# PX 2018: Blockchain - Endterm Presentation

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print

# Introduction

Previous century: researches invented continuously

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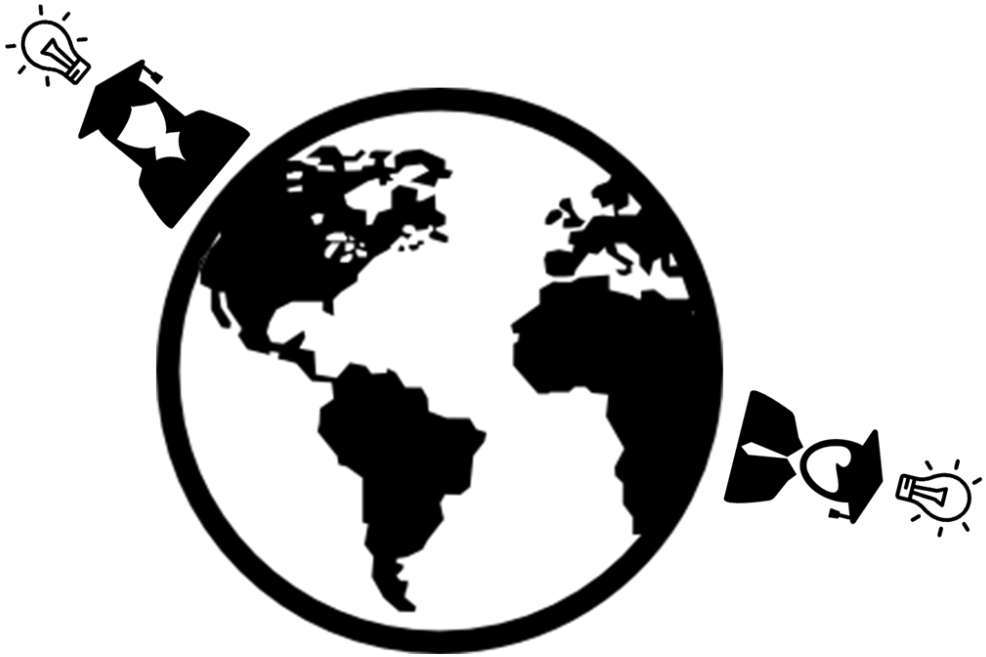

Problem: same ideas by multiple researchers

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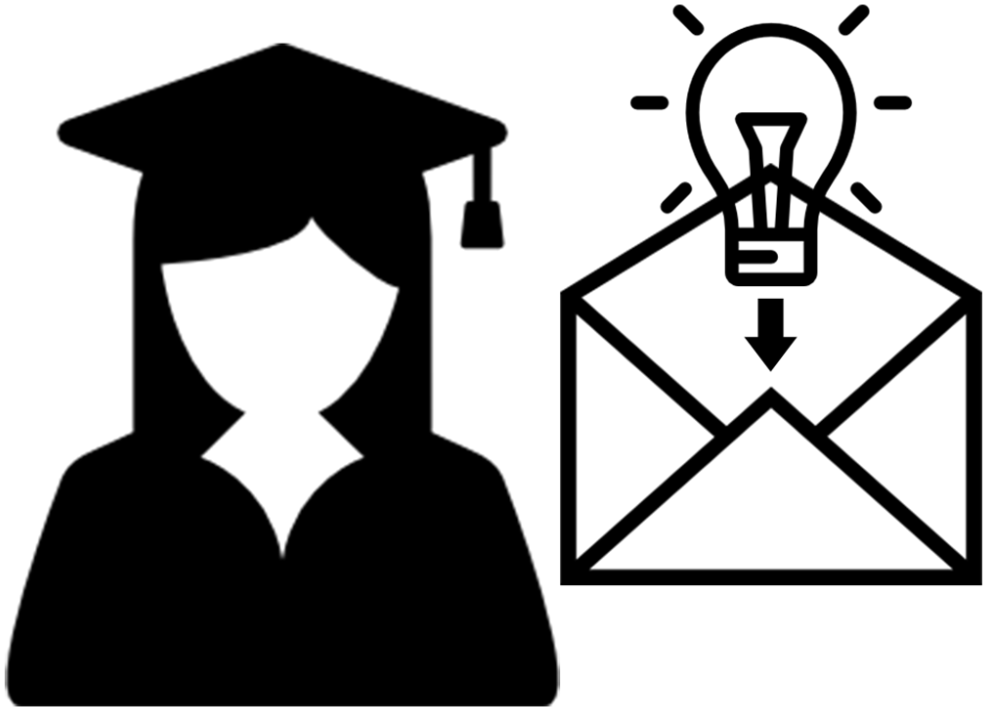

Solution: write down idea and send to yourself

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Post office clerk will stamp each letter with timestamp

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Researcher has proof for invention at specific point of time

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Problem: Post office clerk might not be reliable

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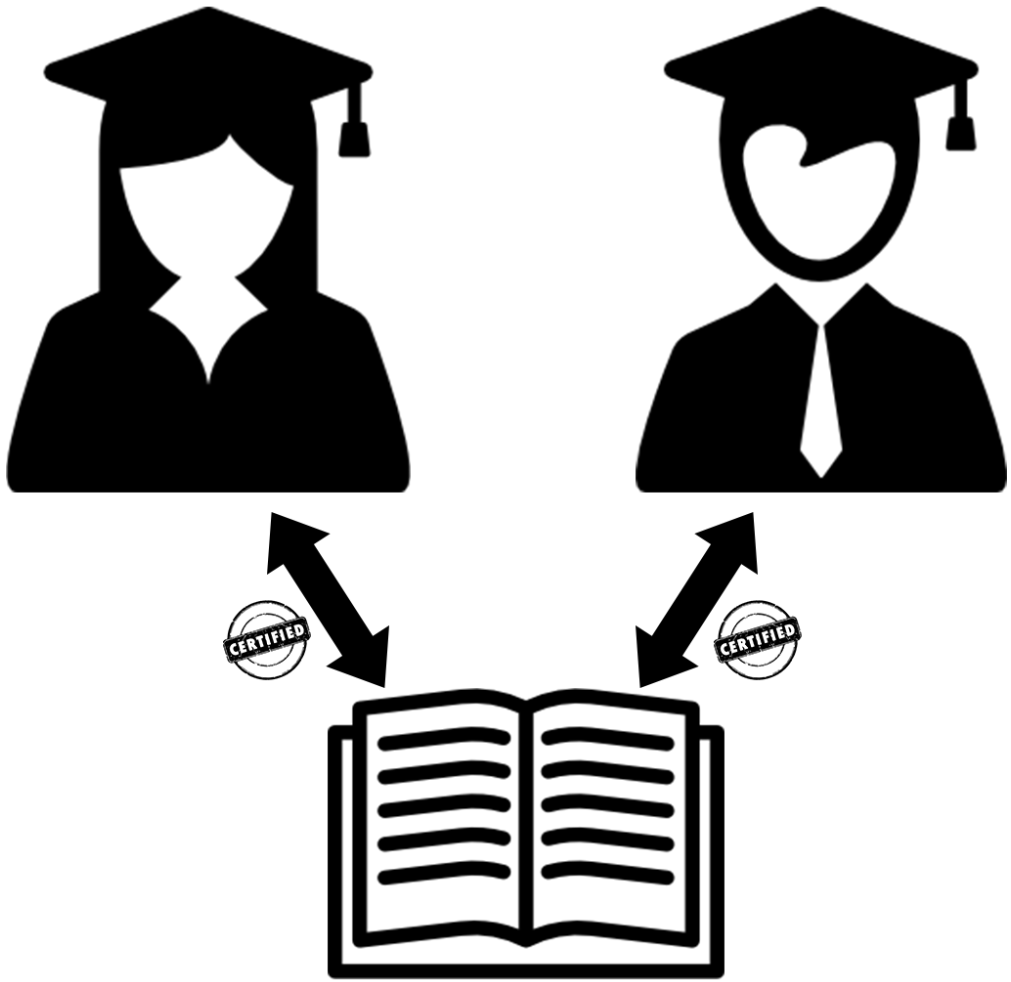


