Blockchain Transactions and Web3.py

FinTech

Lesson 19.1

Class Objectives

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

- Articulate how nodes and the mempool play roles in adding transactions to the Ethereum blockchain.
- Explain how gas fees help determine which transactions are selected for addition to the Ethereum blockchain.
- Describe the six steps required to add a transaction to the Ethereum blockchain.
- Compare and contrast low-, medium-, and high-gas strategies.
- Utilize Web3.py as a provider to access account addresses and balances, and convert ether into different denominations.
- Use Web3.py to define the parameters required for an Ethereum transaction, including the sender, receiver, gas, and ether.
- Explain the role of a testnet in the Ethereum ecosystem.


WELCOME

Let’s begin by recapping the previous unit and lessons.

Recap

In the last unit, you:

01

Built a local blockchain and a decentralized network using a Python library called Streamlit.

02

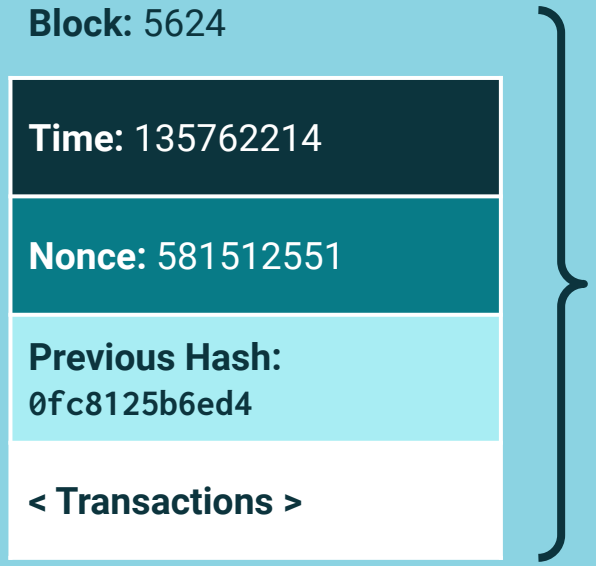
Constructed a complete PyChain blockchain ledger instance.

03

Designed this ledger to record financial transactions among multiple parties.

The Ethereum Blockchain

On the Ethereum blockchain, instead of a record attribute, each block has an attribute named **Transactions** that stores data.



This week, you will learn about **Web3.py** and how to use it to send transactions on the Ethereum blockchain.

The Ethereum Blockchain

Having the ability to send transactions on a blockchain is an important skill, especially if you plan on working in an industry that uses blockchain.

Here are some examples:

Automotive	Healthcare and life sciences	Retail and consumer goods	Supply chain
Banking and financial services	Insurance	Telecommunications	Oil and gas
Government	Media and entertainment	Travel and transportation	Manufacturing

The Ethereum Blockchain

Let’s say you work for a company that wants to make a million or even billion dollar transactions.

Banks will charge a percentage as a fee to send an amount of money this large.

- The ability to send cryptocurrency to facilitate purchases saves thousands of dollars in transaction fees.
- In addition, the transactions will be stored on the blockchain.

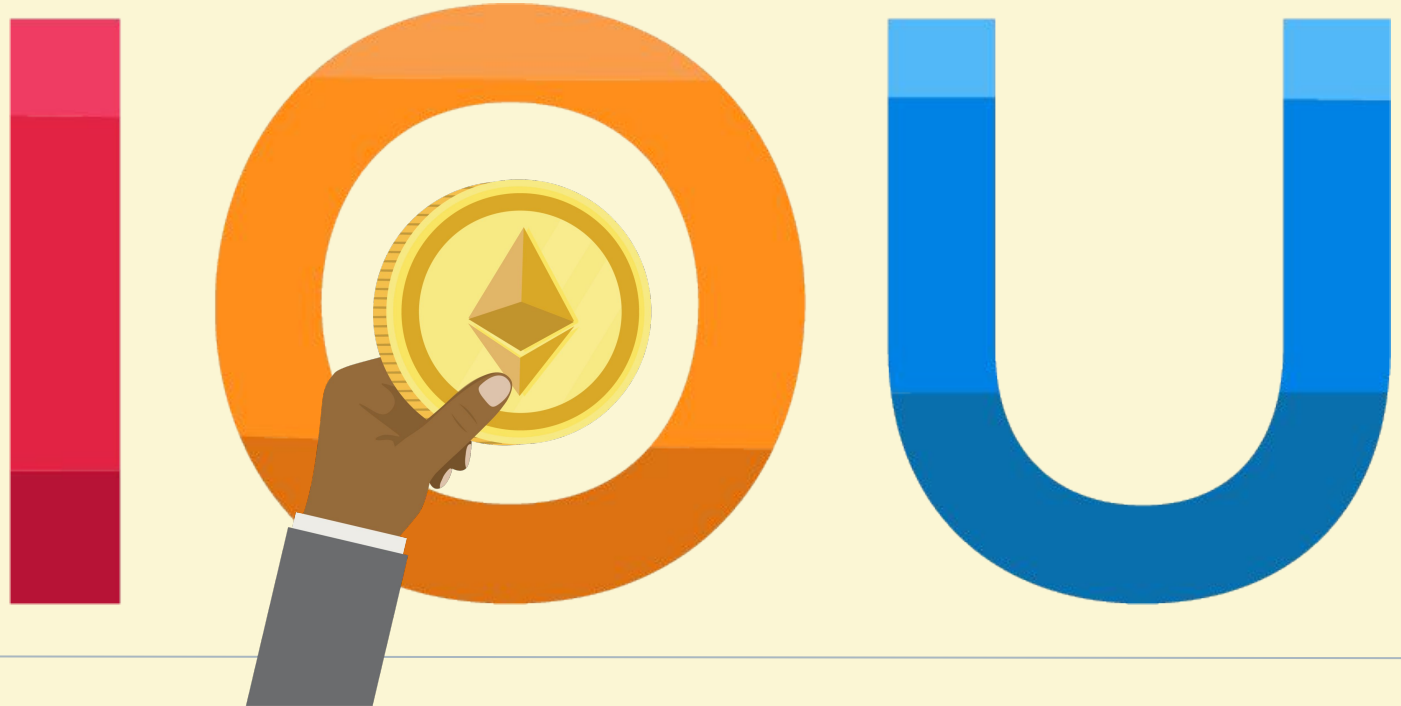
The Ethereum Blockchain

Ethereum is another blockchain with its own cryptocurrency: **ether**.

- It is the second-largest cryptocurrency in terms of market capitalization.
- It is the second-most valuable cryptocurrency.
- The Ethereum blockchain is the most actively used blockchain.
- It is special because it has capabilities that other blockchains do not, such as storing entire contracts that automate transactions.

The Ethereum Blockchain

These contracts can be as simple as an IOU between two parties. Or, they could involve transfers of ownership of cryptocurrency, other financial assets, or even copyrights to intellectual property.

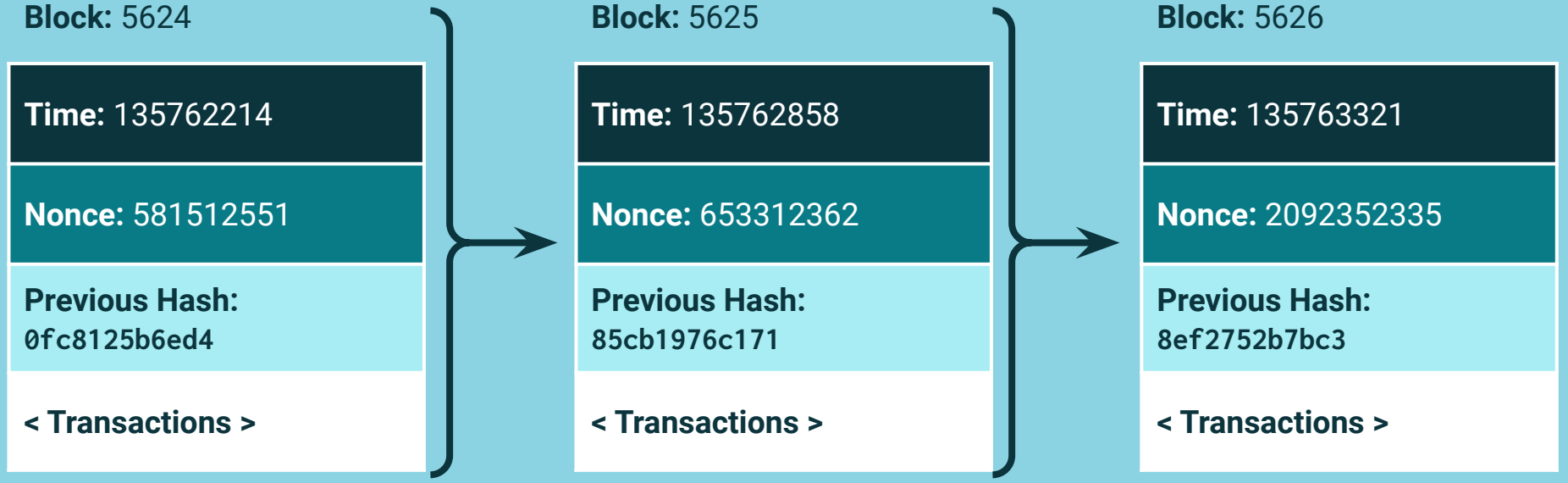


Adding Transactions to the Blockchain

Similar to Bitcoin, Ethereum has a blockchain that stores data in blocks. Ethereum blocks store data such as transactions and smart contracts. The part of the block that stores the transactions is an attribute known as the transactions attribute. On the Bitcoin blockchain, this attribute is called a record attribute.

Adding Transactions to the Blockchain

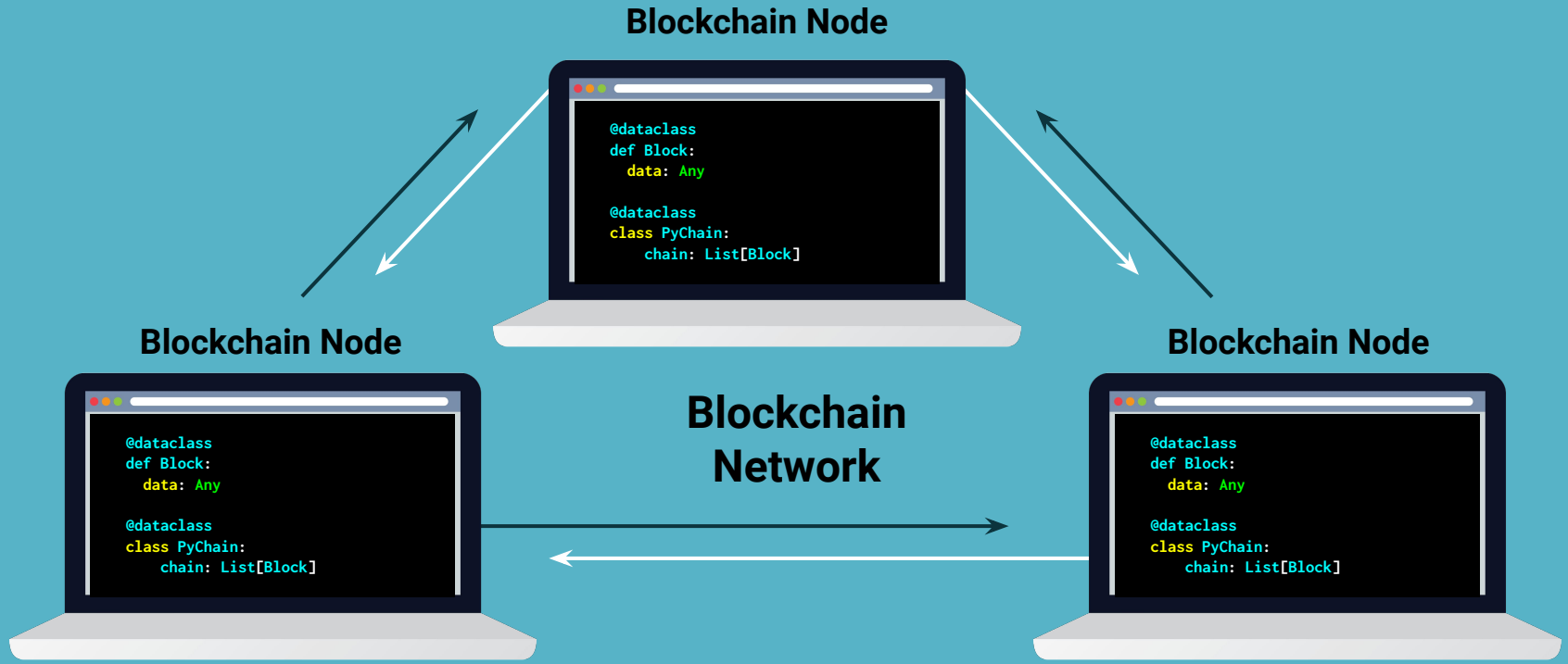
A member of the blockchain network, or a blockchain participant, creates a transaction that will store data or transfer assets over the blockchain.



