



# Solidity Mastery Bootcamp

---

## DAY 1

# ONBOARDING

---



Julien Klepatch  
*@jklepatch*



Damian Kościelniak  
*@cezarry*

**MODULE 1**

Solidity - Beginner

**MODULE 2**

Solidity - Intermediate

**MODULE 3**

Solidity - Advanced

**MODULE 4**

Solidity - Real-world contracts

- 1h30 live class Mon, Tue, Wed, Fri
- 9am PT / 12pm EST / 6pm CET / 12pm CST
- Each module
  - 4 days
  - Day 1: Homework correction
  - Day 2, 3, 4: Lesson + live exercises

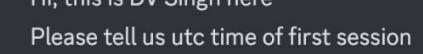
-  Events
-  Browse Channels NEW
-  Members
-  moderator-only
-  START HERE +
-  IPFS 1
-  # ? faq
-  # intro
-  announcements 58
-  PRIVATE COMMUNITY +
-  # general
-  # tutorial-requests
-  Q technical-discussions 1
-  Q career-discussions 26
-  Q jobs 1
-  # bootcamp 259

 Euqariot  Today at 9:23 AM  
GM

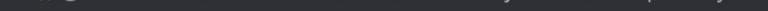
 Andykin Skywalker | TRT.gg  Today at 10:05 AM  
Thank you

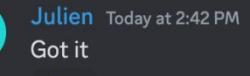
 lokal  Today at 12:39 PM  
Hi Julien. The live sessions start at 3am my local time so I probably will not be there most days but will try my best (with help of caffeine)

 BTC3  Today at 2:04 PM  
Hi, this is DV Singh here

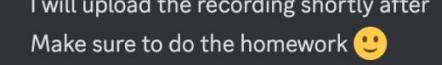
 Please tell us utc time of first session

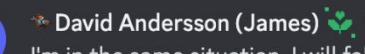
 @lokal Hi Julien. The live sessions start at 3am my local time so I probably will ... 1

 1

 Julien  Today at 2:42 PM  
Got it 1

 1

 I will upload the recording shortly after  
Make sure to do the homework 

 David Andersson (James)  Today at 3:09 PM  
I'm in the same situation. I will follow live every 2 days. Thank you Julien! (edited)

 1

MON

26

TUE

27

WED

28

Module 1

12 – 1:30am

[https://us06web.zoom.us/j/6135667954?](https://us06web.zoom.us/j/6135667954)

Module 1

12 – 1:30am

<https://us06web.zoom.us/j/6135667954?pwd=ZjQ0ZzZ0b1Q4QjJX>

[<> Previous Lesson](#)[Complete and Continue <](#)

## Module 1: Ethereum & the EVM

[Lesson](#)[Homework](#) Draft

## Module 2: Solidity fundamentals

[Lesson](#) Draft[Homework](#) Draft

## ≡ Lesson

Recording will be uploaded shortly after the live class

## Exercise

Explain [this transaction](#):

- What is a block confirmation?
- What is this transaction?
- Who is the sender?



EatTheBlocks / **solidity-bootcamp-4** 🔒

Code

Issues

Pull requests

Actions

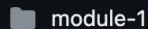


**solidity-bootcamp-4**

Private

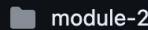


Cezarry Merge pull request #40 from EatTheBlocks/module-8-homework-solution



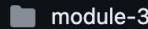
module-1

initial commit



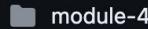
module-2

Replaced owner with msg.sender



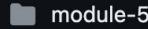
module-3

initial commit



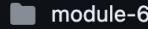
module-4

Module 4 - lesson with homework



module-5

initial commit



module-6

Added homework for module 6

Other inquiries

-

[julien@eattheblocks.com](mailto:julien@eattheblocks.com)

# FIRST SMART CONTRACT

---

# HELLO WORLD SMART CONTRACT

---

```
1 pragma solidity 0.8.25;  
2  
3 contract HelloWorld {  
4     function hi() external pure returns(string memory) {  
5         return "Hello World";  
6     }  
7 }
```

# INTRO TO ETHEREUM

---

# ETHEREUM IN A NUTSHELL

---



- Created in 2015 by Vitalik Buterin
- Smart contract capable
- Development financed by EF
- Entirely open-source
- Lots of contributors

# ETHEREUM VS OTHER BLOCKCHAINS

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- Most used network
- Most used technology
- Biggest dev community

# ETHEREUM USAGE GRAPH



# ETHEREUM

---



## Ethereum White Paper

A NEXT GENERATION SMART CONTRACT & DECENTRALIZED APPLICATION PLATFORM

By Vitalik Buterin

When Satoshi Nakamoto first set the Bitcoin blockchain into motion in January 2009, he was simultaneously introducing two radical and untested concepts. The first is the "bitcoin", a decentralized peer-to-peer online currency that maintains a value without any backing, intrinsic value or central issuer. So far, the "bitcoin" as a currency unit has taken up the bulk of the public attention, both in terms of the political aspects of a currency without a central bank and its extreme upward and downward volatility in price. However, there is also another, equally important, part to Satoshi's grand experiment: the concept of a proof of work-based blockchain to allow for public agreement on the order of transactions. Bitcoin as an application can be described as a first-to-file system: if one entity has 50 BTC, and simultaneously sends the same 50 BTC to A and to B, only the transaction that gets confirmed first will process. There is no intrinsic way of determining from two transactions which came earlier, and for decades this stymied the development of decentralized digital currency. Satoshi's blockchain was the first credible decentralized solution. And now, attention is rapidly starting to shift toward this second part of Bitcoin's technology, and how the blockchain concept can be used for more than just money.

*White paper*

## ETHEREUM: A SECURE DECENTRALISED GENERALISED TRANSACTION LEDGER

ISTANBUL VERSION 80085f7 – 2021-07-11

DR. GAVIN WOOD  
FOUNDER, ETHEREUM & PARITY  
GAVIN@PARITY.IO

ABSTRACT. The blockchain paradigm when coupled with cryptographically-secured transactions has demonstrated its utility through a number of projects, with Bitcoin being one of the most notable ones. Each such project can be seen as a simple application on a decentralised, but singleton, compute resource. We can call this paradigm a transactional singleton machine with shared-state.

Ethereum implements this paradigm in a generalised manner. Furthermore it provides a plurality of such resources, each with a distinct state and operating code but able to interact through a message-passing framework with others. We discuss its design, implementation issues, the opportunities it provides and the future hurdles we envisage.

*Yellow paper*

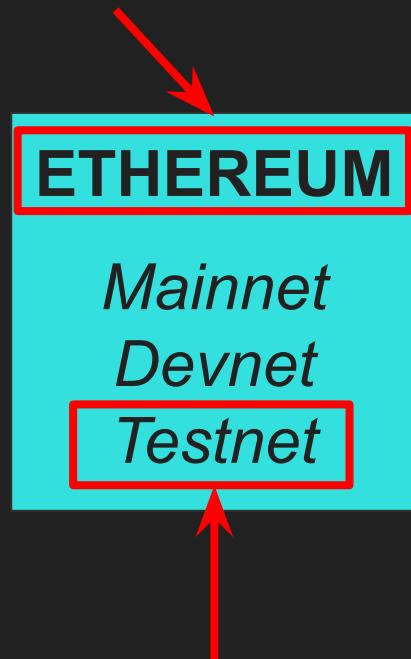
# ETHEREUM NETWORK

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# ETHEREUM NETWORKS

---

*Blockchain*



*Network*

# ETHEREUM NETWORKS

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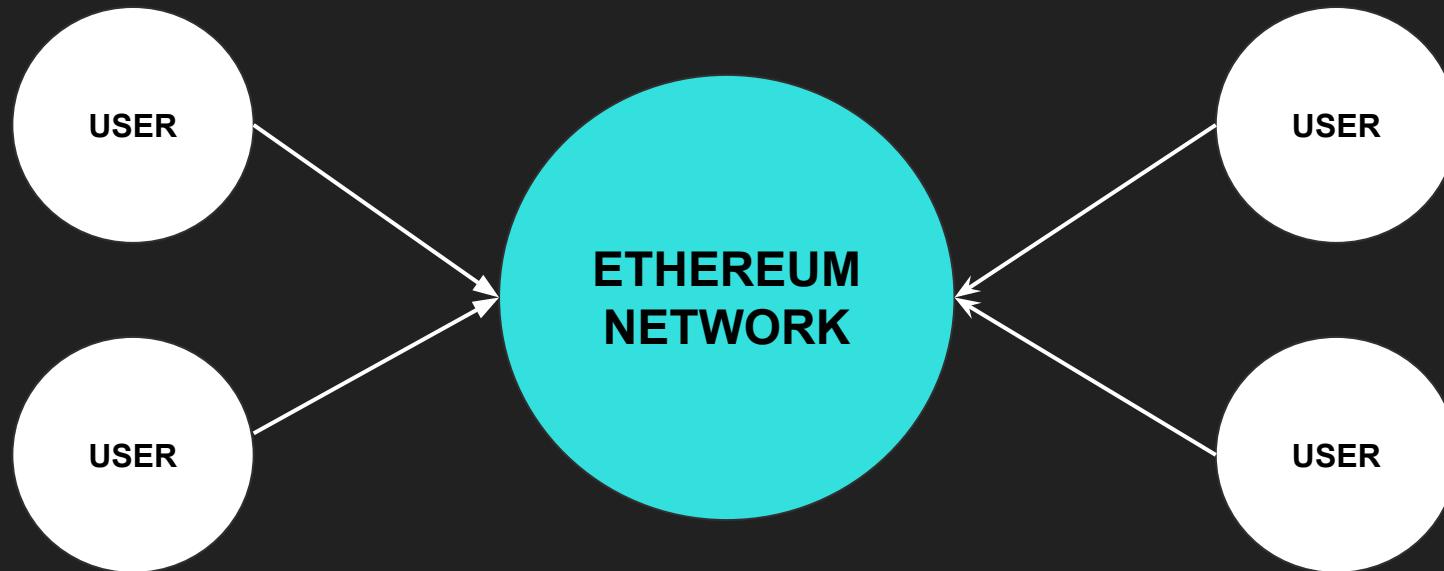
*Blockchain*