Idea: Researchers maintain ledger collaboratively

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# Blockchain

"Decentralized, chronological updated database with a network based consensus mechanism for permanent confirmation of ownership."

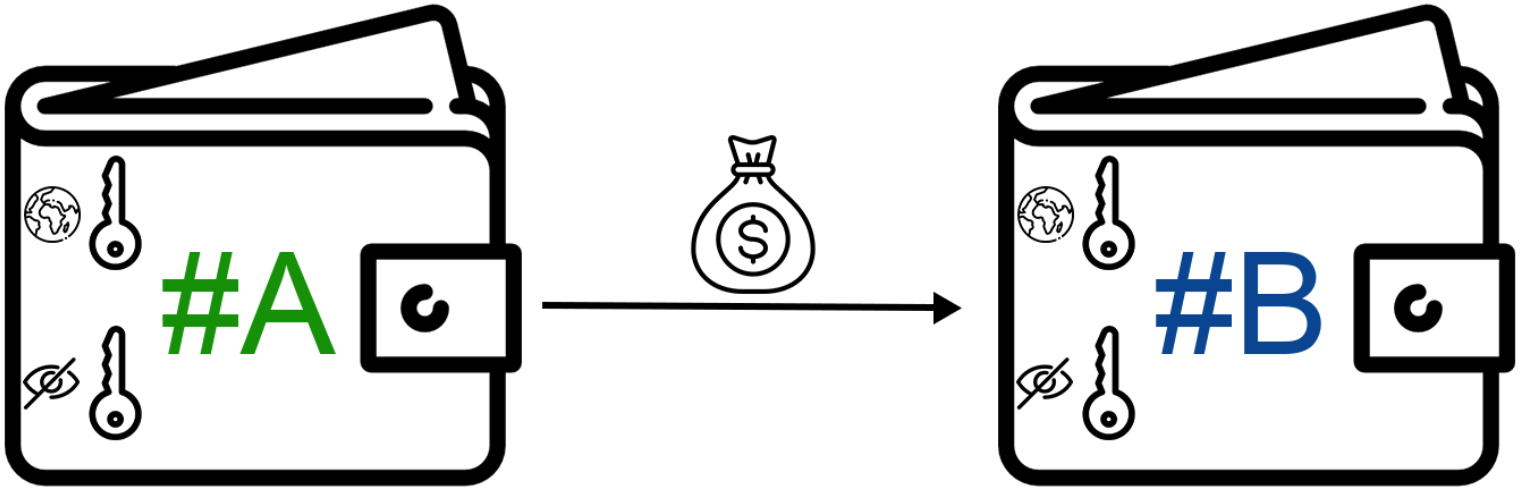
Prof. Dr. Andreas Mitschele

# Bitcoin

- digital crypto currency
  - value skyrocketed from basically $0 (2009) to ~$18.000 (2017)
- concept published by Satoshi Nakamoto (pseudonym) in 2008
  - shared ledger to keep track of all transactions
  - aims to remove necessity of banks to clear transactions
- first stable implementation in 2009

# Concepts

# Wallets transfer money

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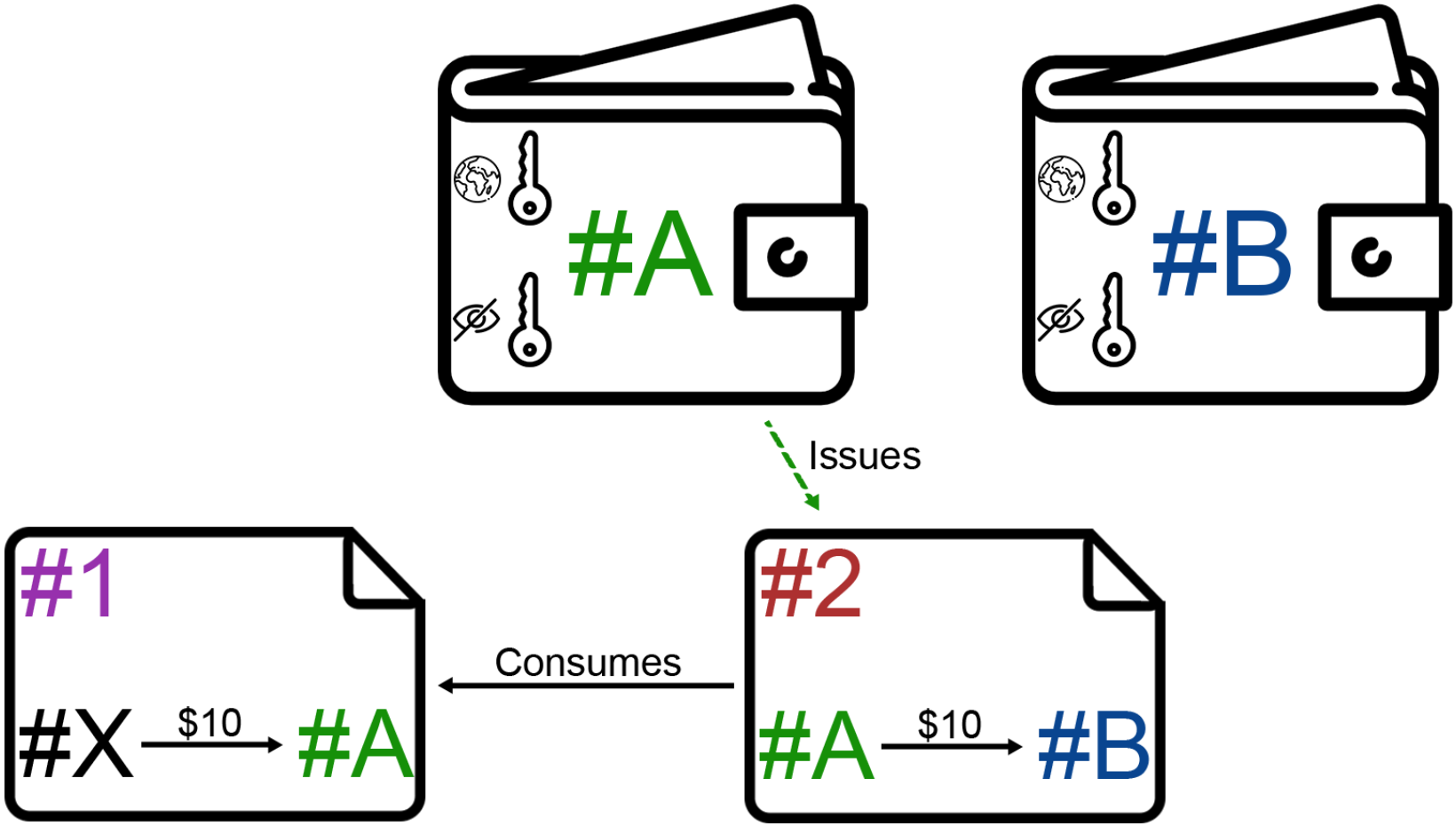
# Transactions gather financials

