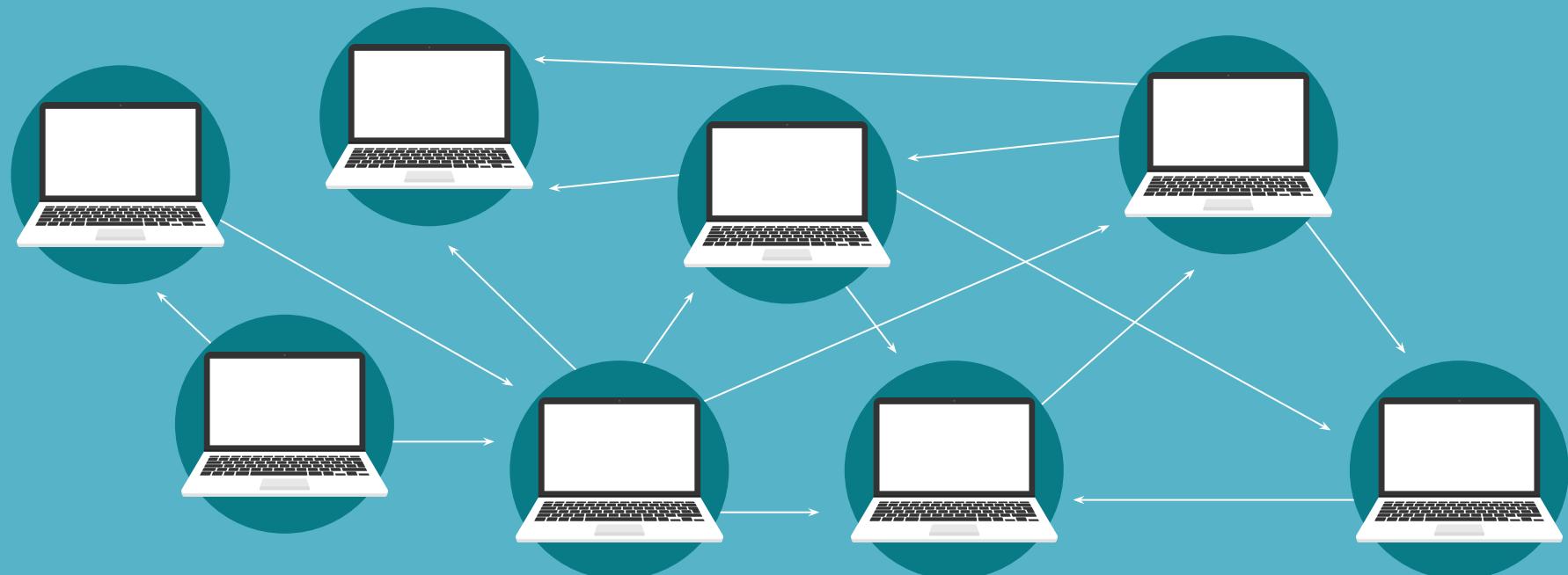


The blockchain standard assures that all of the computers in the network are validating transactions using the same rules. This way, the collection of records represents a source of truth.

# Source of Truth

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The source of truth is created by a number of copies of the blockchain record that are in agreement. This is what prevents hackers from compromising the system.



# Centralized Blockchains

# Centralized System

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While most blockchains are decentralized, it's possible to operate a blockchain as a centralized system.

In a centralized blockchain, only certain participants with special permission can perform transactions on the blockchain.  
These are called **permissioned blockchains**.