What happens after the transaction is created?

Adding Transactions to the Blockchain

The participant sends the transaction to the blockchain network.



A **mempool** is where all new transactions wait to be confirmed by the blockchain network, added to a block, and included in the chain.

Why would a transaction be in a mempool?

What would keep it from being processed?

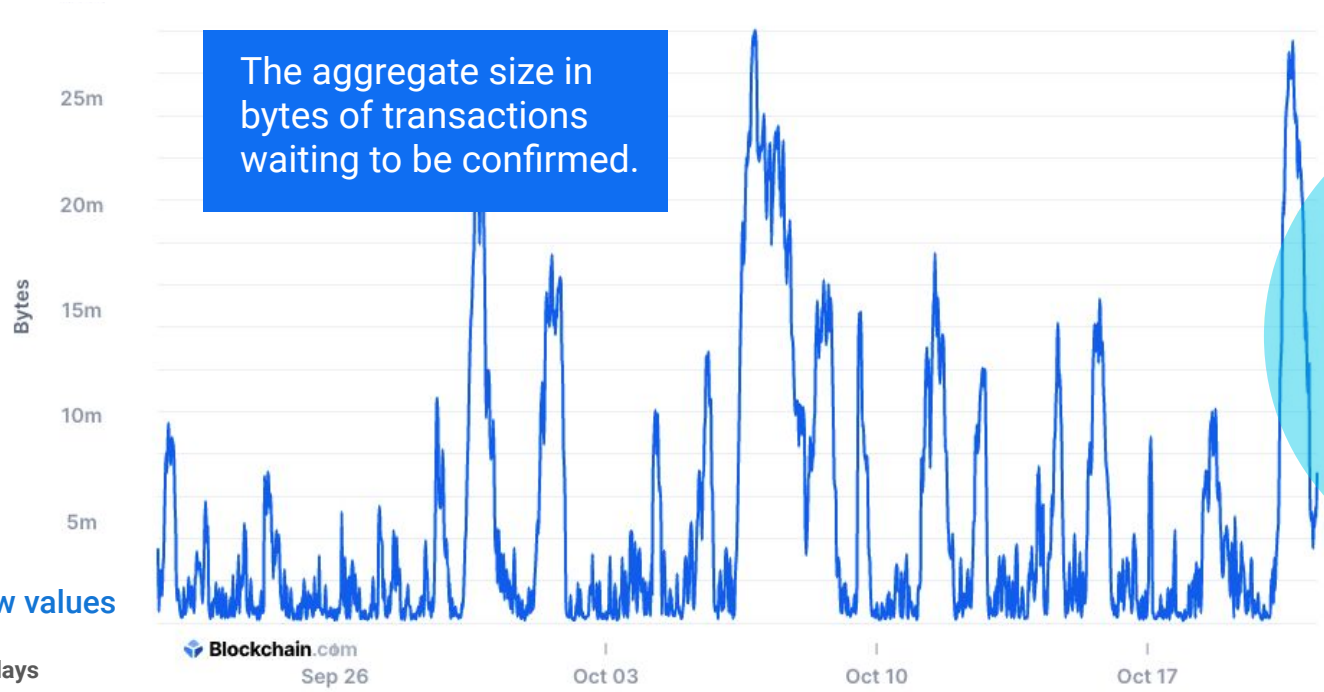
Hint:

Each computer or server that maintains a copy of the blockchain ledger and validates new transactions—in other words, each participant on the blockchain network—is called a node.

Each node on the network has a local mempool. When a new transaction is sent to the network, nodes add the new transaction to their local mempools.

Mempools

The size of a mempool can vary depending upon the network traffic, or the number of transactions that network participants are generating at any given time.



In summary, a miner selects the transaction and chooses to process it.

Blocknative Mempool Explorer

Build real-time data feeds for monitoring in-flight Blockchain transactions

See the introductory blog post →

See documentation →

Polygon (MATIC)

Watch Quickswap Router transactions on Polygon

Watch now

Binance (BSC)

Monitor Pancakeswap v1 and v2 transactions on Binance Smart Chain

Watch now

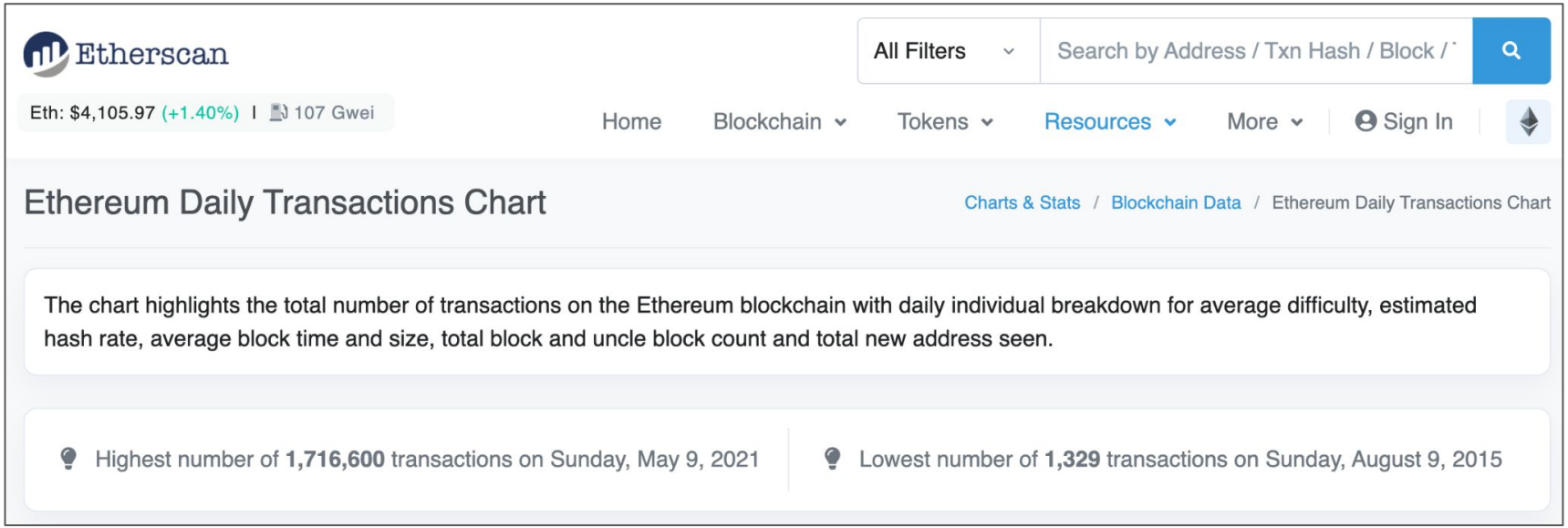
Simulation Platform 🔮

Peer into the future - view simulated transactions on Uniswap now.

Watch now

The Ethereum Blockchain

An Ethereum block currently averages around 500 transactions, and about 2 megabytes of data, per block. However, the number of transactions included in any given Ethereum block is dependent on the size and complexity of the transactions.



https://etherscan.io/chart/tx

Mempool

Transaction

Transaction

Transaction

Miner bundles transactions

Blockchain

Transaction

Transaction

Transaction

Transaction

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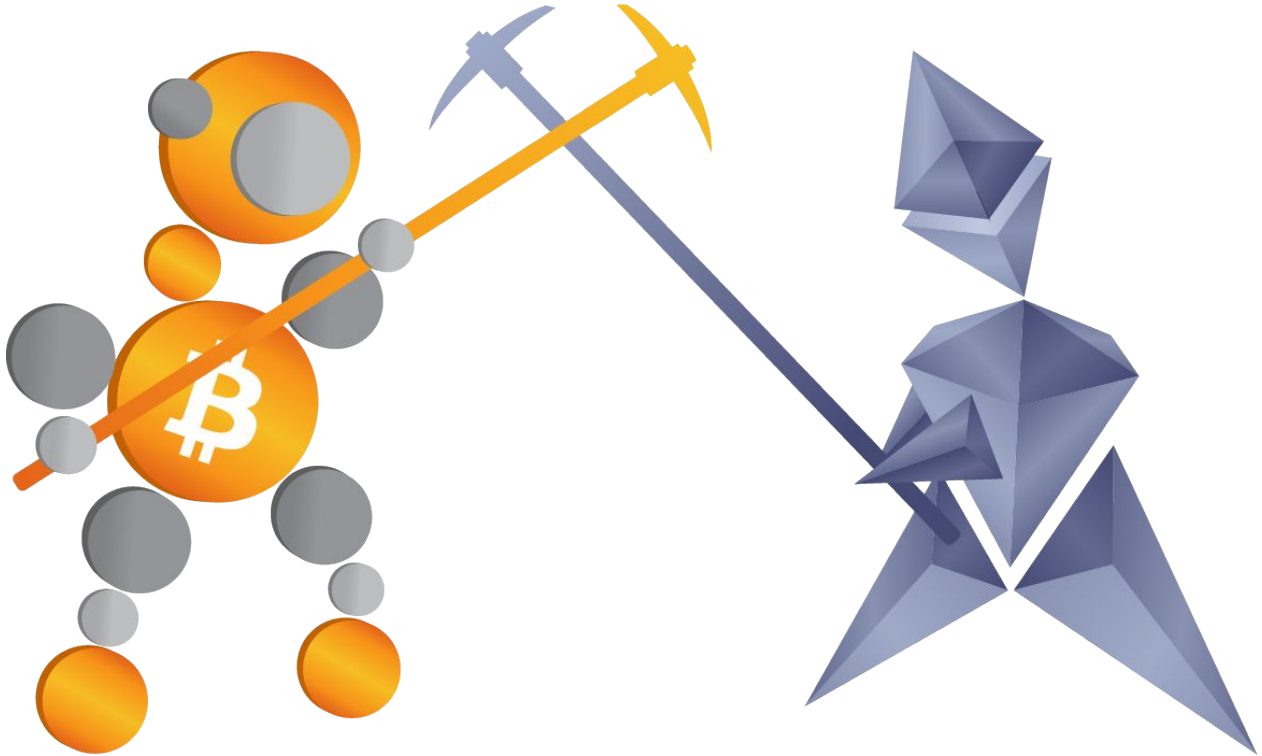
Instructor Demonstration