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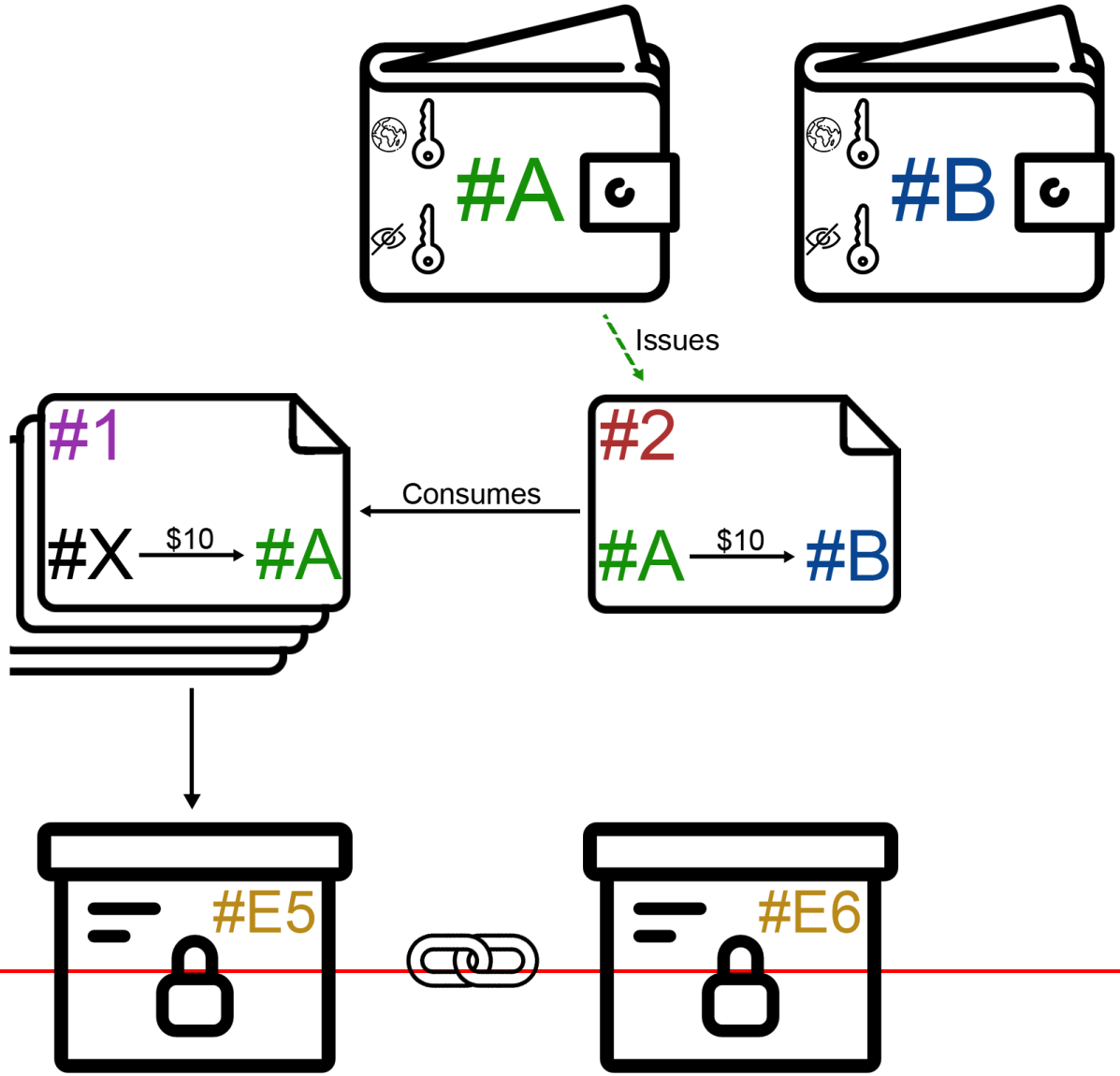
# Blocks keep track of transactions

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# Wallet

- necessary to participate in payment transactions
  - send transactions
  - receive transactions
- basically set of private & public key
  - used to sign transactions
  - public key as identifier in payment network