# Centralized System

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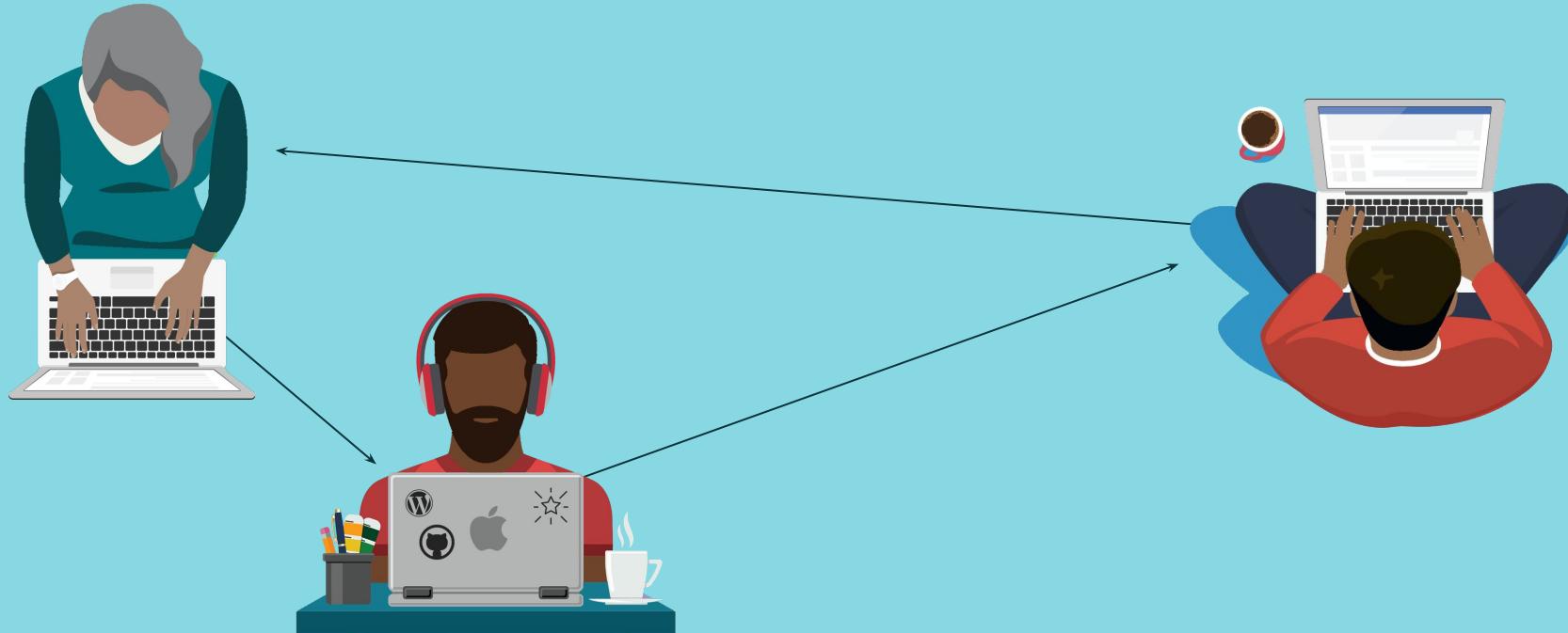
Consider a hypothetical blockchain that allows various departments of a city government to record transactions about each property that's located within its jurisdiction. These might include property tax payments, emergency services, ownership status, and street maintenance history. Placing all of this data in a single ledger would be terrific for efficiency.



# Permissionless Blockchains

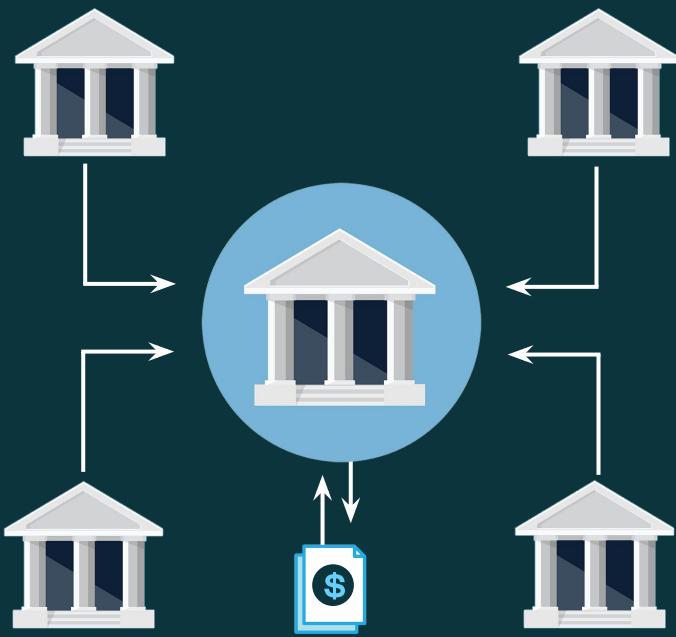
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By contrast, permissionless blockchains allow anyone to transact, or make changes, on the blockchain as it continues forward.