*etc...*

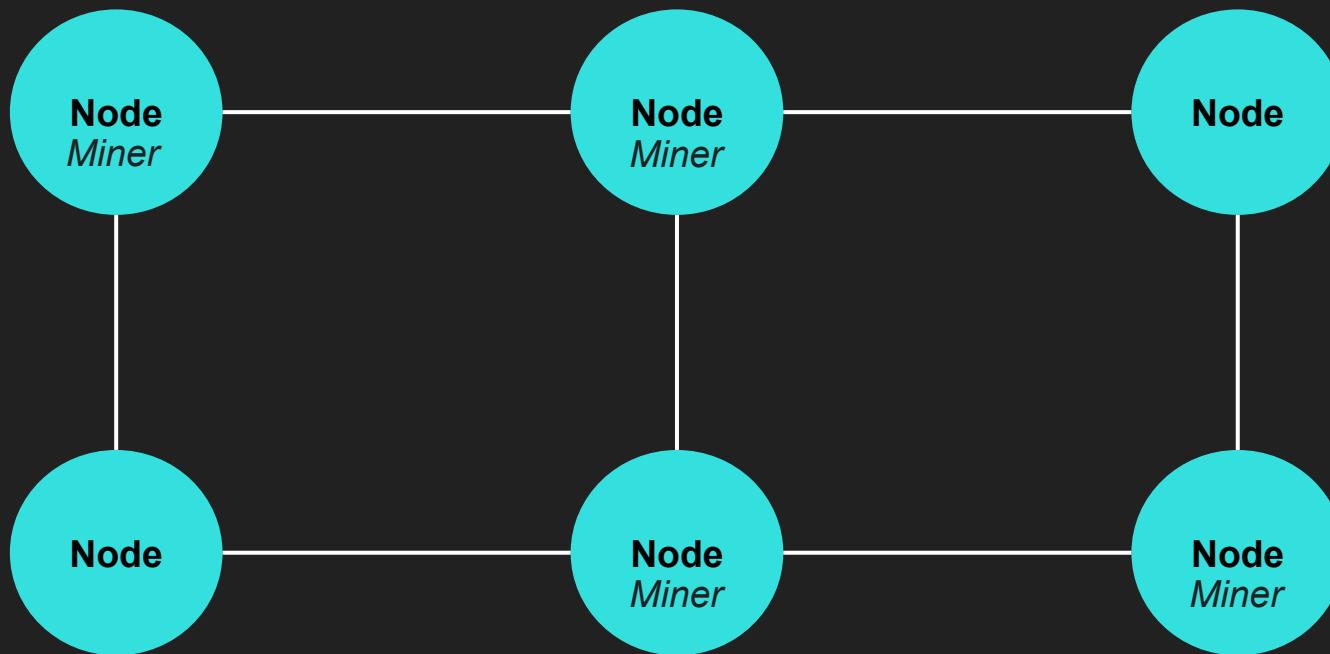
# ETHEREUM NETWORK

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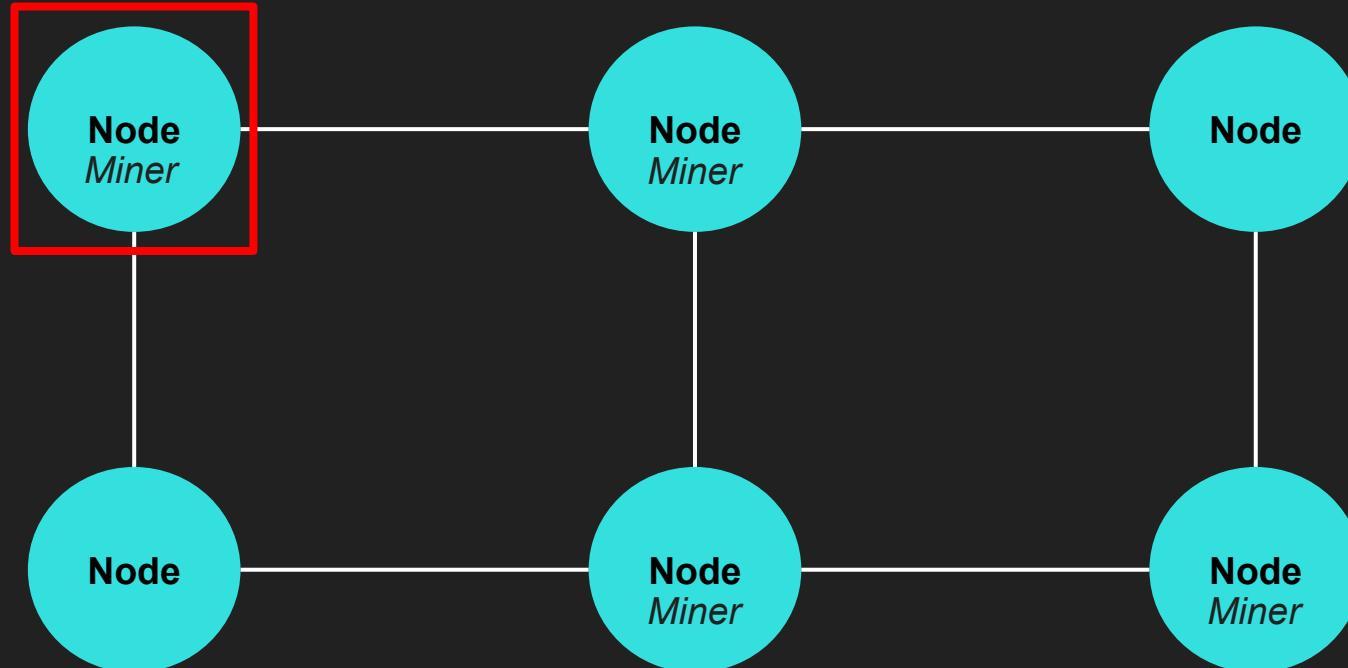
# ETHEREUM NETWORK

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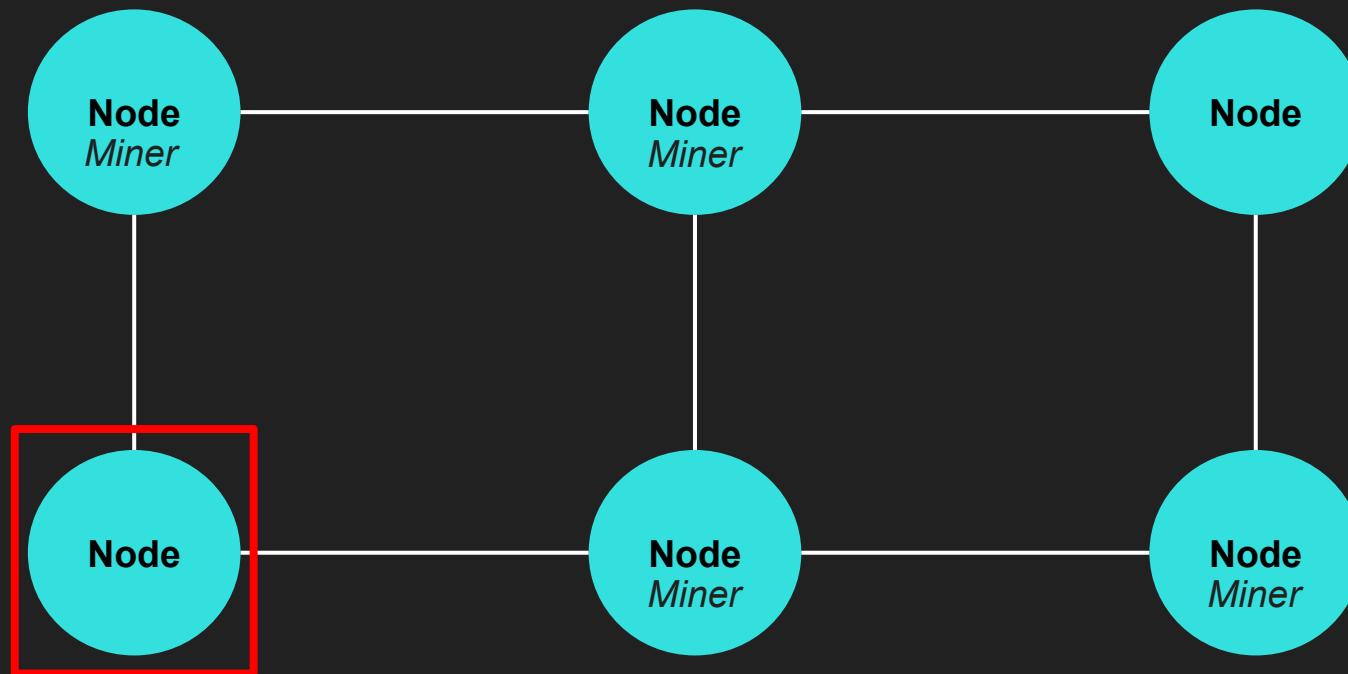
# ETHEREUM NETWORK

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# ETHEREUM NETWORK

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# ETHEREUM CLIENTS

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# ETHEREUM NODES

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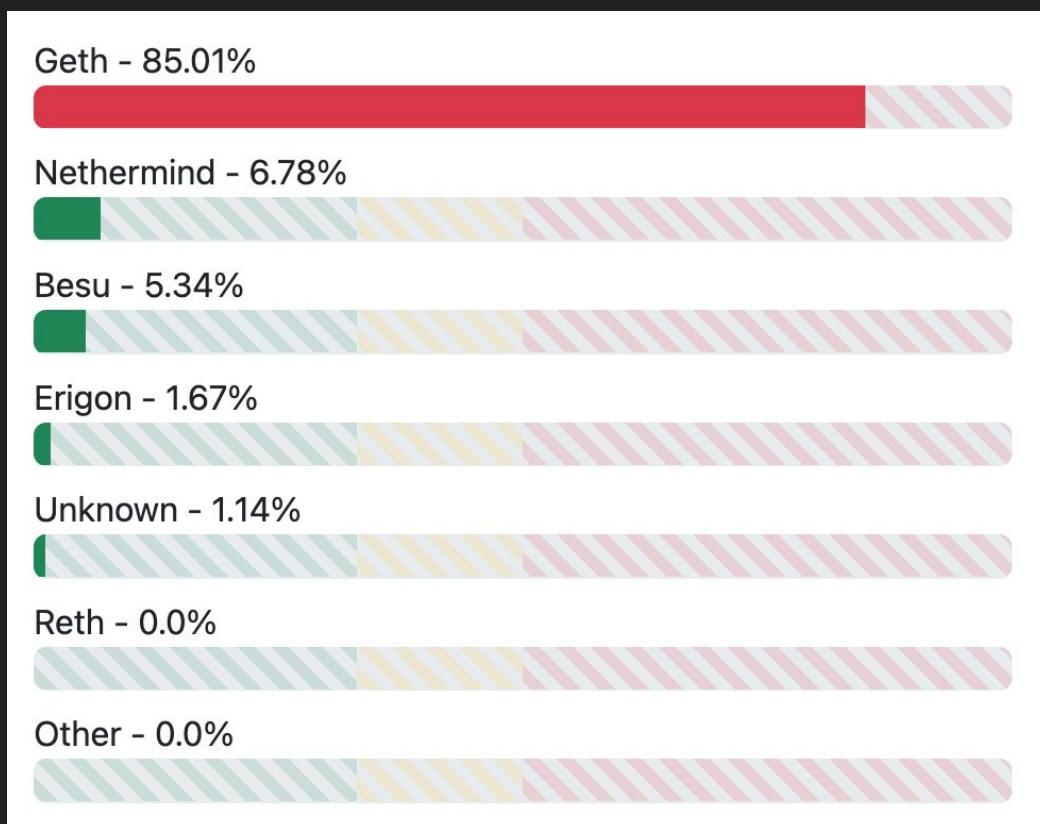
Full  
node

Archive  
node

Light  
node

# ETHEREUM CLIENTS (EXECUTION)

---



# GETH

ethereum / go-ethereum

Type ⌂ to search

Code Issues Pull requests Actions Wiki Security Insights

Watch 2.2k

go-ethereum Public

master 39 Branches 233 Tags Go to file Add file Code

cuiweixie eth: simplify peer counting logic (#29420) 7bb3fb1 · 20 minutes ago 15,014 Commits