Display Implementation

## Usage

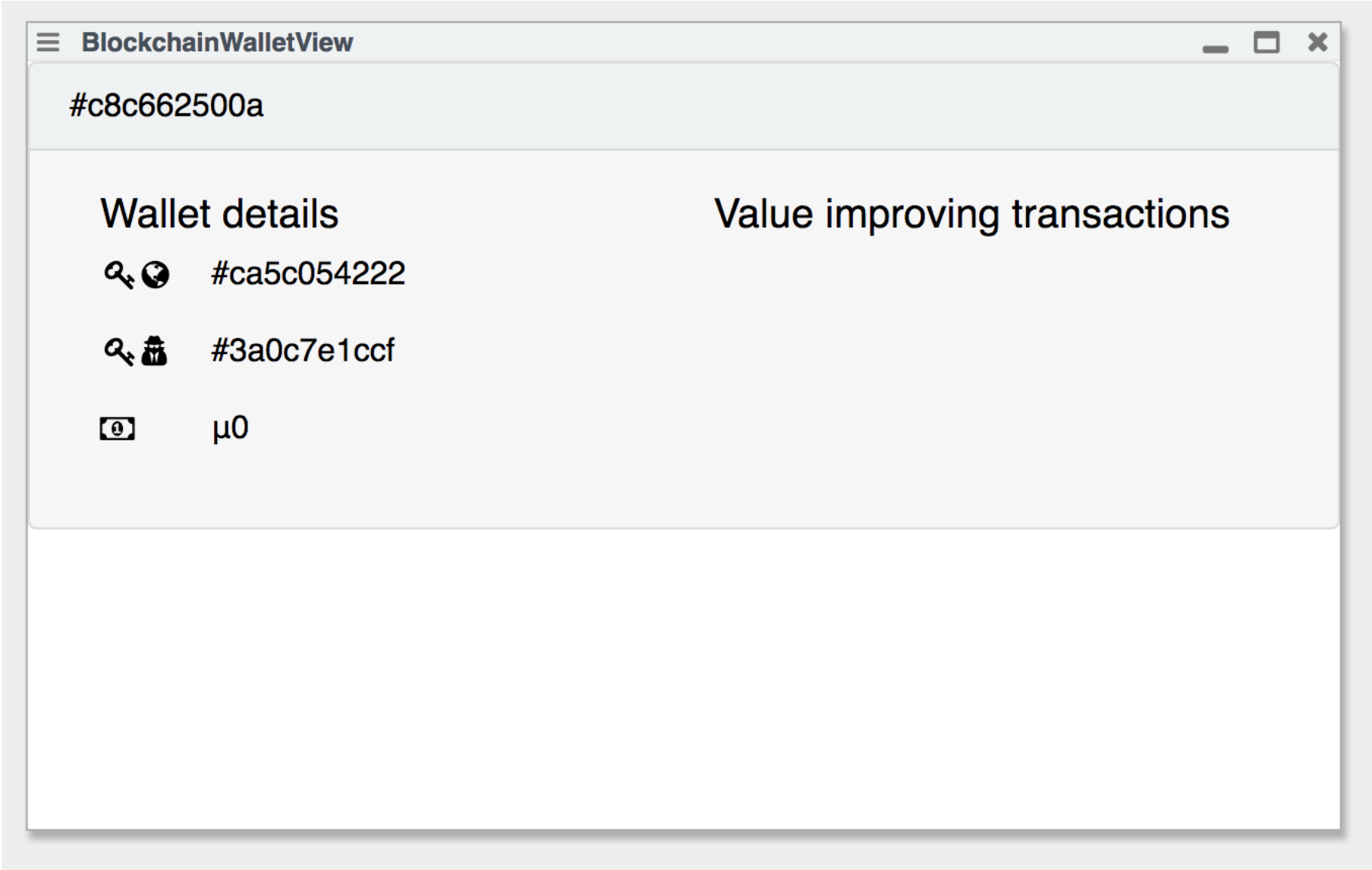
```
import Wallet from 'src/blockchain/model/wallet/wallet.js';
const wallet = new Wallet();
```

Display Wallet

## Receive payment

```
wallet.receive(transaction);
```

Receive Transaction


BlockchainWalletView
#c8c662500a
Wallet details
Value improving transactions
#ca5c054222
#3a0c7e1ccf
µ0

BlockchainWalletView

#f62182afe6

## Wallet details

#c93600d340

#1a51d71851

µ5

## Value improving transactions

#722fa54243 *µ5*

# Transaction

- fundamental atomic component of blockchain data structure
- describes **one** timestamped change within ecosystem
  - Bitcoin: single payment flow reserving some value on a wallet
- issued and signed by one wallet
- consumes outputs of other transactions → produces new outputs, which can be consumed
  - transactions form an acyclic, directed graph
  - Bitcoin: cash flow can be reconstructed

Display Implementation

## Visualization

Display Transaction

# Block

- periodically encapsulates transactions
- comparable to a ledger's page
- transactions summarized into a block are interpreted as valid
- creation of a block is called *mining*
  - requires resource intensive / time consuming work to be done
  - mining is rewarded (mining-reward and fees)

Display Implementation

## Mining Challenge

```
import forge from 'node_modules/node-forge/dist/forge.min.js';

const sha256 = forge.md.sha256.create();

const block = {'prevHash': "#3eFg7FA", "data": "...", "nonce": 0};
```

Setup Mining-Challenge

```
1
block['nonce'] = block['nonce'] + 1;
sha256.update(block);
sha256.digest().toHex();
 => 36928ee16f30168b4982f5f26f21a4acdc4e9d8d2aa891460fbaa2fd58a3daec
```

# Blockchain

- each block refers it's preceding block (chain of blocks → chronological order)
- blockchain as overall ledger: furnishes proof of any change
  - Bitcoin: any financial transaction

Display Implementation

## Formation of a Blockchain

Setup Environment

Wallet details

Value improving transactions

## Formation of a Blockchain

Setup Environment

### #0d99761b95

Wallet details

#c6c619cf2f

#c3941f156e

µ60

Value improving transactions

#78a4de8ea3 µ10

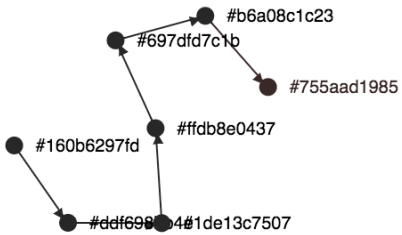
#6105314517 µ10

#14fd6d5883 µ10

#02dd38c646 µ10

#03b86ab111 µ10

#c665b3596c µ10

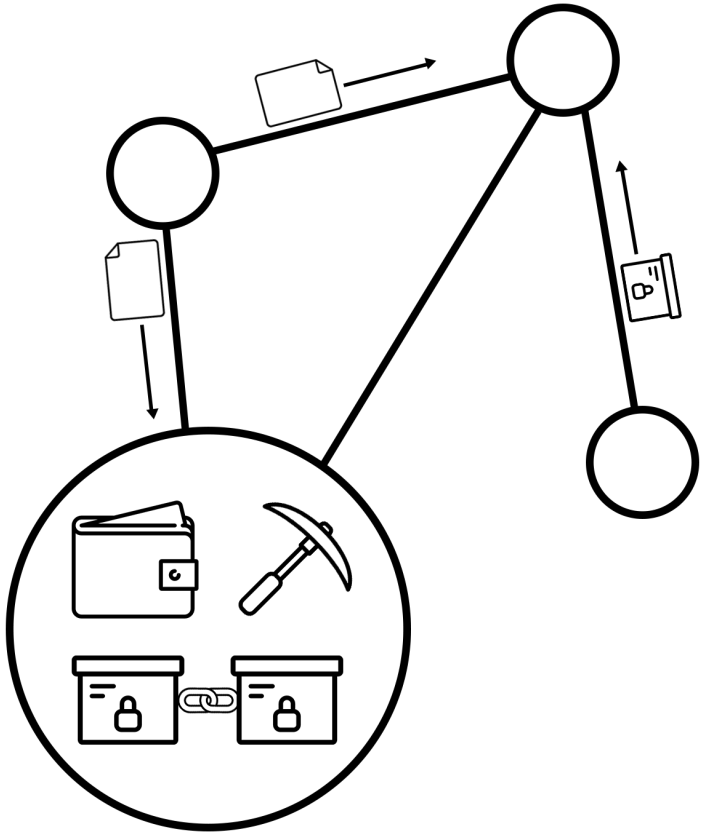



Mine Block

# Networking

# Nodes

- participants within network are called nodes
- each node can perform several actions
  - mine new blocks → Miner
  - propagate Transactions → NetworkComponent
  - maintain it's own Blockchain copy → Storage