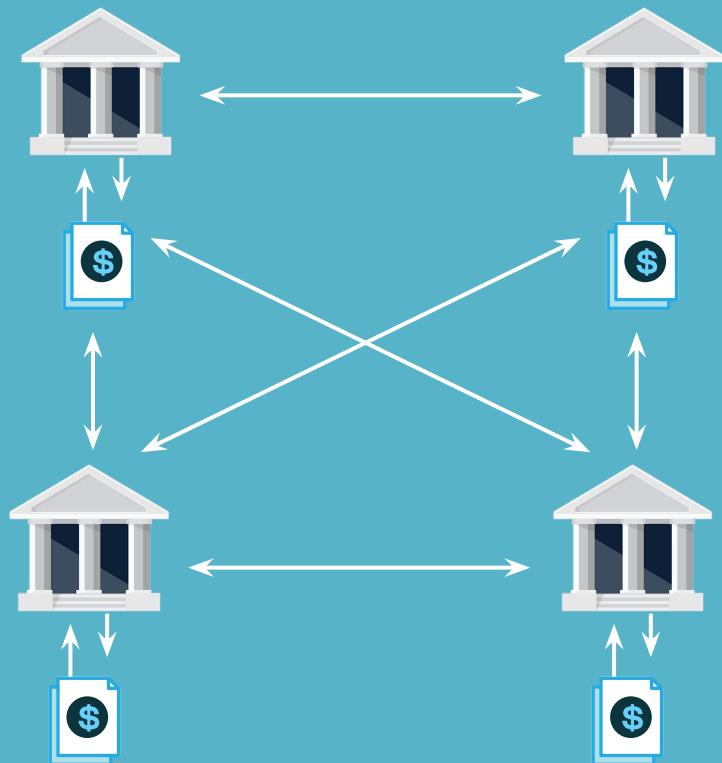
## Traditional Approach

A central and trusted third party controls the database.



## Blockchain Approach

Each participant has a copy of the database, helping to ensure reliability.





In summary, blockchains apply new technology to an old problem:  
**record keeping.**

# Questions?





# Group Activity: Peoplechain

In this activity, you will emulate the activities of a fictitious blockchain that are involved in confirming a transaction.

Suggested Time:

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20 minutes



Time's Up! Let's Review.



What are the four main steps for creating the “Peoplechain”? How do these steps relate to real blockchain functionality?

# Blockchain Functionality

---

The four main steps for creating the “Peoplechain” are:

01

Post cryptocurrency balances on the blockchain.

02

Create blockchain transactions.

03

Validate blockchain transactions.

04

Mine blockchain transactions.

# Blockchain Functionality

<b>Post cryptocurrency balances on the blockchain</b>	In a real blockchain, cryptocurrency balances are usually accessed through a cryptocurrency wallet.
<b>Create blockchain transactions</b>	All transactions on a blockchain contain at least the information detailed in the activity transactions: sender, receiver, amount of the transaction, and a transaction fee.
<b>Validate blockchain transactions</b>	Every transaction posted to the blockchain must be validated before it's written to a block. The validation process keeps users from spending more cryptocurrency than they have. Transactions usually wait in the mempool to be validated and written to the blockchain.
<b>Mine blockchain transactions</b>	Once transactions are validated, they're pulled from the mempool and mined into blocks. Each block consists of a group of validated transactions. Each block has an identifier that ties it to the previous block, which helps to ensure the continuity of the chain.

# Questions?



*Break*



# Blockchain Rules and Trust

**Blockchain standards** are a set of rules that define the blockchain code and how it operates. Who creates the rules that define the blockchain standard? It depends on whether the blockchain is permissioned or permissionless.

# Permissioned vs. Permissionless Blockchains

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## Permissioned

A permissioned blockchain has a trusted, third-party arbiter—for example, a government, corporate CEO or Board of Directors, or another well-respected institution—that acts as the central decision-making authority.

## Permissionless

A permissionless blockchain doesn't have a central authority to provide trust. Instead, people place their trust in the prespecified rules of the blockchain, which are the incentives that keep the users acting appropriately.