Blockchain Transaction Fees

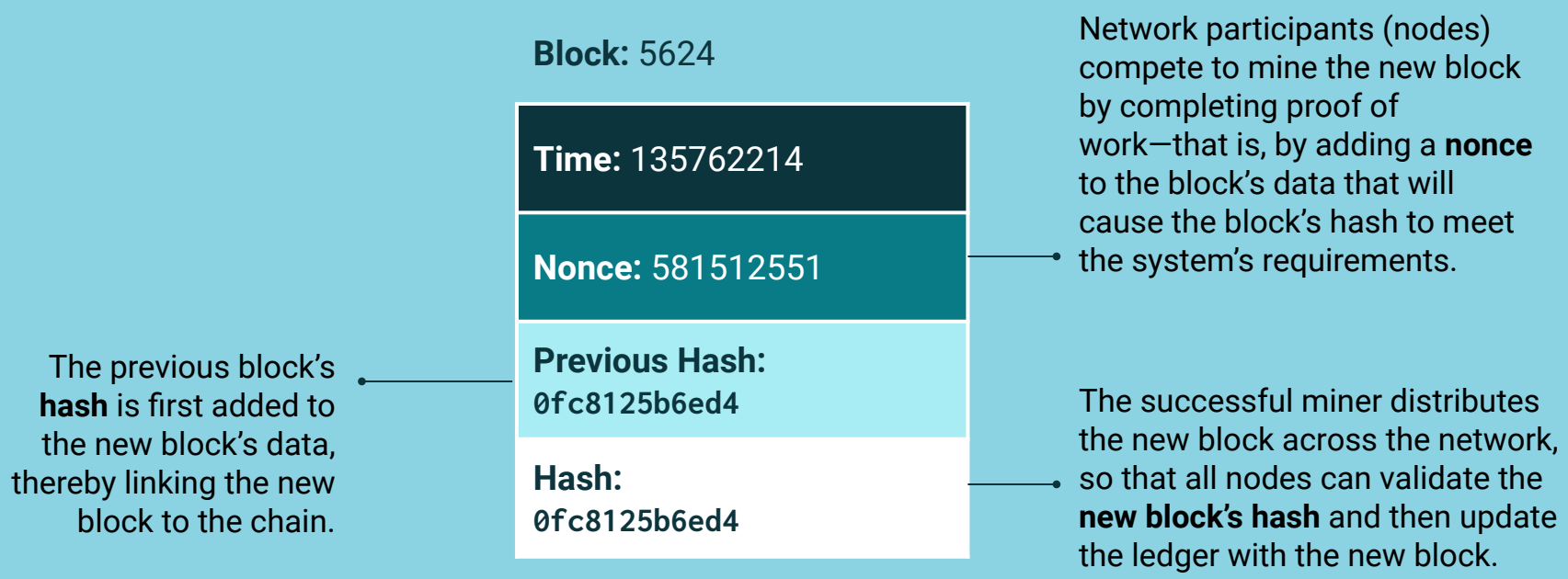
Blockchain Transaction Fees

Miners of Ethereum have a different strategy than those mining Bitcoin because of fees.



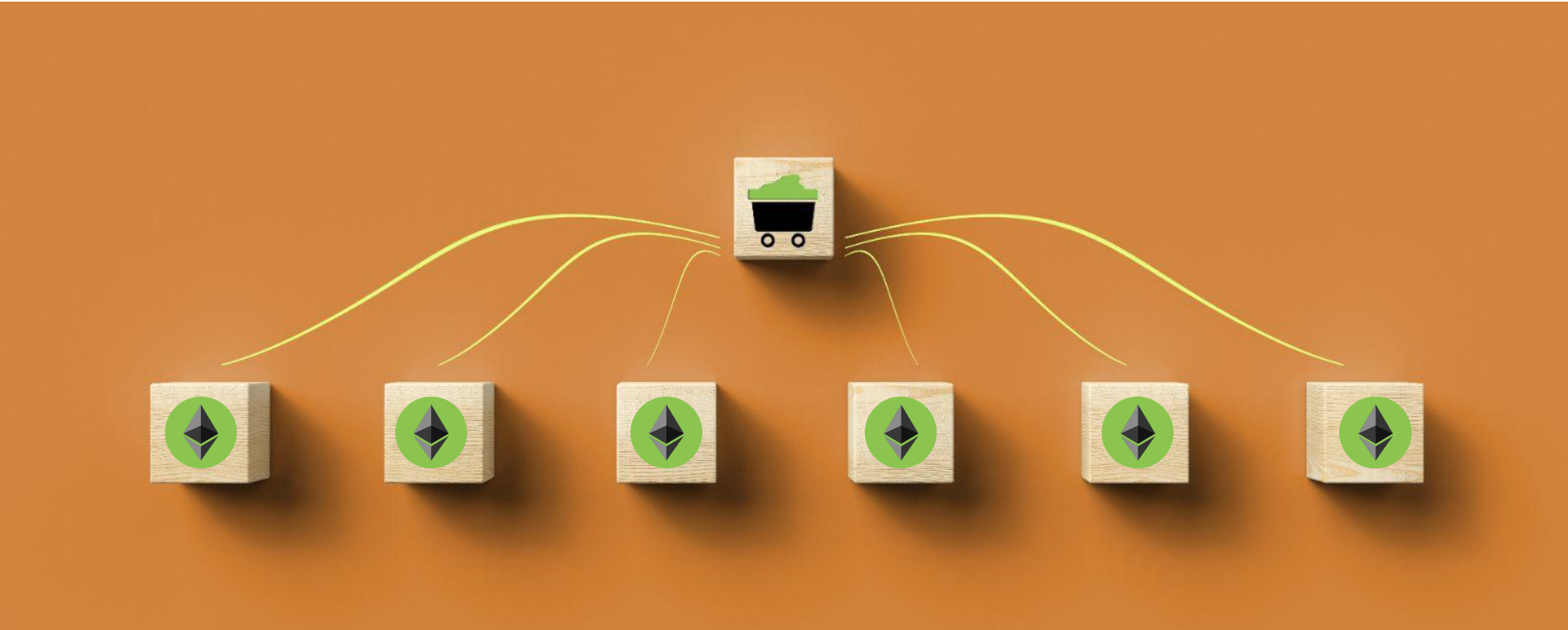
Blockchain Transaction Fees

Recall that when mining Bitcoin...



Blockchain Transaction Fees

Ethereum miners do not view all transactions in the mempool as having equal priority. The reward for mining each transaction is different.



Blockchain Transaction Fees

A transaction fee on any blockchain is an incentive given to people or miners to run the blockchain on their machines; otherwise, miners would have high energy costs and no return.

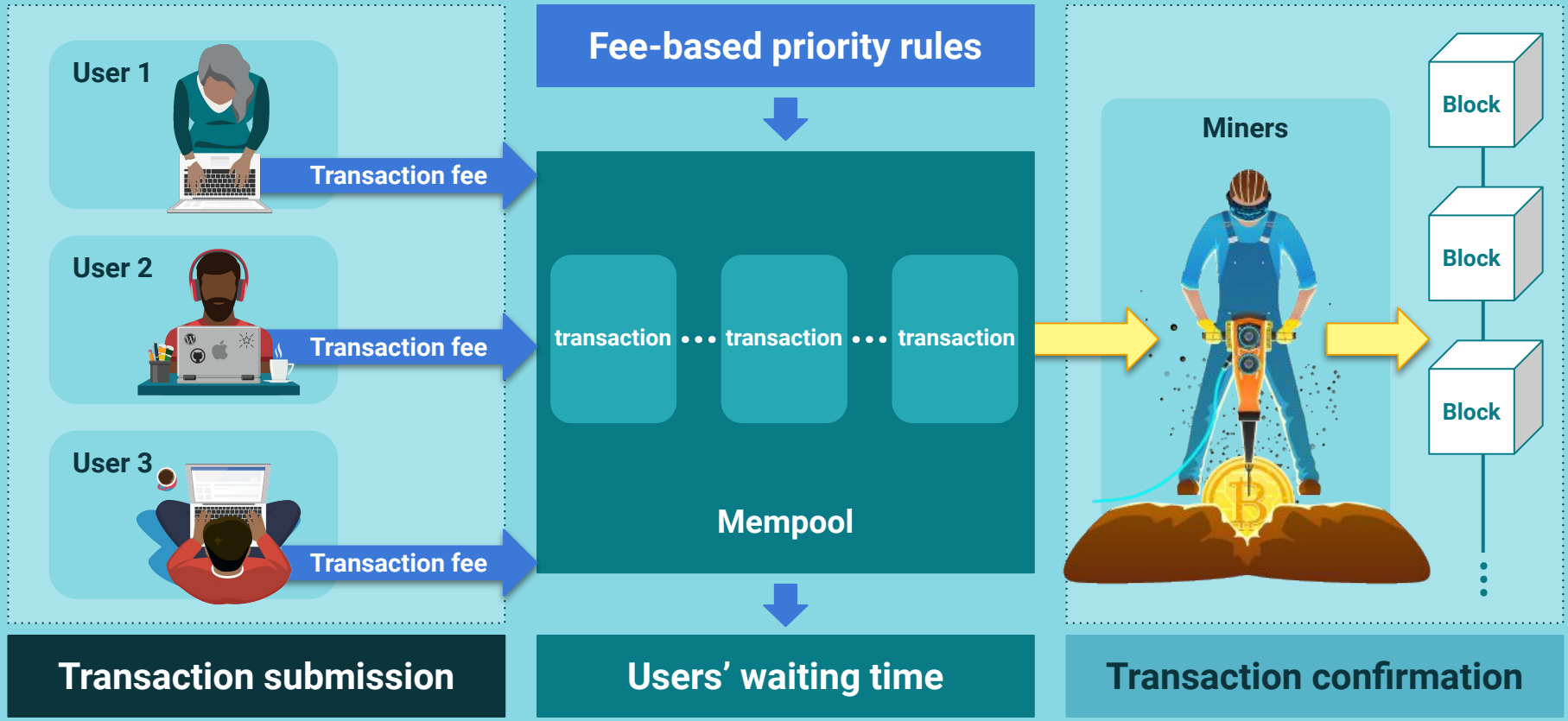
This is why many blockchain networks charge a transaction fee every time a participant records a new transaction onto the chain.

Wiring money through a bank generally has transaction fees.

Blockchain transaction fees are structured a bit differently.

Each blockchain network has its own rules for calculating these fees, and pricing can vary even within one network.
Often, transaction fees increase or decrease

Blockchain Transaction Fees



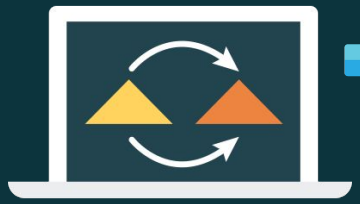
Blockchain Transaction Fees

- On the Ethereum network, transactions wait in the network mempools before a miner picks them up and adds them to the chain.
- Miners don't necessarily add transactions to blocks on a first-come-first-serve basis.
- Computational power on the Ethereum network and space within each block are both limited, and demand for them fluctuates.
- During periods of high demand, the number of transactions sitting in an Ethereum node's mempool may exceed the number of transactions that can fit into a single block.
- The node's miner will decide which transactions to put in a new block and which to leave in the mempool until later.
- During periods of high traffic, when lots of users are sending transactions, miners will prioritize transactions that pay higher fees.
- On Ethereum, the participant who completes proof of work first and mines a new block receives the transaction fees for all the transactions contained within that block.
- In other words, in the Ethereum ecosystem, the transaction fees are included in the block reward.

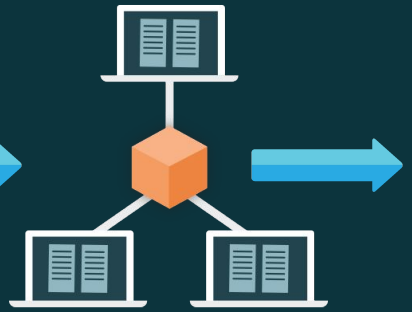
General Rules for Adding Blocks to Blockchains

- A block reward allocates funds to the participant who spent the energy to mine a block.
- It incentivizes a blockchain network's participants to spend energy completing proof of work and mining new blocks.
- After a block is mined and validated, it is written to all of the nodes' ledgers, which effectively executes the block's transactions across the network.
- On the Ethereum blockchain, this entire process usually takes between 15 seconds and 5 minutes depending on network traffic.