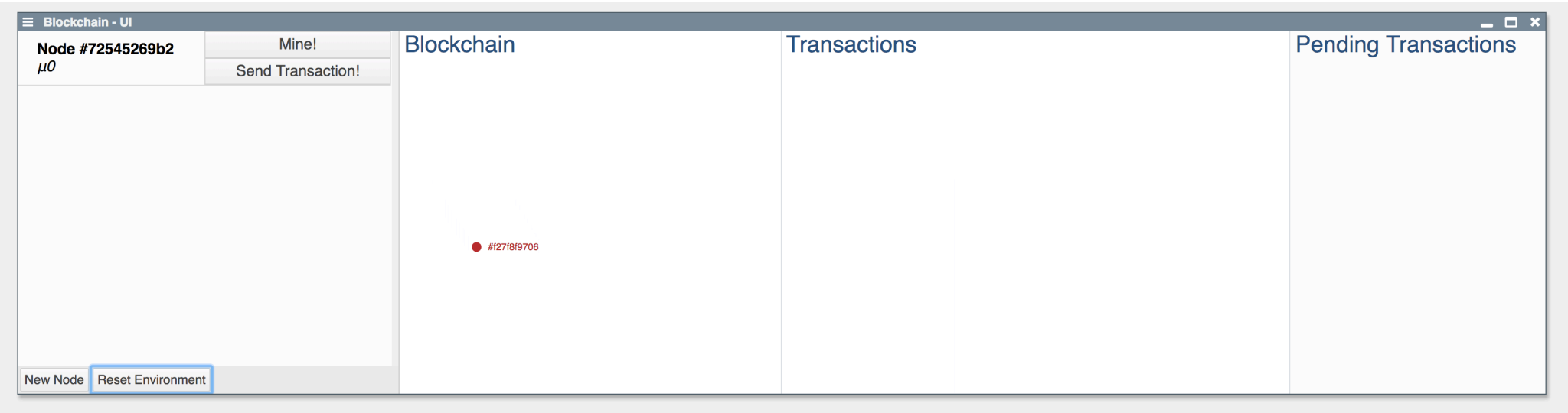
Display Implementation

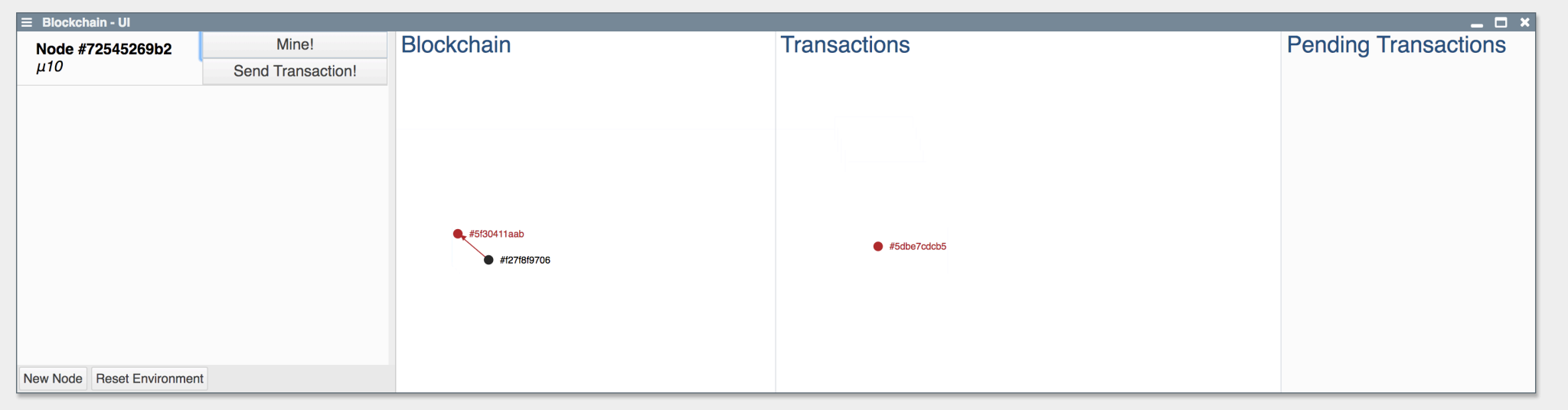
Icons made by Freepik from www.flaticon.com