# Permissioned Blockchain

For permissionless or open blockchains, the code of the blockchain includes its “rules of the game.” This code runs for all the users of the chain—that is, the code is distributed across all the users.



Block 0

Block 1

The `prev_hash` attribute  
contains the hash of Block 0



Bitcoin and Ethereum are examples  
of permissionless blockchains.

# Permissioned Blockchain

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What if the rules need to change?

In this case, permissionless blockchains are rather democratic.

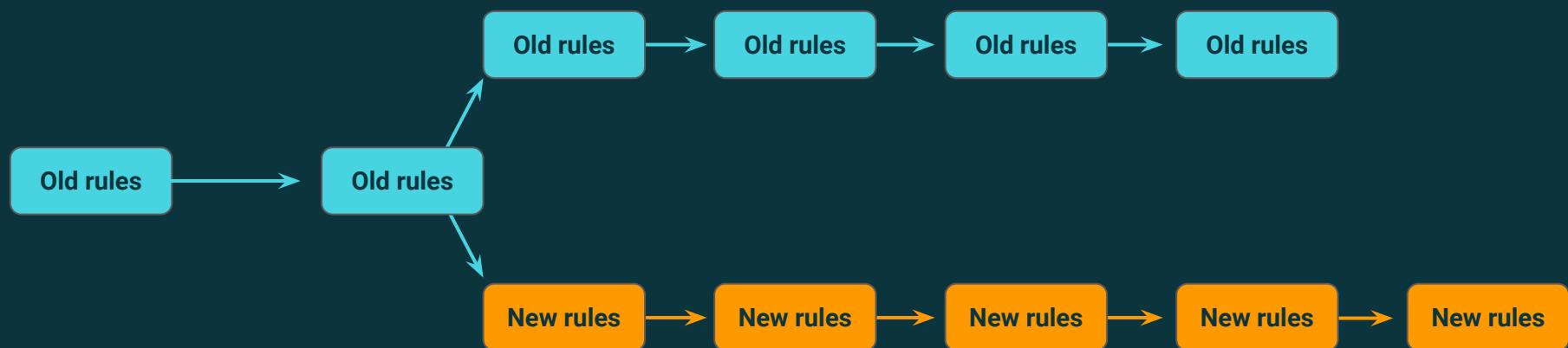
The users of the chain can vote on the proposed changes.

If a threshold of votes (usually a majority) accepts the changes, the code is rewritten going forward.



# A Blockchain Fork

A strong disagreement concerning the proposed changes to a standard might result in a blockchain fork. Those in favor of the new standard “fork” the code into a new blockchain that contains the new rule. Those opposed to the new standard continue using the original blockchain.





A background composed of a dense pattern of white and light gray triangles, creating a geometric and modern aesthetic.

# Trust and Value

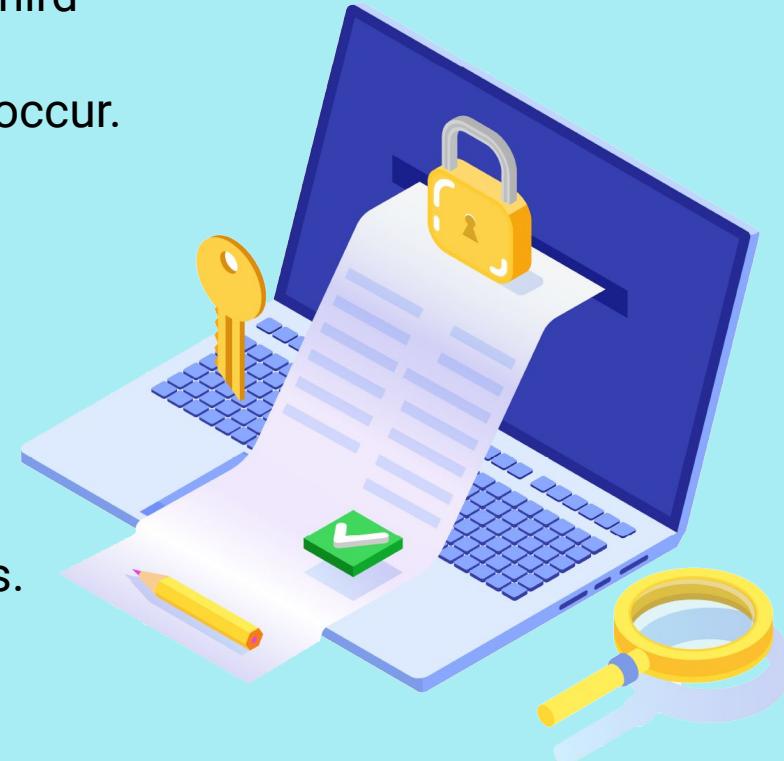
# Trust and Value

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Any financial transaction involves a trusted third party: a person, an institution, or a concept. Without that, the transaction simply doesn't occur.