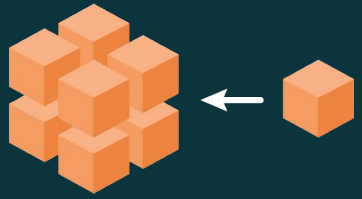
The complete process of adding a transaction to the Ethereum blockchain



Blockchain participants create transactions.

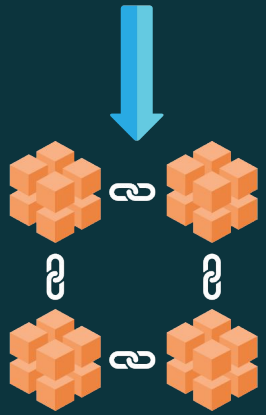


Miners bundle transactions waiting in the mempools into new blocks.



Miners compete to complete proof of work and mine new blocks.

A successful miner sends the new block around the network for validation, and receives a block reward.



The new block is linked to the blockchain.

All blockchain nodes update their copies of the ledger with the new block.

The transaction has been inalterably written onto the blockchain.

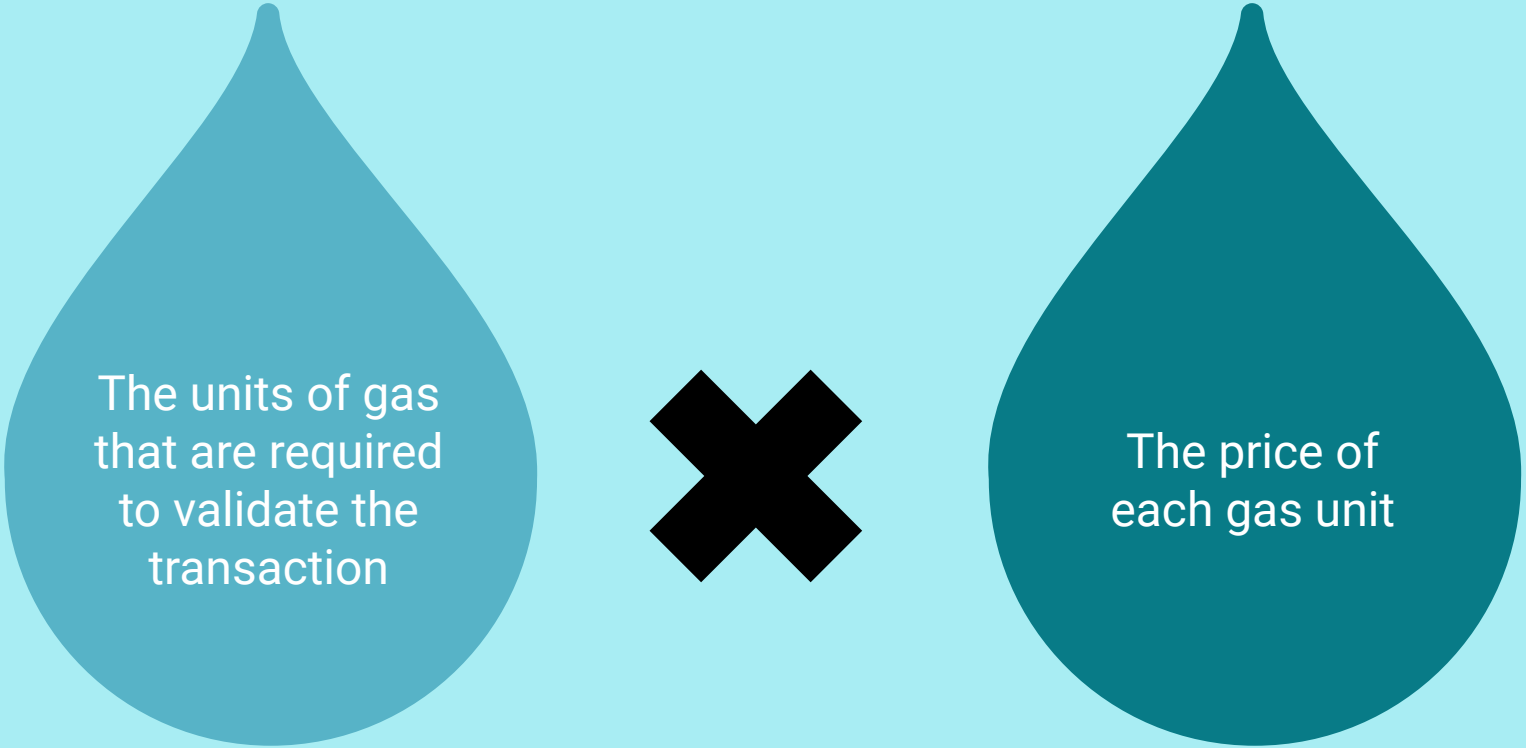
Blockchain Transaction Fees

We are about to review the actual cost and fee structure for sending a transaction to Ethereum.

- Ethereum's transaction fee does not depend on the value of the transaction being processed.
- The transaction fee depends on factors such as the amount of computational power, or gas, that is required to validate the transaction and add it to a block.
- For this reason, Ethereum's transaction fee is known as a **gas fee**.

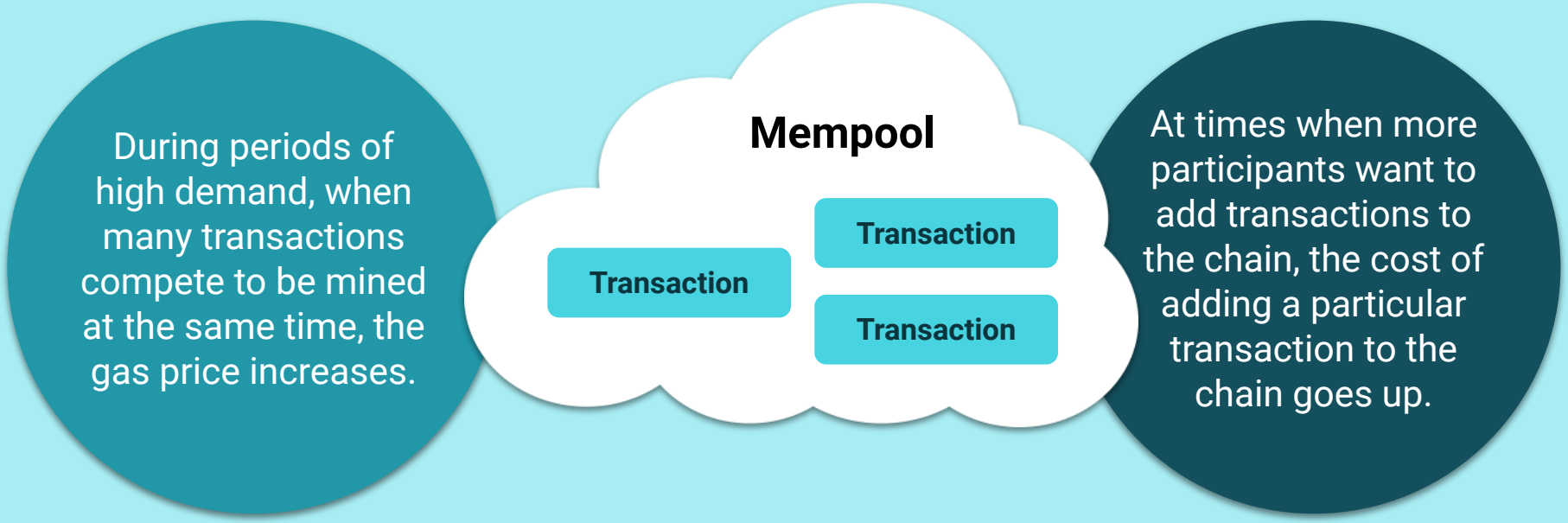
Blockchain Transaction Fees

The calculation of the gas fee for a given transaction is:

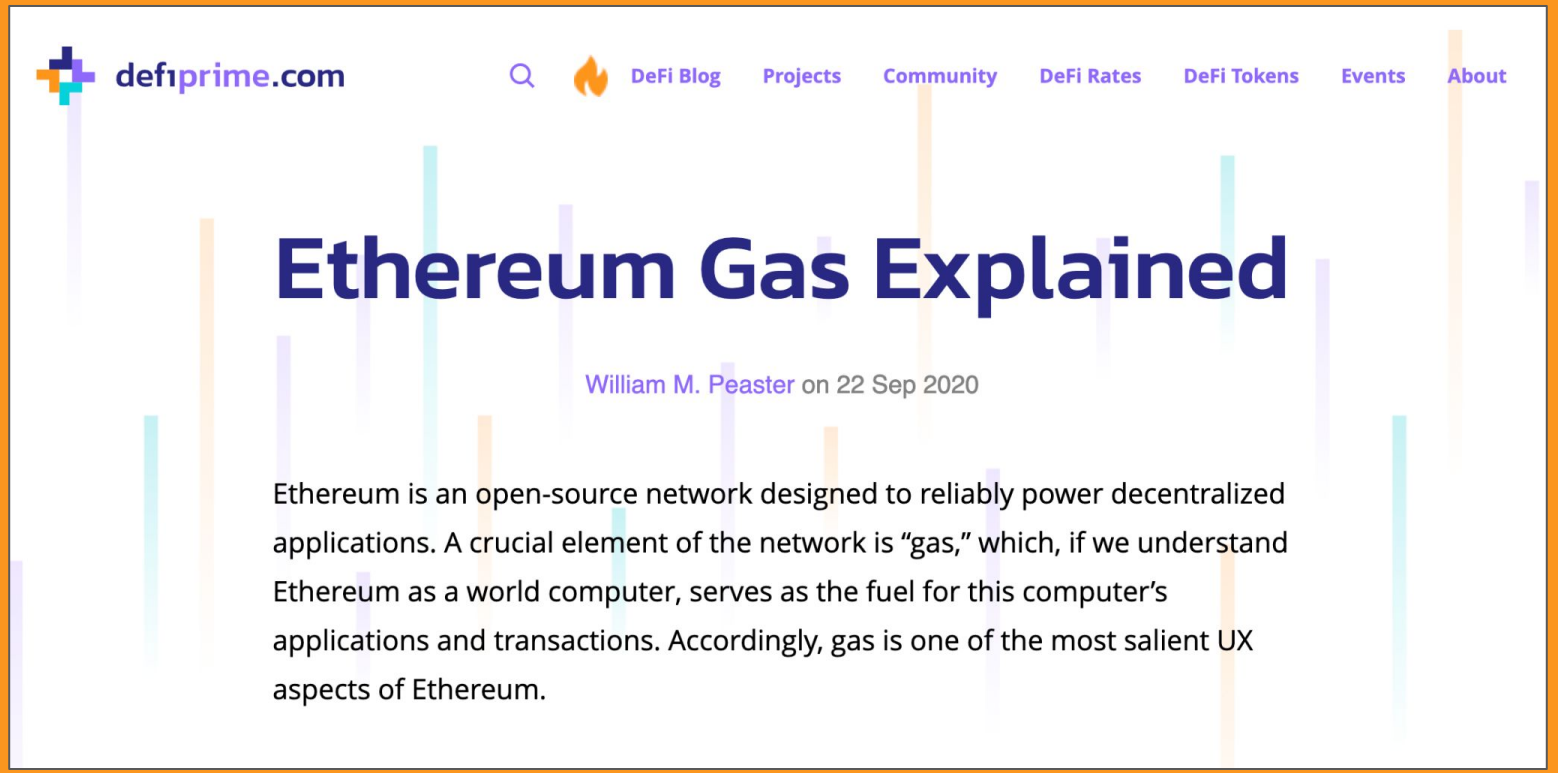


Blockchain Transaction Fees

The price of gas fluctuates based on network traffic, i.e., how many transactions are waiting in the mempool to be picked up by miners.



You can find additional information about Ethereum gas in the Decentralized Finance (DeFi) article “Ethereum Gas Explained.”