.github cmd/devp2p/internal/ethtest: skip large tx test on github ... 3 months ago

accounts accounts/keystore: fix typos in comments (#29336) last week

beacon beacon/engine: Fix json param name in GetClientVersionV... last week

build all: remove dependency on golang.org/exp (#29314) last week

cmd cmd/evm: reopen the statedb for dumping (#29437) 18 hours ago

common common/lru: use clear builtin (#29399) 16 hours ago

consensus all: fix mismatched names in comments (#29348) last week

console console: fix the wrong error msg of datadir testcase (#29...) last month

# GETH

---

```
308     // Add enqueues a batch of transactions into the pool if they are valid. Due
309     // to the large transaction churn, add may postpone fully integrating the tx
310     // to a later point to batch multiple ones together.
311     func (p *TxPool) Add(txs []*types.Transaction, local bool, sync bool) ([]error {
312         // Split the input transactions between the subpools. It shouldn't really
313         // happen that we receive merged batches, but better graceful than strange
314         // errors.
315         //
316         // We also need to track how the transactions were split across the subpools,
317         // so we can piece back the returned errors into the original order.
318         txsets := make([][]*types.Transaction, len(p.subpools))
319         splits := make([]int, len(txs))
320
321         for i, tx := range txs {
322             // Mark this transaction belonging to no-subpool
323             splits[i] = -1
324
325             // Try to find a subpool that accepts the transaction
326             for j, subpool := range p.subpools {
327                 if subpool.Filter(tx) {
328                     txsets[j] = append(txsets[j], tx)
329                     splits[i] = j
330                     break
331                 }
332             }
333         }
334     }
```

# RUNNING GETH / BUILD FROM SOURCE

---

## Building the source

For prerequisites and detailed build instructions please read the [Installation Instructions](#).

Building `geth` requires both a Go (version 1.21 or later) and a C compiler. You can install them using your favourite package manager. Once the dependencies are installed, run

```
make geth
```



or, to build the full suite of utilities:

```
make all
```



# RUNNING GETH / BUILD FROM SOURCE

---

## Download go-ethereum

Altaaya (v1.13.14)

You can download the latest 64-bit stable release of Geth for our primary platforms below. Packages for all supported platforms, as well as develop builds, can be found further down the page. If you're looking to install Geth and/or associated tools via your favorite package manager, please check our installation guide.



**FOR LINUX**  
GETH V1.13.14



**FOR MACOS**  
GETH V1.13.14



**FOR WINDOWS**  
GETH V1.13.14



**FOR SOURCES**  
GETH V1.13.14

[Release notes for Altaaya \(v1.13.14\)](#)

# RUNNING GETH / HARDWARE

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# RUNNING GETH - BLOCKCHAIN API