In sum, value is built entirely around trust. And because trust is a concept, value is also a concept.

Even though a \$100 bill hardly differs physically from a paper towel, everyone agrees that it's worth something—and so it is.





One way that Bitcoin builds trust from its users is by strictly controlling supply. By design, only 21 million coins can ever be created.

# Trust and Value

---

Some currencies that came shortly after Bitcoin—Ethereum, for example—had no restriction on supply. Yet, people seemed to trust this currency, too.

Why? One answer might be that Ethereum adopted many of the security aspects of Bitcoin but improved the usability of doing transactions. And as more users adopted Ethereum for its usability, they began to trust it both as a way to send money and as a store of value.



# Trust and Value

---

In sum:

01

Cryptocurrencies began by presenting an alternative currency in which to place trust, at a time when people questioned their trust in traditional currencies.

02

One possible reason that some cryptocurrencies have maintained that trust is that they continue to evolve toward greater usability.

03

As long as cryptocurrencies and, more importantly, blockchain continue to strike that balance between trust and usability, they're likely here to stay.

# Blockchain Recap



What are the key features of  
blockchain technology?

# Blockchain Recap

---

The five key features of blockchains:

01

Decentralization

02

Distributed architecture

03

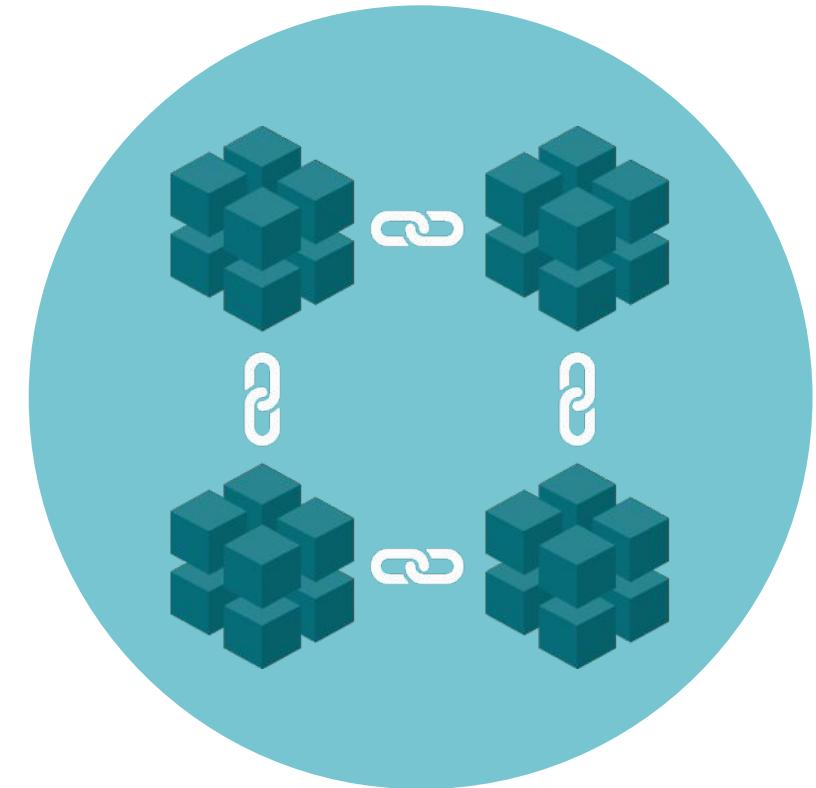
Record keeping

04

Trust

05

Transparency





Why would a fintech entrepreneur  
want to build a software application that  
uses blockchain?