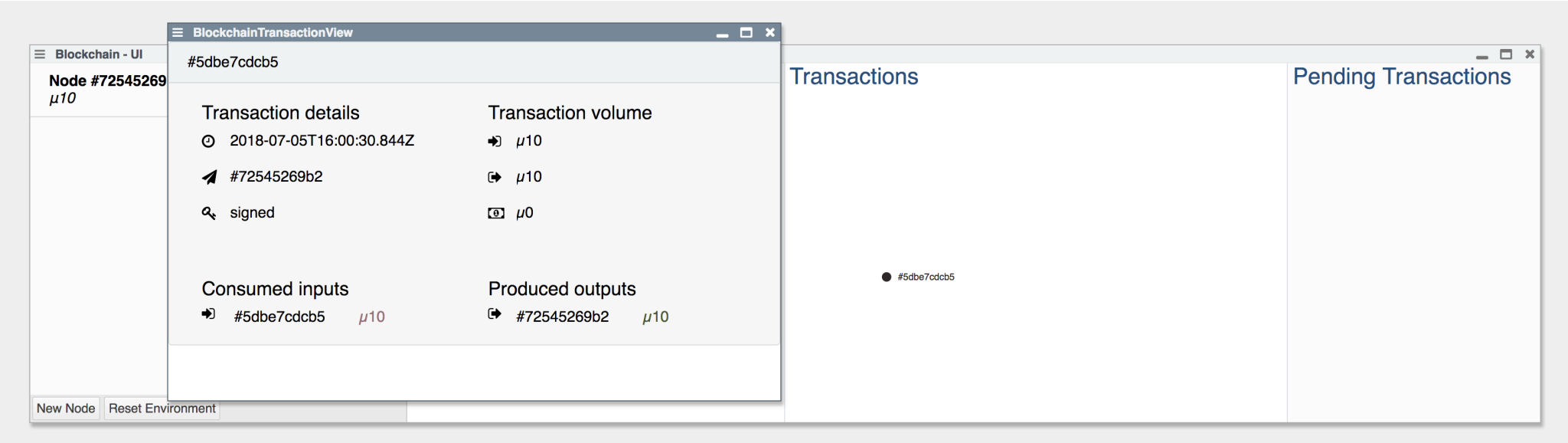
# Peer-To-Peer

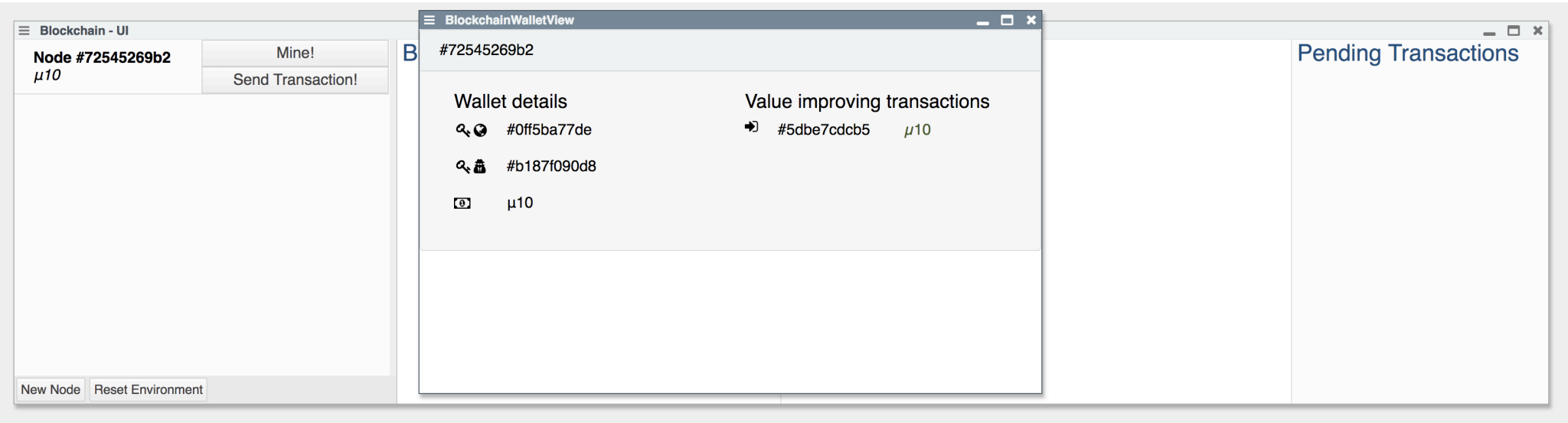
- new nodes contact long-established ones to get initial information
  - other peers
  - already existing blockchain
- consensus rules ensure same Blockchain on majority of nodes
  - blocks with solved mining-challenge are valid
  - each transaction can only be spent once
  - ...
- nodes / miner compete against each other while solving the mining challenge

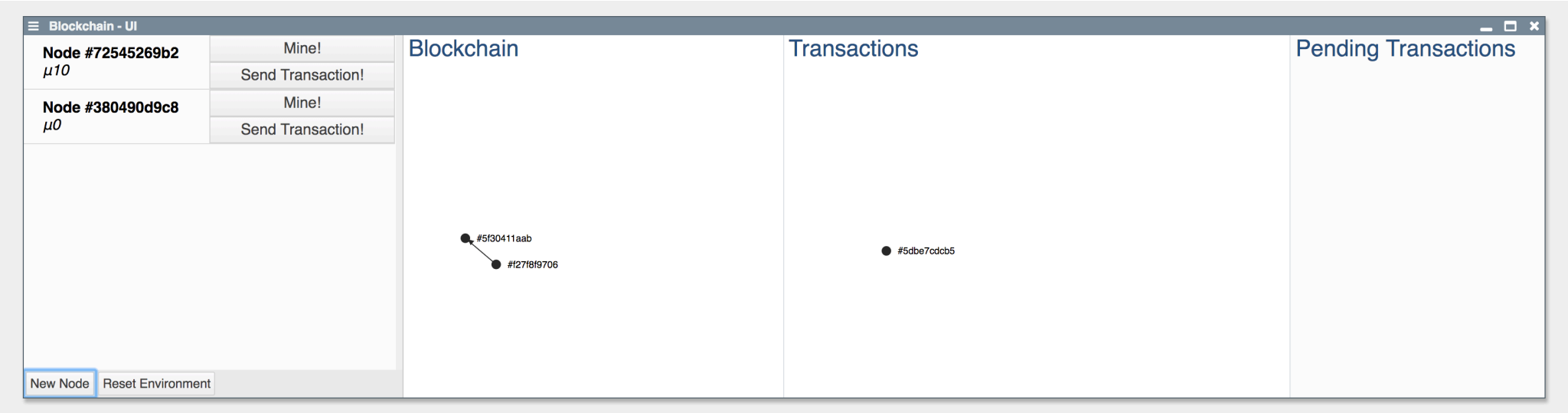
Run full Demo

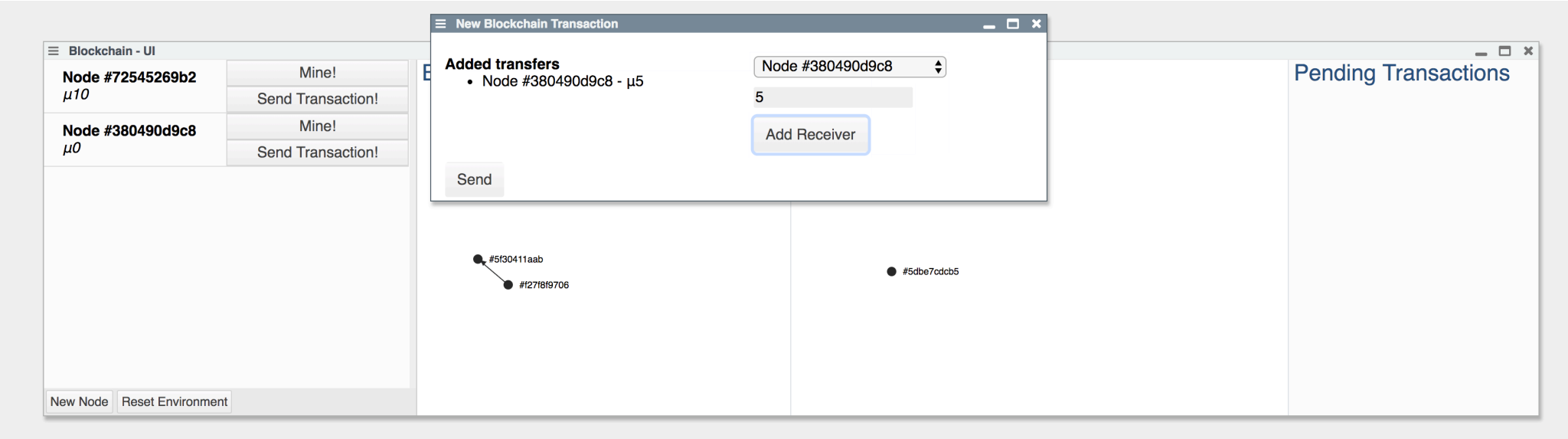

Blockchain - UI
Node #72545269b2
μ0
Mine!
Send Transaction!
New Node
Reset Environment
Blockchain
#f27f8f9706
Transactions
Pending Transactions