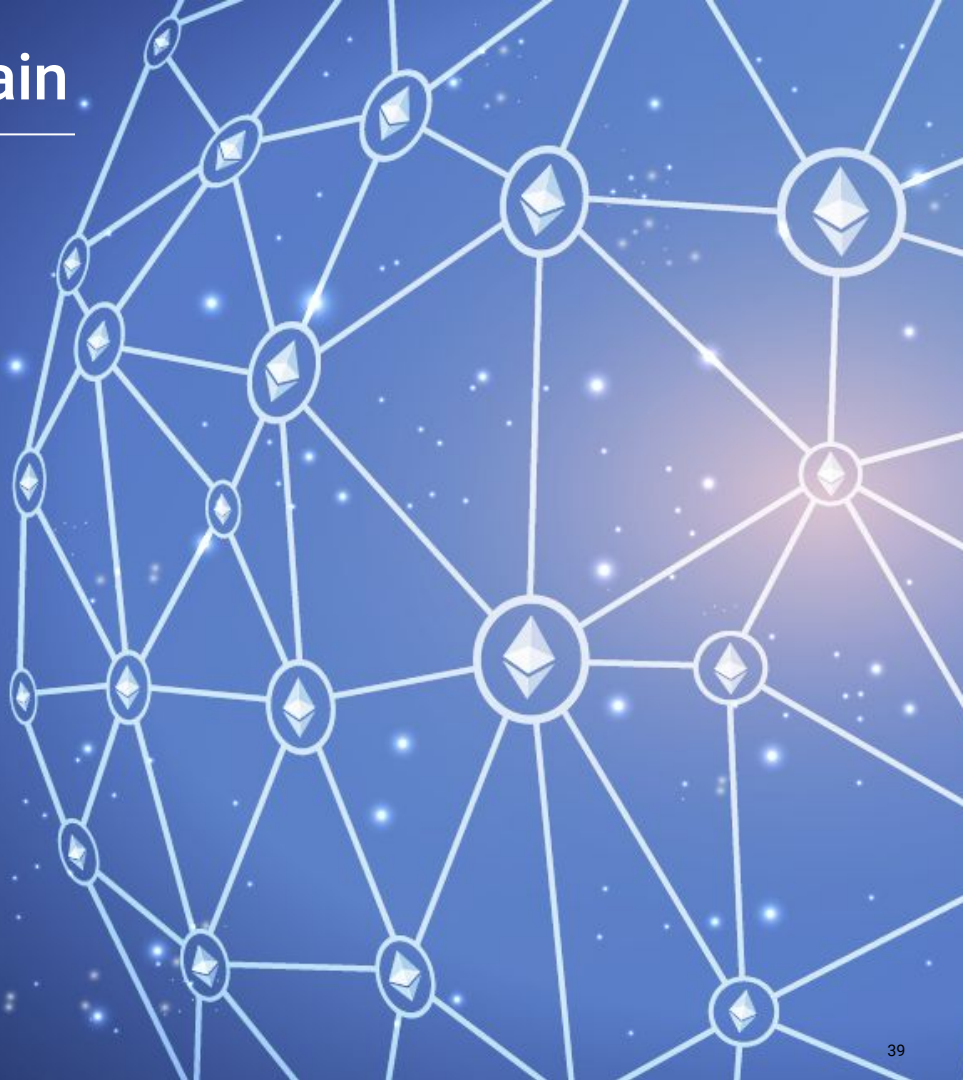
https://defiprime.com/gas

Benefits of Using Ethereum for Financial Transactions

Benefits of Ethereum Blockchain

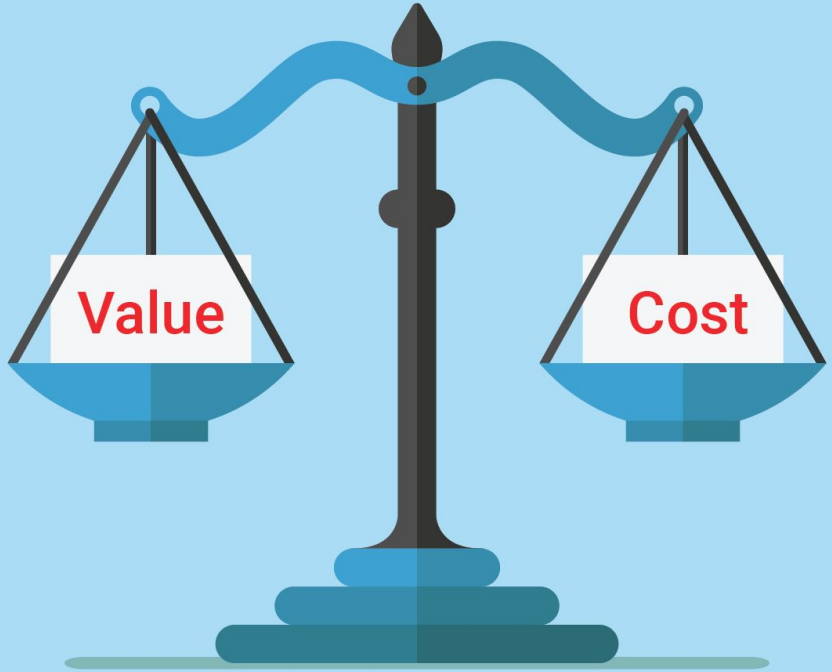
Ethereum nodes are globally distributed. When someone across the globe sends you money, you can access it almost instantly.

This means that you don’t have to wait for your bank to open in order to withdraw your new funds or pay fees for currency exchange.



Benefits of Ethereum Blockchain

Ethereum's dynamic, supply-and-demand–based fee structure offers another unique benefit for financial transactions: the cost of the transaction is not related to the value of the transaction.



Benefits of Ethereum Blockchain

Processing a cryptocurrency transaction that transfers 100 ether from one participant to another might require the same amount (i.e., the same number of units) of gas that processing a transaction of 1,000 ether, or 100,000 ether, does.

Compare this with traditional money transfer systems, which charge increasingly high fees to send larger amounts of money.

Blockchain Benefits

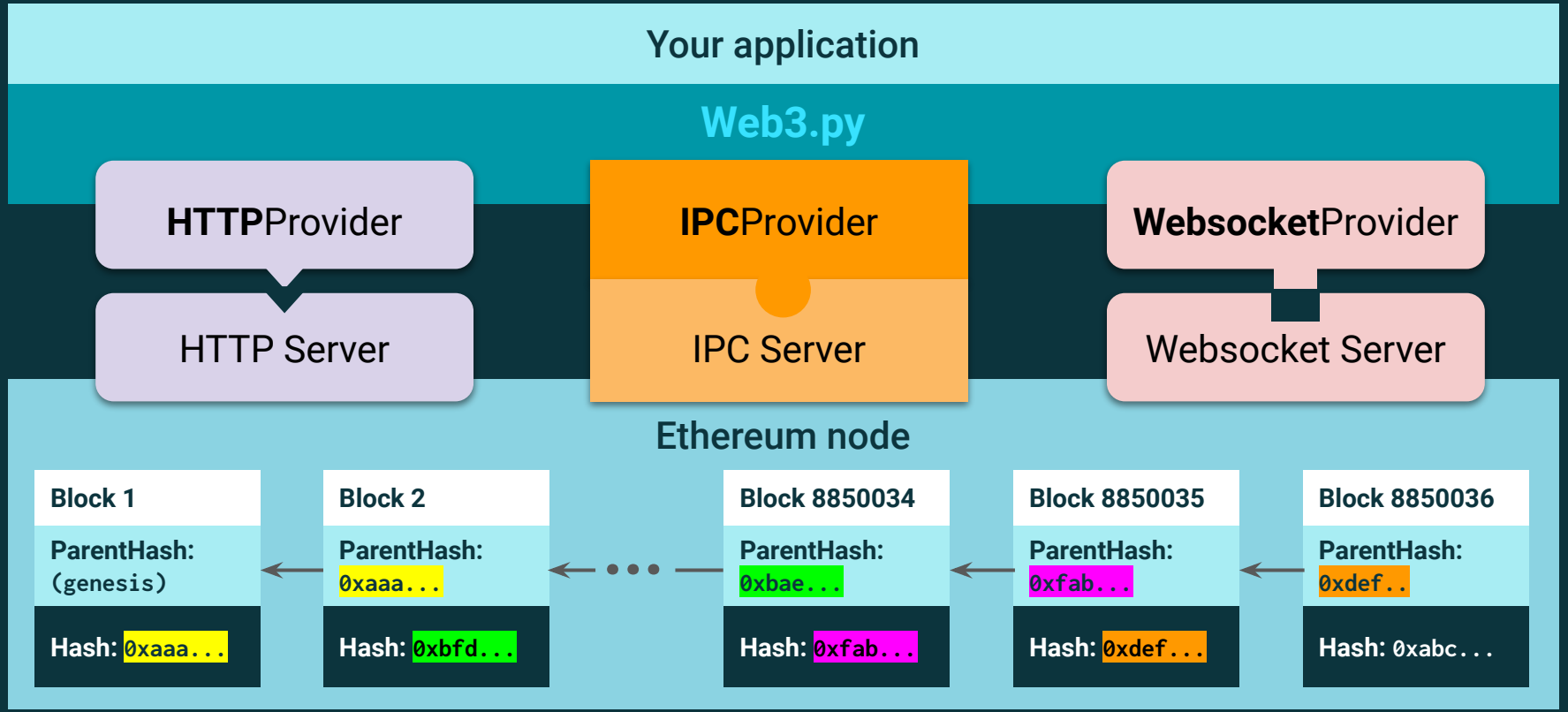
In 2018, cryptocurrency exchange Binace demonstrated the real-world usefulness of a blockchain transaction-fee system by transferring $600 million worth of Bitcoin for a transaction fee of just $7!

A comparable transaction through traditional financial institutions such as banks, or even through digital payment platforms like PayPal, could have cost millions of dollars in fees.

Questions?

Introduction to Web3.py

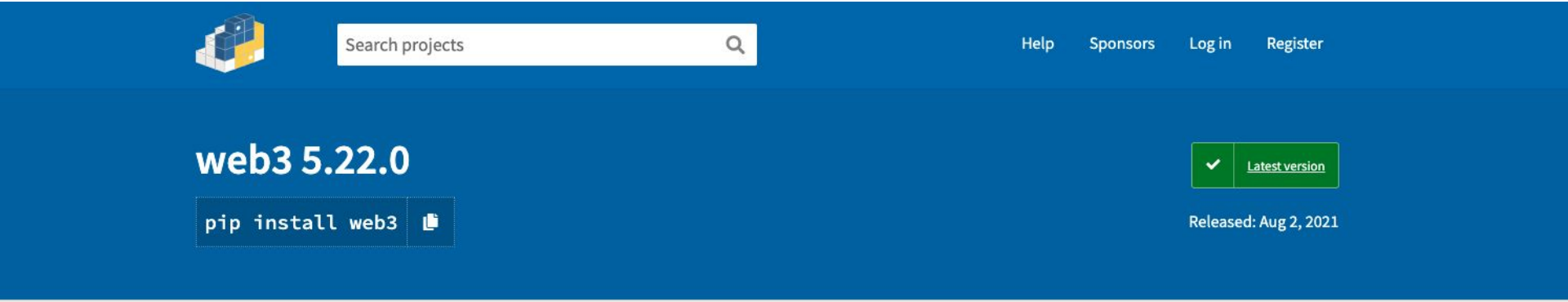
Introduction to Web3.py



(source)

Benefits of Web3.py

- Web3.py is a library that allows us to talk to Ethereum nodes in Python.
- Web3.py is a software development kit (SDK) like any other SDK you've used to talk to other APIs.
  But, this time, the API originates from an Ethereum node.
- Web3.py can help you read block data, sign and send transactions, and deploy and interact with contracts.
- Web3.py allows you to communicate with the blockchain and serves as a window to reading the ledger.