# Blockchain Recap

---

## Reasons to use blockchain:



Permissionless blockchain enables fast, global transactions that are not managed by a single authority.



Blockchain supports borderless, neutral, and censor-resistant finance.

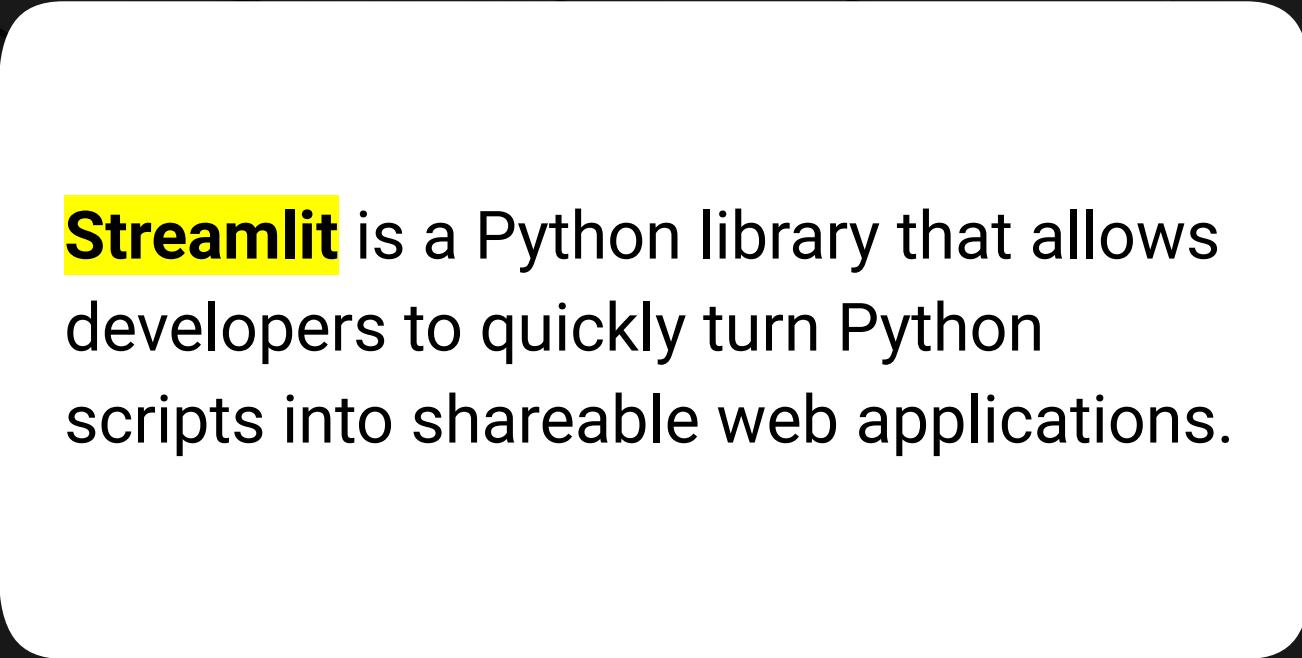


The decentralized nature of blockchain offers a more secure infrastructure for the next generation of application and web development.



A blockchain removes intermediaries such as PayPal, Venmo, and Cash App, and allows for peer-to-peer payments—and thus lower fees.

# Introducing Streamlit



**Streamlit** is a Python library that allows developers to quickly turn Python scripts into shareable web applications.

# Streamlit

---

Streamlit is a Python library that is used to create user-friendly webpage interfaces. In this course, Streamlit will be used to build a front-end interface for blockchain functionality.

```
:streamlit run app.py
```

You can now view your Streamlit app in your browser.

Local URL: <http://localhost:8501>

Network URL: <http://192.168.205.109:8501>

# Streamlit

---

Streamlit is a Python library that works only with Python files (.py files).  
Therefore, it won't work with Jupyter notebooks (.ipynb files).

```
:streamlit run app.py
```



You can now view your Streamlit app in your browser.

Local URL: <http://localhost:8501>

Network URL: <http://192.168.205.109:8501>



# Instructor Demonstration

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## The Streamlit Library

# Questions?





# Activity: A Streamlit App

In this activity, you will create and launch a basic Streamlit application.

Suggested Time:

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20 minutes



Time's Up! Let's Review.

The  
End