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# RUNNING CLIENT - FOUNDRY

---



# SCALING

---

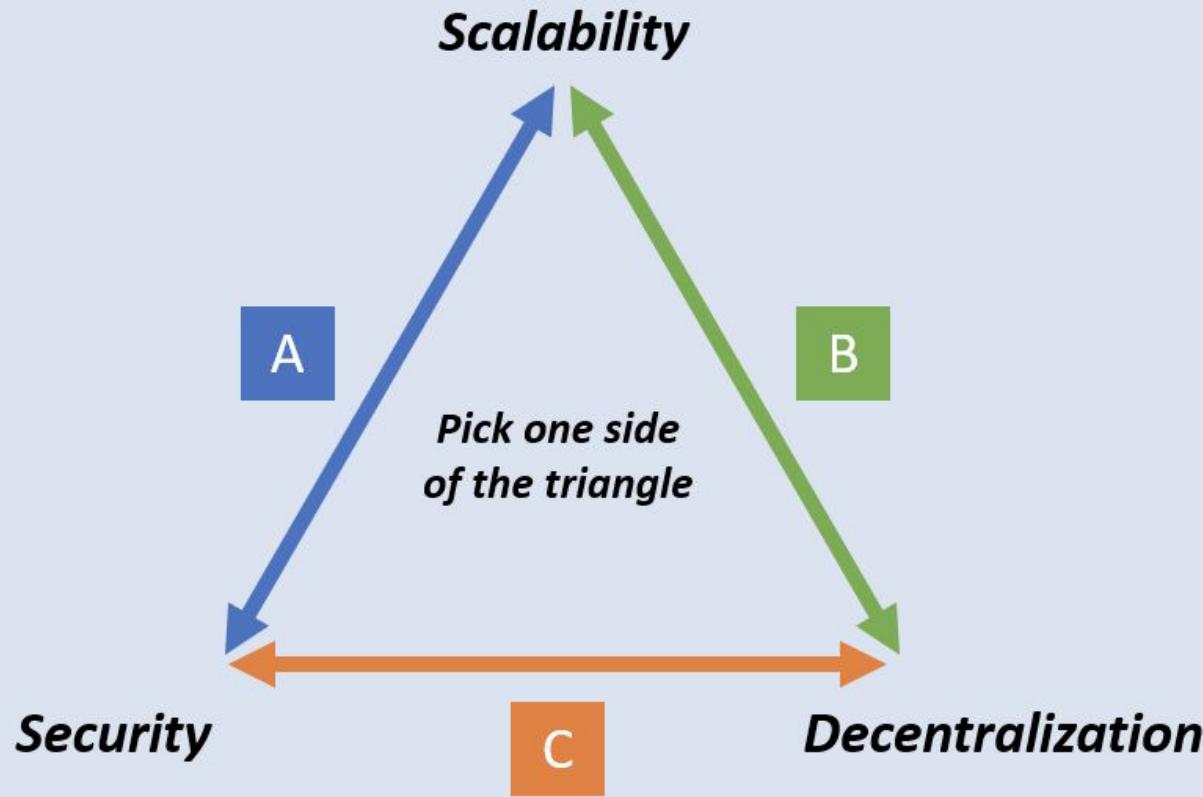


65,000 tx / s



30 tx / s

# The Scalability Trilemma



# SCALING

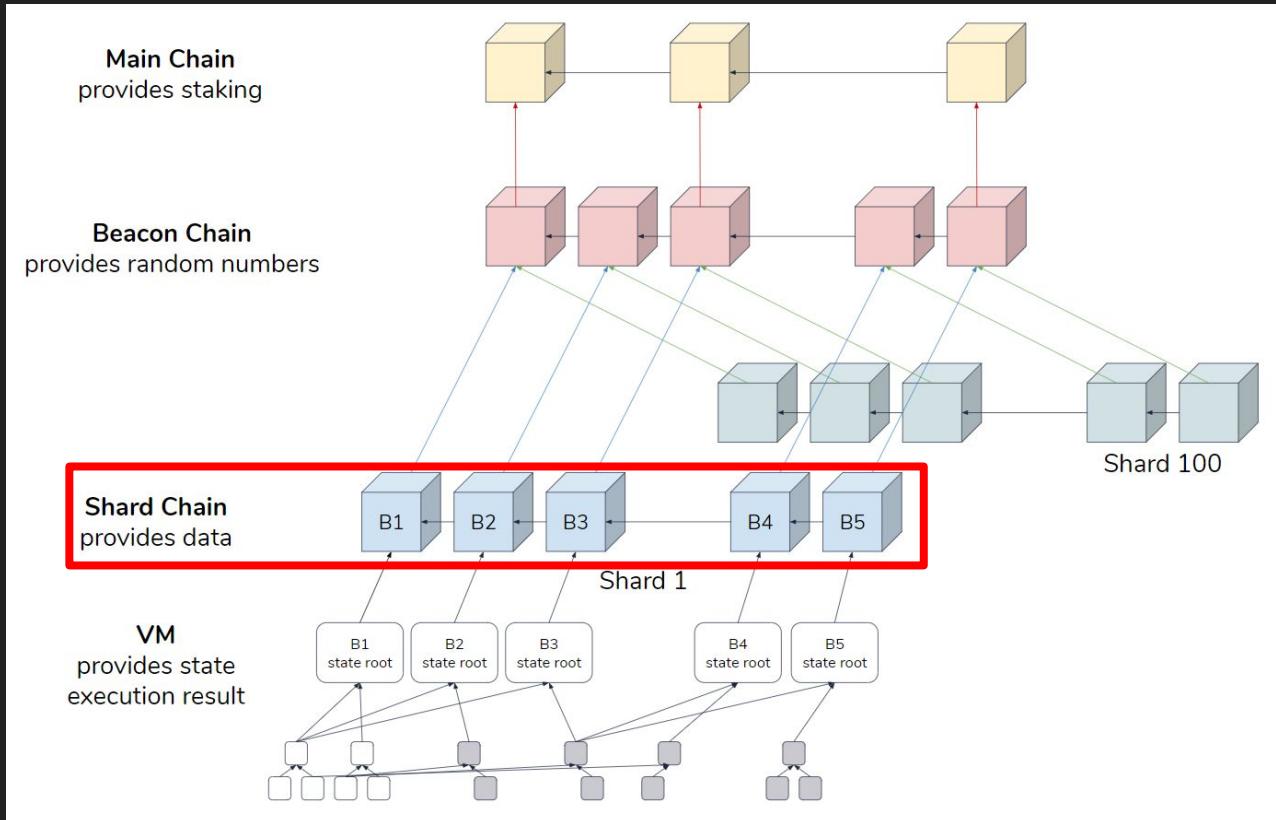
## ON-CHAIN

*Sharding  
(Ethereum 2.0)*

## OFF-CHAIN

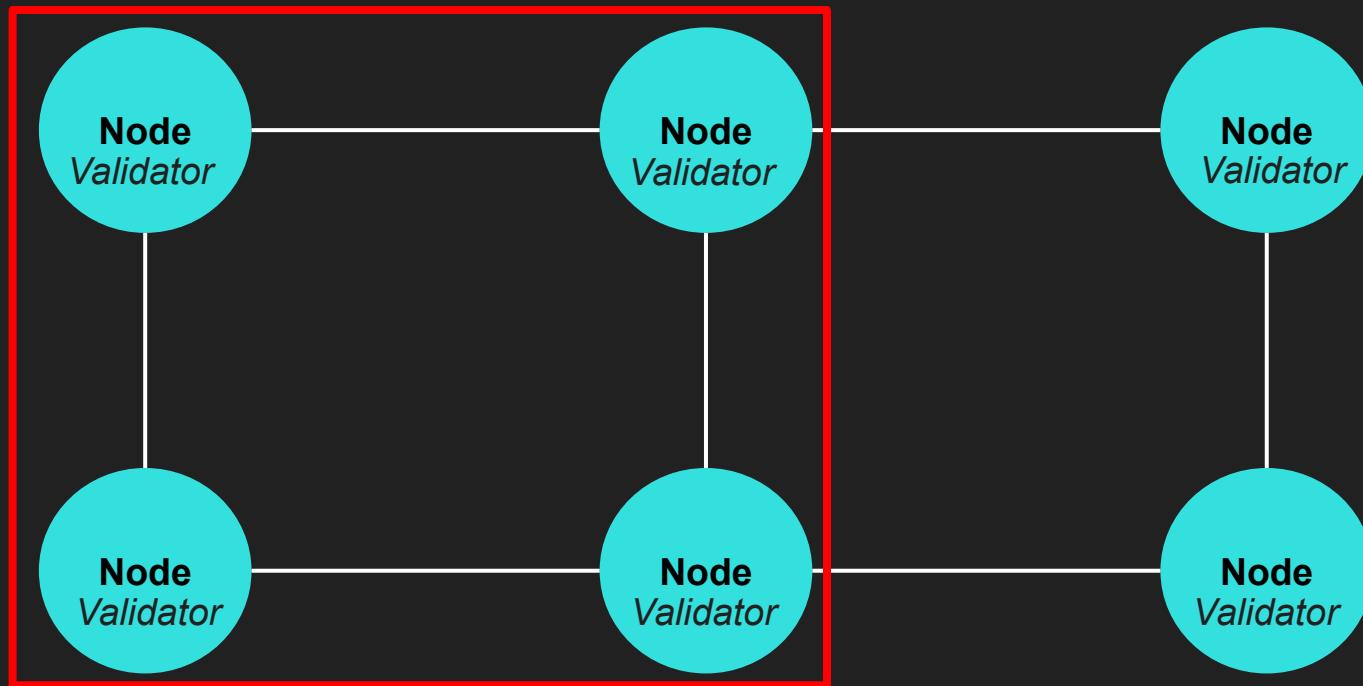
*Layer 2  
Sidechain  
Plasma*

# ETHEREUM 2.0

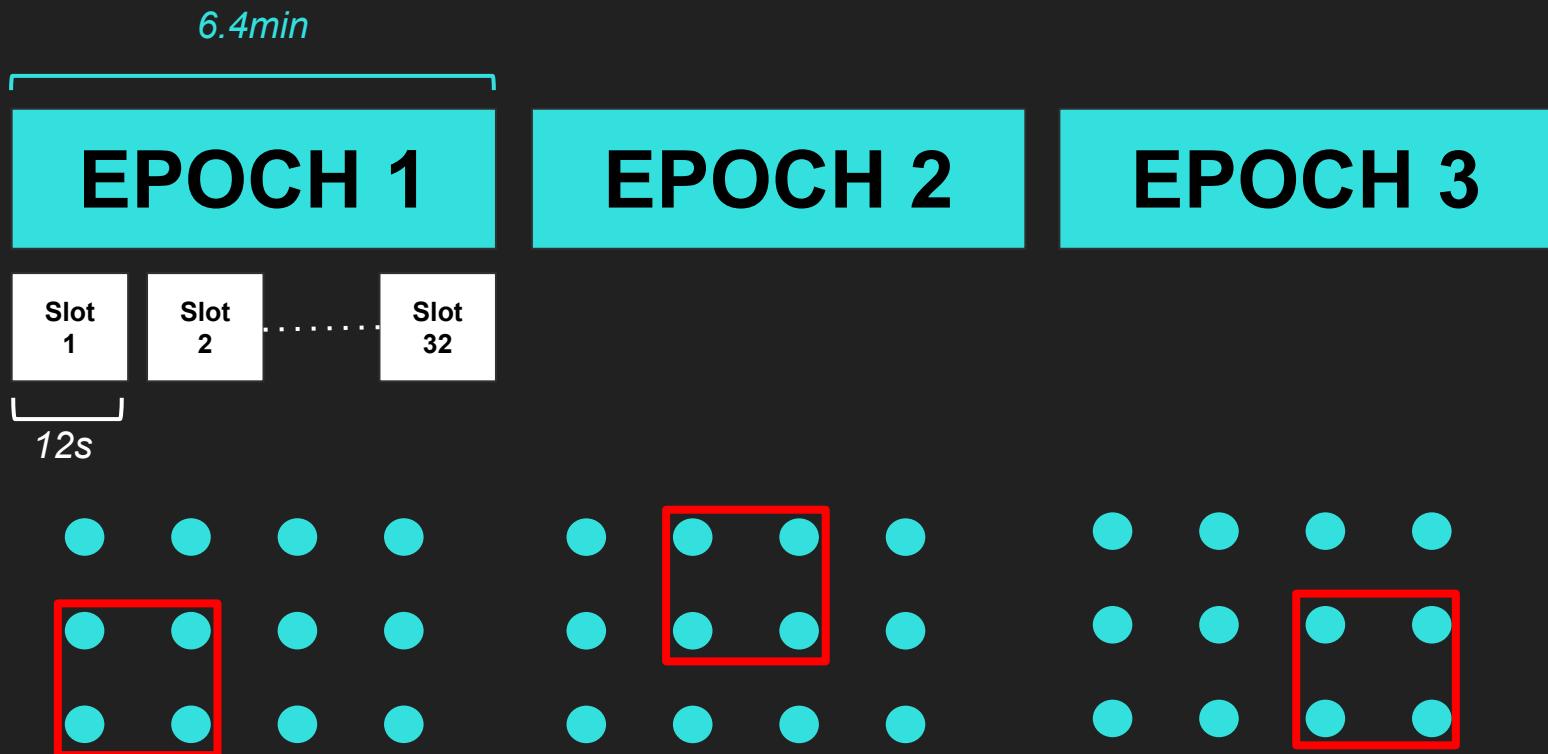


# ETHEREUM 2.0

---



# ETHEREUM 2.0

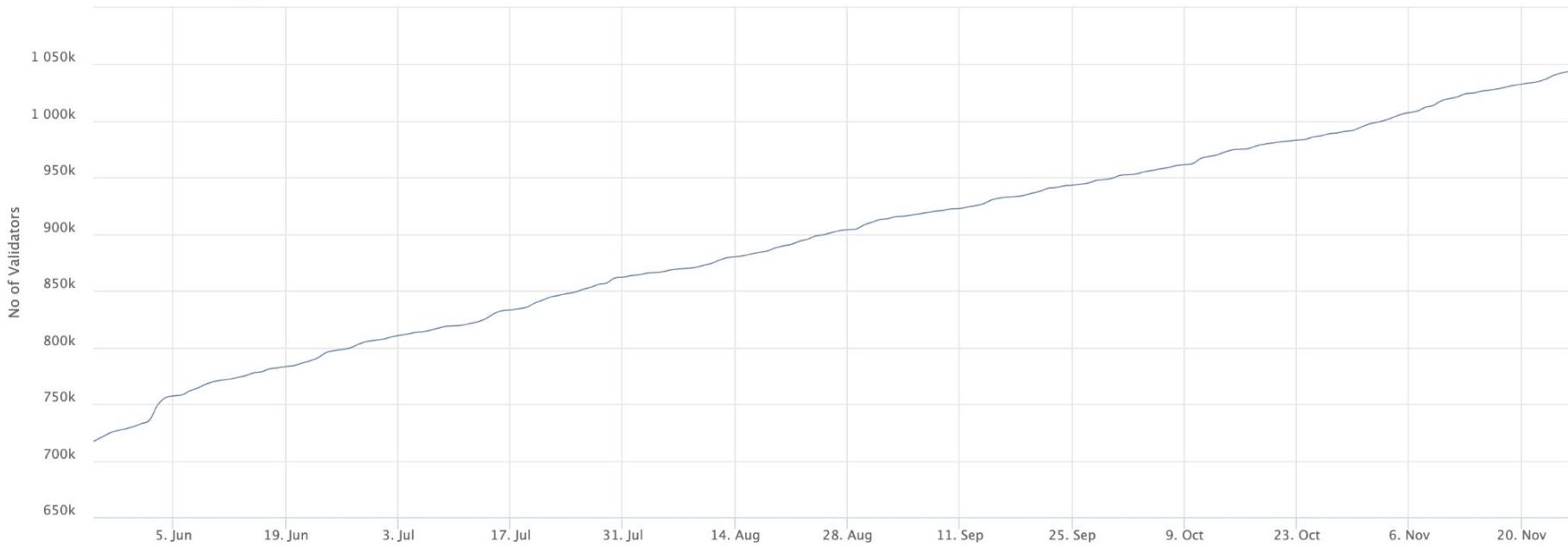


# # VALIDATORS

Source: beaconscan.com  
Click and drag in the plot area to zoom in

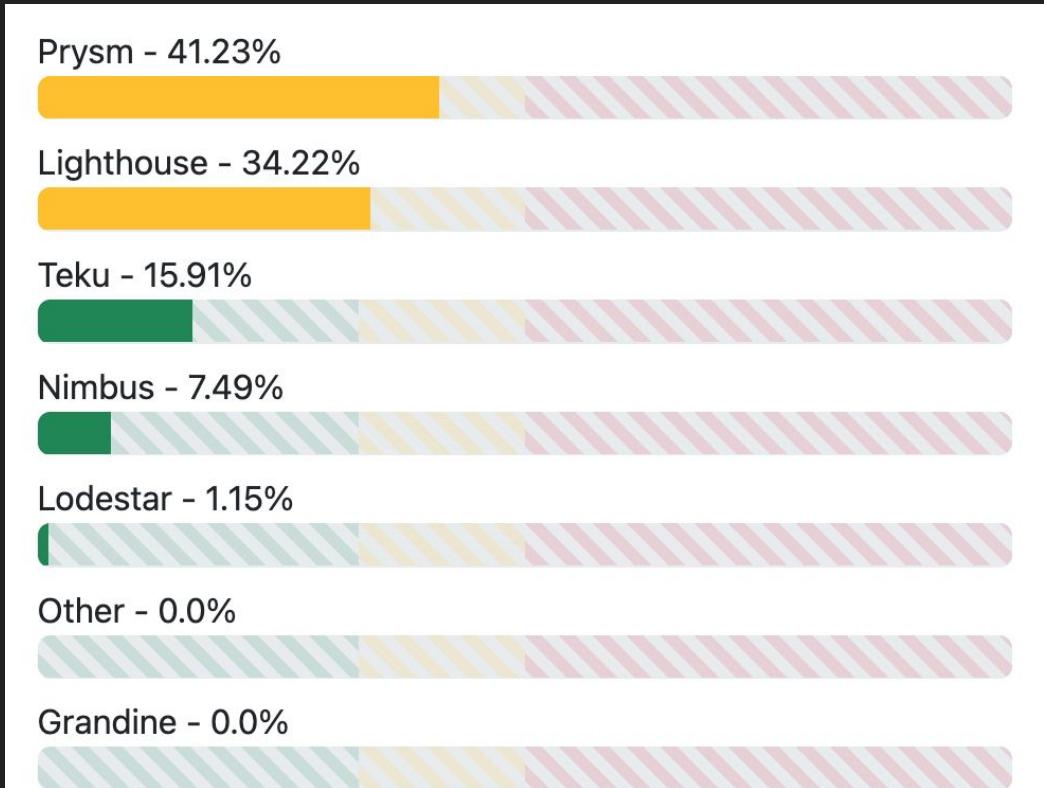
Zoom 1m 3m **6m** YTD 1y All

From May 25, 2023 To Nov 25, 2023



# ETHEREUM CLIENTS (CONSENSUS)

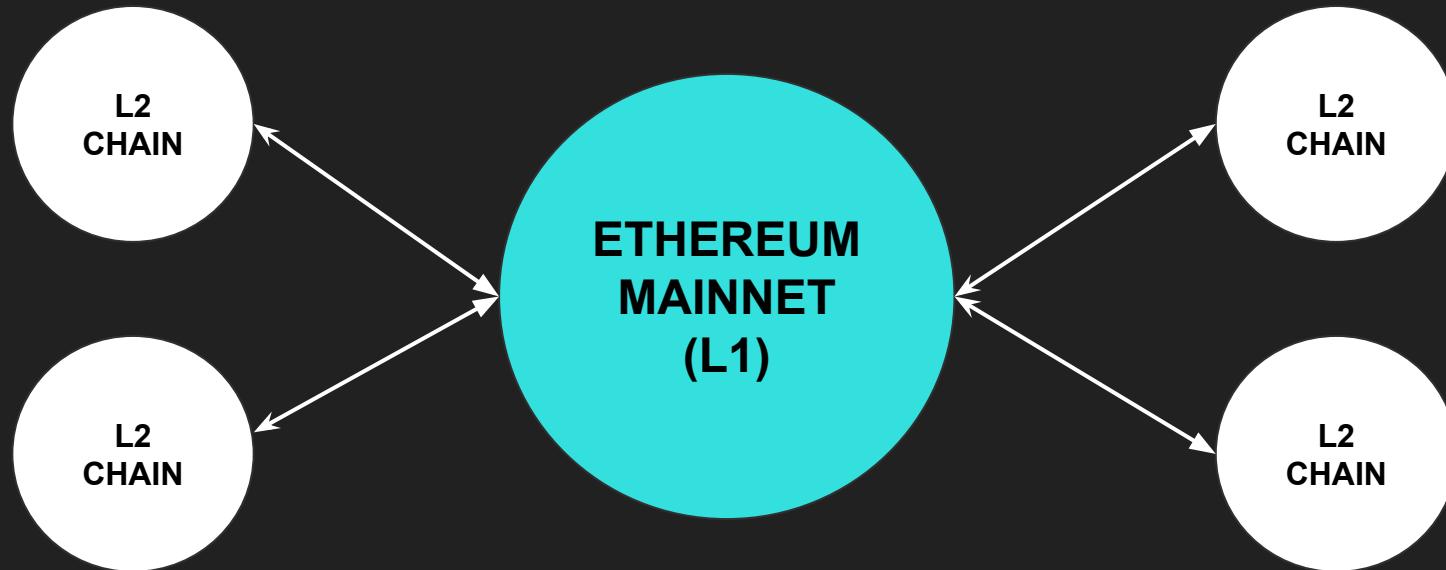
---



Data provided by Sigma Prime's Blocklist - updated daily

# LAYER 2

---



# LAYER 2 GROWTH

## Value Locked

**\$14.79B**

Sum of all canonically bridged, externally bridged, and natively minted tokens, converted to USD

▲ 9.30% / 7 days

2022 Nov 27 – 2023 Nov 26

7D 30D 90D 180D 1Y MAX

\$15.50B

\$12.60B

\$9.70B

\$6.80B