Remote Procedure Call (RPC)

Computers in the blockchain network share information with one another by using protocols as we learned last week.

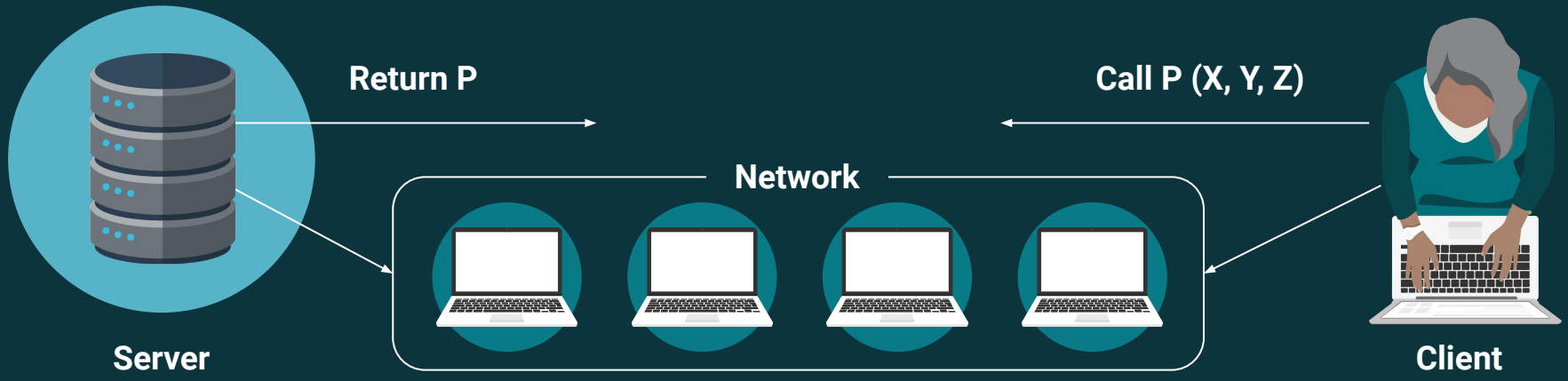
Specifically, they use **consensus protocols**, but this is not the only kind of protocol.

A **remote procedure call**, or RPC, communicates information across a network.

A **procedure call** is an instruction to a computer to execute a process, or procedure.

Remote Procedure Calls (RPCs)

A **remote procedure call** is when a computer program's request causes a procedure to execute on a computer or shared network at a remote location. The computer or network then completes the request made by the initial computer that made the request.



Remote Procedure Calls (RPCs)

Here's how RPCs are helpful to the blockchain:

When a program is executed by using the RPC model, it doesn't matter whether the requesting computer or network is in a different location than the executing computer or network.

Web3.py makes this possible by an RPC provider commonly referred to as a provider. This provider facilitates the connection and communication between our computers and the Ethereum blockchain network. Web3.py comes bundled with several default providers.

The EthereumTesterProvider allows us to simulate interactions with an Ethereum blockchain.

This means that we don't have to run our own blockchain or blockchain nodes in order to test code that interacts with the Ethereum blockchain.

Instead, we will interact with a mock blockchain that the ethereum-tester library and the EthereumTesterProvider makes available to developers for testing purposes.

Instructor Demonstration

Introduction to Web3.py

Activity: Ethereum Through Web3.py

In this activity, you will use Web3.py to connect to a local mock development blockchain. Then, you'll check the account balance of one of the accounts that is available on the mock blockchain.

Suggested Time:

30 minutes

Time's Up! Let's Review.

Questions?


Break

Transactions with Web3.py

Once we are connected to a Web3 mock blockchain instance, we can use several Web3.py methods to create and send ether-based transactions from one account to another.

Transactions with Web3.py

`from:`	The 42-character Ethereum account address from which the transaction is sent.
`to:`	The 42-character Ethereum account address to which the transaction is sent.
`gas:`	An integer representing the maximum units of gas to be used in mining the transaction. A standard ether transfer requires at least 21,000 units of gas. Any unused gas is returned to the sender.
`value:`	An integer representing the amount of money, in wei, that this transaction will transfer from the sender to the recipient.

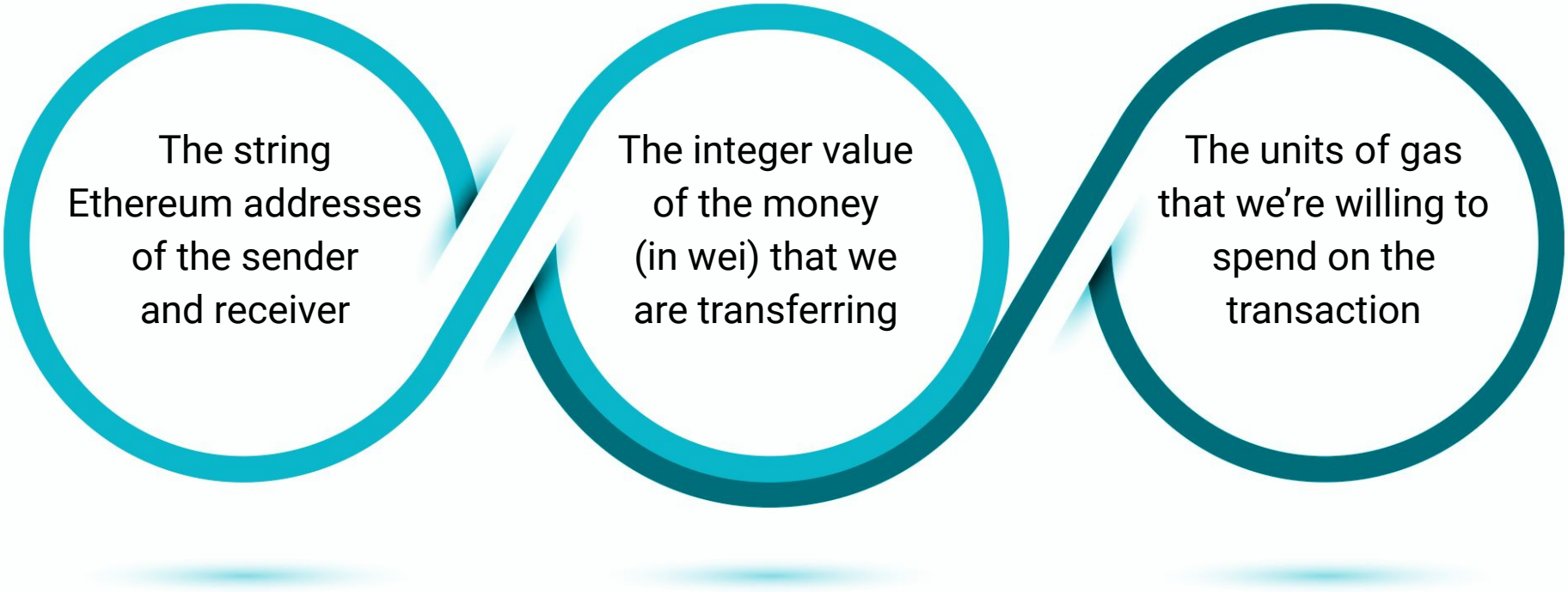
Ether Denominations

You learned about a new cryptocurrency **ether** and the denominations of it.

Unit Name	Wei Value	Number of Wei
Wei (wei)	1 wei	1
Kwei (babbage)	1e3 wei	1,000
Mwei (lovelace)	1e6 wei	1,000,000
Gwei (shannon)	1e9 wei	1,000,000,000
Twei (szabo)	1e12 wei	1,000,000,000,000
Pwei (finney)	1e15 wei	1,000,000,000,000,000
Ether (buterin)	1e18 wei	1,000,000,000,000,000,000

Transactions with Web3.py

In order, to send our transaction, we'll need:



Instructor Demonstration

Transactions with Web3.py

Activity: Transactions with Web3.py

In this activity, you will create a transaction between Ethereum accounts. You will use Web3.py to connect to a local mock development blockchain. Then, you will create, send, and review a financial transaction by using several Web3.py methods.

Suggested Time:

30 minutes

Time's Up! Let's Review.

Questions?

Time to Code

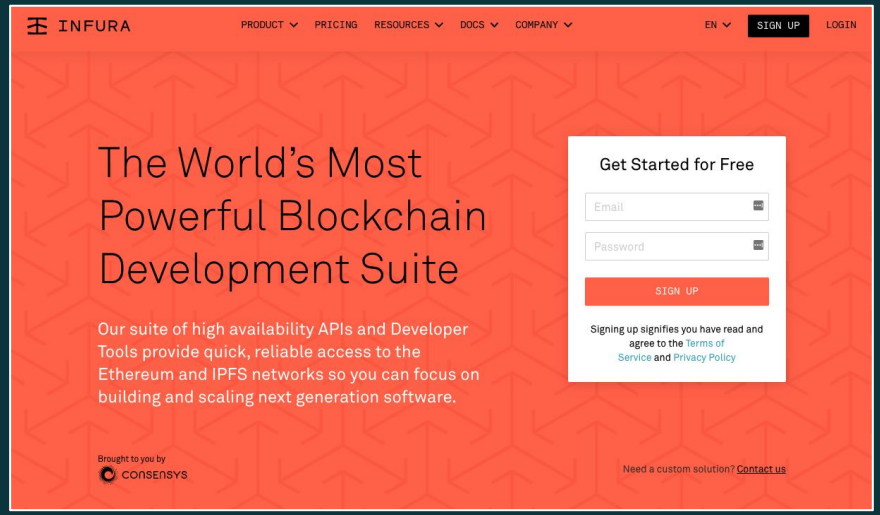
Review Web3.py/Fundamental Concepts

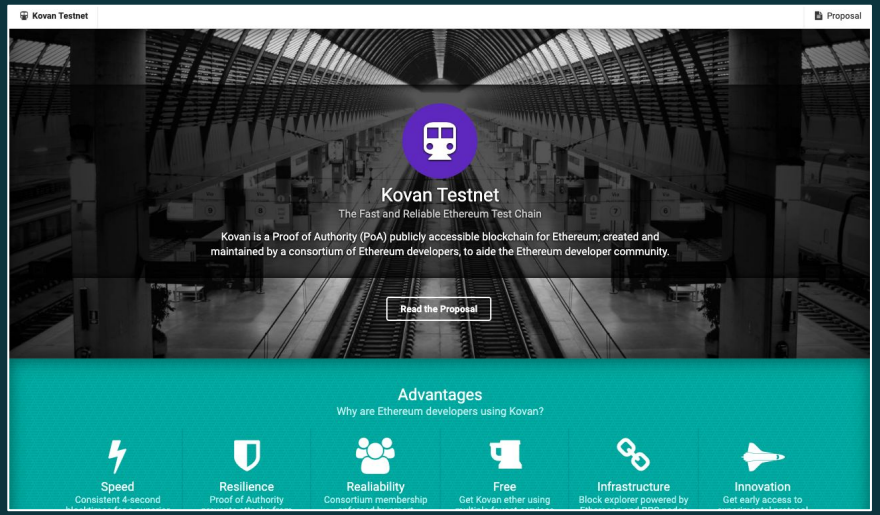
Suggested Time:

20 minutes

Review Web3.py/Fundamental Concepts

Now we will discuss Infura and testnets, tools that help you develop transactions for Web3.