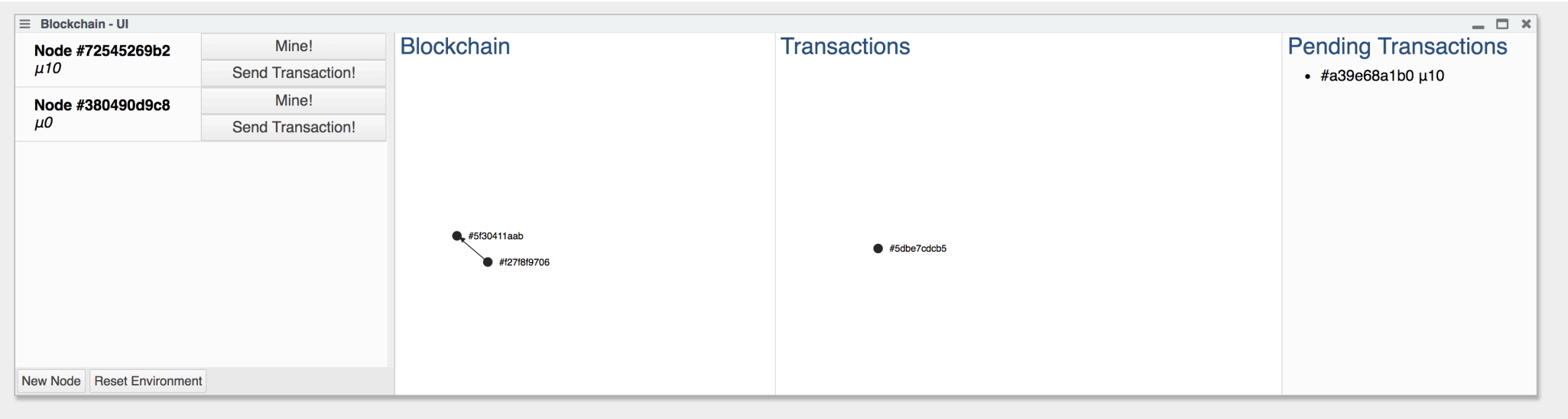

Blockchain - UI
Node #72545269b2
μ10
Mine!
Send Transaction!
New Node
Reset Environment
Blockchain
#5f30411aab
#f27f8f9706
Transactions
#5dbe7cdcb5
Pending Transactions

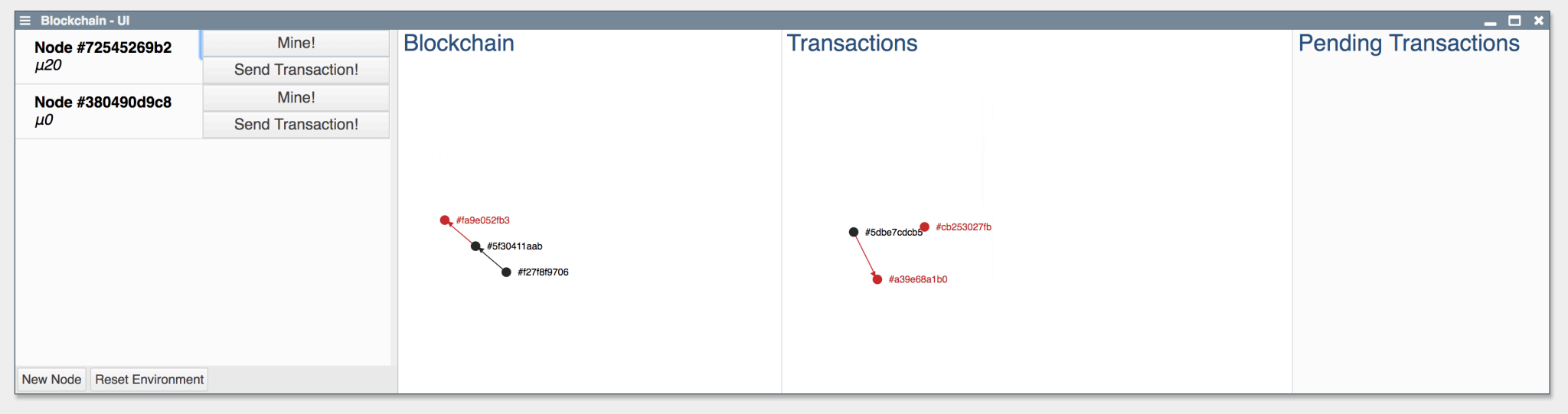

BlockchainTransactionView
#5dbe7cdcb5
Transaction details
2018-07-05T16:00:30.844Z
#72545269b2
signed
Transaction volume
μ10
μ10
μ0
Consumed inputs
#5dbe7cdcb5 μ10
Produced outputs
#72545269b2 μ10
Blockchain - UI
Node #72545269
μ10
New Node
Reset Environment
Transactions
#5dbe7cdcb5
Pending Transactions

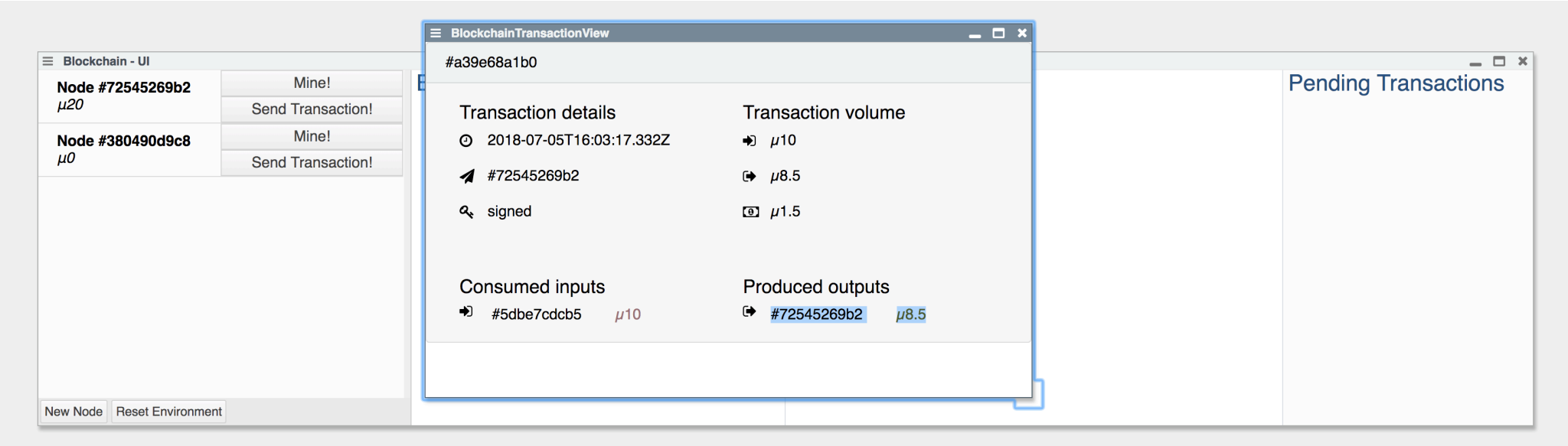

Blockchain - UI
Node #72545269b2
μ10
Mine!
Send Transaction!
New Node
Reset Environment
BlockchainWalletView
#72545269b2
Wallet details
#0ff5ba77de
#b187f090d8
μ10
Value improving transactions
#5dbe7cdcb5
μ10
Pending Transactions