\$3.90B



# LAYER 2 BLOCKCHAINS

#	NAME	RISKS ⓘ	TECHNOLOGY ⓘ	STAGE ⓘ	PURPOSE ⓘ	TOTAL ⓘ	MKT SHARE ⓘ
1	 Arbitrum One ⚠️		Optimistic Rollup 	STAGE 1	Universal	\$7.62B ▲ 4.68%	51.50%
2	 OP Mainnet ⚠️		Optimistic Rollup 	STAGE 0	Universal	\$3.89B ▲ 8.27%	26.32%
3	 Base ⚠️		Optimistic Rollup 	STAGE 0	Universal	\$596M ▲ 4.61%	4.03%
4	 zkSync Era ⚠️		ZK Rollup 	STAGE 0	Universal	\$514M ▲ 18.00%	3.48%
5	 dYdX v3 ⚠️		ZK Rollup 	STAGE 1	Exchange	\$342M ▾ 6.34%	2.31%
6	 Immutable X		Validium 	n/a	NFT, Exchange	\$214M ▲ 32.94%	1.45%
7	 Linea ⚠️		ZK Rollup	STAGE 0	Universal	\$204M ▾ 3.06%	1.38%
8	 Mantle ⚠️		Optimum 	n/a	Universal	\$165M ▲ 4.29%	1.12%
9	 Starknet		ZK Rollup 	STAGE 0	Universal	\$160M ▲ 14.87%	1.08%
10	 Polygon zkEVM ⚠️		ZK Rollup 	STAGE 0	Universal	\$110M ▲ 1.69%	0.74%

# CRYPTOGRAPHY 101

---

# HASH

---

Hello world



64ec88ca00b268e5ba1a35678a1b5316d212f4f36  
6b2477232534a8aec37f3c

# EXERCISE 1: GENERATE A HASH

---

## Hash Generator

Your MD5 Hash: **900150983cd24fb0d6963f7d28e17f72**

Your String: abc

**Enter string for hash data generate \***

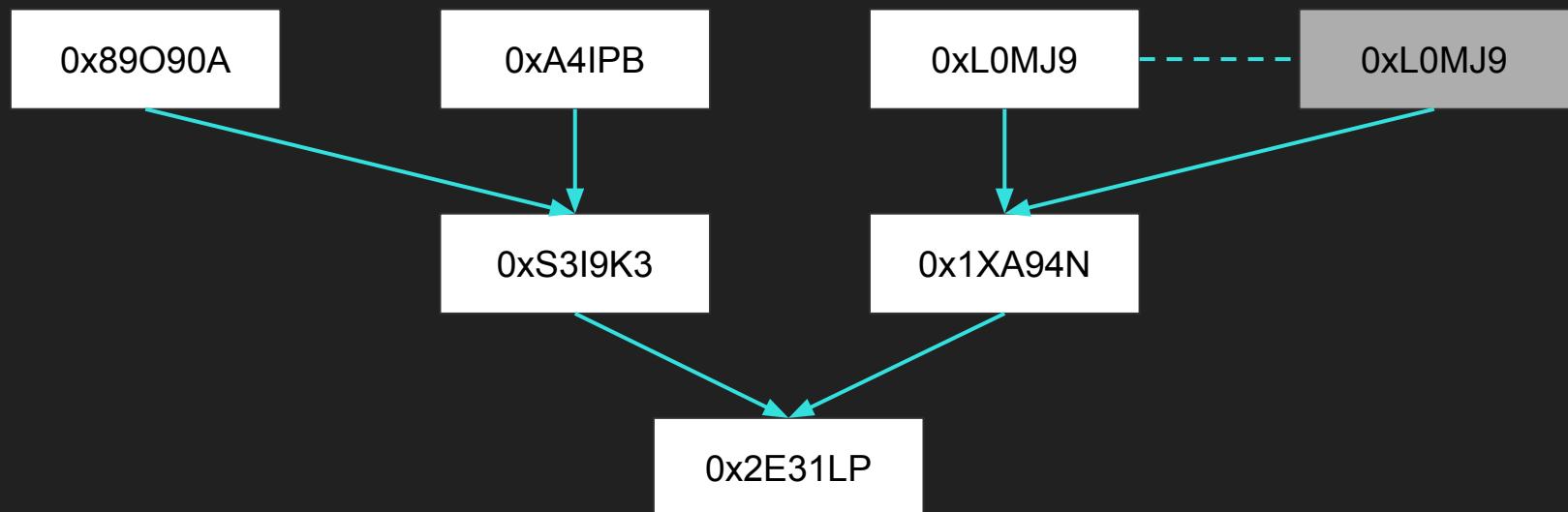
Select hash algorithm:

MD5

**Generate Hash**

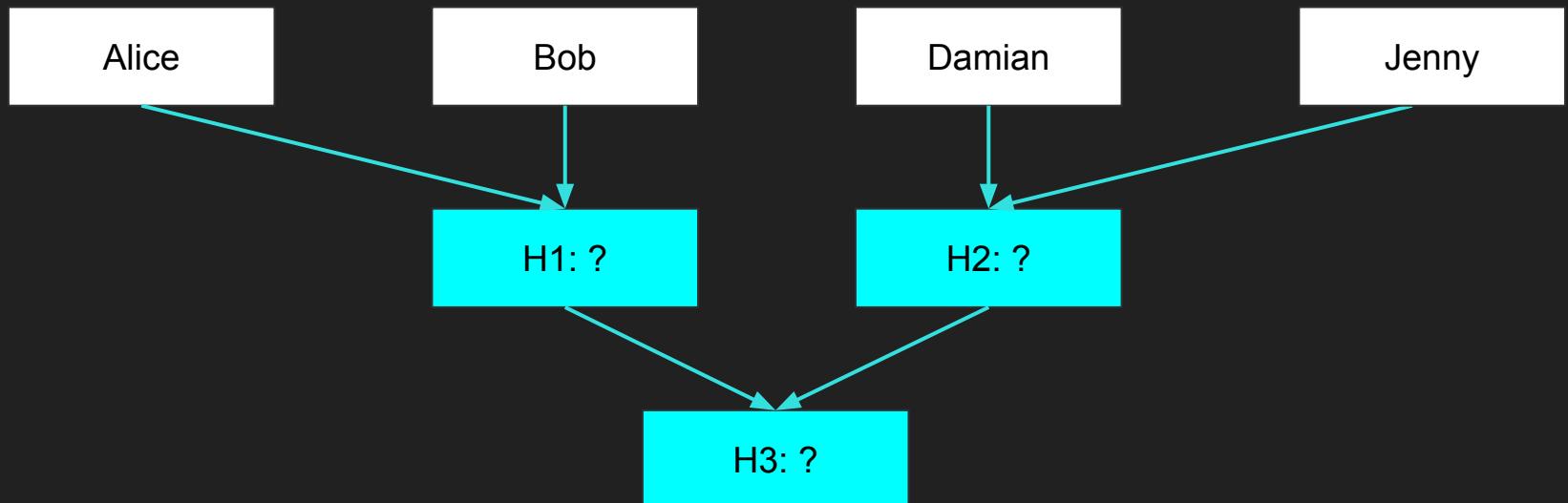
# MERKLE TREE

---



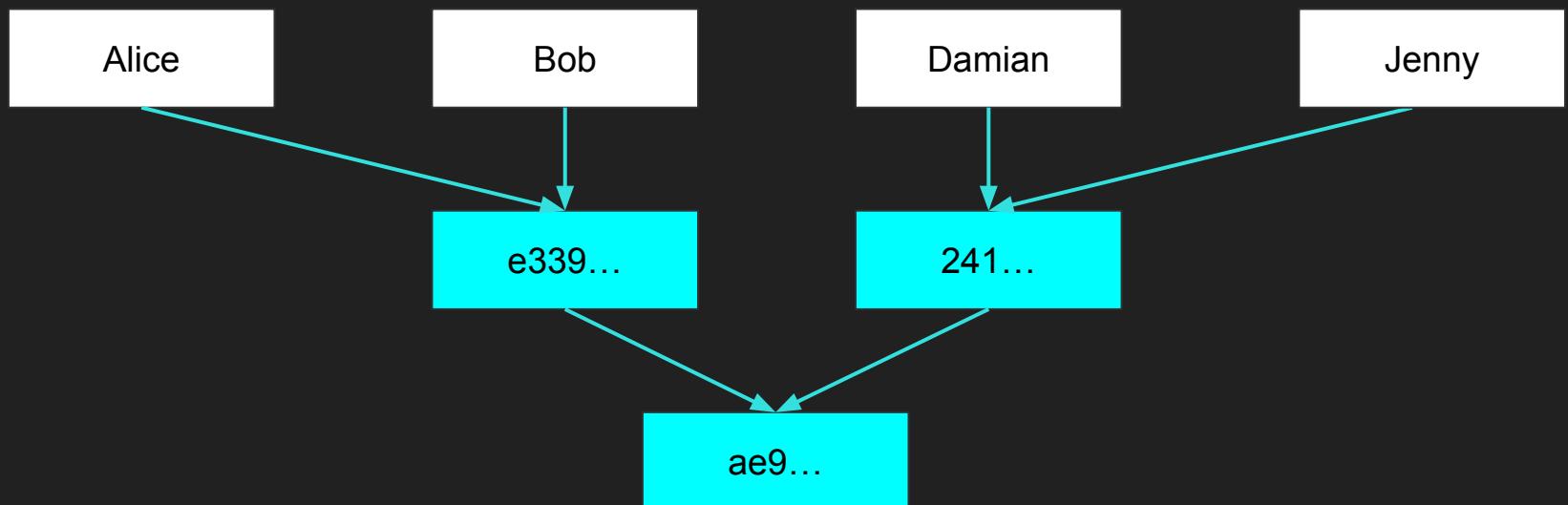
## EXERCISE 2: CALCULATE MERKLE TREE

---



# SOLUTION

---

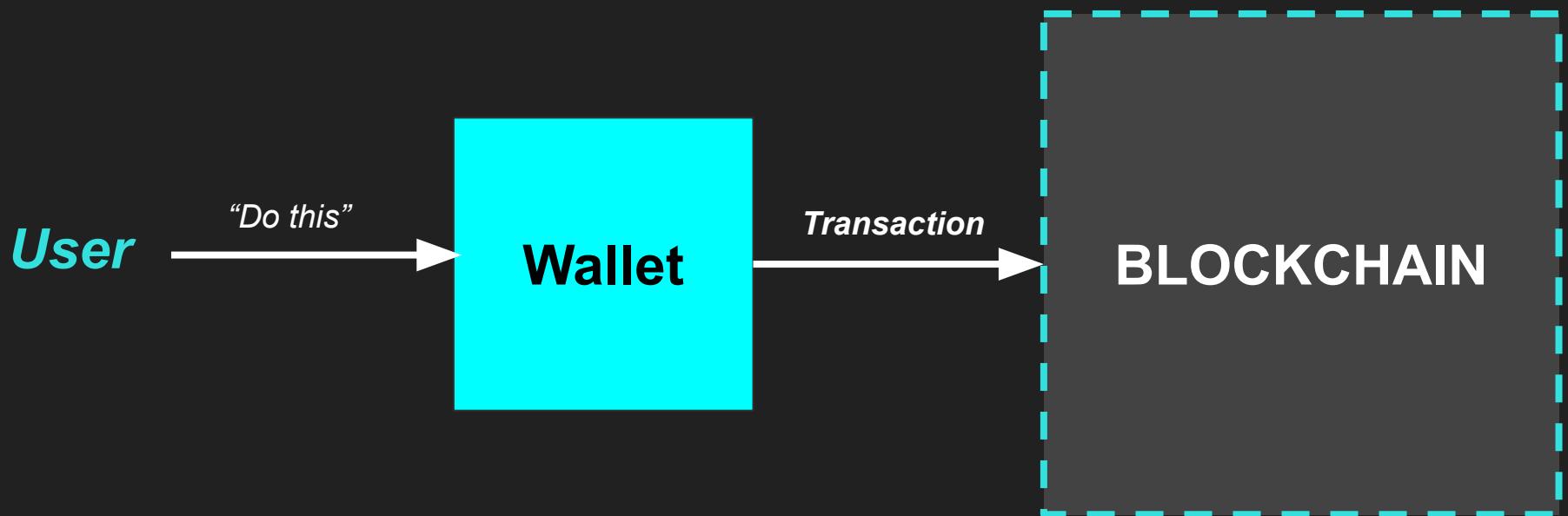


# WALLETS, ADDRESSES & ACCOUNTS

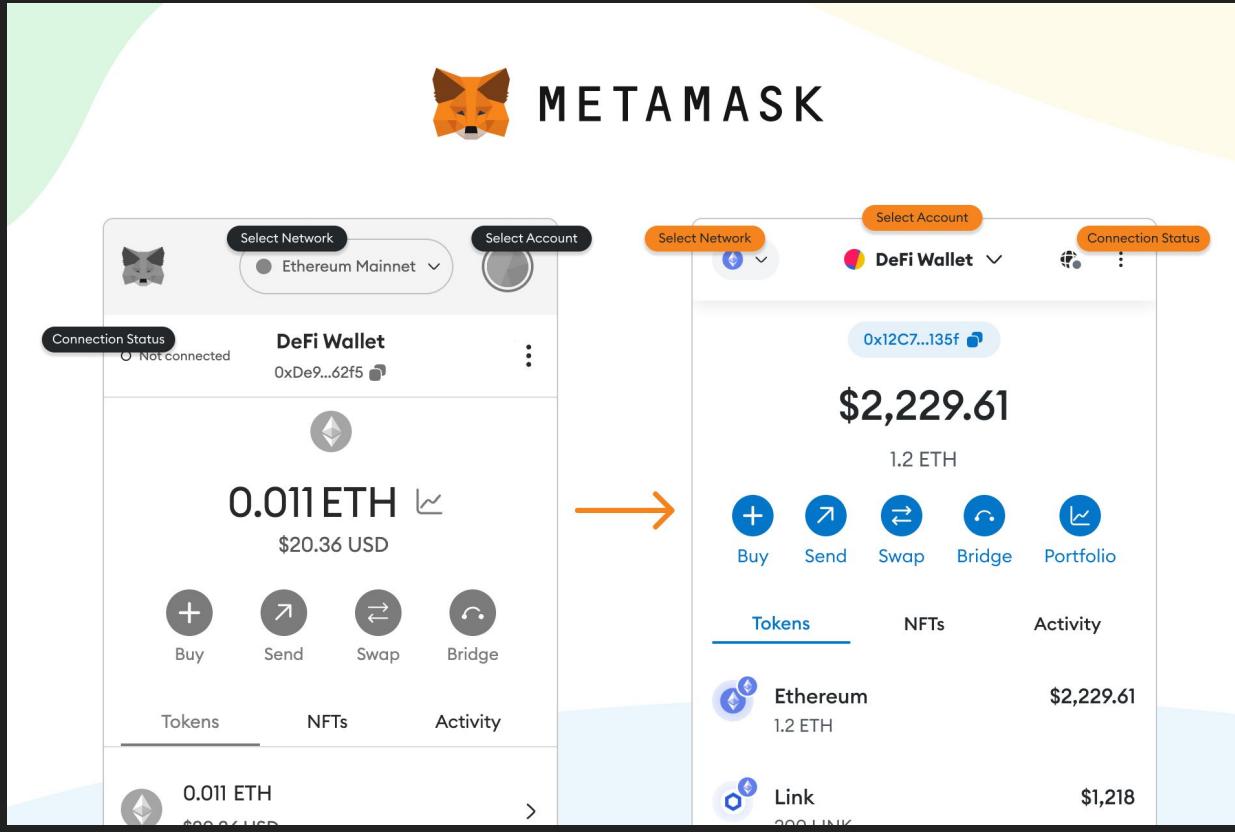
---

# WALLET

---



# SOFTWARE WALLETS



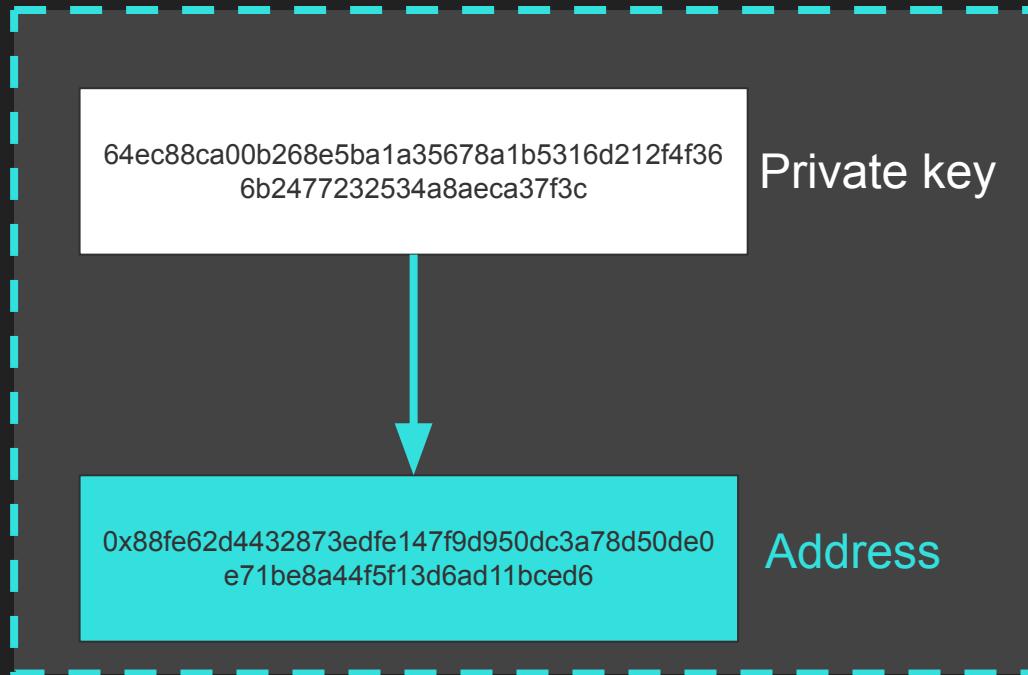
# HARDWARE WALLETS

---



# ADDRESS

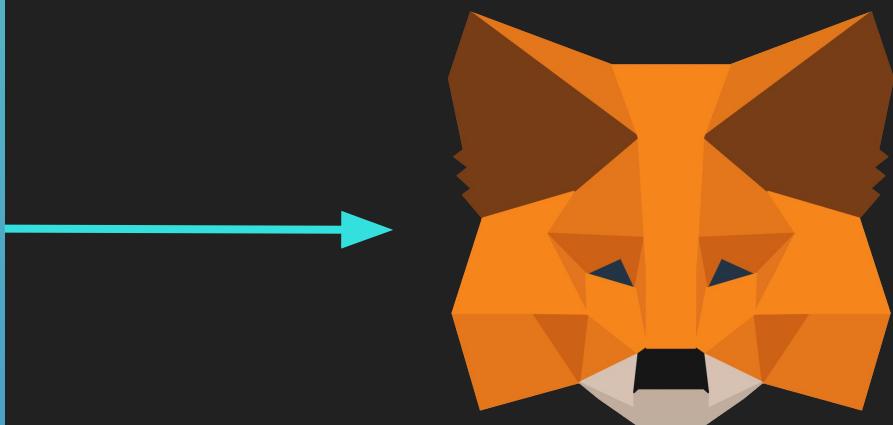
---



*Wallet*

# EXERCISE 3

---



# WORLD STATE & ACCOUNTS

---

## *Accounts*

0x4FC573013eCdeb4B6 ...