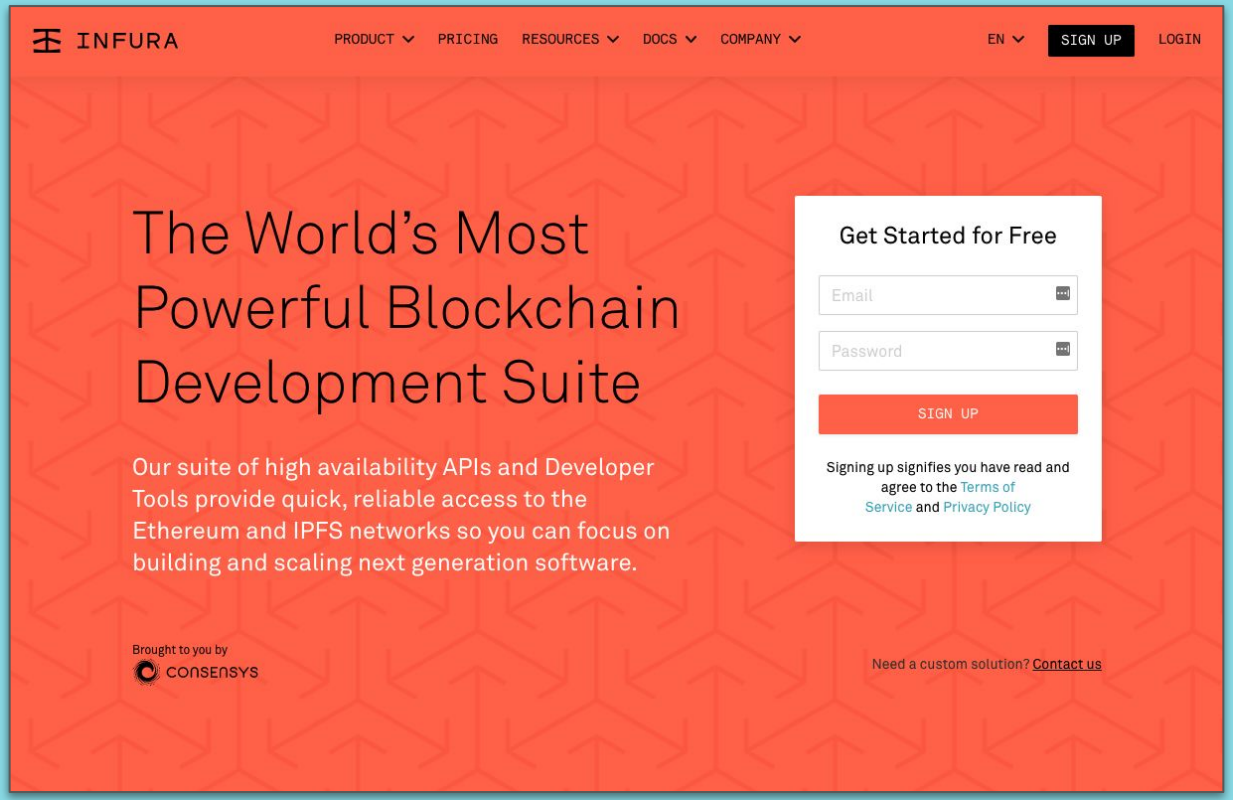
https://infura.io/

https://kovan.etherscan.io/

Infura

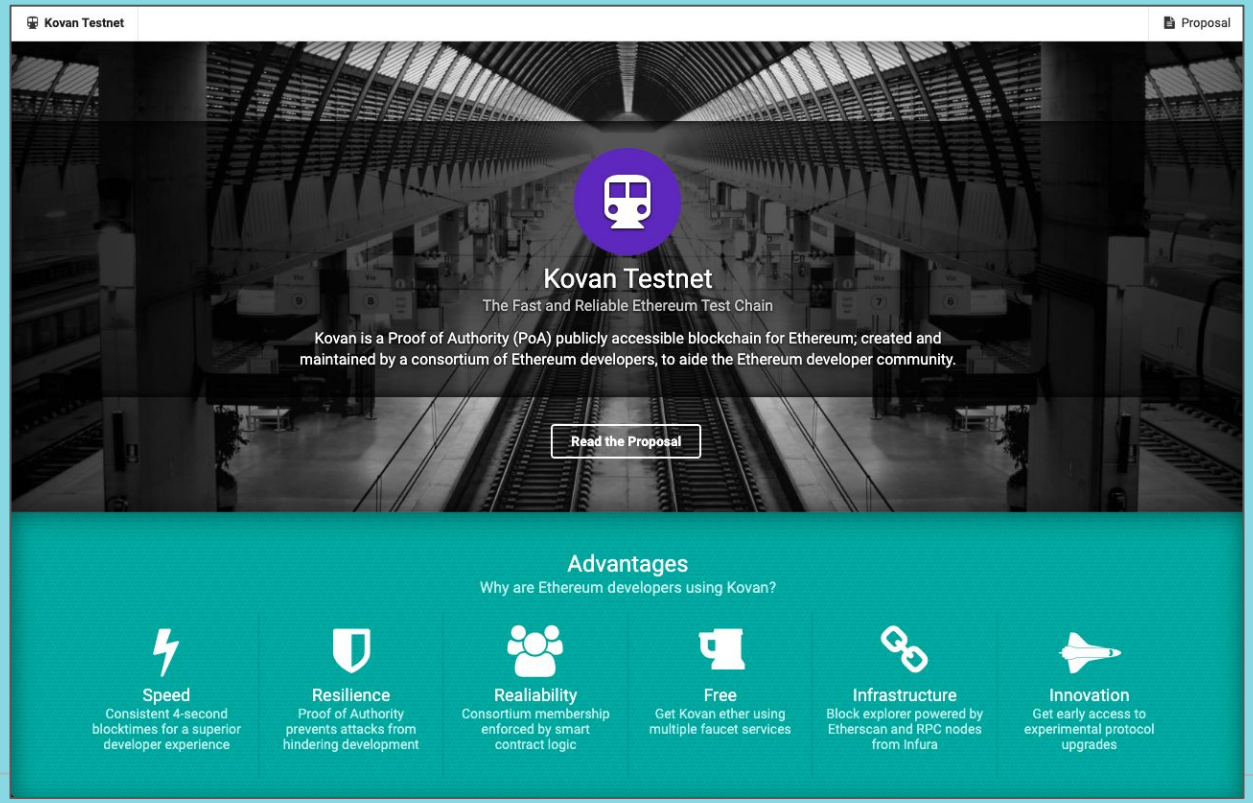
The Infura API connects applications to the Ethereum and IPFS networks, providing access over HTTPS and WebSockets.

This creates infrastructure for decentralized applications to run on the blockchain.



Kovan

Kovan tests our transactions by giving us ether that has no value (KETH).



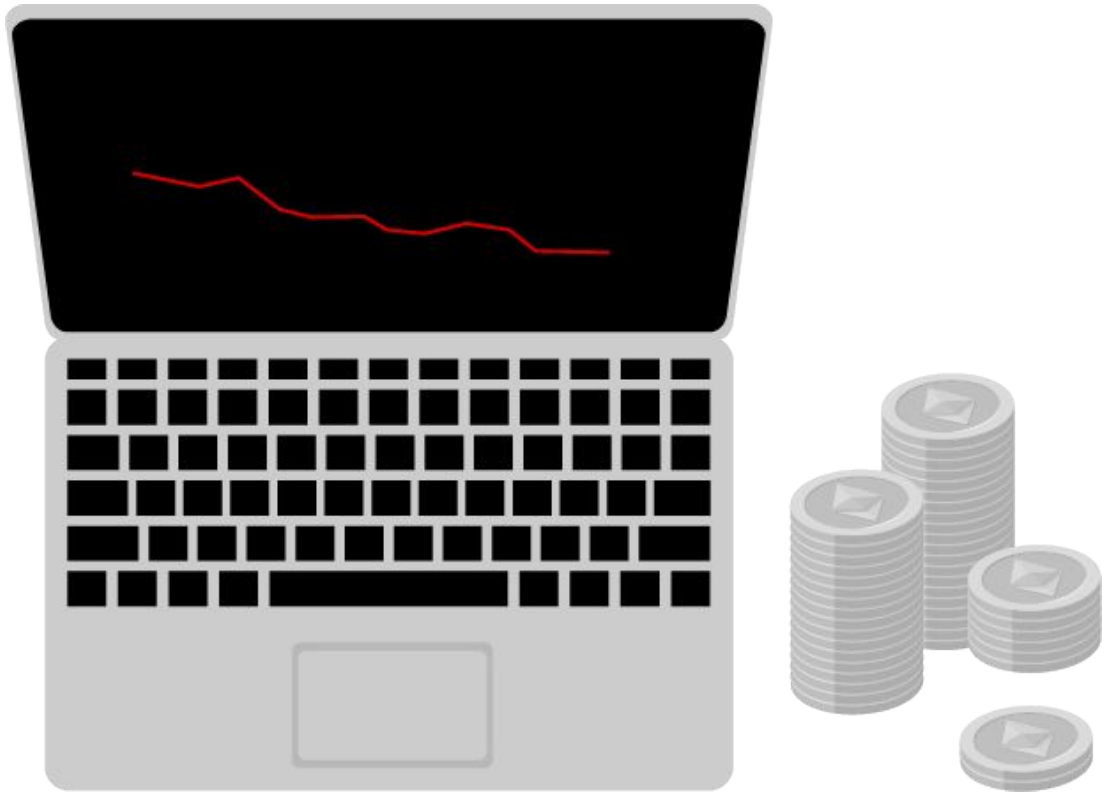
Review Web3.py/Fundamental Concepts

When programming, we usually follow a pattern after coding a finished product.

When things go smoothly, we test and deploy.

Otherwise, we test, test, test, test, and some day, deploy.

Deploying a transaction that is not ready for deployment can cost us a lot in assets or crypto.

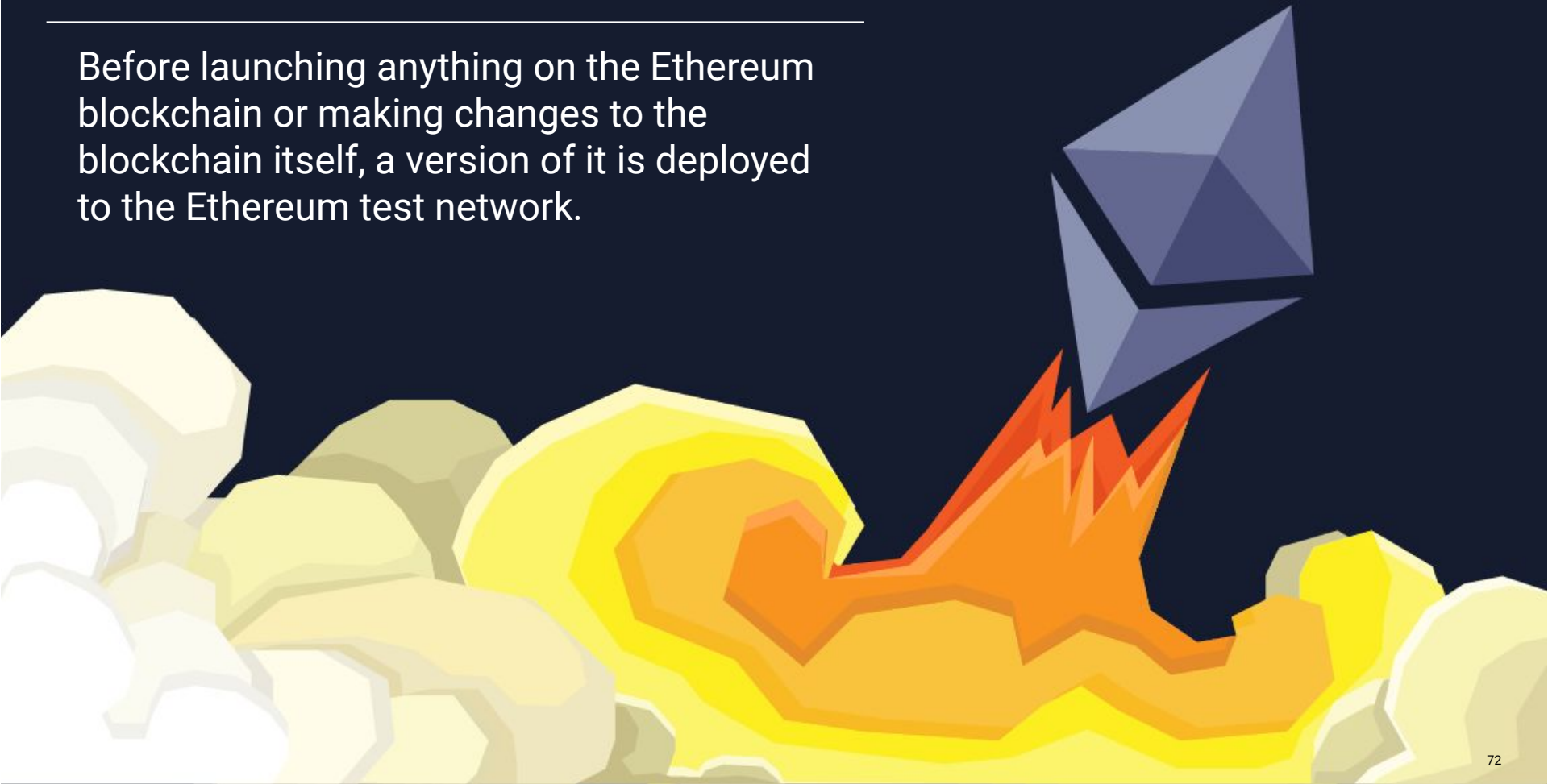


How will we test a transaction without using real money or ether? How will testnets help us?