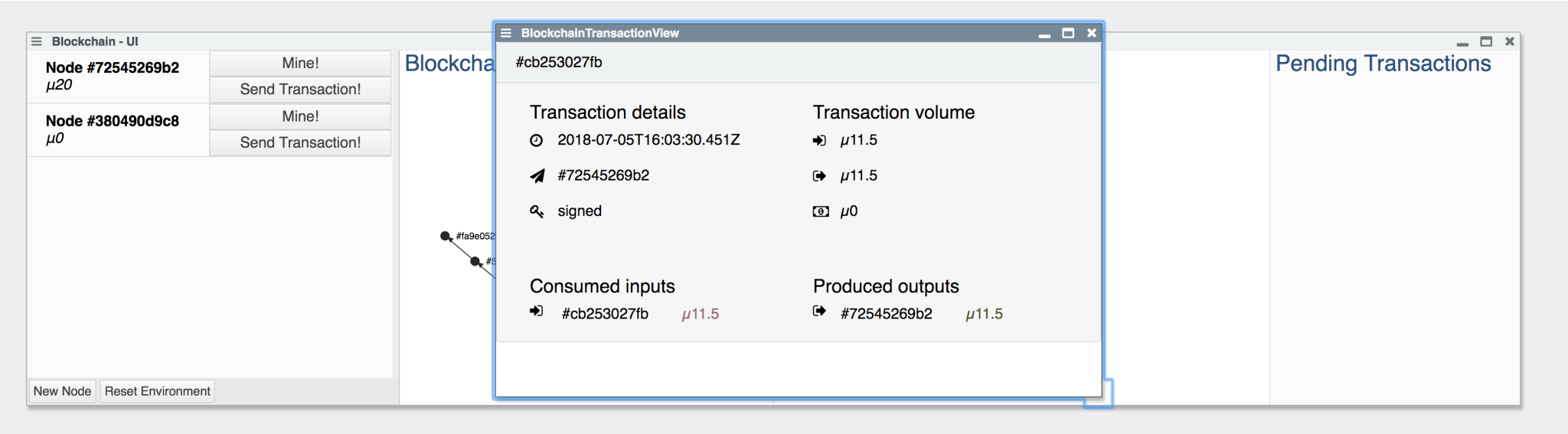

Blockchain - UI
Node #72545269b2
μ10
Mine!
Send Transaction!
Node #380490d9c8
μ0
Mine!
Send Transaction!
New Node
Reset Environment
Blockchain
#5f30411aab
#f27f8f9706
Transactions
#5dbe7cdcb5
Pending Transactions


New Blockchain Transaction
Blockchain - UI
Node #72545269b2
µ10
Mine!
Send Transaction!
Node #380490d9c8
µ0
Mine!
Send Transaction!
Added transfers
• Node #380490d9c8 - µ5
Node #380490d9c8
5
Add Receiver
Send
#5f30411aab
#f27f8f9706
#5dbe7cdcb5
Pending Transactions
New Node
Reset Environment


Blockchain - UI
Node #72545269b2
μ10
Mine!
Send Transaction!
Node #380490d9c8
μ0
Mine!
Send Transaction!
New Node
Reset Environment
Blockchain
#5f30411aab
#f27f8f9706
Transactions
#5dbe7cdcb5
Pending Transactions
#a39e68a1b0 μ10


Blockchain - UI
Node #72545269b2
μ20
Mine!
Send Transaction!
Node #380490d9c8
μ0
Mine!
Send Transaction!
New Node
Reset Environment
Blockchain
#fa9e052fb3
#5f30411aab
#f27f8f9706
Transactions
#5dbe7cdcb5
#cb253027fb
#a39e68a1b0
Pending Transactions


Blockchain - UI
Node #72545269b2
μ20
Mine!
Send Transaction!
Node #380490d9c8
μ0
Mine!
Send Transaction!
New Node
Reset Environment
BlockchainTransactionView
#a39e68a1b0
Transaction details
2018-07-05T16:03:17.332Z
#72545269b2
signed
Transaction volume
μ10
μ8.5
μ1.5
Consumed inputs
#5dbe7cdcb5 μ10
Produced outputs
#72545269b2 μ8.5
Pending Transactions


Blockchain - UI
Node #72545269b2
μ20
Mine!
Send Transaction!
Node #380490d9c8
μ0
Mine!
Send Transaction!
New Node
Reset Environment
Blockcha
Pending Transactions
BlockchainTransactionView
#cb253027fb
Transaction details
2018-07-05T16:03:30.451Z
#72545269b2
signed
Transaction volume
μ11.5
μ11.5
μ0
Consumed inputs
#cb253027fb μ11.5
Produced outputs
#72545269b2 μ11.5

# Distributed Trust

- blocks and transactions are timestamped → data is stored sequentially
- every block contains hash of prevoius block → tampering impossible
- thousands of nodes store their copy of the blockchain independently
- fundamental assumption: Majority of nodes operates trustworthy
  - enough computational power to assert always providing longest chain

## Trust experiment

```
blockchain.isValid();
 => true
```

Validate Blockchain

```
2
blockchain.headOfChain.timestamp = 123456789;
blockchain.isValid();
 => false
```

Validate Blockchain

# Blockchain validation

- ✚ novel approach to persist data tamper proof without need for central authority
  - researcher: Proof for authorship of ideas / inventions without dependence on mail service
  - bitcoin: Financial transactions without need for (central) banks clearing every transaction
- ➖ requires large number of peers to ensure security and tamper-resistants
- ➖ proof-of-Work-Concept consumes a lot of resources ~ 71 TWh / year → Energy consumption Czech Republic
- ➖ waste of storage: Blockchain is duplicated multiple times over all nodes
- ➖ bad throughput in comparison to conventional (distributed) storage solutions

# Active Essay / Interactive presentation

### What we did within Lively

- implemented a basic blockchain (wallet, transactions, -input and -outputs, blocks)
- simulated an entire peer-to-peer network
- built multiple visualizations
- created this interactive presentation

### How does the audience profit from this approach?

- interactive approach lets user apply gained knowledge
- visualizations make complex concept more tangible
- demonstration in separate UI makes collaboration of single concepts better understandable