0xa63e9898bb1cf9fFa ...

0x347F55cEE3F5709b3 ...

0x8F8303bE7e7af3851 ...

0xB8bE5acc32A0a1a64 ...

0x24DDa1dA1FaeeD26a ...

0x7b8B6a2aA96631B7f ...

0x06EC696eE81a32B27 ...

# WORLD STATE & ACCOUNTS

---

## Accounts

0x4FC573013eCdeb4B6 ...
0xa63e9898bb1cf9fFa ...
0x347F55cEE3F5709b3 ...
0x8F8303bE7e7af3851 ...
0xB8bE5acc32A0a1a64 ...
0x24DDa1dA1FaeeD26a ...
0x7b8B6a2aA96631B7f ...
0x06EC696eE81a32B27 ...

EOA

Value	100
Nonce	10
Storage hash	-
Code hash	-



# WORLD STATE & ACCOUNTS

---

## Accounts

0x4FC573013eCdeb4B6 ...
0xa63e9898bb1cf9fFa ...
0x347F55cEE3F5709b3 ...
0x8F8303bE7e7af3851 ...
0xB8bE5acc32A0a1a64 ...
0x24DDa1dA1FaeeD26a ...
0x7b8B6a2aA96631B7f ...
0x06EC696eE81a32B27 ...

*Smart contract account*

Value	1200
Nonce	-
Storage hash	0xG6JNl...
Code hash	0x7UIB4...



# EXERCISE

---

## Accounts

0x4FC573013eCdeb4B6 ...
0xa63e9898bb1cf9fFa ...
0x347F55cEE3F5709b3 ...
0x8F8303bE7e7af3851 ...
0xB8bE5acc32A0a1a64 ...
0x24DDa1dA1FaeeD26a ...
0x7b8B6a2aA96631B7f ...
0x06EC696eE81a32B27 ...

*Smart contract account*

Value	1200
Nonce	-
Storage hash	0xG6JNl...
Code hash	0x7UIB4...



# TRANSACTIONS

---

# ETHER UNITS

---

Unit	Wei value (power of 10)	Wei value
Wei	1	1
KWei	$10^3$	1,000
Mwei	$10^6$	1,000,000
Gwei	$10^9$	1,000,000,000
Twei	$10^{12}$	1,000,000,000,000
Pwei	$10^{15}$	1,000,000,000,000,000
Ether	$10^{18}$	1,000,000,000,000,000,000

# EXERCISE 4: Ether unit conversion

---

Unit	Wei value (power of 10)	Wei value
Wei	1	1
KWei	$10^3$	1,000
Mwei	$10^6$	1,000,000
Gwei	$10^9$	1,000,000,000
Twei	$10^{12}$	1,000,000,000,000
Pwei	$10^{15}$	1,000,000,000,000,000
Ether	$10^{18}$	1,000,000,000,000,000,000

# GAS

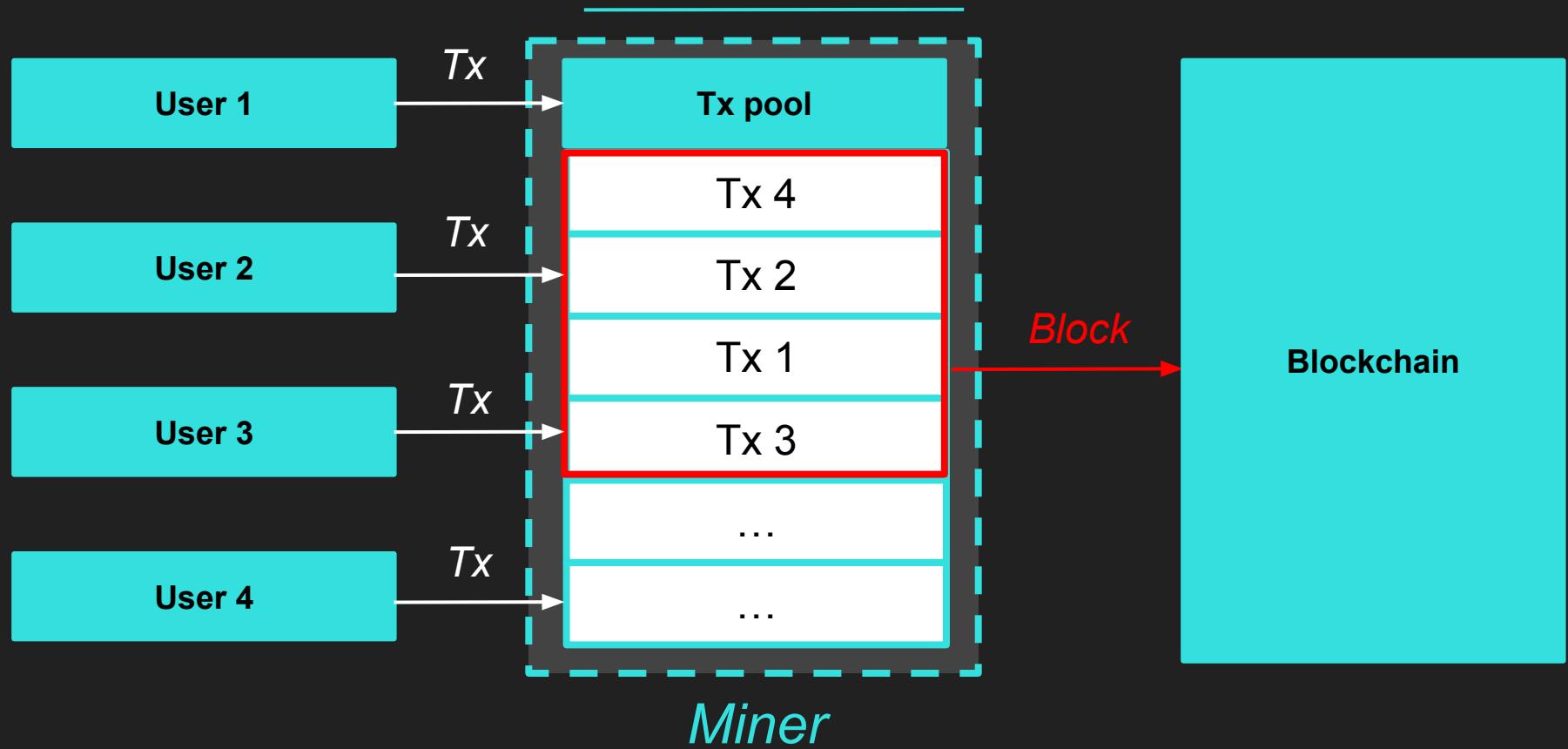
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GAS

Opcode	Name	Minimum Gas	Stack Input	Stack Output	Description	Expand ▾
00	STOP	0			Halts execution	
01	ADD	3	a b	a + b	Addition operation	
02	MUL	5	a b	a * b	Multiplication operation	
03	SUB	3	a b	a - b	Subtraction operation	
04	DIV	5	a b	a // b	Integer division operation	
05	SDIV	5	a b	a // b	Signed integer division operation (truncated)	
06	MOD	5	a b	a % b	Modulo remainder operation	

# MINING



# TRANSACTION

---

Type 0 (legacy)
From
To
Value
Data
Gas limit
Gas price
Nonce
Chain id
Signature

# GAS CALCULATION - Tx type 0

---

$$Tx \text{ fee (ETH)} = \frac{\text{Gas spent} \times \text{Gas price} \times 10^9}{(\leq \text{gas limit})}$$

*gas*      *gwei / gas*

$$Tx \text{ fee (USD)} = \frac{Tx \text{ fee (ETH)} \times ETH \text{ price}}{USD / ETH}$$

*ETH*      *USD / ETH*

# BLOCKCHAIN EXPLORER - BEACON CHAIN

Home | Epoch 275,417 Slot 8,813,371 Price 3,619

Public Key / Block Number / Block Hash / Graffiti / Status

ETH ▾ Log in Sign Up

## ⌚ Most recent epochs

[View more](#)

Epoch	Time	Final	Eligible (ETH)	Voted
275,417	6 mins ago	No	31,380,633	Calculating...
275,416	12 mins ago	No	31,380,825	30,259,702 (96.43%)
275,415	19 mins ago	No	31,381,017	30,071,833 (95.83%)
275,414	25 mins ago	Yes	31,381,017	31,271,089 (99.65%)
275,413	31 mins ago	Yes	31,381,209	31,287,313 (99.7%)
275,412	38 mins ago	Yes	31,381,401	30,942,227 (98.6%)
275,411	44 mins ago	Yes	31,381,593	31,298,353 (99.73%)
275,410	51 mins ago	Yes	31,381,785	31,290,033 (99.71%)
275,409	57 mins ago	Yes	31,381,977	31,279,921 (99.67%)

## 📦 Most recent blocks

[View more](#)

Epoch	Slot	Block	Status	Time	Proposer
275,417	8,813,372	19,611,380	Proposed	37 secs ago	👤 650637
275,417	8,813,371	19,611,379	Proposed	49 secs ago	👤 587830
275,417	8,813,370	19,611,378	Proposed	1 min ago	👤 1324377
275,417	8,813,369	19,611,377	Proposed	1 min ago	👤 399510
275,417	8,813,368	19,611,376	Proposed	1 min ago	👤 155634
275,417	8,813,367	19,611,375	Proposed	1 min ago	👤 1275817
275,417	8,813,366	19,611,374	Proposed	1 min ago	👤 943948
275,417	8,813,365	19,611,373	Proposed	2 mins ago	👤 52910
275,417	8,813,364	19,611,372	Proposed	2 mins ago	👤 239457

# BLOCKCHAIN EXPLORER - SHARD CHAIN

The Ethereum Blockchain Explorer

All Filters ▼ Search by Address / Txn Hash / Block / Token / Domain Name 🔍 Ad

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**ETHER PRICE**  
\$3,566.34 @ 0.050156 BTC (+5.09%)

**MARKET CAP**  
\$428,212,957,652.00

**TRANSACTIONS**  
2,326.37 M (14.3 TPS)

**MED GAS PRICE**  
24 Gwei (\$1.80)

**LAST FINALIZED BLOCK**  
19609670

**LAST SAFE BLOCK**  
19609702

**TRANSACTION HISTORY IN 14 DAYS**

1 360k  
1 040k  
Mar 24 Mar 31 Apr 7

**Latest Blocks**

19609748 9 secs ago	Fee Recipient <a href="#">beaverbuild</a> 121 txns in 12 secs	0.04107 Eth
19609747 21 secs ago	Fee Recipient <a href="#">Lido: Execution La...</a> 168 txns in 12 secs	0.1 Eth