By giving us
“fake” ether to use!

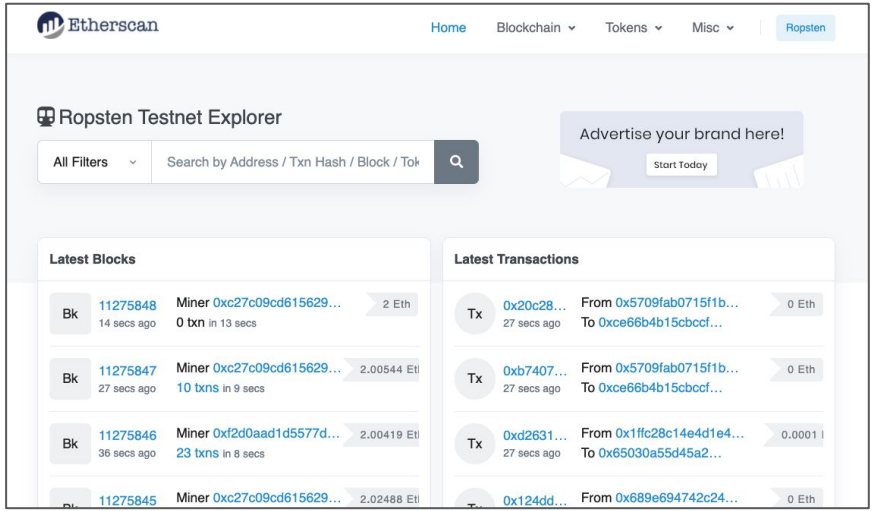
Testnet

Before launching anything on the Ethereum blockchain or making changes to the blockchain itself, a version of it is deployed to the Ethereum test network.



Testnet

Kovan is one of these testnets, but there are others such as **Ropsten** or **Rinkeby** as well. We use **testnets** to work out any issues that we may have before sending real assets. These testnets can provide ether tokens that carry no real-world value and can be requested from the testnet.



https://infura.io/

https://www.rinkeby.io/#stats

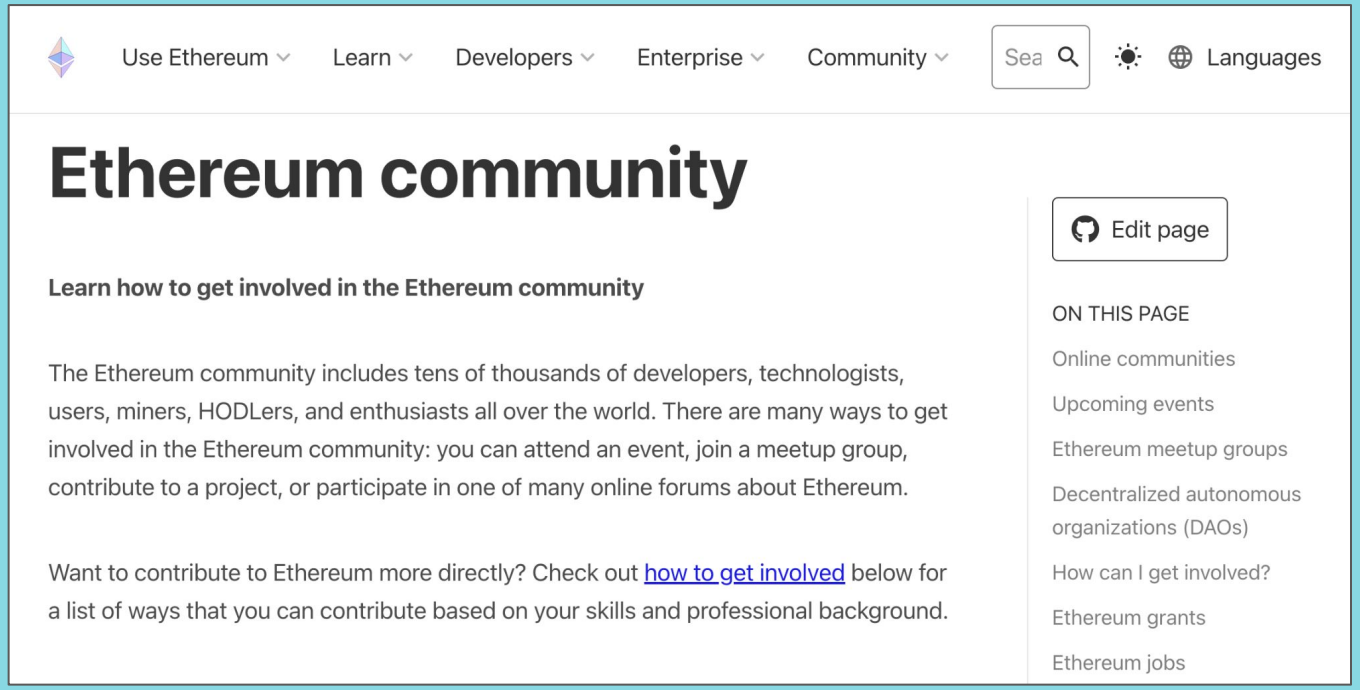
Kovan's Own Definition:

The Fast and Reliable Ethereum Test Chain

"Kovan is a Proof of Authority (PoA) publicly accessible blockchain for Ethereum; created and maintained by a consortium of Ethereum developers, to aid the Ethereum developer community."

Ethereum Community

The proof-of-authority aspect of the Ethereum blockchain gives access to a node by the community, allowing us to use test ether.



https://ethereum.org

Infura's Own Definition:

"A means to provide the tools and infrastructure that allow developers to easily take their blockchain application from testing to scaled deployment—with simple, reliable access to Ethereum and IPFS."

IPFS

The InterPlanetary File System is a protocol and peer-to-peer network for storing and sharing data in a distributed file system.

The file storage on the blockchain!

Infura Features

Infura is a development suite that provides API access to the Ethereum blockchain network.

01

Infura is what Ethereum calls a hosted node, as it hosts all of the services required to interact with the Ethereum blockchain network.

02

Infura requires that a developer get an API key that allows them to monitor who is using services to read from and write to the blockchain.

03

Infura allows the developer to determine what Ethereum blockchain they want to connect with—either the mainnet (the live blockchain) or a testnet like Kovan or Ropsten.

Hosted Node

The primary negative aspect of a **hosted node** is that you are centralizing an aspect of your project's infrastructure.

If the primary use case for blockchain is decentralization, using a hosted node might not make sense.

INFURA

Set Up Your Account

Questions?


RECAP

Recap

Today, you were able to:

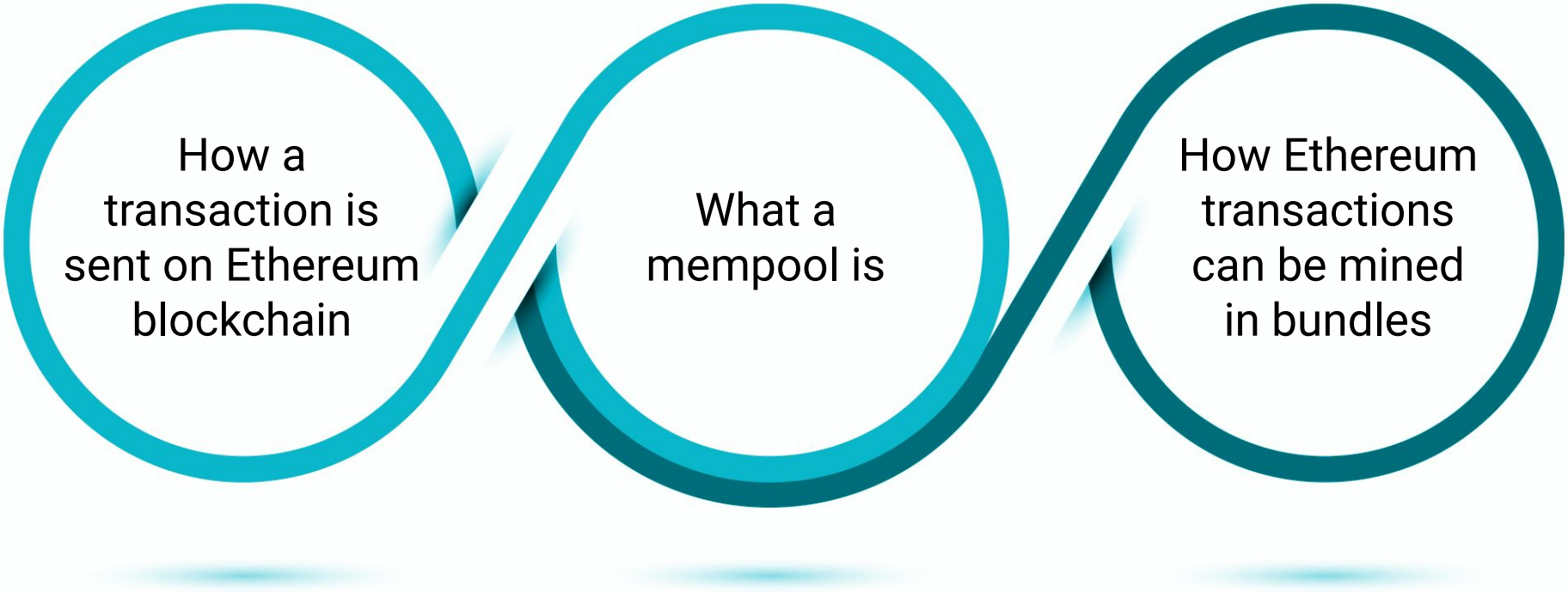
Connect to a blockchain

Read transactions

Send transactions

Recap

You've learned about:



Recap

You learned how miners mine Ethereum in bundles of transactions and how these transactions get prioritized, with the payment being higher or lower based on the amount of gas a sender is willing to send.

Recap

You learned about a new cryptocurrency, ether, and its denominations.

Unit Name	Wei Value	Number of Wei
Wei (wei)	1 wei	1
Kwei (babbage)	1e3 wei	1,000
Mwei (lovelace)	1e6 wei	1,000,000
Gwei (shannon)	1e9 wei	1,000,000,000
Twei (szabo)	1e12 wei	1,000,000,000,000
Pwei (finney)	1e15 wei	1,000,000,000,000,000
Ether (buterin)	1e18 wei	1,000,000,000,000,000,000

Recap

- You addressed some of the benefits to sending transactions on a blockchain rather than through a “brick and mortar” financial institution.
- You created an environment that uses Web3 for connecting to a mock blockchain and testing transactions.

Questions?


The End