**Latest Transactions**

0x87d6a7f1c00... 9 secs ago	From <a href="#">0x95222290...5CC4BAfe5</a> To <a href="#">0xa2d4535b...9285Ad681</a>	0.04709 Eth
0x82952e020b... 9 secs ago	From <a href="#">0x06DC0DA4...F6f3C0054</a> To <a href="#">0x49048044...fAF74E97e</a>	0.3 Eth

# EXERCISE 5: Analyse this tx

② Transaction Hash:	0xfcfc46628756fe718f6bc4264948671d30f1377d03e12af2f5f6ff5a9dd796d65
② Status:	<span>Success</span>
② Block:	19001413 572933 Block Confirmations
② Timestamp:	80 days ago (Jan-14-2024 12:01:23 AM +UTC)
↳ Transaction Action:	Transfer 0.232 ETH To 0x7393A26c...d28f786b0
② Sponsored:	
② From:	0xfb9D1EEA560d1faD972e26b6e8f2d8d7C29fDff4
② To:	0x7393A26c66E6b82944AaD564044dc8Ed28f786b0
② Value:	0.232 ETH \$773.36
② Transaction Fee:	0.000328472508798 ETH \$1.09
② Gas Price:	15.641548038 Gwei (0.00000015641548038 ETH)
② Ether Price:	\$2,470.94 / ETH
② Gas Limit & Usage by Txn:	21,000   21,000 (100%)
② Gas Fees:	Base: 15.541548038 Gwei   Max: 20.23401878 Gwei   Max Priority: 0.1 Gwei
② Burnt & Txn Savings Fees:	Burnt: 0.000326372508798 ETH (\$1.09) Txn Savings: 0.000096441885582 ETH (\$0.32)

# EXERCISE 6: Analyse this tx

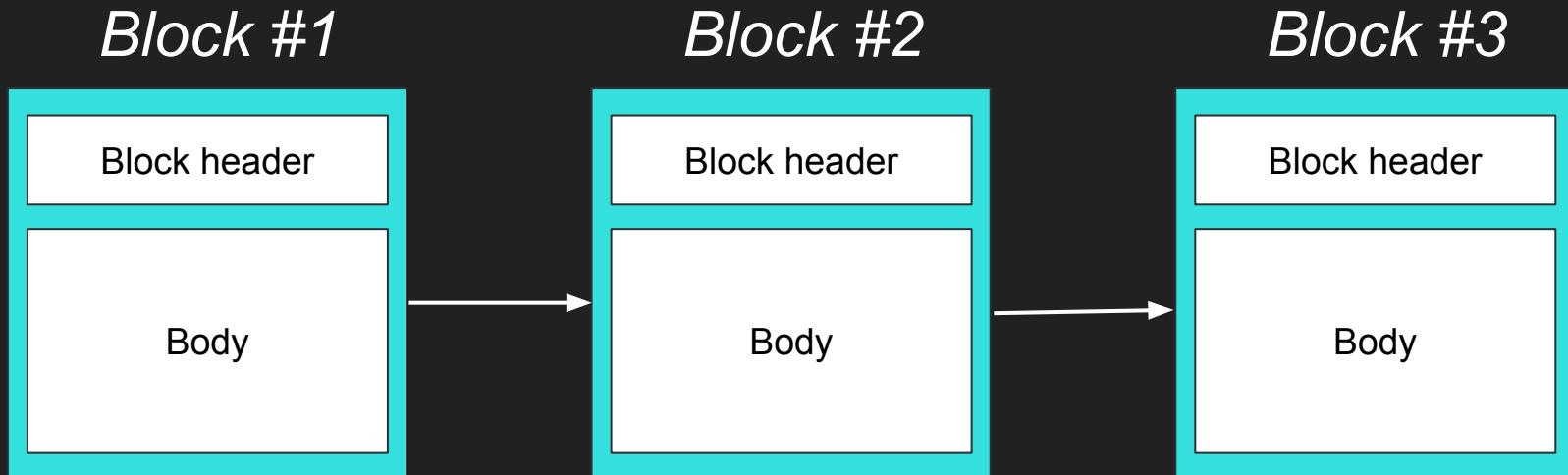
② Transaction Hash:	0x029c6d737c2bf85b78e689bec7aad2804c5e7849a4bf25f874a8815b2cab6f4 <a href="#">🔗</a>
② Status:	<span>Success</span>
② Block:	18998972 575441 Block Confirmations
② Timestamp:	80 days ago (Jan-13-2024 03:50:35 PM +UTC)
⚡ Transaction Action:	Transfer 597  USDC To 0x7393A26c...d28f786b0
② Sponsored:	
② From:	vash.eth <a href="#">🔗</a>
② Interacted With (To):	0xA0b86991c6218b36c1d19D4a2e9Eb0cE3606eB48 (Circle: USDC Token) <a href="#">🔗</a> ✓
② ERC-20 Tokens Transferred:	<a href="#">All Transfers</a> <a href="#">Net Transfers</a>
	From  vash.eth To 0x7393A26c...d28f786b0 For 597 (\$596.91)  USDC (USDC)
② Value:	0 ETH (\$0.00)
② Transaction Fee:	0.00106503990857372 ETH \$3.56
② Gas Price:	23.583700367 Gwei (0.000000023583700367 ETH)

# BLOCKCHAIN DATA STRUCTURE

---

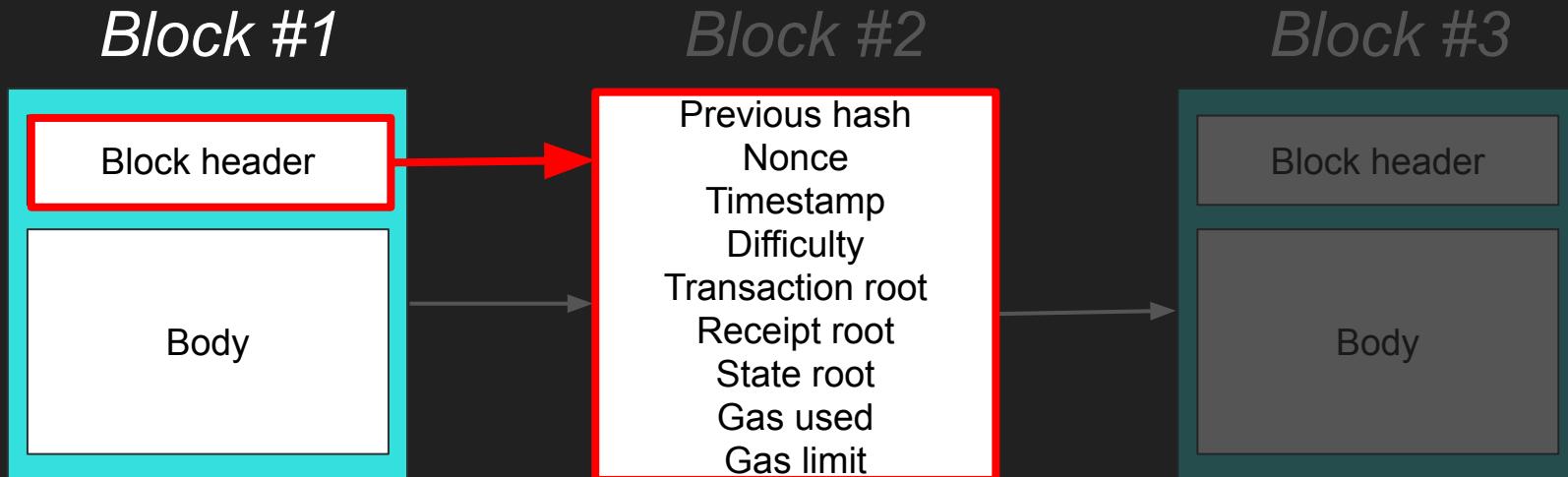
# BLOCKCHAIN

---



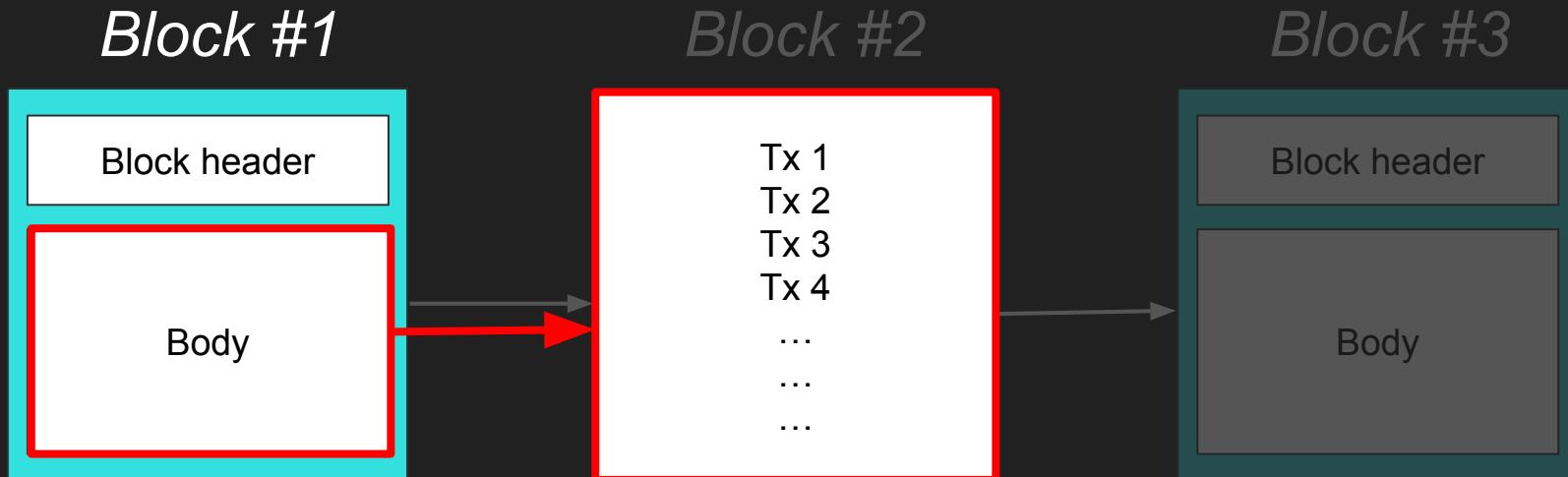
# BLOCK HEADER

---



# BLOCK BODY

---



# EXERCISE

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Etherscan

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Block #19611622

Overview Consensus Info MEV Info Blob Info

② Block Height: 19611622 < >

② Status: Unfinalized

② Timestamp: 12 secs ago (Apr-08-2024 02:43:47 PM +UTC)

② Proposed On: Block proposed on slot 8813617, epoch 275425

② Transactions: 164 transactions and 90 contract internal transactions in this block

② Withdrawals: 16 withdrawals in this block

② Fee Recipient: beaverbuild in 12 secs

② Block Reward: 0.034518164499189583 ETH (0 + 0.446228918325854923 - 0.41171075382666534)

② Total Difficulty: 58,750,003,716,598,352,816,469

② Size: 59,276 bytes

② Gas Used: 13,558,717(45.20%)  -10% Gas Target